The Bottlenecks of the 21st Century

Essays on the Systems Synthesis of the Human Predicament

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The Bottleneck Reader

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A Note on *The Bottleneck Reader*

This isn't a "book" per se, but a complimentary set of essays which dives a bit deeper into some of the subject matter covered in the Reality Blind series, and which is still a work in progress. These essays are brief snapshots and commentary on the huge amount of material that comprises a synthesis of state-of-the-art scientific disciplines in 2019. It's meant to give you the flavor and implications of some of this material as opposed to the bare facts. We hope you enjoy it, understand it, and are moved by it.

NJ Hagens
DJ White
8/21/2019

An Introduction to Reality 101

The way things have been the last several hundred years is not the way they have been for the bulk of the human past, nor will be for the bulk of human future. You exist in a near-stroboscopic blip of time in which humanity is churning through millions of years of resources in a one-time pulse. This has ramifications both wonderful and terrible, and we should probably make ourselves aware of them if we are to make self-awareness actually good for anything.

This course is called Reality 101, where we will attempt to present a more seamless and coherent worldview, synthesized by combining many disparate branches of science, culture, and the human condition. These branches are normally thought of separately.

How are the deep past and the deep future relevant to what we do today and tomorrow? How does energy relate to money, money relate to dopamine, dopamine relate to sexual signaling and sexual signaling to the environment? How is happiness related to possessions? Why and how was it beneficial for us to evolve blindness to many aspects of reality? Indeed, what is a human, and what is life? Which key things that our society believes just aren't so? How is human civilization like a foraging bear? What do humans really eat? What do the expert economists get totally wrong? Do you know the personalities of your invisible slaves? What does "renewable energy" really mean? Are your genes your friends? Do you have a clear idea where your virtual world in your mind ends and the physical world begins? Do you think about how your brain works, and why it does what it does? Why are the big problems of human civilization not being solved? How is human thinking predictably biased? What can we know for sure about the future? And how are these things linked to success and happiness? What would success even be?

You may find this to be a bit of an odd class. In addition to teaching some new connections, it will attempt to teach a new way of thinking and analyzing the world around you, as well as your own inner world. Of knowing yourself, your society, and your species a bit better for what you are, as a way of helping you decide what you'd like to be. To make your own decisions about what success will look like.

It may be a peek into the future, because in our opinion this way of thinking should be taught to students much younger than yourselves, in parallel with all other subjects. However, that hasn't been done yet, so you may find some things in this class surprising. We all have some things to un-learn.

Connecting all these subjects is not so much a complex thing as an unusual thing. Humans in current society don't, for the most part, think this way. We are taught subjects quite separately and tend to remember them that way. That's a good way to become a well-programmed member of a highly social society, but it isn't very creative.

And even though you seldom get graded on it, creativity is more important than we often give it credit for; it's the difference between competence and brilliance, rote memory versus deep understanding. The really important answers tend not to fall entirely within a single subject or area; they occur when you train yourself to think across subjects and disciplines, letting your mind fit the pieces together.

My hope for this class is that it helps you be a sophisticated generalist, with a good - even if hazy - visualization of how everything really fits together. Because everything *does* fit together. The physical world itself exists as an integrated whole, with everything happening at once. The demarcations we make between areas of knowledge are pretty arbitrary, and our knowledge and very ways of thinking are imperfect by their nature. Once you know how things fit together, have that mental model, you can always find the details by using the internet, or just figuring them out. Conversely, if a person knows a lot of specialized things but has no feel for how they fit together, they may develop isolated concepts and activities which may or may not be useful.

Having an integrated mental model is crucial. For instance, if you have a smart phone you're probably fairly good at using it, and know what tricks it can do, how to add functionality. You probably also know an older person who wants nothing to do with a smart phone because it won't do tricks for them. The difference is the mental model. You build a virtual model in your head of what and how your smart phone works, and once you've done that you can interact with it fluently. Without that mental model, a smart phone is just an inert piece of material. **Yet we graduate students out of college without much of a mental model of how the world works.** Despite the fact that "how the world works" may be the most important thing to for students (and citizens) to know. Indeed, many of our most famous societal "experts" have expertise in just one narrow area and may have few clues outside that area.

We have high hopes for this experimental class. Experimental in the sense that it's never been taught until recently, and you're the test subjects. It's our hope and intention that you benefit greatly from taking this class, both immediately and for the rest of your life. But the reframing of knowledge, the teaching of an altered paradigm for thinking about the world, does need to come with a few caveats.

This synthesis brings clarity to many otherwise-disparate areas of human knowledge – but it also comes with a downside – it also brings those likely human futures into much clearer focus. Some people might consider this a blessing while others see it as a curse, because knowledge can strike sparks against belief, and as members of a social society we tend to believe many things that the people around us do, by default. Many of those things will be shown to be incorrect. And looking at our own species as an evolving thermodynamic system will make clear things that are both exciting and sobering, for we are coming up against natural limits, and that will have human implications.

In this way, the information to be covered in this class is existentially challenging, but the human condition has always faced existential challenges of one sort or another which required living humans to rise to them. It's possible to live a full and happy life while engaging with challenges. However, there's a psychological adjustment to make when learning Reality 101, and that has to do with the tapestry of pre-existing expectations and beliefs about the future which we have soaked up from the cultural narratives we exist within. We call this the "Christmas pony" effect. If a child comes to mistakenly believe they're getting a pony for Christmas, they are likely to be disappointed when receiving anything less than a pony, even what they get is something very nice, like a train set or microscope. If their Christmas is to be saved, the imaginary pony needs to be taken to the imaginary glue factory well in advance of the holiday itself. Indeed, this situation foreshadows many of the things we'll discuss: the roles of belief, energy, and the future. Physical prospects for the future will be the same after you take this class as before, but your own awareness and perspective will have shifted. The degree to which you find this exhilarating or dispiriting will have a lot to do with your current belief in those metaphorical Christmas ponies. And you may have unexamined beliefs you don't realize you're carrying around with you coming into this semester.

In this class we'll talk about the limits imposed on reality by physical law and probability, and how to think about the future in a more systematic way than people usually do, as a chaotic system playing out within these strongly bounded limits. Limits which can in principle be known beforehand. And we'll extend this understanding back to the dawn of life on earth and forward to its end, a direction which is inexorable, but with results that are never inevitable.

We'll describe those hard limits as the bottle of life's existence, inside which the chaos of contingent paths plays out. And we'll discuss how energy and resource limits cause the bottle to expand and contract, creating "bottleneck events" which are difficult for life's complexity to pass through, in the deep past, the deep future, and within our lifetimes. What creates bottleneck events, and to what extent can they be

controlled or anticipated? And if a species like ours can learn to anticipate such events, what practical and ethical questions might arise?

The blind dance of evolution has brought us from single-celled bacteria to self-aware personhood, but it has also given us a lot of excess baggage. What things that we think and do originate from this mindless genetic agenda, and what things are truly the product of our conscious reflective minds? Exploring this question will take a lot of twists and turns, into the story of how evolution can - and must - design a brain. And it raises the seldom-asked question of loyalty to the backwards-facing agenda of the gene versus the agendas of empathy and self-aware minds. ***It turns out that understanding the way we think is utterly necessary to understand and engage in the world.***

A big part of that is appreciating the difference between our virtual worlds and the physical world. None of us will ever experience the physical world except indirectly. It's not, even remotely, what we perceive it to be, any more than the picture on an HD TV resembles the stream of digital data which went into the back of the set. The virtual worlds which run as structured information streams within our physical brains are the only reality we can know, and they are not like the physical world, nor would we want them to be. Rather, the realities we each experience are an interface for physical reality, an interface designed by millions of years of backwards-looking evolution to execute successful adaptations to past problems. Brilliantly adapted with pre-programmed hopes, fears, and priorities for a tribal hunter-gatherer existence that we no longer live within. The things which mean the most to us exist within our virtual worlds; and a certain amount of illogic and even delusionality is necessary for our sanity and happiness. Yet unless we are self-aware enough to realize that vital things lie outside our virtual worlds, we are a species not only approaching physical limits, but doing so blindly, and while speeding.

Our species has called itself *homo sapiens*, wise man. As you'll see in this course, we have not earned that quite yet (more apt perhaps is pan-ignis – "fire ape"). But we may yet earn the title of Sapiens, and if we do it will be because we have understood the way things work in the world and come up with a way for our species to last another million years or more on an intact planet. That's not the way things seem to be going now. Yet it is still eminently possible. The same evolved biases and fallacies which cause us to make mistakes can also lead us to (erroneously) feel there's no hope, despite many wonderful things still being possible. Things to try to do that you may think of, that your teachers haven't. Tag, you're it.

This course is about building blocks - *not so much to use in succeeding in a career as about deciding for yourself what success might mean to you, in the context of the*

society and world you'll live in these coming 50 or 70 years. It's a time period whose events will profoundly determine the shape of life on earth for the next half-billion years, and not incidentally, the total number of human childhoods which will exist in deep time.

You're young, you're smart, and you have incredible resources at your disposal. Your generation also faces challenges never before faced by any species evolved on earth. There are paths forward which lead to wonderful futures, and paths forward we should avoid. Figuring out which are which is probably a good idea. This century will be a time for creativity, engagement, and heroism. It will also, judged by historical norms, probably feature a lot of strife and weirdness. We hope to give you some tools to help choose a good path.

Welcome to Reality 101.

Reality World vs Virtual World

What is commonly referred to as "virtual reality" is just a slight electronic boost to the intensely-distorted virtual reality we already live in. This course is about learning to see past the goggles you were born with, and unlearning some of the incorrect stuff you have picked up from your culture.

You're evolved to disbelieve the things you're about to be exposed to here. In fact, it's not an overstatement to say that this course represents a "perfect storm" of unbelievability.
The information in this course:

- *clashes with most of your evolved programming*
- *will create dissonance with many of your beliefs about the world and about yourself*
- *reframes the way you think about your own thinking and conclusions*
- *disagrees with what those around you think and say, and much of what you're learning in other courses (especially economics)*
- *disagrees with most of your cultural programming*
- *disagrees with conventional expertise and conclusions based on most reductionist science*
- *leads inevitably to conclusions which your mind is pre-programmed to avoid*
- *deals with the future as a real thing*
- *points out that your genes can give bad advice, and aren't your little friends*
- *draws a hard line in the sand between the virtual and physical worlds*
- *is not socially or politically "correct"*

Your other courses teach you things that you don't know yet. This course will teach you things your *species and culture* don't know yet, that the *experts* running the human world don't yet know, placing you squarely in a cognitive vanguard which you could well find uncomfortable. After taking it, you may never again see the systems and human activities around you in the same way. Along with the explanatory beauty of this synthesis comes an inability to completely hide from certain logical conclusions. This is a good thing, and necessary for the species to learn, but self-knowledge is a very adult thing, and self-awareness of your species on this level is something inherently new. Until now, the information necessary for this synthesis simply didn't exist the way it now does.

This synthesis is not *difficult* so much as it is somewhat *alien* to the default way humans and our cultures now think. Or rather, its difficulty lies in the fact that it requires thinking in ways which are somewhat alien to most of us. We'll tip our hat to that reality by actually having a (hypothetical, of course) Alien offering color commentary along with the basic presentation.

As we go forward, we'll talk about the *Gene Agenda* which not only predetermines specific biases, errors, and blind spots in our perceptions, but which is enforced by constant ongoing behavioral rewards and penalties from within the brain itself, which functions to prevent people from diverging from default human thinking. Of course, genes don't have an "agenda" per se; they're molecules. However, the attrition of a billion years of gene replication has produced a mindless default "agenda" which shapes human behavior and is very hard to deviate from.

But the first big thing to understand is Virtual Reality. You're familiar with that as a term used with immersive video games. But there's a lot more to it: the entirety of every human's perception is virtual reality. We inhabit a virtual "user interface" for the physical world, which is generated within, and by, the tissues of our physical brains. The world we experience is a construct, like a computer user interface which has us click on screen icons instead of directly manipulating binary code in intricate ways. Imagine a black panther, with iridescent green dragon-fly wings swooping in an azure ocean bay grabbing a barracuda with its large panther talons. If you're like most people you never have heard this particular word combination before, but instantly upon reading it there was an image in your brain of such an imaginary panther. Communicating in this way to others, and anticipating their visualizations and reactions, is central to human experience. But it is purely virtual.

When Worlds Collide

Our virtual world is only very loosely connected with the physical world. This is a good thing, because the physical world as it actually exists is nothing you'd want to

directly experience, or really even could experience. The version of it inside your head which has 3D depth, color, sensation, feeling, meaning, associations and emotional connections is no more like the physical world than the graphic icons on a computer screen are like lines of binary code or the electrons rushing in and out of billions of transistors billions of times per second. Your sensory inputs are filtered for salience, subjected to logarithmic compression, processed with pattern-seeking algorithms, and scattered to hundreds of always-on modules which are forever outside the sphere of your consciousness. They generate outputs which are assembled into the seamless illusory world that you subjectively experience. And it really is a matter of two qualitatively different worlds: the virtual worlds of human experience, and the physical world. We can each only ever experience our own virtual world and universe; in which meaning, love, satisfaction, music, poetry, challenge, exhilaration, pain, magic stories, contentment and everything else we value plays out. Yet those virtual worlds are critically dependent on the physical world, which obeys entirely different rules. It's easy to get them confused, and – as we'll show – with potentially dangerous consequences. Sorting that out is a basic part of this course.

As you'll see, we're "evolved to be wrong" – often spectacularly wrong - in ways which helped our ancestors survive. Yet we now exist in a context in which we can no longer afford to be spectacularly wrong.

Our virtual worlds not only suppress uncomfortable realities, but also overestimate the unpleasantness of anticipated negative events. Most people who lived during the great depression (not in cities) were unaware America was in a Great Depression.[1] People living through World War II felt alive and full of purpose despite rationing, curfews and less personal freedom –the fear of 'being at war' was offset by collaborating for the greater good and working closely with others on similar team. Research on the neuroscience of 'dread' show that people who are afraid of an upcoming event, are willing to actually endure a larger amount of known, advertised pain, in lieu of a smaller, unscheduled variety of pain.[2] In essence, our virtual reality can play tricks on us, in both directions.

Culture Medium

Virtual reality is the main software interface provided by the gene agenda. Part of that "gene agenda" we're born with is a nearly-irresistible need to agree with and conform to those around us, using our beliefs to establish and strengthen who's in our "ingroup" and who's not. This means our genetic evolutionary baggage isn't the end of this virtual confusion, it's just the beginning, because we take our cues from those around us, and cultural evolution iterates at warp speed compared with gene evolution. It turns out that organizing cultures which allow us to exist relatively

peacefully in large numbers require extremely durable shared beliefs in what are in many ways arbitrary and even nonsensical narratives.

The upshot of all this virtual complexity is that we currently do a pretty poor job of understanding physical reality. **We tend to use social rules (heuristics) and inappropriate metaphor to model the real physical world, as though we could bend its rules by the force of our beliefs and desires or replace them entirely due to dissatisfaction with their implications.**

Indeed, just laying out an outline of the ways we think, and think incorrectly, will take up a good slug of the course time. And it may be among the most valuable things you learn. Ever. Yet that's just the first step: because understanding why the course material, and conclusions, are unbelievable is necessary to make learning about them possible: to take a step away from the gene agenda and consider the ramifications of reality.

Your authors have definitely come to their own conclusions about the nature of the human experience, its economy, its ultimate basis and its attainable futures. But these conclusions won't be taught, because it won't be necessary: anyone who comes to understand their own mind's working, and some very basic science about evolutionary psychology, belief, and the rules of the physical universe, will inevitably come to overlapping conclusions, if not the same ones.

Yours is the first generation being exposed to this sort of synthesis. It implies stuff which will seem like good news and stuff that will seem like bad news, when contrasted against prevailing cultural beliefs and narratives. A fair number of students who have taken earlier versions of this class have altered their life plans based on what they learned.

(note to students: as you can see, we're using the term "virtual reality" in a way which is accurate, but which is different than the way the term is used in current culture. You may as well get used to this, as we will be re-purposing a lot of terms as well as introducing new ones).

A Probabilistic View of the Future

We have a dysfunctional relationship with the future.

There are some things we know about the future. For instance, we can be extremely certain that 200 years from now there will not be a 600-foot marble and granite statue of a grizzly bear in Minnesota. How can we know such a thing? It certainly could happen; there is nothing precluding it in terms of energy or technology. Yet there would be insufficient motivation for humans to do such a thing: to get the permits, to organize around that particular mania, to see it through to fruition... so we can assert with confidence that the future will not contain a 600-foot grizzly bear. And by extension, there exists a large class of other things frequently brought up and discussed in our society which are 600-foot grizzly bears in terms of the incredibly unlikely sequences of events which would be necessary in order to make them a part of the future. Humans tend to be blind to this. Most of our actions are prioritized in favor of the Now. Psychologists call this “hyperbolic discounting” of the future, and it’s a part of what we'll refer to as time blindness.

By “time blindness” we refer to the fact that humans don’t think much about the future beyond a narrow, near-term span of time, don’t think about it clearly, and are emotionally detached from it as though it was an imaginary place peopled by

nonentities who don't matter. To the extent we think about the future at all, we tend to think about it as remote, inexorable and inevitable. This is largely because we are aware of our own physical deaths and have adopted strategies to avoid thinking about the future to quell cognitive dissonance. When we do think about the future, we are subject to an optimism bias when it comes to what we decide to expect. Doing so optimizes real-time happiness. Lottery tickets are a bad investment when considered by probability but a good investment in terms of (temporarily) maintaining fantasy futures. We generally expect our personal future to be better, our family's future to be better, and our world's future to be better. But this doesn't make it true.

This is a shame on several levels. Personal success is highly correlated with the ability to defer rewards in time, to be kind to our future selves rather than locking them into predicaments which lower their life quality. But beyond that, we are part of an incredible deep-time story of life, awareness, discovery and recently-dawning wisdom. That story will continue some non-predetermined distance into deep time as we move forward, influenced by your life and its decisions, and the shape of that story should matter to us.

We think about the future in a vague way when we think of it at all. We sometimes assume it as utterly unknowable, while at other times we think of it in terms of specific cultural narratives that tend to be relatively certain - even if they conflict with one another. If we look at popular movies, it seems that we'll either have a Star Trek future with flying cars and universal wealth, or a dystopian apocalypse of some kind. It paradoxically seems like anything can happen, but that we're just swept along in the current towards some predetermined end.

But it's not true that anything can happen, nor is it the case that the end states are predetermined based on what humans currently know.

What we don't appreciate, most of the time, is the extreme level of contingency which directs our actions and guides our individual fates. The consequences of small happenstances plot a course of eventualities that rapidly diverge from one another.

On the day of your conception, any chance movement, a single sneeze by your mother, might have altered which of 100 million sperm fertilized the egg, and whether you would exist. That sneeze, in turn, might have been triggered by a single mote of inhaled dust, whose motion in arriving there was significantly affected by the random Brownian motion of individual atoms. The reality we experience, which seems so solid, has propagated in a nearly impossible way from among nearly infinite possibilities. A dog's bite, a horse's whim, a random encounter by an ancestor, a

chance illness by someone would have otherwise altered the event line which became present day. The world around us is the sum result of these accidents.

But these circumstances play out in a "bottle." A bottle which represents the bounds of possibility and probability which are set by physical laws and the nature of reality. Gravity will continue to exist. The sun will continue to radiate energy for billions of years. Chemistry will work as it always has. Thermodynamics will continue. We know these things about the future absolutely.

The chaotic dance of contingent outcomes is bounded by the impossible and the unfeasibly improbable. It is impossible to predict where a person alive today will be on her 60th birthday, but it will not be on Mars. Mars is outside the bottle. There may or may not be a hurricane in Honolulu next August 30, but if so, it will not have winds of 400mph; such winds are outside the bottle. If you're on the peak of Mount Everest and trip, there are many possible directions for falling down, but you won't fall up. If you seal a monkey into a metal cage, it can be impossible to know exactly where in the cage the monkey will be in a year, but it will be inside the cage.

So, the future is a mixture of nearly-impossible contingent paths that are impossible to predict far in advance, and these paths are strongly bounded by what is physically and probabilistically possible. Thus, there's a mixture of certainties and unknowables, and we can know a lot about which are which, and we should.

We know that in many ways the future will be reliably like the past. The laws of nature have existed since the universe's creation and will continue to be reliable. This means that physics and chemistry, energy and thermodynamic disorder will continue to follow the same rules. Gravity, heat, light, energy flows, chemistry... all will behave predictably.

So, for instance, we can know that if a wolf on an island needs to survive by eating rabbits, and the rabbits disappear, the wolf will not survive. This doesn't tell us exactly what the wolf will do in the meanwhile, and its behaviors might be very complex. But without food, it is absolutely predictable that the wolf will starve. So, the wolf has aspects which are both unpredictable and aspects which are entirely predictable. In addition, some things are far more likely than others, because the paths to them are more numerous.

The atoms in the air around you are mixed randomly, with about 78% nitrogen and 21% oxygen.[3] There is nothing preventing all the oxygen molecules from moving to the ceiling, causing you to pass out. However, that would require very special and improbable things happening, because there are a lot more paths to a well-mixed

bunch of molecules than there are to all the oxygen near the ceiling. It's so unlikely that one could watch a room for the entire age of the universe without it happening. So even though it's not impossible for it to happen, the chance is *probabilistically negligible*, and you don't need to worry about it.

So the future consists of two elements: a slowly evolving "bottle" which contains those things which are possible to attain, and the chaotic dance of happenstance within that bottle. The shape of the first is highly knowable; the second is unpredictable except as a matter of greater and lesser probabilities.

Indeed, the best way of thinking about the future is not as a fixed destiny we are traveling towards, but as a set of shifting probabilities. The probabilities of future events gain greater or lesser probability based on what happens in the now, which immediately becomes the fixed past. If Lincoln is assassinated, he will not pursue his plans for reuniting the nation. If dodo birds go extinct because they're fun for sailors to hit with sticks, all futures contain no dodo birds. Future events inside the bottle are highly contingent on things which alter initial conditions in such a way.

This is also true in the case where things are not precluded, but are made less likely. If you commit a felony, your odds of being president are lessened. If you lose fingers in an accident, it will be harder for you to play piano. If 90% of sea turtles disappear due to fisheries, it is more likely the species will become ecologically extinct due to other stressors.

These days, weather is forecast probabilistically. That is, you'll see on the weather report that there's a 20% chance of rain tomorrow and 35% the next day. This is better than the way they used to do it 50 years ago, when they'd say it would be clear tomorrow and have a 20% chance of being wrong. It is more useful to know the odds of a future occurrence than to have a misplaced sense of certainty. Similarly, without knowing you, we can say that if you're a pretty normal person, we know the rough odds on how you'll die. You have roughly a 1 in 6 chance of it being heart disease, 1 in 7 of it being cancer, 1 in 28 of it being a stroke, 1 in 88 of it being in a vehicle accident, 1 in 112 of it being suicide, and so on.[4]

Yet you can alter these odds. Your 1 chance in 770 of dying on your motorcycle is reduced to 0% if you decide never to ride a motorcycle. If you stay healthy and exercise, you probably alter your odds of heart disease, cancer, and stroke for the better. So instead of sitting in front of the TV all day becoming morbidly obese by eating canisters of Pringles and drinking Mountain Dew, you can eat healthily, take daily walks, avoid tobacco, and many other such things. What you are doing is dynamically altering the odds of negative futures by being conscious of contingent

futures. It’s never certain - healthy people can still be struck by lightning - but it’s the smart way to plan.

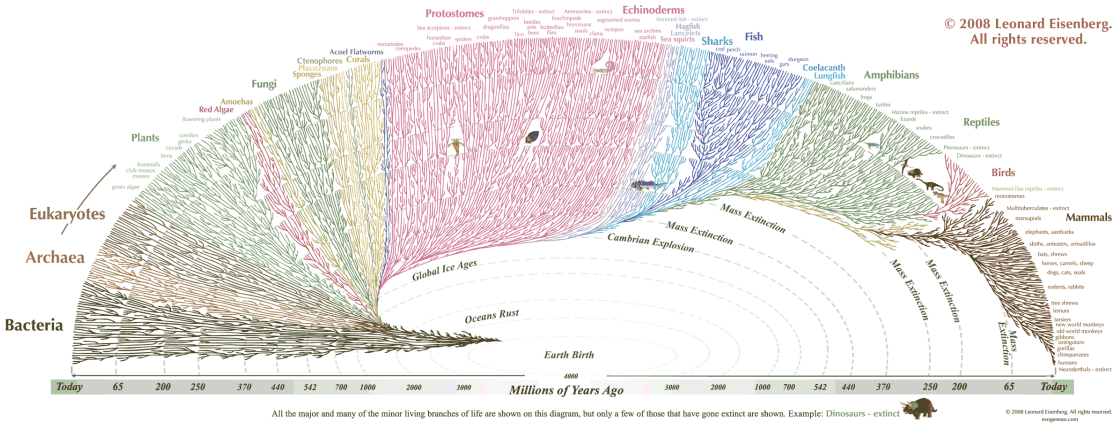
And it’s the smart way of looking at wider boundary futures too: the futures of your friends, family, nation, species, and living world. The far future seems utterly remote, irrelevant, and scary to us. If asking what a person thinks about what the world will be like in a million years, they are likely to note that the sun will burn up our planet in a billion years, so it doesn't matter. Yet the entire story of complex life is far less than a billion years long, and it is entirely reasonable for a species to last a million years. We are innumerate when it comes to the scale, scope, and shape of possible futures, and shouldn't be. These larger futures are no more visible to you than your own, but they too exist as ranges of contingent possibilities. These are constantly in a state of flux, as various future outcomes become more and less likely based on what we do, and things that happen, in the now. The status of earth's future and life's future is utterly contingent upon the things which happen causally to affect the possible outcomes. These are many, varied, and complex. Some systems important to life are chaotic individually and in aggregate; there is no way to know exactly what will happen.

To the extent we are willing to contemplate futures that are less desirable than our hoped-for future, we tend to conflate all futures which seem subjectively depressing to fungible equivalence. Thus, a future in which the stock market goes to zero seems about as bad as one in which the oceans die. However, that doesn't make it true. With some mental effort we can imagine (and plan for) many less-than-perfect futures which would be preferable to others.

So when we hear scary things about admittedly scary topics, like ocean acidification, global heating, or oil depletion, these events are not yet certain and will play out in the walls of the bottle – physically, and in reaction to changing conditions of the events that impact them.

Ultimately, we can know the shape of what *can* happen and what *can't* because we use science and logic and inference to understand the walls of the bottle and path dependence. In sum, the future is best thought of probabilistically. Some future outcomes are highly probable, and others are highly improbable. The odds change constantly depending on what is done in real time. You, reading this, can and will change those odds to a very small, or not so small degree.

The Glorious Story of Life on Earth



Most of our universe's history, and a lot of its existing neighborhoods, are hostile to life. Early in the universe there was just too much radiation zapping things for life to develop. Near the center of galaxies even today, there are so many supernovas, radiation bursts, black hole x-ray beams and other such things that life would be extinguished pretty quickly after starting. So for a very long time, life was only possible in the distant future, and only there in the quieter neighborhoods in the far reaches of mature galaxies.

Even once the energy-zapping quiets down, one needs stars to go through multiple lives and deaths to create heavy elements in supernovas. The heavy stuff we're made of can only be created in exploding stars. That takes a while. Billions of years.

Once you get a cloud of gas with enough heavy elements in it from previous supernova explosions, gravity pulls it together in a spiral, a star forms at the center and solid planets can coalesce around it. But this too is a pretty dangerous place, because after slow accretion, the growing proto-planets whack into each other and get repeatedly melted and pulverized. No life there. Yet the *way* they get melted, smashed, and pulverized turns out to make a huge difference in what sort of life – if any - might be able to exist in that star system millions of years in the future. The series of accidents which becomes 'frozen' into a fixed past determines what can happen. Every collision that happened to our proto-planet became a necessity to the future of life that we see around us now. In planetary formation, some collisions create moons, others bring water, still others bring the heat and metals for a future

magnetic field. At this point, life is still not a good bet to occur. There are innumerably more ways for it to go wrong than go right.

Once this bombardment settles and a planet cools down, it still probably won't have life. It'll be a gas giant with high temperatures and crushing pressures and frequent asteroid strikes, or have no atmosphere at all, or be way too hot or cold for liquid water due to distance from the star. Or it will be just the right size, composition and distance but not have huge outer planets to suck up most of the ongoing comet and asteroid collisions which would frequently boil the oceans.

Even if a planet forms at roughly the right distance from its star, as Earth did; at roughly the right size; as Earth is, and roughly the right atmospheric chemical composition, it still needs a real fine-tuning to look anything like the planet we find ourselves on. Early in its accretion, our planet was nearly blasted in half by collision with a mars-sized object that divided earth into a binary world. Having a relatively large nearby moon - the only one in the solar system - drastically slowed our planet's rotation through tidal friction with the mantle and seas and stabilized its axial tilt and thus its future climatic variations. It did so while leaving the heavy nickel-iron core largely intact, making possible a magnetic field lasting billions of years to shield the earth's surface from the electrically charged solar wind, which would otherwise strip away the atmosphere. And the mantle currents created by this circulating metallic core also created plate tectonics to stabilize the CO2 levels via feedback from rock weathering. The random rain of comets onto the surface of the cooling world left *just enough* water to cover some, but not all of the planet's surface; had this been otherwise, the plate tectonic thermostat would have been unable to function, and the planet would have veered out of a habitable temperature range.

What life needs is special conditions, stability and time. The phenomenon of life is in many ways similar to a whirlwind; matter dancing in a pattern as energy dissipates through it. Self–replicating life is a lot harder to get started than a whirlwind because it's so much more complex, even in its simplest forms. But once it acquires the ability to replicate, it makes up for this initial improbability by being potentially far more durable than a whirlwind. Further steps – each improbable on their own - can add to this durability.

It seems that simple life began almost as soon as the earth had cooled enough to make it possible. That implies that simple life happens fairly easily in the scheme of things IF the special conditions are met. It also implies that life probably began multiple times as our planet was cooling but was sterilized out of existence by large asteroid impacts boiling the seas. We're descended from the life which began after the last impact-boiling of the seas, as is all other life we know about.

It might seem like earth life was home free after getting to that unlikely point in the game. Nope. The universe makes life *possible* but doesn't cut it any slack. Life needs a lot of things to "go right" for it to continue. It needs usable energy sources and nutrients, protection from radiation, a fairly narrow band of temperatures, a lack of toxic compounds, a liveable range of acidity, and much else.

It has been a popular recent conception (James Lovelock) that life automatically made the earth into "Gaia", a pan-species super-organism which acts to nurture life; in effect, life changing the planet to make it continually better for itself. A comforting notion. And humans have a soft spot for comforting narratives like a "mother nature" which strives toward a paradisiacal end.

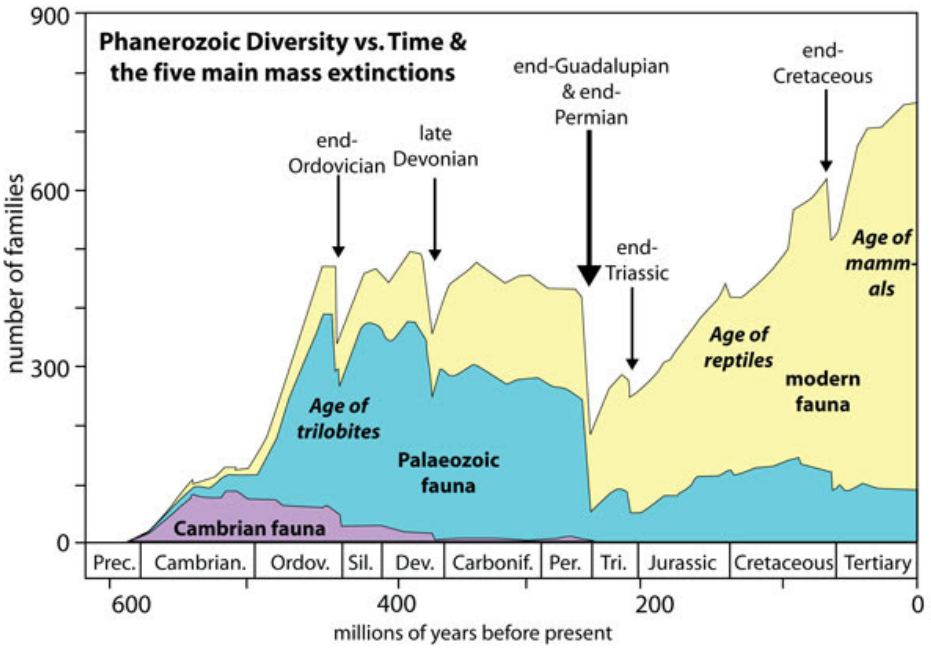
However, one can make at least as good a case for the opposite conclusion: that life tends to run itself off a cliff. In point of fact, it does both things. Sometimes the random dance of living interactions tends to create or enhance more stable conditions, and sometimes it upsets the whole game board. This is because evolution, by its nature, *only looks backwards*. It passes on the adaptations which led to survival in the past, sort of like a lobotomized zombie bus driver who doesn't care if he crashes and whose only view is the rearview mirror. Physical life has no intentions; there is no ultimate goal; it's a relatively complex process but utterly automatic: it doesn't care where it's going or where it ends up. It's just something that happens due to the rules governing energy and matter, like a rock rolling down a hill or a raindrop falling from the sky.

So while there have been processes which have tended to stabilize the earth's environment, such as a large moon and a plate tectonic thermostat to keep atmospheric CO2 levels roughly stable (and the ocean at a livable pH), there have also been phenomena left over from the primordial solar system bombardment to periodically stir things up, like huge volcanic eruptions and occasional asteroid impacts.

Life itself gets into the act of messing things up. The development of photosynthesis is something we appreciate today, but at the time it was apocalyptic, because oxygen was a toxic gas to most life which originally existed on earth. Oxygen pollution nearly wiped out all this original life as it changed the chemistry and mineralogy of the planet's surface, atmosphere, and oceans. And by drawing out so much CO2 and methane from the air and replacing it with free oxygen, it helped cause the earth to freeze into a snowball from poles to equator for huge spans of time, during which periods our simple & tiny ancestors probably only survived near deep-ocean vents beneath miles of ice, independent of photosynthesis. Only the volcanoes eventually

melted this frozen world by slowly outgassing more CO2. Yet, when those volcanoes got widespread and active, in turn, they also wiped out life by overheating the planet and acidifying the seas, again with CO2, which is the main actor in atmospheric heat retention.

When the planet heats from too much CO2 and associated gases, the poles warm far more than the equator. This leads to a drastic lessening between the temperature of the poles and equator, and that means that the energy flows which drive ocean currents and atmospheric wind diminish, and they slow or stop. The oceans become acidified, stratified and anoxic, and the primordial life driven from the surface by the oxygen of photosynthesis has its own unconscious revenge, creating toxic H2S hydrogen sulfide gas which kills off critters that breathe oxygen.



(Source)

There has been a somewhat fractal pattern of extinction events of greater and lesser severity in the deep time since life started, but five planetary mass extinctions stand out. These are extreme events - a mass extinction in which 50% or more of species are lost means that *every last individual* of that species dies out. If a species *almost* dies out, it's not counted even if most of its members do. These near-miss events avoided extinction but were certainly bottlenecks for much of large complex life of the day.

The common theme to these planet-wide extinction events is CO2 and methane heating and its follow-on effects like anoxic oceans and H2S poisoning. (*until recently*

it seemed that the last event, which famously featured an asteroid or comet whacking the earth and killing the dinosaurs, was the exception; but it now seems that a CO2 heating event had begun 150k years prior to the asteroid's arrival). So, it seems a CO2-driven marine mass extinction was well underway, and earth ecosystems especially vulnerable, when the asteroid fell.

The point of this narrative is that as durable and adaptable as life can be, its course has been absolutely determined by many catastrophes and a mix of good and bad luck. From mishaps large and small, 99.9% of all species to ever exist are now extinct. We humans might logically be a fan of these past catastrophes, because we inherited our chance at existence only because prior life was killed off so many times, leaving vacant ecological niches. Yet we'd better also learn (quickly) the lessons clearly written in rocks, fossils, and ice. It has been only a few decades that these lessons have been known at all, and only now is the scientific community starting to appreciate them. To the average human, they remain fairy tales.

One of the lessons we should heed is that life *in general* is durable and quite resilient. Given time and opportunity life grabs hold and persists. However, the *kind* of life which is durable is usually simple life which reproduces wildly and quickly. Bacteria, algae, scum, slime and muck. Worms, jellyfish, and their ilk. Even once the sun boils the oceans away in the future – and it will – bacteria in deep rocks may well survive an additional billion years or more. But is that really what we care about when we think of life?

One thing we perhaps fail to appreciate is that most life is, has been, and always will be simple, single-celled life. Long after complex life is gone, the bacteria and algae will exist on earth. Bacteria and pond scum have not all "turned into" squirrels and rabbits and left their single-celled ways behind. Rather, large complex life is a specialization which *can* exist – temporarily -when conditions are exceptionally stable and benign, with only slow and gradual environmental changes.

The reason that's an important point is that WE are some of the largest and most complex life, and the other species we need to exist are mostly ALSO large complex life. That's a dimension we seldom think about when it comes to mass extinctions. Like, the largest terrestrial animal to come through the KT bottleneck of 65mya weighed about 2 pounds. All mammals, including us, are evolved from critters smaller than that. If nothing else, that should make us less sanguine about future changes. Here's the math: big, long-lived, slow reproducing animals die off when earth undergoes rapid changes. The faster the change, the smaller the size of the complex critters that make it through. They only exist in very special conditions. Large complex life is fragile, pond scum isn't.

So special conditions, stability and luck turn out to be what determines the existence, and molds the shape, of life. Life seems common to us, because in our experience we've found it almost everywhere on the planet. But, now that we're starting to look off-earth, we don't see it anywhere. There's a whole lot of "nobody home" in the universe around us, near as we can tell so far. And the more we learn, the more that makes sense, because so much has to go improbably right for life to exist and persevere.

Since our universe is so unbelievably ginormous, there's almost certainly other life somewhere. However, large complex life may be very, very, rare; since a whole slew of things have to happen just right for it to occur, evolve and remain. Single-celled life probably comes into existence reasonably often if a planet has liquid water; we can infer this since it seems to have begun here about as soon as our planet had cooled enough. But it took billions of years for complex life to form from simple life; which means that the likelihood of it happening was so low that it well might not have happened at all before our sun toasted the planet. Some events, like the chance hybridization of two utterly dissimilar single-celled organisms which became a chimerical organism with a nucleus and mitochondria, seemingly happened only once, in billions of years of single-celled organisms existing in the seas. Without that accident, no animals, no us.

But the rarest thing of all is one of the tricks that chimera's descendants can do: make a brain. And - jumping ahead in the semester a bit - given many millions of years of the right random accidents, a big enough brain can - it turns out - generate a virtual world. Virtual worlds contain thoughts, feelings, qualities, meaning, love, and understanding. They can also, at least potentially, do another trick: steer futures by looking ahead in the physical world. Yet as the most complex aspect of a tall house of complex cards, these virtual worlds – conscious minds - are the most fragile emergent creation of life's quickening, a relatively recent occurrence on a planet well into middle age.

Species in Earth's history which acquired the ability to reproduce wildly have always done so, resulting in overshoot and dieback, and sometimes resulting in crashing the planetary system and scrubbing out large complex life. There has never been a creature we know of which looked very far into the future to inform its species behavior in the now or had the capacity to research and comprehend the glorious story of life on earth. But a creature like that is probably a good idea. Any candidates?

SOME SUMMARY POINTS:

- Conditions have to be met for life to have a chance at starting and surviving. It probably happens only relatively rarely that life forms on a planet and is given billions of years to continue.

-To the best of our knowledge, life started only once, about 3.8bya. All life we have ever encountered is descended from that chance event. All life on earth is not only related to us, but closely related. We share more than half our DNA with *mushrooms.* They are our siblings.

- It happened nearly as soon as the world had cooled off enough, so the formation of simple life may be relatively common in the universe.

- Single-celled life is the main story of life. Multiple-celled life is not the result of a progression, but the expansion of life into broader niches. To a good first approximation, (almost) all life is single-celled, always has been and always will be.
- Single-celled life came up with many innovations and continues to. The evolution of photosynthesis tapped a huge direct power source which changed earth's surface chemistry and made possible extensive biomass powered by the sun. Life has always been about tapping energy flows to create organized structure in opposition to entropy. It always will be, though we forget this.

- Large complex life was created by symbiotic associations of single-celled animals; this was the origin of chloroplasts in plants and mitochondria in animals. Each independent critter kept its own separate DNA, but they came to be hybrid organisms, making possible the energy flows that make large plants and animals (respectively) possible. It took a long time after life began for mitochondria (and thus animals) to emerge; and it may be a nearly impossible occurrence in the universe. But without it, nervous systems, muscles, rapid movement, senses and brains could not have come into being.

- No one way of organizing complex life is necessarily any better than any other. In the Cambrian explosion, a huge diversity of different forms of life emerged. The survivors were largely selected by random chance, the luck of timing and sequence as the environment and life danced with each other. If the movie were to be played again with only minor changes, life on earth might look very different.

- Our lineage traces back through worms, fish, reptiles, mammals, primates, monkeys, apes. Each new species was an unlikely response to competition and environmental change.

- Geology and paleontology gives us true, non-speculative answers about what happened in the past; and the picture sharpens with time as we read this story. Examining what happened on earth in the past is a powerful window on how it may react in the future

- The long-term story of complex life is steered as much by catastrophe as by stability. ~99.9% of all species ever to live are now extinct (or speciated).

- Many families and species perished in 5 planetary mass extinction events; and we have created a 6th.

- The first things to go in a mass extinction are the long-lived, large, complex creatures high on food chains with low reproductive rates. (yes, we are in this category)

- These events were abrupt in geologic terms but extremely slow in human terms

- Science is now converging that the main driver of the past 5 mass extinctions was CO2 levels

SOME PERSPECTIVE/ LOOKING AHEAD TO NEXT SECTIONS

(*Reality 101 students: below are some implications (and conclusions) that derive from the above, which include aspects you have not yet been exposed to - we will discuss most of as the semester unfolds. Don't worry about grasping the complexity of this synthesis yet, but in the back of your mind, put some sticky notes.)*

- When we arrived on the scene as human, it was into a world of fantastic biological wealth. We are a part of that, and it is a part of us. We have always defined ourselves by the other large complex species we interact with.

- We have also more often than not killed off the large complex species we interact with. Our niche as modern humans has been to not be satisfied by a single niche. As we exhaust each niche, we try opening another.

- Very late in the story of life came self-awareness, consciousness. It took 3.7by for life to wake up and think about itself abstractly, and to begin to understand the universe. Yet the strong evolved drives which guided life before abstract thought was possible left little leeway for a self-aware mind to explore.

- Mankind's cleverness at opening new niches finally tapped the dead remains of fossil life from earlier eras. This grew human biomass by an order of magnitude and granted

a bolus of temporary energy wealth, with which humans created industrial society run by the energy of long-dead organisms. This enabled us to reach out and take anything we wanted, leading, mostly out of our direct sight, to mass extinctions. It became clear that our continued actions would also heat the biosphere and acidify the oceans, leading to planetary conditions unlike those which allowed us to evolve. Locked into the compelling agenda of reacting in accordance with the agenda of the gene, we have decided en masse not to worry much about it.

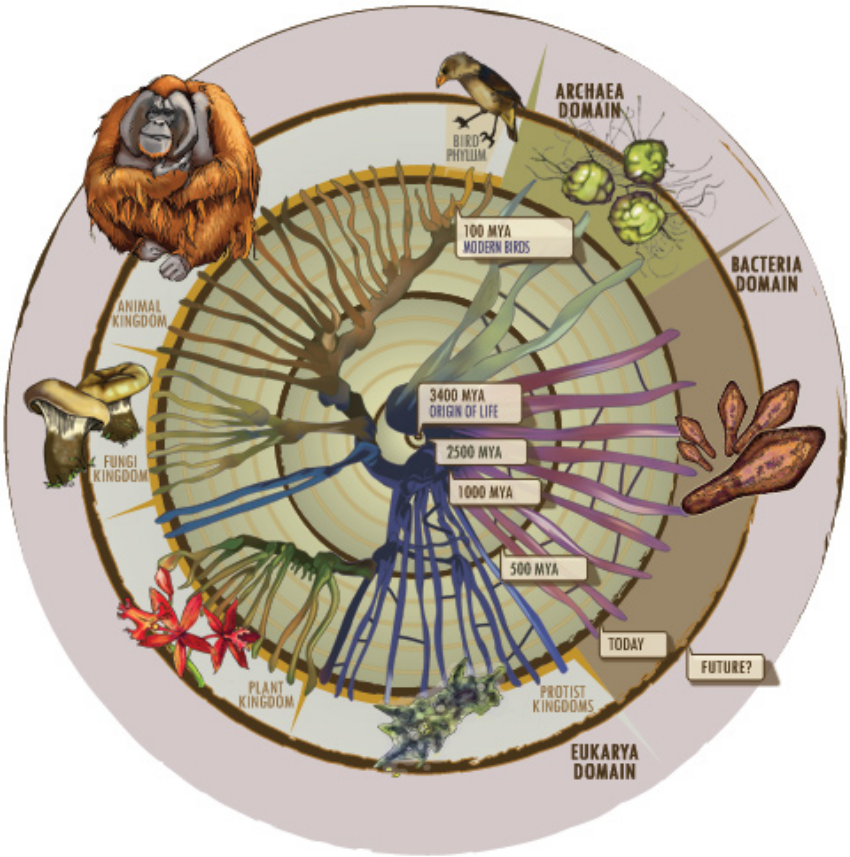
- No future civilization on Earth, human or otherwise, will ever experience such a pulse of industrialization, because the geological and biological concentrations of non-renewable resources are being scattered to the winds (and into space), leaving only lower quality concentrations. Future civilizations may additionally have to get by on a planet with unstable climate, slime oceans, and natural energy flows from a diminished global ecosystem.

- But a step as important as the origination of chloroplasts or mitochondria is now being developed and tested: *the emergence of self-aware minds as a force which can separate themselves from the unconscious agenda of the gene*. Early results of the test scores suggest starkly failing grades. At stake is the future of large complex life which now exists, and all conscious beings. Whether consciousness and self-awareness would evolve again, after a human/carbon cataclysm, would be constrained in many ways, and involve not a little luck. In evolutionary history, high intelligence has not been a strong attractor. Due to the controlling contingent influence of initial conditions, this century, and what we do during it, will to a huge extent determine the fate of complex life on earth for the rest of earth's history. A future without dolphins, elephants or owls means all futures will be lacking those creatures.

- The ability of the brain to rationalize and deny, in furtherance of temporary gratification and immediate reward, is huge. Most people never aspire to do anything but exist and react. Yet these brains are all the experiment of complex life has to work with. The fate of all conscious evolved life of earth now hinges on the way cave-man brains understand and respond to the real world.

The Web of Life on Earth

"*We are here because one odd group of fishes had a peculiar fin anatomy that could transform into legs for terrestrial creatures; because the earth never froze entirely during an ice age; because a small and tenuous species, arising in Africa a quarter of a million years ago, has managed, so far, to survive by hook and by crook. We may yearn for a 'higher answer'– but none exists.*" - Stephen Jay Gould



Earth's life has been evolving for nearly 4 billion years. It has occupied niches from the small and simple to the large and complex and everything in between. During the last several hundred million years, our planet's tree of life has spread into myriad wonderful and fascinating trunks, branches and twigs. From the prehistoric-looking denizens living near the bottom of the ocean to hive-like mole rats in the arctic, from the 80,000 plant species in the Amazon to thousands of species found within an inch of dirt in your backyard, scientists have catalogued that we share this planet with nearly countless other species of creatures – the conventional estimate being 8.3 million *(- yet since so many are small creatures in the soil and in the oceans, some scientists estimate Earth holds as many as a trillion unique species)*.[5,6] Humans share

enormous DNA commonality with every one of earths living organisms– almost 99% with chimpanzees and bonobos, some 90% with cows, 80% with cats, 70% with mice, 60% with fruit flies, and even 50% of our DNA is the same as found in a banana[7,8,9,10]! It is a profound truism that we share a common ancestry (and a current Earth environment) with a huge number of other living creatures.

KEY POINT: ***We are genetically related to every living thing on Earth***

The Universe Doesn't Care – And neither does Evolution

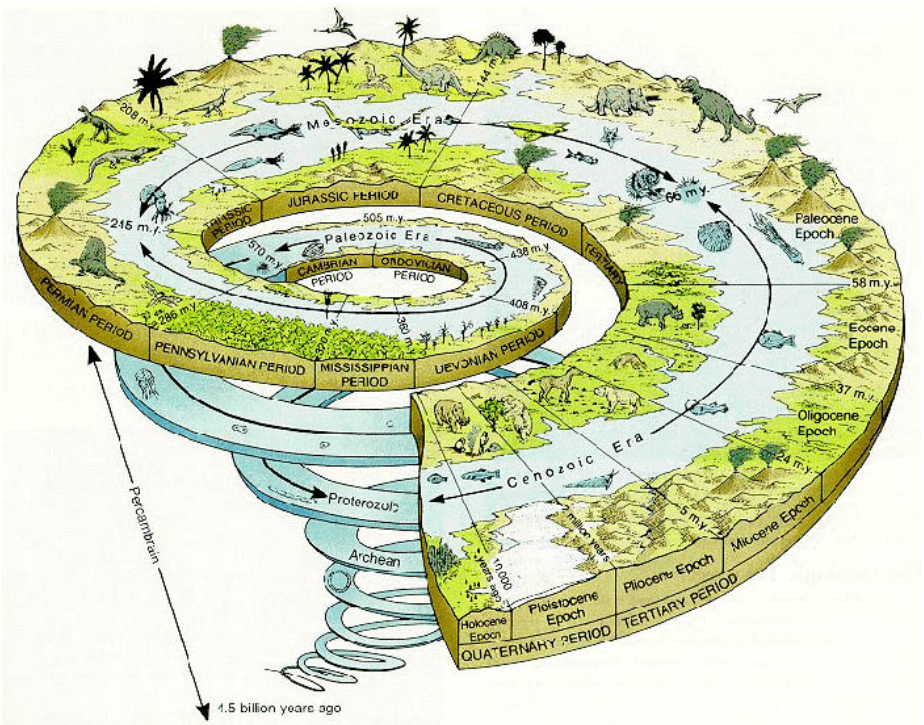
How did this all happen? Was our human shape, form and behavior the long range 'objective' of evolutionary processes? Or did new phylogenetic scaffolding build-on top of existing structures in ad hoc ways as the pulse of life expanded outward to new niches and opportunities, reacting to changing contexts?

We humans think and communicate in stories, because stories are easier to both process and remember. We'll get around to discussing that, and its implications, later in the course. But right now, in OUR story we're in the chapter about deep time and evolution. These are possibly the greatest stories ever told, and we (as a species) are understanding their details pretty well these days. Which is why it's important to mention that our culture tends to get aspects of these stories wrong in peculiar (and important) ways.

The birth and evolution of our universe, and the subsequent birth and evolution of life on earth, are easy to romanticize as a majestic series of events designed to bring us - or something very much like us - into existence. Astronomical and geological evolution, and subsequently biological evolution, are just a logical continuum: a "march of progress" from inanimate matter to microbes to mammals. But instead the common story is that the universe has played out its destiny in seeking the crown of creation: the hairless social fire apes, a.k.a. humans.

It can certainly look that way… that there was an intentionality and purpose behind our seemingly meteoric ascent. That's what happened, right? Here we are, reading and writing and communicating magnificent stories in all our glory, the dominant creature on a beautiful, rich planet. But this narrative is simplified, misguided, and ultimately a bit dangerous. A gene doesn't care if it survives any more than a raindrop cares if it

falls. They are each just bunches of chemicals obeying the laws of physics, chemistry and biology. Evolution and its products are an accumulation of billions (or trillions) of events which just happened to work out a certain way. Our penchant to retroactively imbue this process with direction and intentionality is part of our natural pull towards comforting and complete "teleological" stories. Teleology is a belief that events have reasons for happening, and that the 'universe' seeks out desired end states. A teleological story is one which imbues false purpose and directionality. Oxygen exists so humans have something to breathe: an apple falls from a tree because it wants to, tornados are attracted to trailer parks, and (from the perspective of a dog) humans exist to throw Frisbees and provide snacks –are all examples of teleological thinking, which demands that there be a final cause or purpose. That evolution occurred in order to produce us, or that the universe exists to produce life, are similar such stories.



The universe doesn't actually care about life. It has no brain to care with. It has no preference for life, nor does it cut it any slack. This is important to realize, and it fits together with the fact that life itself sometimes makes a world better for life, and sometimes causes life to be wiped out. The universe's only big favor to life is that it doesn't preclude it. Most parts of the current universe are utterly inimical to life. The entire universe was prohibitively hostile to life in the deep past and will be for the huge majority of the deep-time future. There's a tiny window of time in which the

universe has stars, light, heat, energy flows and elements in the right proportions and proximity to - rarely - allow conditions which make possible the emergence of life. If and when that happens, it is barely possible that a preposterously unlikely series of events will make possible highly energetic life with something like brains, and then barely possible that those brains will encounter circumstances under which evolution causes them to grow large enough to think abstract thoughts. And then after some time the universe will kill them again, with no more prejudice than when it allowed their creation. Life will only be possible for a very small part of this universe's duration.

Earth has had life on it for nearly 4 billion years.[11] It has had simple brains of one sort or another since worms developed them around 550 million years ago (mya), so even those first brains took a while.[12] An unbelievably long while. Brains didn't automatically evolve to get bigger and smarter, because brains are costly in resource and energy terms. It took the next half-billion years to evolve something as smart as a chicken. Only fairly recently, and as a result of a number of re-sets due to mass extinction bottleneck events, did the mammals get a chance at becoming large, with a few of them growing larger, more complex brains. Only VERY recently (as far as we know) has the world seen things like elephants and whales and apes with large brains which are self-aware and capable of complex abstraction. These exist ONLY in a small subset of quite large mammals, which wouldn't exist at all if not for the utterly random crash of an asteroid into an enormous fossil oil reservoir 65 mya, which finally cleared the non-avian dinosaurs out of the big-critter niches. If not for that random crash, abstract thoughts like you are reading wouldn't exist, and mammals would still likely be small bug-eaters skulking in the dinosaurs' shadows**.** There is pretty much NOTHING more random than two enormous rocks banging together after 13.8 billion years of gravitational interaction. Yet upon that chance (and many others) rested the existence of large mammalian brains, nerve-dense neocortices, a perception of the universe and self, and Honors courses.

Evolution is the result of the mechanism of natural selection, in which traits which allow an organism to survive and reproduce are passed on and proliferate in a population. If we understand that the universe doesn't care, it's a short step to grasping that evolution doesn't care either. Far from evolution seeking us out, it has staggered in a random drunkard's walk for 3.8 billion years with no more intentionality than the steel ball in a playerless pinball game, until it accidentally hit upon our combination of traits, and we accidentally woke up. If we disappear, the odds are high that nothing much like us will evolve again. Evolution is clueless, mindless, directionless, and not even smart enough to be stupid.

So how about a non-romanticized example of evolution: take a new box of Raisin Bran and shake it. You'll observe that the longer you shake it, the more the raisins concentrate near the bottom. The smaller and more spherical raisins get there first,

followed by the larger spherical raisins, followed by the large irregular raisins followed by the small partly mashed weird-shaped raisins that the raisin-bran people get bargain rates on because they're weird-looking.

You've just simulated evolution. That's not even a metaphor, that's actual fitness selection, in which the arbitrarily-designated "fitness" of some raisins got them to the bottom of the box (analogous to the "today" of evolution) while other raisins were left behind. In that who-gives-a-damn context, "raisin-race fitness" is determined by size, density, relative sphericity, surface wrinkles, and microscopic texture enabling van der Waals force and friction, as well as the specific shape and size context of that exact assemblage of rodent excreta, bug legs, and whatever else found its way into the bran-flake machine.

One could develop a cosmology around the "bottom of the box" being a preferred location, but preferred by who? Not the raisins. And this is exactly what genes do. They aren't trying to replicate into the future. They aren't trying to do anything. Some of them move more successfully through the aggregate "stuff happens" energy-pumped physical-world phase space than others, and others don't. That's it. Rinse and repeat, and ta-daaa! Here we are 3.8 billion years later, the raisins in the planetary box - lucky as hell to exist, serial lottery winners all of us (and, ironically, betting it all on the next lottery ticket, as though wild luck were a dependable part of our inherent nature).

Evolution has no goal. Its about which adaptations survive, and brains can just as easily evolve to get smaller (and stupider?) as they can to get larger and smarter. One human species, *Homo floresiensis*, apparently did just that, as they emigrated to an island ecosystem, natural selection favored smaller and less energy intense bodies (and brains).[13] Interestingly, our OWN brains have gotten about 10% smaller in the last 10-20k years, as we have moved toward deeper and more complex social networks, offloading individual processing and specialization to our "cultural cloud.[14] If that trend continues for another 10k years, we'll be back to the brain size of a homo erectus and still shrinking (so study while you can!). Evolution is not a "march of progress."

The notion that evolution has a direction, and that we're "it," is a teleological fallacy. Funny word, but one worth learning, because it's a fallacy we humans fall into very often, along with hundreds of others, many of which we'll learn about in the weeks ahead.

KEY POINT: ***Evolution is a process without a destination or purpose.***

From Fitness Maximizers to Adaptation Executors

What causes the things we do to feel good (or feel bad)? Is it random, or are we responding to some software in our brains that we (humans) all share? It turns out that the hurdles and bottlenecks that our great grancestors x10^{16} generations– all the way back through other primates, other mammals and simpler organisms– successfully navigated, have a direct bearing on what we do, what we like and what we strive for during our own lives.

Why does something feel bad or good to us at all? It's because the ancestors who "felt good" about doing things which happened to enhance their relative fitness *at that time* survived to pass on these tendencies and the behavioral rewards inherent in their particular brain structure. Sex feels great. Eating high-energy-content food feels great. Being a high-status tribal member feels great. Hating outgroups feels great. And killing large prey (and outgroup members during wartime) feels great. This is, to some of us, such an uncomfortable thing to hear that it feels incorrect. Our ability to recognize the way our own brains function is limited because our conscious minds can access only the output results of the more-powerful brain regions which influence us, and not the processes they use to arrive at those results.

If we look back through deep time, the organisms that were shaped and sculpted to what they look (and act) like today, did so via the relentless gauntlet of 'relative fitness'. In almost all animal generations there is born a surplus of offspring relative to what the ecosystem can provide for. Either food and water scarcity, or predation, or disease, or accidents mean that the number of organisms (insects, fish, animals, what have you) that live to die of old age is a very small percent of the total. It is largely the beneficial genetic mutations (and chance), causing small advantages during the organism's life that allow incrementally better survival (and incrementally more success at mating and producing offspring). Relative fitness quite simply is the survival and/or reproductive rate of a genotype (genetic make-up) or phenotype (observable traits) **relative** to the maximum survival and/or reproductive rate of other genotypes in the population. It is from this theme that the (in)famous phrase by Richard Dawkins 'The Selfish Gene' emanated.[15] He didn't mean that there was a gene for selfishness, (or that genes themselves gave a damn) but rather that whatever happened during an organism's life that advanced its survival/mating success relative to others of its species meant that its genes (or genotype) would be more highly represented as a % of total genes in the next generation than they were in the generation when it was born.

This means that evolution is about 'fitness maximization' when looking backwards (which is the only direction evolution can be seen/experienced: fitness exists only in

retrospect). We (and our dogs, and the spiders in our basements and the coyotes in our backyards, etc.) are products of a long series of 'what worked better' in each particular generation of that species that came before, multiplied and stacked on top of each other.

How would this really work? Let's say there are 1,000,000 generations of history in what led to a biologically modern coyote. In generation #536,488 there was an extreme famine, and only a few of coyotes with the most efficient metabolisms made it through the coyote bottleneck of that era. Later, in generation #697,793, there was a series of hard winters, and only the coyotes with the mutation to grow thicker fur when the weather turned cold survived. And in generation #945,400, there was a disease found in mice that would transmit itself into the coyote gut and lead to fatal diarrhea and illness – only the few coyotes that were immune to this bacteria made it through. If we come to generation 1,000,000 – today – all living coyotes will: a) have extremely efficient metabolisms, b) grow thick fur when it is cold outside and c) be resistant to that certain form of mice-originating bacteria – even though these coyotes might live in a warmer climate, with plenty of food, and no mice. This is because these coyote genotypes made it through the various bottlenecks in their evolutionary history – these traits (for now) are 'locked in' the coyote genotype – irrespective of what the current environmental conditions might be: hot/cold, plentiful vs little food, etc.

A quick note on relative vs. absolute fitness. If, in a coyote generation, ALL coyotes survived and reproduced healthy litters of 8 coyote puppies who all live full lives, reproduce themselves and die of old age, the *absolute fitness* (how many survived) of these coyotes was very high, and the differential reproduction of their parents was zero. They all survived and bred. Relative fitness only comes into play when something new or unique (or lucky) allows one individual or line to have differential survivability/mating success. This can occur when the population is huge, or, in some cases, very small, allowing only a few individuals through some environmental bottleneck. Seen through the backward lens of deep time, it is primarily the accretion products of relative fitness that have shaped and sculpted the living things we see around us today.

Let's move from coyotes to dogs. Dogs, originally from wolf stock, have been artificially selected for various traits for companionship or work for humans. I (Nate) have a golden retriever, Quinn. If I throw a ball for him, he ecstatically will run and fetch it back to me – for hundreds of times in a row if I keep throwing it. His ancestors who were more fired up to retrieve birds or game were selected by their owners to breed. Fitness, in the historic golden retriever sense, was artificially maintained by whatever traits the dog's owners preferred. When Quinn sees a ball or Frisbee thrown,

his neural response is one of joy – as if this is what he was born to do – in his case, this is pretty close to the truth. His breed has a series of historical adaptations that make his behavioral response retrieving, as opposed to digging, or fighting, naturally pleasing and rewarding.

So, let's move to humans. All of us alive today are the product of a long series of historical environments and bottlenecks in which certain genotypes survived and mated. When we look back at this long series of lives lived and babies born, we know that in each particular generation, those who had a slight advantage in survival and mating were more likely to be our ancestors than those without those preferences or traits. In fact, many in the pre- and post-hominid populations did not breed at all, and hence are not our ancestors. We are, all of us reading these words, quite simply, descended from the best of the best (or perhaps more correctly the luckiest of the luckiest) at surviving to be old enough to mate, and successfully rearing offspring. Looking back at this history, ours is a long series of 'relative fitness' in each sequential trial (life).

But, (and here is the important punchline) we do not think about maximizing fitness during our own lifetimes. We do not go through life calculating the odds of each situation to improve our survival chances. We do not use each encounter with the opposite sex to produce more offspring. (though the goal of some of these encounters is to go through those motions). Although we sometimes appear to be pursuing fitness on behalf of our genes, we really are just executing our evolved neural programs that were shaped in environments of our ancestors in ways that give us the same 'feelings' (read: neurotransmitters, hormones, endocrine cascades, etc) that our ancestral blueprint locked in as they were successful at surviving and passing on their templates through past bottlenecks. **Organisms (including humans) are *adaptation executors, not fitness pursuers*.** We go through our lives pursuing activities in today's world that are completely (in most cases, bizarrely) different than our great grancestors on the Tanzanian savannah – but obtaining similar feelings of pleasure, motivation, pain, and avoidance, etc. as they did under vastly different historical circumstances. As we'll see in a few weeks, the activities leading to survival, higher status, sex and anything central to our ancestors achieving relative fitness in prior eras, 'feel' especially strong to us.

One final note, with a bit wider boundary. Absolute fitness is the measure of an organism's fitness independent of other individuals. If you're a chicken, and you lay 1024 viable eggs in your life, your fitness was 1024. Relative fitness, on the other hand, is absolute fitness divided by mean fitness. Thus, if the mean fitness of the population was 982 eggs then the relative fitness would be 1024/982 = 1.04.

Absolute and relative fitness are most often relevant when discussing the ontogeny of a single organism. But species also compete with each other for resources, habitat and niches – therefore it also makes sense to discuss relative fitness *between* species. Every species to exist since the dawn of life has been fit enough to survive *at that time and in that situation.* Yet 99.8+% of those species are now gone, because they were eventually insufficiently fit relative to competitors and changing contexts as time and accidental events marched forward. For instance, a large part of earth's current marine animal biomass are the pteropods (marine snails) known as sea butterflies, which evolved after the last major mass extinction (KT) and have been very fit in the conditions which have recently prevailed.[16] However, the sea butterflies' shells are now dissolving in high-latitude seas due to increasing CO_2-caused acidity which causes their aragonite shells to fizz away. What was "fit" in the oceans of your grandparents may not be fit in the oceans of your grandchildren, because another 20-40 years of continued fossil fuel burning will (if it occurs) render aragonite chemically impossible for (at least) hundreds of thousands of years. This, in turn, will alter the *relative fitness* of animals which evolved to be dependent on pteropod-intensive food webs, compared to jellyfish or other ocean creatures that seek food unrelated to pteropods.[17]

KEY POINT: ***We don't seek to maximize our fitness, we execute adaptations via doing things that feel good or "right" to do.***

THINKING AHEAD FURTHER IN THE SEMESTER

So how does this relate to Reality 101? In this class I will oft suggest that it's time to move towards a consciously-designed agenda of the self-aware mind and away from the agenda of the gene. But there really isn't an "agenda of the gene" any more than there's an "agenda of the raindrop" - it's a useful metaphor, and we largely communicate with one another in metaphors because there's no other way to quickly communicate a complex idea with language. The *agenda of the gene* simply means that while walking our own path, we gravitate towards the behaviors and actions that give us 'feelings' that our ancestors (on the road behind us that has disappeared) got as they successfully navigated survival and mating challenges on their own paths.

That's one of the problems with following what "feels good" to do: those feelings were designed to feel 'good' by the same sort of process of attrition that gets some raisins to the bottom of a box before others. Again, not a metaphor, the same sort of process. We are by default relying on that process to pull a miracle out of a hat as we reproduce ourselves past the 10 billion mark 'eating fossils,' as though our genes have a plan.

Before we were born, our ancestral gene trajectory functioned to make the maximum numbers of copies of themselves. That was its sole distinguishing characteristic, which is as intention-free as the crystallizing of a snowflake. The agenda of the gene therefore pushes for the largest-possible biomass of human existence, while our quality of life is not even a consideration. This is important to realize. While our brains have evolved so we “feel better” when we do things that happened to help our ancestors survive, “feeling good” is not a design goal of any sort. Our genes will *always* strive towards 20 billion miserable humans on earth in lieu of 2 billion happy ones. Because being hungry, having (and making) babies, being fair to other in-group tribal members all occur in the same way that water flows downhill. That’s how the fitness game has always worked.

Here’s the catch. Going along with the gene agenda feels good. Eating junk food, blaming outgroups, acquiring more and better possessions than our neighbors... all of this feels great. Pursuing a different agenda not only has no evolved deep-brain reward circuits; it runs afoul of evolved brain aversive systems. Going on a diet feels terrible. Loving our enemies feels messed-up. Living an austere life feels like a sacrifice. So, the behavioral dice are loaded in favor of the gene agenda, and that’s what we see writ large in the world around us. Our species may only make it to the trillionth human childhood if we start doing things which make logical sense, but don’t initially feel good to us. And how do we do that!? (we’ll come back to that question as the semester continues).

Just as that shaken cereal box will wind up with the raisins on the bottom, the result of our population overshoot is as predictable as yeast replicating in a wine bottle. We are not going to evolve away from requiring food. Once we have used up the dead fossil stuff, we'll have to go back to eating the things we used to eat, and what’s available at that time will only be a fraction of what our hugely enlarged population needs.

Yet there's a small "but." We have brains which can in principle understand where the agenda of the gene is heading to, and the broad shape of the inevitable results. It is not impossible that we could anticipate this and modify our behavior to achieve something new in the history of life: a forward-looking fitness based on understanding the physical world (hope for such ‘intelligent foresight’ is why I’m teaching this class and we’re writing this book).

The problem - and it's a big problem - is that we are deeply programmed. Our brains evolved to get us to the bottom of the raisin bran box faster than the other raisins. All the things that make us "feel good" are about that journey. All the things we are pre-programmed to care passionately about are linked to our long-ago evolved reptilian limbic systems, while the abstractions of the "conscious" part of our neocortices have

no such deep links. We will gun each other down over road rage or being snubbed for a promotion, but the gradual loss of a natural world just causes us to blog.

The mindless progress of life across the ages has created a world of incredible wonder and diversity. Our current economics consider this to have zero value, but in our minds we *(most of us)* realize otherwise. Swimming over a coral reef, walking in a rainforest with its sounds and smells, hiking a desert, we are surrounded by our deep-time kin, the other evolved species to have survived until now. They are not our enemies or our resources, they are our family; the things most closely related to us in a near-infinite universe, the things that have made the world we recognize. There's so much we don't know yet. How does an elephant, a dolphin, a macaw see the world? What does a 250-year-old bowhead whale think about, under a ceiling of ice, seeing with reflected sound, and thinking with a brain more than twice the size of ours? What really exists, unknown, in the oceans we're dredging to rubble at the end of multi-mile-long steel cables? We are genetically adapted to ignore those things in favor of consumption and reproduction, like yeast in a wine bottle, and our brains come pre-loaded with rewards and disincentives weighted to make that continue to happen.

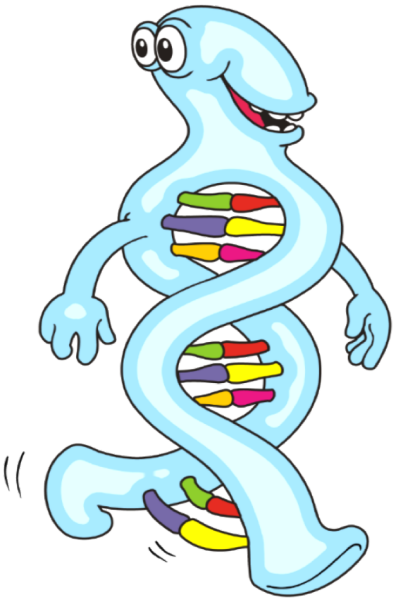
But it hasn't happened *yet.* And we are capable of learning and understanding the way our brains work... a central part of Reality 101.

KEY POINT: ***Blindly following the 'agenda of the gene' leads to ecological problems***

Section II - Human Behavior

The story of deep time is our story: we are a product of deep time, and both our physical and mental existence is inexplicable without understanding this. As we approach the year 2020, we finally have enough pieces of the puzzle to see the big picture, and it's a picture which is quite unlike the stories we have previously told about ourselves. For we have arrived in a modern world with barely-altered 'caveman' brains, optimized for small tribal survival and scarce resources on the African savannahs. Understanding how we think, and why we act in the ways we do individually and collectively, is a necessary step in the big synthesis. If we are to really know anything about the world around us, we need to know ourselves; to know where our minds might take us we need to understand where they've been and why.

Enter the Gene Agenda



Humans are special, but we are still mammals - and primates. Our brains and behaviors are products of what worked in our past just as much as our kidneys or feet are. In effect, we are 'adaptation-executors' that go through our lives trying to replicate the emotional states of our successful ancestors. Some interesting (and relevant) problems arise when the physical world we've described merges with humans trying to attain the same 'feelings' as our ancestors. To describe these challenges, may we present Mr. Gene Agenda (shown at left, *walking forward with its eyes looking backward*). The "gene agenda" we are referring to is symbolic of unconscious preferences and proclivities we are born with. Among them are:

Status – We intensely care about *relative* status. In a globalized modern culture with marketing, and advertising, we compete for resource intensive stuff. (Status can also be linked to respect, ethics, and community, instead of things!!)

Supernormal stimuli – Modern technology can hijack our neural reward system, which was designed for much slower daily experiences. We can (and do) become addicted to the 'unexpected reward' of the next encounter, episode, or email, and at an ever-more-rapid pace

Me vs Us, Us vs Them – We are products of competition against others for status and resources, but also of cooperation with others to meet shared challenges. We are intensely groupish. This is why social media today is about the 'messenger' rather than the message.

Cognitive biases – We didn't evolve to have a veridical view of our world. We think in words and images which are disconnected from our physical reality. This results in myriad cognitive biases. Rationality is the exception not the rule.

Time Bias – We naturally – biologically - care about the present very much more than the future. We make promises to change 'tomorrow' until tomorrow becomes 'today'. Our neocortex can imagine them, but we are emotionally blind to issues like climate change, sea level rise and biodiversity loss.

***Denihilism* –** Our challenges are: complex, in the future, abstract, scary, have no immediate answers, and few on TV or in politics are discussing these things. The interconnected challenges of the human predicament appear as the perfect storm for

the human brain. To resolve the disturbing dissonance the brain attempts to ignore or deny the evidence of the risk.

The consensus trance-We use ineffective social sorting mechanisms to solve complex physical world problems.

The above list is a short summary of our inherently programmed behavior tendencies – our 'gene agenda'. Hardly any of us understand and admit that our evolutionary heritage is highly relevant to sustainability and upcoming cultural responses. Why? How did the gene agenda come about? Can we do a 'work-around' this agenda? Here's a very brief summary:

Of course, "genes" don't have an agenda; they're molecules. They care no more about whether you survive than a raindrop cares if it falls. But your genes have programmed an agenda: your "behavioral defaults" have been shaped by genes undergoing differential survival under harrowing circumstances in tens of millions of years of prehistory. This agenda exists for good reason: the de facto "gene agenda" greatly preceded the evolution of brains, and for that matter complex life. It's a molecular mechanism to make sure that you are likely to make decisions, have motivations, and interact with the world as closely as possible to the way your ancestors did. It was created and shaped by their surviving and reproducing when those around them didn't. Understanding that there's something which can be usefully referred to as the "gene agenda" is a first step in grokking the systemic predicament that our species is facing.

Having a brain means that one has some behavioral flexibility, and that can be valuable. But brains had to evolve as 'add ons" to the gene agenda which already existed. If their flexibility departs greatly from the gene agenda, it is also departing from the actions and reactions which conferred survival upon one's ancestors. Thus, the more potential autonomy conferred by an evolving brain, the more that autonomy must be held in check lest it diverge from crucial programming and die out.

The way this is handled is that brains offer behavioral rewards and punishments deep in their core structure, to reward "gene agenda" actions and to deter actions which run counter to the gene agenda. The way we and other animals subjectively experience this is "good feelings" and "bad feelings." Going along with the gene agenda feels great and is highly rewarded. Eating sugar, hurting enemies, agreeing with tribe-members, having sex, gaining social status, getting *at least* our tribal "fair share" of stuff, escaping predators, nursing babies and many other such actions; all are immediately rewarded in the specialized parts of the limbic system via neurotransmitters like dopamine, oxytocin and endorphins.

Actions, thoughts, which are NOT part of the gene agenda do NOT feel good in the same deep way, and generally run afoul of punishments. For instance, being hungry feels bad, being thirsty feels really bad. Letting yourself get injured HURTS. (Think how quickly you learned not to bite your tongue while eating). Going without sex feels bad; disagreeing with tribe-members feels bad. Having dissonant thoughts (inner conflicts with the gene agenda) feels REALLY unpleasant.

This means that while conscious, self-aware animals like humans have some potential to depart from the gene agenda - and this has had survival value - it's very difficult to do. New ideas arise in the neocortex, and the neocortex is forever disconnected from the deep reward systems which make things "feel" important to us.

The gene agenda isn't confined to the brain's reward & punishment systems; it also derives from the fact that the world we experience is NOT the world in which we physically exist. We inhabit and experience a "user interface universe" (UIU) which is wholly generated by our physical brains using greatly-modified inputs from our senses. This UIU is infused with color, emotion, meaning, sound, love, hate, ambition, triumph, disgrace, pleasure and pain, good and evil. It *corresponds to* the physical world in ways that were useful in the genes' past. However, it is no more an accurate representation of the physical world than the screen of your cell phone is "like" the billions of transistors and electrons obeying quantum rules in billions of computing cycles per second inside it.

This "user interface universe" evolved just as your body did, for the reproductive success of genes, and it's skewed in many ways toward survival and utility, and away from veridical (truthful) reflection of physical reality. For instance, your brain has hyperactive face-detection and will see faces in random patterns, because missing a real face has disproportionate consequences to imagining an unreal face. We also have hyperactive agency attribution, for much the same reason: we tend to infer malign intent and plots where none may exist. When you add that to a further list of inborn "gene agenda" cognitive fallacies, biases, and illusions as long as your arm, you wind up with a brain that is pretty loosely attached to what's actually going on in the physical world. We're biased to perceive our modern world in terms of *small-tribe hunter-gatherer salience*. This worked great for small tribes on the African Savannah, which is still what we're mostly programmed to be; but we're now in new territory. We get "emergent effects" from our various misperceptions which make it difficult to make good decisions about reality.

As one example, the combination of face detection, agency attribution, stimulation via supernormal ideation, consensus belief and "thinking in words" has created tens of thousands of supernatural mythologies for which we have historically killed and died;

and with no relief in sight; from Aztec sun sacrifice to Easter Island "stone heads" to neoclassical economics. The common thread is that they *feel good* to believe and have *organizing value* to societies larger than 150 members, creating more competitively-formidable superorganisms (as our nations, societies, corporations, religions and alliances have turned out to be).

But aren't genes our friends? We wouldn't be here without them!

So do we owe some debt of loyalty to our genes? One occasionally hears such sentiments expressed. And that's foolish, because genes aren't our little friends. They program solely for reproductive success because that's all evolution COULD program them for. This is usually accomplished at the cost of mortality and (in conscious species) misery, because its sole method is over-reproduction and attrition. We are, during a brief one-time period of energy excess, insulated to an unprecedented degree from this attrition; but it will begin a return to old Malthusian norms during your lifetime, as increasing physical-world "energetic remoteness" of resources forces us inexorably back toward steady-state existence.

History is full of accidents which led to our existence. One might as well honor the Chicxulub meteor as honor their genes… especially since the meteor is no longer dangerous, while the gene agenda IS. Logically, we owe no debts to random accidents.

Genes *accidentally* produced the consciousness we experience, and the virtual universes we experience it within, and will be perfectly "happy" to get rid of those things in the future if it helps reproduction. Already our brains have shrunk about 10-20% in the last 20k years as we have relied more on large groups and less on individual thinking, and our genes will be just fine if we evolve to have walnut-sized brains, get pregnant by age 4, and eat cockroaches, which is a far more robust ecological niche than long-lived brainy ape (and one better-suited to a changing, hotter world). Not caring much whether that happens is, again, "gene agenda": it's an abstract idea about the future with no way to reach our limbic systems.

Pretty much ALL negative-feeling future possibilities are similarly discounted, even those which are more likely than not. For instance, most humans choose to believe that their conscious existence will not end when their bodies perish; so it's perhaps no surprise we choose to believe all sorts of lesser dissonance-avoiding stories. And there again, relieving cognitive dissonance is "gene agenda", because dissonance causes stress and stress challenges health and tribal functionality. We're evolved not to be too happy or too sad, but to dwell in a metastable homeostasis in which we are maximally motivated by the brain's deep evolved reward and aversion systems.

We've met the enemy, and he's inside us

So if there have been so many past benefits to Gene Agenda, what's the problem? Well, the problems are many and we're running into them all right about now, due to a couple centuries of fossil-energy-driven exponential growth hitting a lot of limits at about the same time. The short answer is that the very same "gene agenda" which brings a conscious species like ours into existence and power over nature, will - if it continues to be dominant - tend to wreck the world's carrying capacity and environment, killing most of that species off and leaving it with a relatively grim future. Only if such a species can *transition* from "gene agenda" to a more sapient ecologically-aware agenda can that be avoided.

That must, of course, be done before the damage is locked in. And so far, all popular narratives to the contrary, we aren't doing that. We're 99.9% Gene Agenda, and those humans (99.9% of them) connected to the global economic system are pedal to the metal in nearly every dire consumptive and destructive variable which can be graphed. To a good first approximation, we're still nothing BUT gene agenda. So far, we have come a long way hitching a ride on what is essentially a runaway train; but without the wisdom to jump off before the crash it may all come to nothing.

Thus, anyone who understands "Energy Primacy" (see next section) as the basis of life, and the broad outlines of a science-synthesis view of reality, must conclude that the "gene agenda" is something we need to try moving beyond, and quickly. It's a full-speed train heading for a bridgeless chasm. The authors strongly suggest that humans attempt a sapient, ecologically-informed deep-time ethic of life so that the human experiment on earth can last a long time and involve a lot of happiness, discovery, and trillions of childhoods in the garden this planet can be. This is still possible but will NOT become likely until and unless we make it so, and it could easily become *impossible* during your lifespan due to the cumulative weight of irrevocable bad decisions.

An agenda to die for…

So to sum up, the problems with the Gene Agenda, as a plan for the human species going forward, include:

- It is mindless, with no intentionality whatsoever. It not only cannot plan for the future, it has no mind to know there IS a future. It's just replicating molecules which have accidentally made life and can just as easily unmake it.

- It is antithetical to rational thought and reasonable ethics, fogging our collective minds with a “consensus trance” of selective reality-blindness.

- It is deeply compelling, with roots in the limbic system of every brain which curtail and enslave our freedom of thought. It feels right and passionately important because it was designed to by millions of years’ attrition. Its rewards are blissful, and addictive and its punishments are immediate: it is hugely difficult and stressful to overtly depart from.

- The gene agenda is the deepest “common denominator” of human behavior, shared by all. That means that behavior which “feels good” to the limbic system is *ratified* by the social approval of those around us, and seeking their approval is another part of the gene agenda. It will tend to dominate any consensus decision-making system and drive out rational analysis.

- It will always strive for 20 billion starving, warring humans with destroyed ecosystems, rather than 2 billion happy peaceful humans with sustainable living practices.

- Its reliance on the brain’s mirror-neuron system means we empathize with one suffering child, but are wired to ignore a million suffering children. One is “felt” as an individual, the other is “felt” as a concept with no strong roots. Thus, to run a world we need better empathy than the “gene agenda” is wired for.

- The gene agenda causes us to heavily err towards uncritical belief in unrealistically-optimistic future outcomes. This is a spectacularly bad bit of agenda for a world-controlling species focused on short-term gain.

- Not understanding energy, thermodynamics, or science, the Gene Agenda rewards us when we find “others” to hate and blame for what were entirely foreseeable problems, because it *feels good* and *confers tribe solidarity* to do so. In a species armed to the teeth with nuclear missiles and heading into a period of drastically declining resources with utterly no clue as to why, this is another dire default.

If this “gene agenda” is so powerful, is it realistic to hope - even in principle - that it can be challenged? Yes. There are strategies we will recommend, and these have been proven to work, by us and some others. And even if that were not the case, there is little choice: we must find and employ an alternative, an “agenda of self-aware mind” which can in crucial applications supplant the ultimately-suicidal “feel good” agenda our brains came pre-programmed with. And it must happen quickly, during the next few decades of your lifetime.

We hope this brief introduction of the concept has helped you see that “Gene Agenda” exists and is at this point our species’ principal adversary. This is a new and original framing, but one with deep scientific roots and explanatory value which we hope you’ll adopt in your thinking.

There are abundant ecological examples of species which overshoot the sustainable carrying capacity of an environment due to a temporary bolus of resources. This corrects itself in a “dieoff” phase during which the population stabilizes at a far lower level or is extinguished. It is emblematic of our “gene agenda” that we can know this to a scientific certainty yet be blissfully confident it doesn’t apply to us.

Delusional R Us

Part 1: Introduction
Part 2: The Gift and Curse of Mind Modularity
Part 3: The Power of Crazy
Part 4: Delusional R Us: Conclusion

Part 1 - Introduction

"The most common of all follies is to believe passionately in the palpably not true. It is the chief occupation of mankind." - H. L. Mencken

"Reasoning was designed by evolution to help us win arguments." -Hugo Mercier and Dan Sperber

"We apply fight-or-flight reflexes not only to predators, but to data itself." -Chris Mooney

DJ has a single, one-of-a-kind bumper sticker on his car: "*Humans Are Delusional*", which may sum up a lot about our current predicament(s). It's probably reasonable to say we don't so much have an energy problem, a pollution problem, a population problem, a biodiversity problem, a resource problem, or a climate problem so much as a brain problem.

Your authors Nate & DJ are delusional. They admit it. And by realizing it and beginning to understand the nature of this delusionality, they consider themselves

several steps ahead of where they were before they learned of it. They're not particularly delusional relative to other members of their species (though that's always open to debate!). Rather, they're delusional simply *because* they're homo sapiens: an evolved delusionality comes free with a human genome and upbringing.

Clearly, we're not talking about "delusionality" in the usual sense you hear it. Indeed, the usual definition of "delusional" is a person who considered to be self-deceiving or insane. We will instead show that there really *isn't even any such thing* as self-deception, only an evolution-honed modularity of mind. And the definition of "insanity" is "not behaving in a normal manner", so if the majority does it, it can't be insane. So surely our use of "delusional" is no worse than that.

We have been told many times that the word "delusional" is a terrible choice to use in these descriptions: it seems pejorative, negative, insulting to human nobility and achievement. But we keep coming back to it cause it's just so darned accurate, and because a little metaphoric cold water splashed in our collective faces may not be a bad idea at this stage. So how are we re-tasking the word "delusional" for the purposes of waking our species up to smell the coffee?

We'll show that humans are delusional:

- genetically, with a built-in landscape of biases and behavioral rewards/punishments skewed heavily toward the mindless "agenda of the gene" and away from logic and clear analysis;

- due to an evolved mind module central to our consciousness which continually invents stories and makes us passionately believe in them;

- culturally, with organizing beliefs based significantly around evolved mythologies of various types;

- due to limited ability to deviate from the consensus beliefs of other humans we interact with;

- in a reductionist manner due to the micro-division of expertise caused by ultrasociality;

- in believing that narratives (stories) capture the essence of the real world;

- relative to dealing with the real physical world, mis-using social sorting routines and heuristics to parse physical-world propositions and situations, confusing virtual-

world phenomena and rules with those of the physical world, and having selective blindness to many aspects of the real world;

- as to the nature of our own minds and the way it thinks, with misplaced certainty in a very fallible process which is much more constrained than it feels;

- relative to what we think we are;

- relative to the scope and complexity of the predicaments we have worked ourselves into.

And this is a very truncated list; we could easily have included a couple hundred bullet points.

We're Nate and DJ, and we're delusional. As they say, the first step is admitting you have a problem.

Part 2 – Human Cognitive Biases – An Overview

In order to understand the human predicament, the most important thing to understand is the human. A key part of this book is an attempt to explain the particular handicaps of the human brain and why our blind spots and biases, in aggregate, make it difficult to plan and implement benign futures. We have broken this into several segments:

1. An introduction to and examples of common human biases and fallacies
2. An explanation of why our minds are 'modular' but portray a feeling of unity and belief
3. An explanation of the power of metaphor that crosses the borders of fantasy
4. Summarizing the opportunities and constraints of our human delusionality

Let's get started. The following personalities are generalizations (though each one is based on people we know and some of them are verbatim emails). We expect you might recognize aspects of each of these characters as people in your own lives. When asked the following question: **'*What do you think about the future, and mankind's ability to overcome the challenges of living on a planet with finite resources, like oil and gas?'***

Their responses are given below.

Kyle

"Sir, the scientific world has known since the 1950s that oil is not a "fossil" fuel. It is a natural product of the Earth created as a result of core thermal interaction with the mantle. I challenge you to consider the possibility that oil is not a fossil fuel and is being regenerated continuously. I know this phenomenon well because I studied in graduate school under the best known Russian geologist on these matters who now oversees a government laboratory in Moscow. Where I now live in Louisiana, old dry wells are now being reopened because oil is returning to those holes. Oil is plenty useful stuff, but the earth is creating more of it everyday."

Phyllis

"For all intents and purposes on human time scales, our resources are not limited at all. Whenever mankind has faced a challenge, we have proven the naysayers wrong by somehow overcoming it– the Manhattan Project, walking on the moon, Y2K, etc. We are smart (and getting smarter), developing technology that can better access and improve the energy and ore extraction processes. We are becoming more efficient at utilizing materials. We combine hard work, intelligence and free markets and come up with answers. That's what humans have always done and always will do. Sure, there will be recessions and maybe a depression or two this coming century, but people alive in 2100 (and after) will have higher living standards, and access to technology that we can only dream of today. Sure, we joke about flying cars and things like that, but there is really no limit to human ingenuity – those worrying about resource shortages and global environmental sink capacity are doing society a disservice, leaking confidence away from those working on real solutions. If a commodity – like oil – gets scarce its price will eventually go up, and the higher price will incentivize new technology to pull out more resources or alternative sources. Please remember that oil is just a commodity – the true juggernaut of the human condition is our ingenuity and inventiveness."

Jay

"You are wasting your time with that question and wasting your time with this god damn book. Humanity is doomed. We are no smarter than yeast. Look at what we've done to the biosphere. Even if we could figure out a way to live without oil it's too late. Runaway climate change is around the corner. Methane burps from the permafrost, destabilized methane hydrates, positive feedbacks from melting ice caps and lower albedo etc. are going to cause Man's extinction well before 2100 and probably before 2050. And well before then we will have World War 3 over resources, and those remaining will revert to our core nature, every man for himself, loss of social order, food shortages, etc. I expect cannibalism to be widespread in Europe and North America within a generation. All you can do in the meantime is enjoy each day, build your bunker with guns, whiskey and tradeables, and stay away from economists!"

Rowan

"Yea, our oil situation has nothing to do Obama's policy or the way the EPA, the DOJ, etc. fleece American corporations with random acts of sodomy. America got what it deserved....a free spirit prez that doesn't know diddly poo. Ohhhh, but Costco is still hiring! Our lame president will handle all these oil and environmental problems. Ohhh right after he goes on the Mike and Mike show and makes basketball picks. Obama will go down as the worst president in the history of this great country. Mark my words. Oh and you ask about oil. Where is it headed next? If you're a so called expert let me know, I need to make some shekels."

Abigail

"I don't know much about oil or natural resources but I really don't need to. God put them there for us to find and use. If you read Genesis 1:28 all the fishes of the seas and trees in the forest are there for our dominion. I expect it's the same with oil and gas and whatever we discover next. I can't imagine that He would put resources there, for us, if they were going to run out! In any case, I think society overly worries about the future – everything we do is part of God's plan. We need to just pray and trust in the Lord. I know I do and I rarely feel anxious at all. It is amazing to see the wonder of how it all fits together on God's green earth. God bless you and God bless America."

Barbara

"The earth is a big place! Too much to worry about in my own life to spend time thinking about things I can't control or influence! Humans will figure stuff out, or we won't. I've read nothing in the newspapers or Fox news or CNN to suggest there is any serious problems with oil or other resources. As far as oil, if I had to guess, I'd say we have, well, about 1 million years left 2 million years? +/-? That's just a guess though, I've never thought about it. But if everyone just gets off their butts and gets jobs, I expect we'll arrive at the future in good shape."

Kevin

"I saw this show, I think on the History Channel, that showed some Tesla fellow from Europe had developed a perpetual energy machine a long time ago – but the government put the clamps down because if energy was free or too cheap to meter there would be no energy industry or war industry. It's all about profits man! If we ever really have resource issues, I expect the government will resurrect that Tesla machine and other secret devices that are hoarded by the Rothschilds and their cronies. There is a backup plan for it all but only the rich will benefit. I do think science is pretty cool though– I love the History Channel."

Do you recognize some of these themes in your daily interactions with friends and colleagues, or perhaps some things you yourself might think/say? What do these people have in common? Well, we can list at least 3 things:

1. Each of them is descended from the best of the best at surviving, procuring resources and mating successfully over thousands of human generations. (we know they mated successfully because to be our ancestors they had to, by definition, mate…)
2. Since there is little overlap, *each of their beliefs about oil and our resource future is unlikely to represent the reality of our physical world. At most one of them could be 'right.'*
3. Each of them (probably) 'feels' as confident in their world views as you do in yours, or as the authors of this book feel in ours.
4. Few of the people answered the question directly and completely but focused on their perception of one aspect of the question and spoke to that.
5. A common theme was to redirect the 'fault' of a potential resource/environmental crisis towards some sub-group of society (a politician, the unemployed, the naysayers, etc.).

   We can also guess at some additional things:

6. Presenting each of these people with facts, data, charts, handouts, or books that refute their world view will not persuade them. If anything, it may trigger them to dig in their heels, use motivated reasoning, and even more strongly defend their viewpoints.

7. When these people, (or any people), get stressed about money, or their job, or family or anything in life that adds to anxiety and worry, these beliefs about the world are likely to intensify and become more rigid.

8. If these people encounter someone with similar beliefs about the world, they are likely to befriend them, irrespective of other nominal differences. We gravitate towards people who agree with us.

With this personality/belief sample as a springboard, this chapter will explain the prevalence (and likely origin) of our beliefs, biases and logical fallacies. Before we get to that synthesis though, let's do a quick run-through of some commonly known human biases. By the way, here is how the authors would have answered that question about oil and our resource future.

Nate/DJ

"Our human economy is fully based on energy and natural resources. The level of wealth and complexity of society is directly related to energy surplus (benefits less

costs measured in natural resource terms instead of dollar terms). As we gradually burn through the really high-quality basins we will likely go to costlier, dirtier, harder to get to resources. There is plenty of oil left – but the increasing cost of extracting it – both in energy and environmental terms - implies a long-term decline to human benefits (lower standards of living, higher percentage of poverty, or both), increasing environmental concerns (global heating, acidifying oceans, and increasing stress on wild nature) and more risks of social disruption. Technology can potentially slow this decline, but most technology has been going to 'apps' and 'gadgets' that ultimately require higher baseline use of quality primary energy. Mankind will have to become 'wiser' as opposed to 'cleverer' to meet the mounting challenges and a general trend of living with less each year instead of more. But we might be wrong."

Below is a brief overview of some prevalent human biases - do you recognize any of these?

COGNITIVE DISSONANCE

Cognitive dissonance is where holding a particular belief is too 'dissonant' with other aspects of one's life, and the dissonant belief is smoothed, removed or modified so that the dissonance (pain, stress, fear, anxiety etc.) is removed.[18] Consider an example (made famous by Jared Diamond, in "Collapse").

"*Consider a narrow river valley below a high dam, such that if the dam burst, the resulting flood of water would drown people for a considerable distance downstream. When attitude pollsters ask people downstream of the dam how concerned they are about the dam's bursting, it's not surprising that fear of a dam burst is lowest far downstream and increases among residents increasingly close to the dam. Surprisingly, though, after you get to just a few miles below the dam, where fear of the dam's breaking is found to be the highest, the concern then falls off to zero as you approach closer to the dam! That is, the people living immediately under the dam, the ones most certain to be drowned in a dam burst, profess unconcern. That's because of psychological denial: the only way of preserving one's sanity while looking up every day at the dam is to deny the possibility that it could burst. If something that you perceive arouses in you a painful emotion, you may subconsciously suppress or deny your perception in order to avoid the unbearable pain, even though the practical results of ignoring your perception may prove ultimately disastrous. The emotions most often responsible are terror, anxiety, and grief."*

CONFIRMATION BIAS

Confirmation bias is when we selectively search our environment for evidence and information to confirm what we already think.[19] Implicitly, we tend to 'ignore' and

therefore not spend any time seeking information that does not support our beliefs. If I believe in UFOs I am going to frequent websites and buy books about UFOs and will not buy (or read) literature debunking the existence of UFOs. Basically, the human mind tends to only test the predictions of our personal hypotheses by using data that will support them. We all do this to some degree, and it is why the scientific method culturally evolved –to test ALL potential hypotheses. You might guess that those who deny risks of human-induced climate change tend to only read literature on why climate changes naturally, and without human influence (which is true but only part of the story). Similarly, those very worried about global heating tend to gravitate towards articles and news spelling out the grave dangers of continuing to burn fossil carbon. (and the internet makes this bias especially insidious, as an articulate passionate blogger carries as much weight as an atmospheric scientist). In effect, we humans are cherry pickers because it gives us confidence and reduces dissonance. (Note, after a while you will see this is a common theme with many of our biases.)

SOCIAL/GROUP BIASES

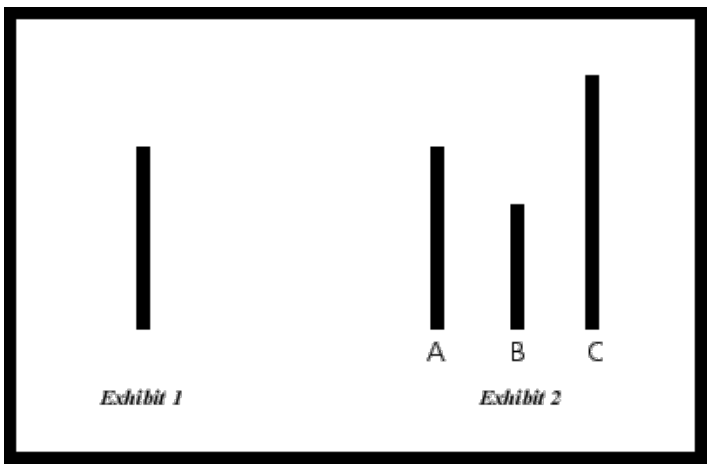
In-group bias is one of a cluster of cognitive biases known as group biases. Essentially, it is exhibited whenever someone gives preferential treatment to members of a group to which he or she belongs. One of the interesting things about this bias is that it has been demonstrated in randomly assigned groups as well as more organized ones; for example, in-group bias will be exhibited by members of groups which have been created through a coin toss, and also by members of the same sports team, or people of the same religion.[20]
Do you like your social group's friends better than their perceived adversaries? Do you like your state's sports team better than its rival? These are (small) examples of the sociological phenomenon of in-group bias, where we give preferential treatment, often irrationally so, to members of a group to which we belong (and we each belong to lots and lots of groups). In our own groups we attribute our success to our own smarts and personalities, but our mistakes we blame on environmental circumstances and bad luck. But in 'out groups' we attribute their successes to luck (or unsavory actions like cheating) and their failures to their personalities or lack of intelligence, etc. We also tend to lump outsiders together using broad swath descriptions, while treating in-group members as unique and valued individuals. Think for a moment why such favoritism for our in-groups - whether they are political or collecting rocks- is so prevalent and intense (*hint: it has evolutionary origins*).

We are social creatures. We do not act or make decisions in a vacuum but look to others to inform our behaviors. This social pressure to conform has been studied intensely and has various subcategories: 'groupthink', the bandwagon effect, and the conformity effect among others.

Groupthink occurs when a group of people possess an evolved imperative for harmony and conformity within the group, and thus make dysfunctional or incorrect decisions. The members of the group try to reach a consensus while suppressing conflict and dissenting viewpoints and without critical looks at alternative viewpoints and outside sources. Groupthink became famously known during the Cuban missile crisis when President Kennedy's advisors all agreed with his analysis and statements - a group consensus that brought us perilously close to a nuclear war. Kennedy afterwards required all people to speak their minds to the limits of their individual expertise even if the information was unpopular (see chapter on '*We Solve Physical Problems Using Social Sorting Mechanisms'*).[21]

The **bandwagon effect** is a phenomenon when the rate of adoption of beliefs and ideas increases more when they have already been adopted by others - something you are probably familiar with in high school. If everyone at school wears blue one day, and you wear green, you will immediately feel anxious and nervous that you don't belong, -and not belonging historically came with steep penalties.

More generally, we will go to extreme measures just to fit in - this is called the **conformity effect**. In the famous Ashe experiment, a subject was seated (last) after 7 'confederates' and was given a series of questions. It was shown that over 2/3 of the time, the subject would give the wrong answer when the other people in the room all agreed on a different right answer. Would you say that Line C in Exhibit 2 is the line most like the line in Exhibit 1? 66% of people tested did.[22] When they were interviewed after the experiment, most of these people acknowledged they didn't really believe their answers but went along with the group consensus for fear of being ridiculed or thought to be weird. How much of what is occurring in modern society is a giant version of the Ashe experiment?



AUTHORITY BIAS

We have a strong tendency to listen to and believe statements coming from **authority** figures like priests, politicians, professors and CEOs. Though the why of this is yet to be sussed out, Richard Dawkins believes it is an adaptive byproduct of children who unquestioningly followed adult instructions during the thousands of generations of our ancestral environment.[23] Presumably, the penchant for adults to easily believe things that they are confidently told is a carryover from the children who did NOT eat the berries, touch the snake, or swim over a waterfall as they were told not to– these children survived to have children of their own. Though not authority figures necessarily, we also trust confident and **charismatic** people and will prefer their predictions even if we know that other more boring, uncharismatic analysts have better track records!

Irrespective of its origins and as uncomfortable as it sounds, we DO inherently believe in authority figures, as the famous and controversial Milgram experiments evidenced.[24] Sixty-five percent of volunteers delivered what they thought were fatal doses of 450 volt electric shocks to human subjects while being calmly encouraged to continue by the experiment 'administrators' (doctors in lab coats). The other 35% of participants still delivered high voltage shocks to the point of unconsciousness in the subject but refused to administer the 'highest level' shocks. Interestingly, none of these 35% insisted that the experiment itself be terminated, nor left the room to check that the victim was okay without first asking for permission. So much for independent thinking. In interviews prior to the experiment respondents predicted that only the most 'sadistic' 1.2% of participants would be willing to hurt another participant with electric shocks, yet 100% of the participants DID administer the shocks. The power of authority figures is indeed strong.

OPTIMISM BIAS

Individuals have a tendency to be overly **optimistic** -we are taught from an early age to 'look at the bright side' and that 'every cloud has a silver lining', and therefore it's natural that the majority of people discount 'pessimistic' viewpoints and worldviews. Adults are particularly vulnerable to self-deception when comparing their own intelligence and attractiveness to others. Research has shown that we systematically exaggerate our chances of success, believing that we are more competent and more in-control than we really are. Eighty-eight percent of people think they are better drivers than average, ninety-four percent of professors believe they are better at their jobs than the average professor, etc. (By definition, almost half of those surveyed are 'overly optimistic').[25]

There are good neural explanations for being optimistic. Even if the pessimistic view may be more accurate, the stress of incorporating that particular negativity into one's

worldview releases a cascade of stress-activated hormones that can seriously compromise a person's health. In addition, pessimism can lead to depression, which suppresses the normal functioning of important neurotransmitters such as serotonin, which in turn can lead to reduced physical activity, mood swings, and a number of other physical symptoms and diseases.[26] Optimistic attitudes also reduce secretion of cortisol, a stress hormone that inhibits the immune system, as well as increase production of helper T-cells.[27] The placebo effect is a well-known but little-understood medical phenomenon that improves patients' physical response with no actual medication. In depression patients, placebos increase wellbeing by an average of 30-50%.[28] Apparently, when we 'think' positively that something is helping us medically, even if it's a sugar pill, it 'works'.

IDEOLOGICAL IMMUNITY

"Educated, intelligent, and successful adults rarely change their most fundamental presuppositions," stated social scientist Jay Snelson. The more knowledge a person has gained and the more effort they have put into establishing their beliefs and theories, the greater their confidence in their views about the world. Psychologists have shown that the higher one's intelligence (as measured by IQ, admittedly not perfect), the greater one's ability to defend one's established viewpoint.[29] Furthermore, the higher one's IQ, the SMALLER the ability to consider alternative points of view. Ergo the higher one's intelligence the higher the chance of resistance to one's current ideology and belief. It couldn't be that our intelligence came about not to solve problems as much as to win social arguments for status, could it? (Nate says, the day I finished my PhD I 'felt' smarter, even though that of course was not the case, I was probably dumber by that point).

POST HOC ERGO PROPTER HOC

Post hoc ergo propter hoc literally means 'after this, therefore because of this' in Latin - it can logically be written as 'B follows A, therefore A caused B'. This is an extremely common fallacy which you might be familiar with hearing your teacher admonish 'correlation doesn't imply causation.' Because the rooster crows at dawn, and then the sun rises, does not mean that the rooster caused the sun to rise. There are countless examples in our culture where people see Event B follow Event A and assume a (incorrect) relationship. Our brains are easily tricked in these ways.

In addition to the brief sample above, here is a longer list of human cognitive biases:

(***Note: Reality 101 students, no need to read or remember any of these -the point is only THAT THERE ARE SO MANY).***

Ambiguity effect – the tendency to avoid options for which missing information makes the probability seem "unknown."
Anchoring – the tendency to rely too heavily, or "anchor," on a past reference or on one trait or piece of information when making decisions (also called "insufficient adjustment.")
Attentional Bias – the tendency of emotionally dominant stimuli in one's environment to preferentially draw and hold attention and of a person to neglect relevant data when making judgments of a correlation or association.
Availability heuristic – estimating what is more likely by what is more available in memory, which is biased toward vivid, unusual, or emotionally charged examples.
Availability cascade – a self-reinforcing process in which a collective belief gains more and more plausibility through its increasing repetition in public discourse (or "repeat something long enough and it will become true").
Backfire effect – Evidence disconfirming our beliefs only strengthens them.
Bandwagon effect – the tendency to do (or believe) things because many other people do (or believe) the same. Related to groupthink and herd behavior.
Base rate neglect ***or*** Base rate fallacy – the tendency to base judgments on specifics, ignoring general statistical information.
Belief bias – an effect where someone's evaluation of the logical strength of an argument is biased by the believability of the conclusion.
Bias blind spot – the tendency to see oneself as less biased than other people.
Choice-supportive bias – the tendency to remember one's choices as better than they actually were.
Clustering illusion – the tendency to see patterns where none actually exist. Also referred to as "patternicity" by author Michael Shermer.
Confirmation bias – the tendency to search for or interpret information in a way that confirms one's preconceptions.
Congruence bias – the tendency to test hypotheses exclusively through direct testing, in contrast to tests of possible alternative hypotheses.
Conjunction fallacy – the tendency to assume that specific conditions are more probable than general ones.
Conservatism or Regressive Bias – tendency to underestimate high values and high likelihoods/probabilities/frequencies and overestimate low ones. Based on the observed evidence, estimates are not extreme enough.
Contrast effect – the enhancement or diminishing of a weight or other measurement when compared with a recently observed contrasting object.
Denomination effect – the tendency to spend more money when it is denominated in small amounts (e.g. coins) rather than large amounts (e.g. bills).[14]
Distinction bias – the tendency to view two options as more dissimilar when evaluating them simultaneously than when evaluating them separately.

Empathy gap – the tendency to underestimate the influence or strength of feelings, in either oneself or others.
Endowment effect – the fact that people often demand much more to give up an object than they would be willing to pay to acquire it.
Exaggerated expectation – based on the estimates, real-world evidence turns out to be less extreme than our expectations (conditionally inverse of the conservatism bias).
Experimenter's **or** Expectation bias – the tendency for experimenters to believe, certify, and publish data that agree with their expectations for the outcome of an experiment, and to disbelieve, discard, or downgrade the corresponding weightings for data that appear to conflict with those expectations.
Focusing effect – the tendency to place too much importance on one aspect of an event; this causes error in accurately predicting the utility of a future outcome.
Forward Bias – the tendency to create models based on past data which are validated only against that past data.
Framing effect – drawing different conclusions from the same information, depending on how that information is presented.
Frequency illusion – the illusion in which a word, a name or other thing that has recently come to one's attention suddenly appears "everywhere" with improbable frequency (see also recency illusion). AKA "The Baader-Meinhof phenomenon".
Gambler's fallacy – the tendency to think that future probabilities are altered by past events, when in reality they are unchanged. Results from an erroneous conceptualization of the Law of large numbers. For example, "I've flipped heads with this coin five times consecutively, so the chance of tails coming out on the sixth flip is much greater than heads."
Hard-easy effect – Based on a specific level of task difficulty, the confidence in judgments is too conservative and not extreme enough
Hindsight bias – sometimes called the "I-knew-it-all-along" effect, the tendency to see past events as being predictable at the time those events happened.
Hostile media effect – the tendency to see a media report as being biased due to one's own strong partisan views.
Hyperbolic discounting – the tendency for people to have a stronger preference for more immediate payoffs relative to later payoffs, where the tendency increases the closer to the present both payoffs are.
Illusion of control – the tendency to overestimate one's degree of influence over other external events.
Illusory correlation – inaccurately perceiving a relationship between two unrelated events.
Impact bias – the tendency to overestimate the length or the intensity of the impact of future feeling states.
Information bias – tendency to seek information even when it cannot affect action.

Irrational escalation – the phenomenon where people justify increased investment in a decision, based on the cumulative prior investment, despite new evidence suggesting that the decision was probably wrong.
Just-world hypothesis – the tendency for people to want to believe that the world is fundamentally just, causing them to rationalize an otherwise inexplicable injustice as deserved by the victim(s).
Loss aversion – "the disutility of giving up an object is greater than the utility associated with acquiring it". (see also Sunk cost effects and Endowment effect).
Mere exposure effect – the tendency to express undue liking for things merely because of familiarity with them.
Money illusion – the tendency to concentrate on the nominal (face value) of money rather than its value in terms of purchasing power.
Moral credential effect – the tendency of a track record of non-prejudice to increase subsequent prejudice.
Negativity bias – the tendency to pay more attention and give more weight to negative than positive experiences or other kinds of information.
Neglect of probability – the tendency to completely disregard probability when making a decision under uncertainty.
Normalcy bias – the refusal to plan for, or react to, a disaster which has never happened before.
Observer-expectancy effect – when a researcher expects a given result and therefore unconsciously manipulates an experiment or misinterprets data in order to find it (see also subject-expectancy effect).
Omission bias – the tendency to judge harmful actions as worse, or less moral, than equally harmful omissions (inactions).
Optimism bias – the tendency to be over-optimistic, overestimating favorable and pleasing outcomes
Ostrich effect – ignoring an obvious (negative) situation.
Outcome bias – the tendency to judge a decision by its eventual outcome instead of based on the quality of the decision at the time it was made.
Overconfidence effect – excessive confidence in one's own answers to questions. For example, for certain types of questions, answers that people rate as "99% certain" turn out to be wrong 40% of the time.
Pareidolia – a vague and random stimulus (often an image or sound) is perceived as significant, e.g., seeing images of animals or faces in clouds, the man in the moon, and hearing hidden messages on records played in reverse.
Pessimism bias – the tendency for some people, especially those suffering from depression, to overestimate the likelihood of negative things happening to them.
Placement bias – tendency to believe ourselves to be better than others at tasks at which we rate ourselves above average (also Illusory superiority or Better-than-

average effect) and tendency to believe ourselves to be worse than others at tasks at which we rate ourselves below average (also Worse-than-average effect
Planning fallacy – the tendency to underestimate task-completion times.
Post-purchase rationalization – the tendency to persuade oneself through rational argument that a purchase was a good value.
Primacy effect – the greater ease of recall of initial items in a sequence compared to items in the middle of the sequence.
Pro-innovation bias – the tendency to reflect a personal bias towards an invention/innovation, while often failing to identify limitations and weaknesses or address the possibility of failure.
Pseudocertainty effect – the tendency to make risk-averse choices if the expected outcome is positive, but make risk-seeking choices to avoid negative outcomes.
Reactance – the urge to do the opposite of what someone wants you to do out of a need to resist a perceived attempt to constrain your freedom of choice.
Recency bias – a cognitive bias that results from disproportionate salience of recent stimuli or observations — the tendency to weigh recent events more than earlier events (see also peak-end rule).
Recency illusion – the illusion that a phenomenon, typically a word or language usage, that one has just begun to notice is a recent innovation (see also frequency illusion).
Regressive Bayesian likelihood – estimates of conditional probabilities are conservative and not extreme enough
Restraint bias – the tendency to overestimate one's ability to show restraint in the face of temptation.
Selective perception – the tendency for expectations to affect perception.
Semmelweis reflex – the tendency to reject new evidence that contradicts a paradigm.[46]
Social comparison bias – the tendency, when making hiring decisions, to favor potential candidates who don't compete with one's own particular strengths.
Status quo bias – the tendency to like things to stay relatively the same (see also loss aversion, endowment effect, and system justification).
Stereotyping – expecting a member of a group to have certain characteristics without having actual information about that individual.
Subadditivity effect – the tendency to estimate that the likelihood of an event is less than the sum of its (more than two) mutually exclusive components.
Subjective validation – perception that something is true if a subject's belief demands it to be true. Also assigns perceived connections between coincidences.
Unit bias — the tendency to want to finish a given unit of a task or an item. Strong effects on the consumption of food in particular.
Well-travelled road effect – underestimation of the duration taken to traverse oft-traveled routes and over-estimate the duration taken to traverse less familiar routes.

Zero-risk bias – preference for reducing a small risk to zero over a greater reduction in a larger risk.
Actor–observer bias – the tendency for explanations of other individuals' behaviors to overemphasize the influence of their personality and underemphasize the influence of their situation (see also Fundamental attribution error), and for explanations of one's own behaviors to do the opposite (that is, to overemphasize the influence of our situation and underemphasize the influence of our own personality).
Defensive attribution hypothesis – defensive attributions are made when individuals witness or learn of a mishap happening to another person. In these situations, attributions of responsibility to the victim or harm-doer for the mishap will depend upon the severity of the outcomes of the mishap and the level of personal and situational similarity between the individual and victim. More responsibility will be attributed to the harm-doer as the outcome becomes more severe, and as personal or situational similarity decreases.
Dunning–Kruger effect an effect in which incompetent people fail to realize they are incompetent, because they lack the skill to distinguish between competence and incompetence
Egocentric bias – occurs when people claim more responsibility for themselves for the results of a joint action than an outside observer would.
Forer effect (aka Barnum effect) – the tendency to give high accuracy ratings to descriptions of their personality that supposedly are tailored specifically for them, but are in fact vague and general enough to apply to a wide range of people. For example, horoscopes.
False consensus effect – the tendency for people to overestimate the degree to which others agree with them.
Fundamental attribution error – the tendency for people to over-emphasize personality-based explanations for behaviors observed in others while under-emphasizing the role and power of situational influences on the same behavior
Halo effect – the tendency for a person's positive or negative traits to "spill over" from one area of their personality to another in others' perceptions of them (see also physical attractiveness stereotype).
Illusion of asymmetric insight – people perceive their knowledge of their peers to surpass their peers' knowledge of them.
Illusion of transparency – people overestimate others' ability to know them, and they also overestimate their ability to know others.
Illusory superiority – overestimating one's desirable qualities, and underestimating undesirable qualities, relative to other people. (Also known as "Lake Wobegon effect," "better-than-average effect," or "superiority bias").
Ingroup bias – the tendency for people to give preferential treatment to others they perceive to be members of their own groups.

Just-world phenomenon – the tendency for people to believe that the world is just and therefore people "get what they deserve."
Moral luck – the tendency for people to ascribe greater or lesser moral standing based on the outcome of an event rather than the intention.
Outgroup homogeneity bias – individuals see members of their own group as being relatively more varied than members of other groups.
Projection bias – the tendency to unconsciously assume that others (or one's future selves) share one's current emotional states, thoughts and values.
Self-serving bias – the tendency to claim more responsibility for successes than failures. It may also manifest itself as a tendency for people to evaluate ambiguous information in a way beneficial to their interests (see also group-serving bias).
System justification – the tendency to defend and bolster the status quo. Existing social, economic, and political arrangements tend to be preferred, and alternatives disparaged sometimes even at the expense of individual and collective self-interest (see also status quo bias).
Trait ascription bias – the tendency for people to view themselves as relatively variable in terms of personality, behavior, and mood while viewing others as much more predictable.
Ultimate attribution error – similar to the fundamental attribution error, in this error a person is likely to make an internal attribution to an entire group instead of the individuals within the Cryptomnesia – a form of *misattribution* where a memory is mistaken for imagination.
Egocentric bias – recalling the past in a self-serving manner, e.g., remembering one's exam grades as being better than they were, or remembering a caught fish as being bigger than it was.
False memory – a form of *misattribution* where imagination is mistaken for a memory.
Hindsight bias – filtering memory of past events through present knowledge, so that those events look more predictable than they actually were; also known as the "I-knew-it-all-along effect."
Positivity effect – older adults remember relatively more positive than negative things, compared with younger adults.
Reminiscence bump – the effect that people tend to recall more personal events from adolescence and early adulthood than from other lifetime periods.
Rosy retrospection – the tendency to rate past events more positively than they had actually rated them when the event occurred.
Self-serving bias – perceiving oneself responsible for desirable outcomes but not responsible for undesirable ones.
Suggestibility – a form of *misattribution* where ideas suggested by a questioner are mistaken for memory.

Telescoping effect – the effect that recent events appear to have occurred more remotely and remote events appear to have occurred more recently.
Von Restorff effect – the tendency for an item that "stands out like a sore thumb" to be more likely to be remembered than other items.
Choice-supportive bias: remembering chosen options as having been better than rejected options.
Change bias: after an investment of effort in producing change, remembering one's past performance as more difficult than it actually was.
Childhood amnesia: the retention of few memories from before the age of four (odd, isn't it?)
Consistency bias: incorrectly remembering one's past attitudes and behaviour as resembling present attitudes and behavior.
Context effect: that cognition and memory are dependent on context, such that out-of-context memories are more difficult to retrieve than in-context memories (e.g., recall time and accuracy for a work-related memory will be lower at home, and vice versa).
Cross-race effect: the tendency for people of one race to have difficulty identifying members of a race other than their own
Cryptomnesia: a form of *misattribution* where a memory is mistaken for imagination, because there is no subjective experience of it being a memory.
Fading affect bias: a bias in which the emotion associated with unpleasant memories fades more quickly than the emotion associated with positive events.
Generation effect (Self-generation effect): that self-generated information is remembered best. For instance, people are better able to recall memories of statements that they have generated than similar statements generated by others.
Google effect: the tendency to forget information that can be easily found online.
Humor effect: that humorous items are more easily remembered than non-humorous ones, which might be explained by the distinctiveness of humor, the increased cognitive processing time to understand the humor, or the emotional arousal caused by the humor.
Illusion-of-truth effect: that people are more likely to identify as true statements those they have previously heard (even if they cannot consciously remember having heard them), regardless of the actual validity of the statement. In other words, a person is more likely to believe a familiar statement than an unfamiliar one.
Leveling and Sharpening: memory distortions introduced by the loss of details in a recollection over time, often concurrent with sharpening or selective recollection of certain details that take on exaggerated significance in relation to the details or aspects of the experience lost through leveling. Both biases may be reinforced over time, and by repeated recollection or re-telling of a memory.
Levels-of-processing effect: that different methods of encoding information into memory have different levels of effectiveness.

List-length effect: a smaller percentage of items are remembered in a longer list, but as the length of the list increases, the absolute number of items remembered increases as well.
Misinformation effect: misinformation affects people's reports of their own memory.
Misattribution: when information is retained in memory but the source of the memory is forgotten.
Modality effect: that memory recall is higher for the last items of a list when the list items were received via speech than when they were received via writing.
Mood congruent memory bias: the improved recall of information congruent with one's current mood.
Next-in-line effect: that a person in a group has diminished recall for the words of others who spoke immediately before or after this person.
Osborn effect: that being intoxicated with a mind-altering substance makes it harder to retrieve motor patterns from the Basal Ganglion.
Part-list cueing effect: being shown some items from a list makes it harder to retrieve the other items.
Peak-end effect: that people seem to perceive not the sum of an experience but the average of how it was at its peak (e.g. pleasant or unpleasant) and how it ended.
Persistence: the unwanted recurrence of memories of a traumatic event.
Picture superiority effect: that concepts are much more likely to be remembered experientially if they are presented in picture form than if they are presented in word form.
Serial position effect: items in the middle are the least likely to be remembered
Self-relevance effect: that memories relating to the self are better recalled than similar information relating to others.
Source Confusion: misattributing the source of a memory, e.g. misremembering that one saw an event personally when actually it was seen on television.
Spacing effect: that information is better recalled if exposure to it is repeated over a longer span of time.
Stereotypical bias: memory distorted towards stereotypes (e.g. racial or gender), e.g. "black-sounding" names being misremembered as names of criminals.
Suffix effect: the weakening of the recency effect in the case that an item is appended to the list that the subject is *not* required to recall.
Suggestibility: a form of misattribution where ideas suggested by a questioner are mistaken for memory.
Telescoping effect: tendency to displace recent events backward in time and remote events forward in time, so that recent events appear more remote, and remote events, more recent.
Tip of the tongue phenomenon: when a subject is able to recall parts of an item, or related information, but is frustratingly unable to recall the whole item. This is thought

an instance of “blocking” where multiple similar memories are being recalled and interfere with each other.
Verbatim effect: the “gist” of what someone has said is better remembered than the verbatim wording.
Von Restorff effect: that an item that sticks out is more likely to be remembered than other items
Zeigarnik effect: uncompleted or interrupted tasks are remembered better than completed ones.[30]

WHAT THE ?!!!!? This is but a sampling of the hundreds/thousands of biases in human thinking that have been observed and quantified. **What is going on here?** Why did this come about? Aren't we the smartest organism on the planet? Is rationality (making the right decision given access to the relevant scientific facts) the exception, not the rule?

It turns out that humans tend to be delusional in well-established ways, for good evolutionary reasons – these reactions to everyday things by our ancestors were adaptive. However, the evolved mental 'shortcuts' that served us well in dominating the world are ill-suited to our long-term well-being now that we have dominated it. Let's explore how this came about, how it all fits together, and how such knowledge might improve our lives and possible human futures.

Part 2 - The Gift and Curse of Modular Minds

As you read this sentence, your thoughts and conclusions about it are affected by how dirty your computer is, the font I chose, how comfortable you are, the hardness of your chair, the pheromones in the air, the contents of your stomach, the things you plan to do after reading this, who else is in the room and what your relationship with them is, whether there's a color picture on the page, a black and white picture or none, your mental assumptions of Nate and DJ, the things in your peripheral vision, the sounds in the background, whether you just had a fight with your girlfriend, the vague personal past associations you have with words in the sentences, what happened the last time you were in this room, and thousands of other tiny neural modules speaking at once. This *parallel processing* in your brain considers nothing irrelevant, and folds it all in to your real-time experience and conclusions. If asked, you will invent reasons for your conclusions - and believe them - without knowing even in principle what, why, or how your brain’s modules perceived and communicated what they did. And every moment of your life is constructed this way.

Well, here's one thing you probably don't know about yourself: you don't *have* a "self" in the sense that it feels like you do. That's a story, albeit a convincing one, told by a

single brain module among many. You've often heard the phrases "*he's deceiving himself,*" "*you know better than that,*" or the general term '*self-deception.*' These terms arise from our subjective feeling that there is a little spirit in our heads which is "you" - the captain of the ship, the executive in charge, the mahout astride the elephant. It feels like the senses bring in accurate information about the physical world and our little voice inside assembles and organizes this info and makes (mostly) rational decisions about it, like a tiny Captain Kirk on the bridge of a starship. But actually, that little voice in our heads is more like a junior copy editor for a supermarket tabloid, having no knowledge of the real world at all, just story ideas from contributors he's never met, and a mandate to get an exciting paper out to those supermarkets every day which look good and sell. To do his job best, the facts not only aren't important, they slow him down.

Modern science has shown that the entire reality we experience is an after-the-fact rationalization, strung together by our little tabloid editor, based on input that has only a passing relation to reality. Our minds, like our bodies, were sculpted by evolution, and evolution did not set out to build an all-purpose computer capable of understanding the real world. Thus, a primitive life-form far back in our evolutionary lineage would have only had a few sensory tricks: eating, simple smelling, detecting light from dark, and being able to stand still or run. Such a critter would not need descriptive meta-information about the environment, such as the earth being round, the existence of gravity and oxygen; nor would it need to *integrate and reconcile* its different brain systems to create an abstract, cohesive template of the whole world.

Moreover, in addition to reacting in the correct direction, evolution was about reacting *quicker* than those around you. The fewer parts you can use to make a processing system, the faster it is. So our ancestral critter separately evolved processing modules, using bunched local groups of neurons for eating, moving toward or away from light, running or standing still, smelling, etc. To work in the real world, these systems had to all operate at the same time, *in parallel*. Predators and prey won't wait around while an animal chooses which of her skills and senses to activate.

Fast-forward to the better part of a billion years later, and those adaptations still work (as a trillion cockroaches can attest!). But as evolution expanded life and complexity, a few branches of the animal tree led to lifeforms which could support larger brains. These brains evolved with excruciating slowness, which is the natural pace of evolution. When a new ability was adaptive, it was tacked on top of and in front of the existing neural scaffolding of prior successful adaptations. A subsystem that originally evolved to smell things might get better at reacting to the smells which proved salient to the critter's survival, but such a "smelling module" wouldn't *additionally* evolve to perform something entirely unrelated, like detecting the sound of approaching

footsteps. Doing so would just have slowed down a perfectly good evolved smell module by getting it to do something entirely different. As such, the smell module would be *conserved* over time, and a new brain modality would be added.

Modern airliners don't actually need pilots; they can take off, fly to their destination and land perfectly well. They have nothing LIKE an understanding of the world; they have utterly unconscious heuristics which cause them to do certain things at certain times, consult both GPS and doubly-redundant inertial navigation devices, radar to avoid whacking into things, and various programmed responses to conditions airplanes have encountered in the past and are thus likely to encounter in the future. However, the plane doesn't understand the world, see the world, or even 'know' a world exists.

And that's what evolution has done with our large and spectacularly successful human brains as well. Just like the plane, most of the process of *thinking* is just like the cockpit machinery in that aircraft. Our brains are large aggregates of context-triggered brain modules; IF this happens, DO this. We don't have to think about breathing, speeding or slowing our heartbeat, priming our nerve potentials preceding movement, topping off our muscle cells with ATP, enacting peristalsis, emitting the right amount and kind of saliva, maintaining our blood sugar, balancing upright to walk, or maintaining thousands of other processes which keep our bodies working, and that's a darn good thing since a central self would be swamped if it had to do those things consciously. A whole lot of things have to go right for a brain to see a flower and know it's a flower.

In other words, most of the 'thinking' the brain does is kept invisible to our consciousness for the same reason we don't have to consciously excrete insulin after a meal: it would bombard a conscious mind with overwhelming stimuli to the point of helplessness. Our brain does these bodily tasks for us quickly, frugally, and quietly. Modern neuroscience terms this functional modularity 'fast and frugal heuristics.'

One relevant phenomenon resulting from our modular minds is that we tend to go overboard in attributing agency (**agency** = *the existence of an entity (person, animal, monster, deity) behind some movement, action or phenomenon*). It was extremely valuable in evolutionary history to detect predators, enemies, dangers, and emergent threats to social and mating status. So much so that the downside of "false positives" was disproportionately far greater than "false negatives". This created critters who erred greatly on the side of detecting dangers and enemies, and often attributing agency where it didn't exist. There was a negligible cost to thinking a pile of grass was a lion, but a very large cost to concluding a lion was just a pile of grass. Our visual

systems are primed for predator and face recognition, so we see predators and faces in random shapes.

Moreover, we generalize this to infer conscious agency for many occurrences in the physical world unconnected to living systems. As such, most humans have a thriving coterie of imaginary friends and enemies, despite the fact that this is technically insane. Many people have a whole pantheon of angels, saints, and other entities they believe in. Many also believe their dead family members are with them and consult them. Some people threaten their cars. Most people believe in the "invisible hand of the marketplace" as a guiding force in current society, etc. Since our default mental mode is to conform with our tribe, our social relationships with invisible friends, enemies, and abstractions are generally considered more important by the human species than the ecological details of our physical world. *What could possibly go wrong with that*?

Human brains have morphological modularity (dedicated functional substructures like the optic lobe, medulla, cerebrum, limbic system, cortex, neocortex, and R and L lobes); functional/heuristic modularity such as dedicated sub-areas which have been assigned by evolution to carry out certain kinds of sub-processing like language, face recognition, snake recognition, etc; and contextual program/story modularity, such as Christianity, biology, conspiracy, aspects of self-image, cultural narratives, personal narratives, etc.[31] This modularity exists to prevent neural processing bottlenecks: if everything the brain processed had to be run through a single "you", you'd be so slow that sparrows could prey on you. Our modules process all sensory information heavily and forward only the filtered results between modules.

What emerges from this unique neural machinery is nothing less than our reality, our "selves," and the biological basis of bullshit. Brain researcher Michael Gazzaniga notes, "*Consciousness is not a single generalized process. It's an emergent property that arises locally out of hundreds or thousands of widely-distributed specialized systems and modules. From moment to moment, different modules compete for attention and the winner serves as the neural system underlying that moment of conscious experience. We don't experience a thousand chattering voices but a unified experience. Consciousness flows easily and naturally from one moment to the next with a single unified and coherent narrative. The reality we experience emerges out of a particular specialized system I call the 'interpreter', which is specialized to the brain's left hemisphere. It is the trigger for human beliefs which constrain our brain*."

It turns out the "conscious self" we are aware of is a small subsystem in the left hemisphere of our brain which creates a seamless illusion of "self", which probably evolved to make us more effective in social interactions. This module is *entirely unaware* of the other modules as their inner workings are invisible to it. Our conscious

minds have no more access to the roots of our quick decisions than they have to knowing about the secretion of hormones by our pituitary. For example, learning that an optical illusion isn't real still doesn't make it go away, because the little specialist module which misinterprets what it sees doesn't understand words or communicate – it sends its results on a one-way line. There is no way you can "introspect" your way into the working of the limbic system or take conscious control of your blood's salt balance. We have no conscious access to the cognitive modules which make us feel a negative impression of someone due to a faint background odor in the room or because they look like someone who scared us when we were two years old.

The kicker to all this is that since the "interpreter" module has NO knowledge of (or access to) the other modular sub-processes of the brain, but only to the outputs (decisions) made by thousands of babbling idiot subsystems, it just makes stuff up, typically settling for a self-consistent story that reflects most favorably on the individual tribe-member in question: YOU. As such, we live inside self-constructed virtual worlds of post-hoc confabulation. This is the story which is communicated to those around us. It can be pretty much entirely BS, but it's *our* BS and we are evolved to believe it absolutely, without question. Even if we frequently (and retroactively) change this story, our feeling of belief and confidence in it seldom wavers.

So, one high-level module, out of thousands, acts as an "interpreter" of events, and is tasked with making our experience of the world into an internally-consistent story. Yeah, that sounds wacky, but it's true. It can be directly tested in people who have had an operation to cut the connection between brain hemispheres. There's a large bundle of nerves called the corpus callosum which acts as a high-speed conduit for information-sharing between the brain's left and right hemispheres, and it turns out that some kinds of seizure disorders can be cured by the drastic step of severing this bundle of nerves. What results is that each side of the brain becomes a separate person, entirely unaware of the other, each with a specific subset of the sensory information and motor control the original person had, and these 2 'people' *have entirely different personalities.*

By asking questions of these patients and feeding different sensory information to the separate minds, one can see the left-hemisphere "interpreter" in action, creating a made-up reality by filling in the gaps. For instance, one can show the right hemisphere a picture of a dog and the left hemisphere a picture of a bird and tell the right hemisphere to draw a picture of what it sees (with the left hand, which it controls). One can then ask the right hemisphere why the left hand drew a picture that looks a lot like a dog. Rather than saying "I don't know", (the correct answer), the left hemisphere makes up a plausible story, such as "when I last saw a bird it was being chased by a dog.*" It's the interpreter's job to make us believe we know, and thereby*

to help us convince those around us with the best story it can come up with. It clearly doesn't just do this between hemispheres, but with all the structurally and functionally independent processing centers of the brain. Instead of "interpreter," we might just as well call this module the "Public relations" module, the "press secretary," or the "storyteller."

What emerges is that the interpreter creates a self-serving story and believes it utterly, even though it has literally no idea why a quick decision was made or action taken. Our "sense of self" that arises from this "interpreter" (or "executive secretary") module stitches our inner voices into inferences and explanations that create a narrative that is socially advantageous to the individual. These stories may have little to do with truth or reality, the sole requirement is that they reflect well on the individual in a social context and are plausible to other tribe members. The most efficient way of deceiving other apes is to sincerely believe your own lies. There are good evolutionary reasons for this: it's hard to lie without detection. There are many physiological changes which occur when active lying is taking place (as the best poker players know), and it also requires that one keep track of multiple complex storylines (as devotees of soap operas know). Therefore, to the degree possible, it is most efficient and advantageous for an organism to really believe what it says.

This eliminates any "tells" which might prevent successful beneficial-to-the-self lying. But as you might guess, it makes it difficult for us to do non-social thinking, or to believe facts which do not fit well within such self-helpful story lines. Additionally, our narratives are exclusively post-hoc, created from whole cloth after decisions have already been made. And, though these narratives are what we generally refer to as 'reality', they are only weakly anchored in physical reality if at all.

Having multiple modules means that we can *sincerely* hold many mutually incompatible beliefs in our heads. This works because they're context-triggered. We don't reconcile our beliefs: they exist in parallel. So one may not believe in evolution when it comes to creation of life on earth, but still believe it's a good idea to get a flu shot every year due to the influenza virus evolving virulence in a competitive evolutionary dance with the human immune system. If evolution didn't exist, we wouldn't need annual flu shots. But the human mind does not reconcile its conflicting beliefs produced by different modules, because with modular beliefs you get the adaptive benefits of belief while avoiding the downsides of the extended implications of such beliefs. Being human means, for the most part, never having to reconcile your 'beliefs'.

To further complicate things, most of our modules don't synthesize, while the real world does nothing but. Our brains can shift focus quickly, but we mainly do one

thing at a time. In school we learn our subjects separately - Spanish, math, psych, etc., and that's the way they stay. Yet that isn't the way things happen in the real world of complex adaptive systems.

So:

1. *our 'self' is actually hordes of independent idiot-savant mini-brains and modules who for the most part have no knowledge of what the other brains do, or that other modules even exist.*
2. *Our interpreter module seamlessly creates stories that are socially acceptable to inputs it wasn't privy to.*
3. *We believe this process was decided rationally by us and is the 'truth.'*

Our brains work this way, and well, simply because this was adaptive to our ancestors and continues to be adaptive to us as individuals today. *But* y*ou, dear reader, are in the first generation of creatures in a billion years to learn this information about the actual nature of your mind*. This wasn't known before, and now it is. We are specifically evolved to make up stories and utterly believe them. That has historically helped our fitness as tribal primates. In a species which is now controlling an entire planet, it's an interesting (and relevant) factoid to grasp. We are each of us an enormous committee of specialized idiot-savants ensconced in a single brain case, experiencing a virtual world which is created for us by an amalgamation of parallel simple processing systems, integrated by unconscious processing, and interpreted for social purposes by a small, recently-evolved module which - unaware of what the rest of the brain has actually considered - creates ever-changing stories about the world and the self. (While writing this paragraph, it strikes me that it's no wonder we haven't understood this process!)

So where does that leave us? We have modular minds, structurally and functionally, plus an illusion of unity, knowledge, and certainty. Yet the upside of recognizing all this (call it '*self-aware modularity*) might be significant. This mind modularity is a new and alien-feeling concept, but it is clearly central to our humanity. We need stories to arrange our lives and perceptions by, need a sense of *ourselves*, need to function in one body in the modern world despite being a committee of idiot-savants playing by obscure, stone-age rules.

Understanding ourselves in this way could remove the stigma from believing two conflicting things at once, which is often a practical necessity to live as a well-adjusted social human. If we cut ourselves some slack, we can with a bit of discipline have magic coexisting with science in the stories of our lives. We might *choose* our beliefs without requiring that they be logically congruent with one another, to be happy socially while being responsible ecologically. It might be possible to be a

Christian atheist or scientist magician, or any other combination of beliefs which allowed us to live happily and sustainably in the future. To actually love our enemies.

Our human minds are the most complex weavings of information in the known universe. Indeed, each of them constitutes a virtual universe which comprises the "reality" we subjectively experience. But none of us evolved to possess a mental module with a task of *accurately understanding the world*. Things feel "right" based on the agenda of the gene, for a good reason. They feel right because in the past they have aided our ancestors' survival, not because they are *correct*. This is a good thing, since physical reality would suck to experience directly, while our virtual version of it can be delightful. However, it is becoming clear that collective delusion about the physical world is leading to (big) problems.

So if we live in retroactively-confabulated worlds and are evolved to passionately believe our own made-up stories based on the outputs of a huge internal committee of anonymous enfranchised savants and imbeciles, what do we do? Well, one choice is to believe this is not the case and carry on, which is probably the default. Another option is to be open to becoming aware of our own cognitive biases, questioning our firmly held beliefs, where they came from, and why they feel so strong. And hopefully it will help us appreciate that our "interpreter" module has at least opened the door to kinds of thinking which did not evolve with the brain, but via human culture. Things like logic, mathematics, science, and an ethic based on ecological first principles rather than feelings. These thoughts don't come naturally, and they lack the evolved power of feelings, but they can potentially filter our thinking in useful ways, and open our beliefs, and ultimately actions, to change.

This speaks to us as individuals. However, in a super-social species, our brains possess some other relevant neural machinery that was adaptive to our ancestors, which we politely refer to as 'The Power of Crazy'.

Part 3 - The Power of Crazy

Once upon a time, there was a species which told stories to itself. Some of the stories were very clever, others were very fanciful; still others contained wisdom about the experience of life and love, or insights into the physical world around them. This served the species well as it expanded into a functional social hive, but there was a catch: the species couldn't easily tell its stories apart. As it conquered more and more of the earth, wiping out predators and opponents, and pretty much everyone born survived to middle/old age, the lives of its members became increasingly detached from the physical consequences of believing fanciful stories, and a convergence of

evolved mental traits led to the pervasive belief in stories which were in some ways wildly at odds with long-term survival needs. And this species is….us.

So why are we a story-telling species? How is the "story" a central part of being human?
Members of a species need to communicate with one another. Members of species that live in groups, even more so. And extremely social species –like our own – greatly depend on ongoing communication between individuals. As we developed into *Homo sapiens*, evolution increasingly favored verbal communication over simpler forms. Human speech evolved from making sounds to making words and ultimately to stringing together complex and nuanced word groups into sentences and speeches. We started using words to represent things and actions, and to invoke references and metaphors to convey abstract concepts.

This conveyance of abstractions was (and remains) adaptive. Speech is a "serial" communication system – each additional word sharpening the texture and meaning of the image/concept conveyed by the preceding words. For example, "*The eggs of the Thunder Turtle are as bright as a thousand sunrises and bigger than the early moon and they smell like crushed red flowers.*" Metaphor drastically speeds up communication by invoking comparisons with complex things that already reside in another person's mind. "*That thing I saw was like a leopard but bigger. And brown.*" "*If that rock falls on you, it will be like when the mammoth stepped on Uncle Paz.*" Narrative immediately creates a virtual reality in the mind of others (did you just envision a woolly mammoth stepping on a caveman?).

In order to work, narrative communication is inherently imaginative when referring to things and concepts. It doesn't need to be perfect; the real-world standard for a competitive advantage is *fast* and *good enough.* It doesn't matter that the way one person envisions a leopard may not be exactly the same way as their friend, or whether each has the exact same virtual memory of a smashed uncle.

As purely imaginary creations of the brain, narrative and metaphor are by definition untethered to physical reality. As such, this type of communication has no built-in correction mechanisms for corresponding to reality. Sentences could be constructed which evoked vivid pictures in the mind of both the speaker and listener, pictures of "crazy" things which had no real counterparts in the physical world.

This wasn't just confined to communication. As humans became more socially verbal, it became more efficient to not only communicate in metaphorical narrative but to ***think*** using the same language/syntax used in that communication. This ability allowed the thoughts of one mind to be quickly and approximately communicated to

another. Communication using words which invoke metaphors takes advantage of the shared experience and great similarity between tribe-members' minds. Most members of a small tribe will have very similar memories – many of them visually, auditorily, tactilely, and olfactorily complex – and the ability to refer to these memories and concepts in another brain by triggering that brain with a short phrase is powerful and "good enough" even though no two people remember the crocodile stealing the gazelle from the leopard in exactly the same way (since no complex situations will be exactly alike).

Visual thinking can be extremely powerful, but there is no practical way of transmitting visual-cortex abstractions quickly between minds. Pantomime? Drawing a picture in the dirt? A picture, the saying goes, is worth a thousand words; which is another way of saying it would take a thousand words to describe a simple mental picture. When running from a pride of lions or chasing a gazelle, it made evolutionary sense for tribe-members to think in ways which were capable of being quickly communicated, and that meant an internalized language in the mind.

As an alternative to actually transferring a complex, information-dense physical experience somehow, the ability to refer to concepts that already exist in the mind of the listener allows the speaker to insert subjective emotion and imagery merely by creating a rough facsimile in the others imagination. Consider how this skill would have provided advantages to individuals and tribes on the Pleistocene (and to those of us reading these pages even now).

And, the actual thoughts received by the listening human did not need to be the same as those of the speaking human – the communication just had to be "good enough" to get the job done. There's an old joke about a hillbilly who fell through the floor of an outhouse and yelled "Fire!" After he was rescued, he was asked why he yelled "fire!" And he responded, "Well I didn't reckon anybody would come if I yelled "shit!"

If your friend says that flying standby on Podunk Airlines is like being the new kid in a Turkish prison, it's a pretty vague metaphor, but your interpreter module will make some sort of sense of it... or try its best. It probably doesn't matter that you have to imagine what that means: you get the gist that he didn't like it. Orangutans and bonobos do not have this skill.

So if by "crazy" we mean objects, abilities, situations, entities, relationships and propositions which don't exist in the physical world, it's clear that it's not easy to sort "crazy" from real. The funny thing is that, for most of human existence, this turned out not to be a problem. The narratives which were obviously contradicted by the evidence of our senses were corrected. "*Antelope dead at bottom of cliff, so antelope*

can't fly like owl." Those which never required obvious correcting based on physical evidence became harmless nonsense beliefs which varied from tribe to tribe, spun into tall tales and legends which gave hunter-gatherers something to do with their large amounts of leisure and campfire time. A bit of crazy was a small price to pay for a workable abstract communications toolkit between tribe members.

And yet the "power of crazy" ultimately turned out to be hugely important in human history, allowing us to navigate fundamental bottlenecks on socialization and cooperation.

All social primates face processing limits with brain size relative to the number of interconnected nodes/relationships in a group. In our species with a 1300-1400 cubic centimeter brain, an individual can keep tabs on and maintain real relationships with about 150 other humans (Dunbar's number).[32] All things being equal, larger organisms are more formidable competitors than smaller ones. Tribes cohesively functioning as a 'superorganism' would be more formidable still. But populations larger than 150 or so could not easily coordinate actions because as numbers increase, it becomes less feasible to maintain effective "social grooming," which requires familiarity and trust etc. Among other things, our finite neocortical capacity limits our ability to accurately detect falsehoods and form alliances when interacting with too many people due to the time investment needed to familiarize with each individual. Furthermore, larger and less cohesive groups would be less efficient at everyday tasks because individuals could 'free ride' and cause instability. Ergo, most ape groups are constrained by a maximum size, and this been the case for humans through most of our history.

Enter the power of crazy. It turns out that thinking in metaphor-laced narrative opened the door to super-socialization. It does this through:

a. the attractive appeal of supernormal ideation (hat is, thinking about made-up things which have qualities that "peg the meter" of supernormal stimulation inside a brain). e.g. "*The Thunder Turtle is bigger than a mountain and poops lightning, and flies so fast it cannot be seen.*"

b. the agreement by group members upon beliefs such as imaginary entities and authority figures, enabling one to rely on *predictable actions by others based on their holding these belief*s. e.g. "*We both know that the Thunder turtle favors our tribe and will reward us if we do his will. I know that you know that he sees our thoughts so neither of us will cheat.*"

c. reshaping individual self-image in accordance with a belief in these shared mythologies. e.g. "*I am a member of the Thunder Turtle clan and cannot be easily harmed. If I am harmed, the Thunder Turtle will make me well.*"

This transition to *entirely virtual* communication conferred behavioral cohesiveness in our ancestral groups that could not have been achieved by using purely physical descriptors of real world situations. Imagining and then communicating imaginary things and weaving narratives around them was only limited by our ability to creatively visualize in our heads. These narratives then merge with others and evolve into ever more coherent-seeming and awe-inspiring stories – even crossing over into mythologies. Using an evolutionary lens, the more stimulating, inspiring, calming, enraging, etc. story elements were 'fitter' and thus were highly conserved in a virtual process analogous to gene-sharing in viral evolution.

The "game theory" calculation *(correct behavioral cost-benefit action to take)* changes if you know that the members of all tribes which believe in the Thunder Turtle share the same understanding of the Thunder Turtle's desires, because all believers in the Turtle will dependably punish cheaters who disobey those desires lest the Thunder Turtle punish them. A shared narrative and mental visualization provides a reliable basis for trust and cooperation with less-known extended tribal members living in different territories. Aligning your own goals with those of the Thunder Turtle was a path to a larger and more powerful group than the ~150 humans in close proximity would allow. And, moving another level up the hierarchy, an alliance of tribes which all believe in the Thunder Turtle could in turn form a more formidable superorganism than smaller groups of tribes, and the resultant cohesion and coordinated fast response would in no way depends on the Turtle intervening, or even existing! Thus the power of crazy had (and can have) very practical results.

Indeed, being "crazy" in this sense may be a necessary quality enabling a belief system to confer these benefits. An arbitrary supernatural belief system that empowers its believer cannot include things which are subject to obvious falsification, such as "*Thunder Turtle shamans bleed purple when stabbed.*" They need to be impossible to check, and to have a good fit with our grab bag of evolved cognitive biases, fears, and lusts. Moreover, if a supernormal narrative does not "peg the meter" of imagination, it is subject to being replaced by one which does. Thus, mythologies successful at organizing at larger population levels evolve toward significant disconnect from the physical world, and toward imaginative hyperbole.

Believing in the supernatural turns out to be enormously effective as a social glue, and one of the chief powers of crazy is that one's own concept of self evolves side-by-side with the organizing narratives. This is so powerful it can enable army-ant style

selflessness in order to benefit strangers. For instance, Japanese kamikaze pilots truly believed they were descended from the Sun god, were representing a holy emperor, and that by crashing their planes into the ships of the 'monkey-people' they would earn favor and live forever. Our hunter-gatherer tribes have come a long way.

As world population and wealth increased, first newspapers, and more recently social media and internet talk shows and news, have expanded our narrative communication at warp speed along billions of human neural nodes. And the most common mythology of our time may be the faith in progress and markets. Abstract financial alchemy and arcane econometrics formulae underpin our institutions and cultural expectations. Our modern democracies have no Plan B beyond growing indefinitely on a finite planet. Such is the power of crazy.

Part 4 - Delusional R Us – Conclusion

The statement that "humans are delusional" refers to a core fallacy: the belief that humans perceive and understand the physical world the way it actually exists. No animals actually understand this, so *it's only a fallacy because we assume that we do*. But can any species really be delusional? All are evolved to successfully reproduce, and by doing that, they have met the test of survival and evolution.

We'd say that all species are delusional relative to having a perfect understanding of the world, and that it *usually doesn't matter*. A housefly knows nothing of plate tectonics, it just knows how to find dog poo, avoid dragonflies and spiderwebs, and mate, and that suffices.

Yet if a border collie believed it could successfully land a jumbo jet, that would be pretty delusional. Not as delusional as if it were a Dalmatian, but pretty delusional, and fraught with no small consequence for the dog and its trusting passengers. "You can do it, girl!" "Arf!"

As we enter the 21st century, we're in a roughly analogous situation to beginning a dead-stick night landing of a 747 with a confident dog in the pilot's chair chewing on the throttle knobs, because while we have minds which are wonderfully well-evolved to exist in small tribes of hunter-gatherers, we have surged in population and impact to the point that those evolved systems are entirely inadequate to the current careening crop of emergent predicaments we have created.

But border collies are trainable, and so are we. This Honors seminar would be rather pointless if there was no possibility of altering the course of events, and I hope to show that by understanding ourselves and our world according to logical "first

principles," we can derive a good overall view of the world which is not skewed by evolutionary baggage, and can learn the discipline to work with the minds we actually have.

A thermostat might do a great job of keeping your house between 55 and 68 degrees but expecting it to also give stock market advice would be delusional. The thermostat isn't delusional, but outside its realm of functional competence, it would be effectively useless. Similarly, we have used the word "delusional" with respect to humans believing their mental constructs represent the physical world as it actually exists and making decisions about the physical world as though that were true (for instance, deciding that sea level can't rise because a particular God wrote a book saying the world would never flood again). So, the principle delusion is that the brain characteristics which have evolved to enable past survival and reproduction are equally well-suited to making decisions about the physical world now that our species is the top predator and controlling the world's biomass, chemistry, temperature, climate, and other systems.

So do we intend "delusional" to be pejorative, another way of saying "stupid," a snarky way of putting down those who haven't come to the same conclusions we have?

Emphatically, **no**. In fact, a fair degree of what we term delusion is probably necessary to be sane, and certainly necessary to enjoy being a human, and find happiness. It's a gift. The physical world we exist within is not what you'd want to perceive directly. It's a place without color, texture, meaning, love, humor, or anything else we value. Our minds present us with a virtual world vastly different, with all these wonderful things added to it, with our senses and brains logarithmically compressing wide ranges of real-world variation in brightness, loudness, smell, touch, etc. into subjectively linear experiences.

It's hardly surprising, then, that we treat our virtual simulation as real: it's the only thing we will ever, *can* ever, experience. In our virtual worlds, magic exists, and anything is possible. Which is a great way to live as a member of a hunter-gatherer tribe. But perhaps it's not as well matched to overseeing a planetary ecology we currently dominate but don't collectively understand (arf!).

It may be that in a far future where humans have sagely avoided a thousand kinds of disaster, delusion will become celebrated for the central role it plays in the quality of human life, and will be pursued in full realization that we are delusional, and that's grand. If so, there will have to be a demarcation in each mind between what IS and IS

NOT delusional relative to the realities of the physical world, or else have a subset of the population acting as “designated drivers” to run things using delusion-filtered thinking, to allow the rest to enjoy the bliss of unfettered delusion without wrecking the planet, our resources, or each other.

So Nate & DJ are not only delusional, we spend most of each day knowing we're *being* delusional because that’s where the fun, camaraderie, enjoyment and pleasure exist. However, we’ve found that it’s possible, in principle and in practice, to index our delusions - to identify, acknowledge, and correct for evolved bias, known fallacies, and the usual human blind spots; and to use delusion-filtered thinking to understand and deal with physical-world reality. Doing so continues to be an interesting journey, full of “mind bombs” which reframe the stuff we always thought we understood.

But that’s not all there is to it. There’s also an emergent quality to the process: gradually seeing the way the puzzle parts start to fit together in understanding why the world is the way it is, and what we can know about the future. Our physical world does really exist as a cohesive whole with everything happening at once: to some extent, if we don’t at least dimly understand how the parts fit together, we don’t understand anything.

Delusion is necessary to be human and to enjoy being human, yet non-delusional thinking is necessary for some classes of decision, in order for humanity to continue to exist in deep time rather than crashing into limits. We need both for different uses, so we’d better learn to tell them apart.

Time Bias and the Fourth Dimension

We possess a certain evolved cognitive bias which the psychological literature refers to as the **discount rate** because of our tendency to discount the value of things we expect to receive in the future relative to the value of things we expect to receive immediately. We prefer to call this phenomenon the **time bias**, in hopes of moving its discussion out of academia and into mainstream thought. It seems a perfectly reasonable name for it, because it does relate to time, and it is indeed a bias: rather than making logical decisions about the future, we are perpetually pulled towards the immediate by an ancient yet intact hunter-gatherer instinct which keeps telling us that "a bird in the hand is worth three in the bush."

How did the time bias evolve? First, the vicissitudes of fortune and the general uncertainty of life have conditioned us to take advantage of opportunities quickly, lest they be lost to us forever. In nature, most organisms do not live as long as their biological potential, making long-range planning on their part problematic. Therefore, their emotions and instincts drive animals to pursue short-term goals such as eating and mating. These are automatic behaviors, rooted in older brain regions such as the limbic system, and they are inherently myopic: as long as they remain active, the future carries little weight. Indeed, most species have no concept of "future" whatsoever, and humans are still developing one. In our planet's past, had you waited to eat, that food might have ended up in another's belly instead of yours—or *you* might have ended up in another's belly! In a healthy ecosystem, resources necessary for life do not go long unclaimed.

Second, the risk in deferring immediate consumption by betting on the future comes in many specific forms: risk of spoilage, risk of destruction and risk of your own non-survival, among others. For example, a healthy 30-year-old male in the US has a 7.96% chance of failing to survive until his 50th birthday. The list goes on and on: risk of loss of access, risk of government expropriation, risk of obsolescence, risk of you forgetting what it is you are waiting for?...

Time bias is cross-linked with another bias: **loss aversion**. It *feels* better to us to avoid a loss than to realize an equivalent or a greater gain.[33] The thought of giving up a doughnut we have *feels* more important than the thought of getting an extra doughnut.

Time bias is strengthened by our lack of certainty about the future. You can eat all of your seed corn now, or plant some of it in hopes of reaping a harvest next year, but if you think that you might starve before then, then it makes more sense to you to just eat the seed grain. If a friend offers to buy you two doughnuts tomorrow in exchange

for eating your one and only doughnut today, you might wonder whether she really means it, whether she will remember her promise tomorrow, whether she will even be here tomorrow, whether she will have the money to buy the two doughnuts, whether donuts will be available tomorrow, and so on.

In all, it just *feels* a lot more important to us to get something sooner than later. Such feelings have come from evolutionary adaptations passed down to us from our ancestors, who didn't analyze such things at all. They did what they had to in order to survive, which was to err on the side of the immediate. And since they did survive, they passed on their tendency to favor the immediate. These *feelings* are the bias. Keep in mind that nearly all of our decisions are made on the basis of feelings rather than rational thought.[34] The processes that give rise to these feelings aren't even conscious. We rationalize our irrational decisions after the fact, if at all.

Are you starting to see how these biases can lead to problems such as obesity, hoarding, and mindless consumerism? In the unnaturally plentiful conditions of an industrial economy, the same strong urges that helped our ancestors survive can easily drive us to excess, even imperiling our survival.

Our current society does little to help us control and moderate these urges. If it feels good to immediately spend your entire paycheck on things that make you feel good right here right now—fast food, alcohol, tobacco, drugs, entertainment, massages, status symbols, toys—then what is to stop you? But this focus on immediate reward can lead to a dysfunctional lifestyle: over time, it takes an ever-increasing amount of consumption to achieve the same level of euphoria. This is called the **hedonic ratchet effect**, and it leads one to develop ever-larger, entirely unnecessary or even harmful habits.[35]

We can be said to inhabit a three-dimensional (3D) world—but only if we disregard the **fourth dimension**: time. It is easy to imagine a person's past as being 4D: not only can we see what that person was doing at any single point in time, but from our vantage point in the present we can trace out the entire four-dimensional shape of her life as it has played out. Your own past life will also have a discernible 4D shape, since you know about your own past. But since we cannot see the 4D shape of the future we tend to fall back to 3D, leading us to concentrate on immediate gratification rather than long-range planning. Most of the time this works. But it is just as useful to consider the future as 4D as it is the past, especially when it comes to large-scale phenomena: economies, civilizations, species and ecosystems. Life unfolds in 3D, but it leaves a 4D trace in our minds, which we can, in principle, project into the future using our imaginations to actively plan out our 4D future.

Most of us already know how to do this in our own lives, to some extent. We learn to defer rewards available to us in 3D reality in order to have a more successful life as

viewed in 4D. Saving part of our paycheck makes us more resilient to unexpected problems. Controlling our appetites to avoid becoming morbidly obese gives us better chances in the future. We restrain ourselves from killing someone in anger because we can see, with our 4D vision, that this action is likely to result in severe negative consequences.

To the extent that we can defer gratification, we tend to do this more as a culture than as individuals. Our culture encourages us to learn how to ride a bike, study foreign languages, pursue a college degree, save money, eat healthy, etc. We also build things that provide benefits beyond our lifetimes, like cathedrals, institutions, social contracts (in theory). None of this necessarily implies having a sophisticated vision of the future. Your parents did not independently deduce that you should learn to tie your shoes, ride a bike or go to college; they just followed a **cultural template**.

In the most extreme examples of deferred gratification, people defer their rewards until after they are dead and buried. Those who believe that their consciousness will survive after they are dead, and that the greatest possible reward will be given to them once they "shuffle off this mortal coil," can defer their reward permanently. Even though this is a nonsensical proposition— in order to be realized, reward has to be perceived by a living brain—its behavioral effects on individuals and populations can be profound. It may be seen as a culturally evolved workaround to the time bias and other such bugs in our genetic programming, and in many ways, it is a useful "behavioral patch" for impulsivity.

Such supernatural and non-rational behavioral patches are ultimately framed by selfish individual motives. In addition, they are subject to an inherent limiting factor too: they are not based on logical thinking and observation—that is, they are not based on bias-free thinking—and this makes them useless for defining and attaining any specifically desired complex-system or ecological realities. If *Homo sapiens* were to live up to the name, some of us would need to learn how to chart a path for our collective futures by relying on facts rather than feelings, deferring immediate gratification based on realistic 4D aspirations and waiting for the good feelings to follow later.

The good feelings we seek now are no different than the emotions that helped ancient hunter-gatherers survive, but the activities done now to attain those feelings just don't align with the original evolutionary world and aren't consistent with 4D planning. We can derive satisfaction from music, art, sports, games, social events and much else—all the things that do not automatically cause problems in the future. Moreover, we can learn to care, and to derive a deep satisfaction from being a responsible part of a much larger story, knowing that our efforts on behalf of innumerable future childhoods can make them possible, and happy. These efforts would not be on behalf of just *our*

future children: in deep time, the same choices that make future human childhoods possible also allow other large complex species to continue to exist.

Case in point: since we have come to exist as a species, there have been fewer than 100 billion human lives lived. How many will there be in total, in 4D, and what will their quality of life be? This question is *never posed*, even though it is perhaps the most important consideration for a self-aware species. Nor is it a particularly abstract question: it will, one day, have a specific, concrete answer.

Most mammalian species persist for at least 5 million years.[36] If we follow this pattern, we have many millions of years left, and if we exceed this expectation—because we are, after all, an unusually adaptable species, able to exploit numerous ecological niches—we could perhaps persist for tens of millions of years, and many trillions of lifetimes left to play, discover, create, and experience. This sounds like science fiction, because we can't really imagine it. And because we can't imagine it, and it doesn't *feel* important, we don't even try. We live with a time bias, favoring people who have already been born, and assign to future humans the status of nonentities—mere abstractions—because it *feels like* the thing to do.

From a 4D perspective, by around the year 1800 AD the only thing we had to do to attain *trillions of human childhoods over millions of years* was to follow a simple dictum: "Don't wreck the planet." This is probably the first time you have ever heard this point made in this way, because it comes from an alien perspective that has been hiding in a human blind spot. Even if we set our sights on just the first trillion human lives, that would already be ten times as many humans as have ever lived since we evolved. These are the lives we may be condemning to nonexistence by using up all the non-renewable natural resource concentrations as fast as we can and by wrecking the biosphere and the populations of wild animals. These lives may feel abstract, but your own existence doesn't seem particularly abstract, and it wasn't so long ago that you had the exact same status as they do.

Will the future of the Earth allow for even one trillion more human childhoods? That is doubtful, *if* we continue on our current "business as usual" trajectory of digging up and burning up the planet. Our best science tells us that we are pushing toward a hothouse climate that the Earth hasn't experienced in 55 million years, entirely unlike the one we evolved in.[37] It would seemingly be an overheated world with parched lands and stagnant oceans full of jellyfish, worms, and slime. So, will there be room for ten billion more human lives in this world? Or 50 billion? Or 110 billion? This question will eventually have a specific, precise answer—an answer significantly determined by what we do, and do not do, in the coming decades.

We could decide that the future has an importance that transcends our own lives. The idea of a trillion happy human childhoods is not only grounded in reality, but it is also

wonderful enough to act as a highly motivating supernormal stimulus. That is, it is possible for us to decide that the goal of enabling these future lives rather than preventing them is a very good goal. Then we would gain pleasure simply by aiming for it. We are not *evolved* to think this way, but neither does evolution preclude such thinking.

The question of whether we should learn to *unselfishly* defer rewards to the future has deep ramifications for our species' existence, and the quality of that existence. The agenda set by our genetic programming is to perpetuate a feelings-based system geared toward maximum reproduction, maximum power, and maximum consumption in the now, and to cultivate a lackadaisical, see-what-happens attitude toward the future. It will always favor giving birth to 20 billion starving humans over 2 billion happy ones. But the agenda set by the rational mind can take into account quality of life and 4D time and can—in principle—chart a path that optimizes our species' 4D existence, both quantitatively and qualitatively. The agenda set by our genes may feel good, but if we pursue it, it will *not* get us to a trillion childhoods, and it *will* wreck the planet as a habitat for large complex life for a very long time.

Yet our failure to plan for the future is an understandable thing: in the 3.5-billion-year history of life on Earth no organism ever thought particularly far ahead until quite recently, when fairly advanced brains came on the scene.

Plants and animals can only focus on the present moment. Even a squirrel gathering acorns for the winter is instinctively focused on the all-consuming "now" of doing what feels right to do immediately. It doesn't think about the coming winter, nor does its DNA have any concern about a coming winter. Being a squirrel implies hiding acorns during autumn, and the more acorns it hides, the better it feels. It is following the unconscious agenda of its genes and needs no concept of the future. The first squirrels to accidentally hide some acorns turned out to be more likely to survive and leave progeny that was increasingly driven to hide acorns. The fact that squirrels only ever find a small fraction of the acorns they hide illustrates the blindness of this accidentally evolved mechanism. It could be re-framed as the oak trees being really in charge and are breeding squirrels to better serve them by burying their acorns and *not* digging them up. Periodically, the oak trees stop producing acorns for a season, allowing just the particularly burying-obsessed squirrels to survive—

Like squirrels, we have a lot of things that feel right for us to do, too, for much the same sorts of reasons.

A lot of perfectly functional animals don't *have* a sense of "now." They exist in a mindless world of causality, sequence, duration, and path-dependence without the need of a "now," reacting instinctively, never once stopping to puzzle out cause and effect. Considerations of past and future never come up.

Evolution has shaped our brain to react in ways that worked in the past, and to form associations between short-term causes and effects. This requires hardly any conscious effort at all. Thinking about what *could happen* in the future is a very new activity for our species. It was only once our brains gained the ability to construct mental models of possible futures that this could even become an option, and that is probably a relatively recent development in the history of the triune brain, long after the emotion and reward systems fully evolved. The very notion of the future is probably similar to the notion of a tool: a relatively recent emergent property of larger, modular brains passing some cognitive complexity threshold.

We are alive at a very special time—not only on the cusp of huge changes, for good or ill, but a time that offers possibilities beyond what life has evolved to do. But for now, they are only possibilities—improbable ones.

Few governments, businesses or institutions plan beyond a year or two—five years at the outside. In effect, they impose a **threshold of relevance**, beyond which nothing is considered to matter. This attitude turns nearly all of the future into a single, gigantic blind spot. The ramifications of this blindness are huge, but we are so blinkered ourselves that it's not obvious to us—unless we take a step back.

Consider: the devices we use to help us live our lives could have been designed to last a very long time, yet our landfills are full of perfectly functional computers and phones that were considered cutting edge just five years ago. What's the harm? There isn't much harm, provided we can convince ourselves that anything we don't see doesn't count, that nothing past a five-year horizon matters, and that dollars of profit are the only criterion that determines success.

Even when we look at scientific reports that describe the effect human activities are having on the Earth, we see that the longest period they generally consider is 100 years—a little more than one human lifetime. All the climate change forecasts and estimates of ocean acidification, sea level rise, loss of species and so on, end at 2100, even though the effects they describe will be felt in 2200, 2500, 3000, 5000, and many will have ramifications a million years out. That doesn't seem particularly sane, but it *feels* right *because nobody after 2100 matters*. The transient effects of CO_2, for instance, are far less significant than its systematic, long-term effects on the planetary climate, but we only pay attention to what will happen fairly soon. We could do otherwise, but we don't, because we are still making our individual and societal decisions based on how things *feel* to a stone-age brain, reinforced by modern cultural goals and mores.

The way we think about time can make a big difference in the way we operate. For instance, a calculation was made about whales in the middle of the 20th century: the remaining great whales reproduced more slowly than the interest paid on money in the

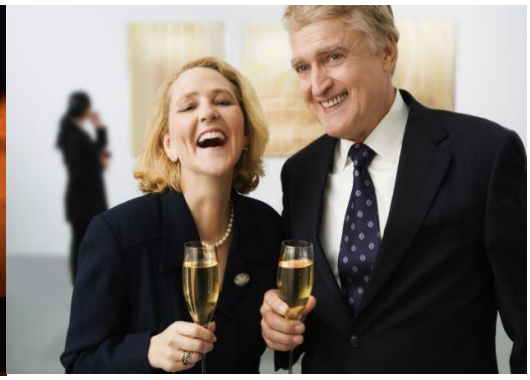
bank. If great whales could only reproduce at, say, 5% per year, and money in the bank could earn 7% per year, it made more business sense to get rid of the “low value” whales by wiping them all out, putting the money from catches in the bank to accrue interest, and then recycling the whaling ships. And that, to a large extent, was exactly what was done. However, making biosphere decisions with million-year consequences based on five-year financial plans was shortsighted to say the least.

Yours could be the first generation to seriously consider active engagement with deep timelines for our species, for other large species, and for the planet: the first to lead a conscious 4D existence. This prospect is not of just a revolutionary cultural breakthrough, but a first for life on earth, and unique to our species. It would represent a break from the agenda of the gene, which is centered on feelings-driven consumption and reproduction, and a shift to the agenda of mind that rationally maximizes what we value, such as people, happiness, and healthy ecosystems.

The new agenda would lead to a very different set of assumptions and conclusions about the wisest courses of action, and therefore it would initially come into conflict with those cultures and institutions that set a time relevance threshold. If all of a sudden, we were told that we should reasonably share what we have with future multitudes, our tendency would be to resist, because it wouldn't feel right to us; it would feel like a loss. We would be tempted to treat those who espouse such notions—along with the hapless inhabitants of the future—as a hostile out-group. That is why we chose to call it the **time bias** rather than the **discount rate**: it has implications beyond a simple economic preference for immediacy. It is one of the greatest prejudices with which our species must contend, worse than the racism and slavery of past centuries, which divided peoples, for this prejudice divides the entire human race from its future. Our current societies exist within a consensus temporal solipsism which devalues the future by default.

If our species and our world are to thrive, we need to learn to use our brains in ways that are at odds with what they have evolved to do. This is no minor task; but by reading this, and by thinking about it, you will have at least opened the door to this possibility.

Using Social Sorting Mechanisms to Solve Physical World Problems



Our brain carries with it a vast array of algorithms that were constructed (adapted) to solve problems of our ancestral past. The higher impact these had on survival (and mating) success, the more prone to 'firing' they are in related situations today. Imagine thousands of generations of hominids living in tribes of 25-150 people on the savannah in Africa. In addition to finely tuned fight-or-flight reflexes, agility and quick responses to fighting and killing game, etc, among the most important traits that made our ancestors our ancestors was being the best of the best at improving their mating prospects, both in quantity and quality. The results of this sexual competition were highly linked to social status.

As a fish swims in water, so do we humans swim in a world of social status. And, just as the fish has no need to be aware of what water is or how it works, we don't typically recognize how social rules, social acceptance and social status influence and constrain our daily behaviors. We are evolved social primates, and although our sociality tethers long predate the hominid line (think grooming in other primates), the importance of social cohesion and connectivity in humans exploded after we developed tools and language and had to compete/war with other tribes. Just as with most animals in nature, in our ancestral environment, those men (and women) who successfully moved up the social hierarchy improved their prospects for access to resources and improved their mating prospects. Those at the bottom of the status rung not only possessed fewer mating opportunities but many did not mate at all. Status among our ancestors was probably linked to those attributes providing consistent benefits to the tribe: hunting prowess, strength, leadership ability, storytelling skills etc. In modern humans, status is defined by what our modern cultures dictate. As we

are living through an era of massive wealth from mining ancient sunlight 10 million times faster than it was sequestered, pure physical prowess has largely been replaced by digital wealth, fast cars, high political connections, etc.

Getting a compliment from a high status person, getting an email from a popular (and attractive) man/woman at our workplace or school, winning an award for some accomplishment, these are all things that give us bursts of happiness and motivation (that probably exaggerate their real impact on our lives). In short, status seeking (and equally; avoiding situations that reduce status or social approval) is one of the loudest-shouting modules in the human brain. As such, personal rank and public perception hold a lot of influence over 'affecting the future' and 'a healthy planet'.

Solving Physical Problems with the Wrong Module

In the last 200 years or so a lack of predators and other historic dangers, and the effect of wealth and modern medicine, have served to greatly diminish any immediate penalties associated with misunderstanding the nature of our physical world; while social status has remained a strong driver of human behavior. Other than overtly risky behavior like base jumping, surfing during a hurricane, or drug experimentation, today's world offers few immediate physical risks *if* one toes the social line and goes with the social flow. Short of illness or serious dysfunctionality, it is very difficult to starve or do damage to oneself in contemporary Western societies, because our wide social network protects our members even from themselves. Among other things, this has resulted in social status and conforming being sufficient for survival, with most physical-world considerations mooted.

In a study called the "smoke filled room," 3/4 of people when left alone in a room would report smoke unexpectedly coming under a door. And for good reason, since dying in a building fire is one of the few major immediate dangers we are still subject to. However, if in a room with two other people who ignored the smoke, 90% ignored it too**.** Basically, the risk of minor social awkwardness was more disturbing than the threat of fire**.** It's almost as if our physical-world concerns are considered adequately dealt with if others have the same information. Clearly this makes little sense from afar, but it's what we do, up close, every day. Our social "consensus trance" overrides other considerations, and as such we don't notice it. We are wired to be more worried about not conforming to the social signals which upvote or downvote our daily social hierarchy scorecard than to other more relevant risks, often even to immediate physical risks. **I once (wrongly) thought I was having a heart attack and my most pressing thought was being embarrassed for the people I was with at the restaurant. The thought I might be 'dying and never able to be in another restaurant forever' was outshouted by my social anxiety.

Our evolved genetic and cultural tendency is to pass information on to the tribe, and then observe whether the tribe gets agitated. If the tribe gets agitated, some behavior then ensues which resolves the agitation, and we go along with it. This has led to what might be termed the "enlightenment" model of social activism, in which the individual goal is not a specific physical-world system state but only the transmission of information. It tacitly assumes that if real problems exist it is due to information not being effectively transmitted to tribe members.

And if the tribe *doesn't* get agitated, then the information probably wasn't important. But modern 'tribes' aren't trained in physical world details beyond what happens in their kitchen or garage. This theme underlies the default assumptions of current social and environmental activism, and as such highlights their core weakness.

Most humans have weak science and math skills, which take some study and practice to master; and even those who have some training are ill-equipped to assess super complex real-world propositions. So, in most cases in our society, we deal with such issues the same way we deal with smoke under a door**: by observing the reactions of our contemporaries**. There's a reason we do this: the risk of being at odds with our social group shouts very loudly inside our brains. It is *usually* the greatest risk we face, and it certainly feels like it, with a direct hotline to our emotional limbic system in the core brain. But the result is that we use social routines to sort physical propositions. If we get new information, we parse it, in effect, by posing unseen binary neural tests: "who is the information coming from?" "does my in-group believe this?" "does a known (and hated) outgroup believe it?" "Who wants me to believe this and what is their motivation?" And this neural routine and the resultant answers/reactions generally suffices for questions of childhood vaccination, environmental issues, and concerns about future energy supplies. Even those who are science experts mostly use such social filters.

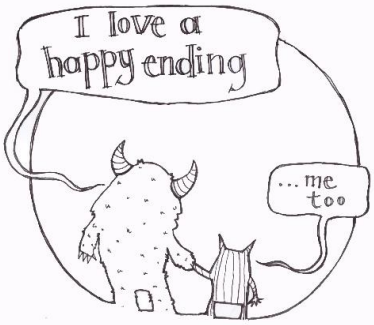
All this might not matter much on the large scale, except that our additional evolved module for fairness means that many modern governments are at least in theory run by the popular vote. But based on our social sorting propositions, not only do people feel entitled to their own opinions, they feel entitled to their own facts and rules of nature. In modern America this results in the opinion of a bartender or a bus driver being expected to count on a scientific question such as ocean acidification, as though one could vote on the way nature and the universe works. Thus, bartenders and bus drivers - who may be innocent of actual knowledge - expect one another to have opinions on climate change and any other combination of words they see in the news. Where do they get these opinions? Perhaps from taking night-courses in physics and

atmospheric chemistry- but most of the time just by absorbing and repeating the opinions and beliefs of their friends, family and in-group. It is in this way that presidential candidates may win votes by raising their hands and proudly noting that they don't believe in evolution! This is one reason modern democracy doesn't deal well with environmental predicaments, especially long term ones. It's our eusocial Achilles heel of "fairness ad absurdum". The evolutionary hangover of adaptations from seeking social status in small groups during the Pleistocene is that glue-sniffing pimps and child soldiers often have pronounced and vocal opinions on the 6th great extinction and other complex topics. And on the other end of the spectrum, a large % of environmental and social advocacy ends up just assembling and networking famous people but accomplishing little to nothing that's actually effective.

Even in my own public talks about our societal and planetary future, I (Nate) notice myself socially conforming. I often worry about what my audience wants to hear, rather than stating the most accurate physical description of an issue. To myself, I tell 90% of the truth (I am human, and self-deceive, of course). To my best friend I tell 80% of the truth – for some things I withhold because I know she'll disagree or will get upset. In a card game with 5 friends I'll tell 60% of my 'truth' because one of them works for Monsanto, and another just suffered a family tragedy and I don't want to overly concern him about future events. In a lecture to 100 people, I tell 40% of the physical truth, because there are a lot of strangers who I don't want to offend with what might seem controversial statements if they haven't studied them. And so on, as one expands the size of the human group. Imagine a politician speaking to an arena of 40,000 people. Our core brains are motivated by *feelings*. And in a nation of hundreds of millions, making decisions with "feelings", does not handle physical world complexity very well. ***Note: our Reality 101 lectures are organized around scientific articles – so my lectures are based on 'truth', but if we stray too far off topic, this same dynamic is at work, though it lessens as I get to know you students.*

Our current institutions and politicians require stories that involve 'growth', at the same time our biophysical science informs us growth is almost over. The disconnect between the *social* and the *physical* stories is what is causing us anxiety now and disruption in the near future.

Quite simply, it's hard to be a self-aware actor while interacting with other humans. That's OK, but one needs to be aware of this phenomenon and balance it, because the agenda of anticipating social reaction really is the evolved agenda of the gene. If 'we' as a species are going to navigate the next century and beyond on a living world, we need to see humans and our systems ecologically as well as socially. This realization doesn't shout loudly other than in quiet moments by ourselves when we can imagine the closing scenes of our movie.


I love a happy ending
...me too

Section III - Understanding Energy and Economy

It's not an overstatement to note that this human century is, and will be, defined by the intersection of copious excess energy and human behavior. The way our evolved brains, perceptions, wants and stimulation interact with a temporary energy extravaganza has been the main story of humanity for the last hundred years and will be for the next hundred; and the ramifications will determine which direction the human story takes and how long it lasts. Energy is (just about) everything. And our culture is *energy blind*.

Energy, Candy, and Reality

(*by author DJ*)
Laying out this book seemed fairly straightforward on first blush. Why, it was just a matter of explaining some of the basic concepts necessary for the synthesis to make sense.

Then as we started making lists of the things that science shows to be true, but that human society in general doesn't understand or believe, a funny thing happened. The list grew and kept growing. But it's not that these things are obscure or complicated, a lot of it is just stuff we forget as we grow up.

I never thought much about energy as a kid, other than craving sugar with a fierce intensity, and going hyperactively **nuts** once I found any. There was pretty much nothing I wouldn't eat if it had sugar in it. My parents kept the sugar away from the kids mostly, so my obsessed little brain focused on the sugar-centric holidays: Christmas, Easter, Valentine's Day, Halloween; during which usually-scarce sugar would be on colorful display in an array of treats.

Of course, the reason I lusted after sugar so much is that I was evolved to. Candy was a supernormal stimulus which pegged the ancient motivation meter in my skull. I was never offered candy to murder anyone, and in retrospect that's probably a good thing.

Yet in the pursuit of candy I unknowingly learned a lot of lessons about humans and energy which are just as true today as they were then, looking for Easter eggs amid the

venomous snakes and giant snapping turtles of my swamp-adjacent Indiana back yard.

Firstly, I learned about scarcity and intermittence. If it wasn't a sugar-centric holiday, sugar was hard to come by and unreliable as an energy source. I once found an entire crate of mildewed apple-flavored jell-o concentrate in the basement which my mom had bought marked down to a half-penny a package because it was horrible, and then stored in the basement because it *was* horrible, presumably as standby food for the aftermath of a soviet invasion. I spent several months in the dark, disconsolately gumming those horrid humidity-congealed globs of discolored gelatin stuck to waxed paper and have the aftertaste of mildew and fake apple still in my mind 63 years later. I also discovered, about a year later, a gallon of sweet Mogen-David wine in a low cupboard which I swigged gulps of over several weeks until it was gone, tipping the jug I was too small to lift. But those were exceptions to what was a very sugarless status quo. My human brain was well-adapted to intermittence of supply, times of lean and times of plenty. Which meant it had a raptor-like focus on sugar holidays.

The ostensible rationales for the various sugar-related holidays seemed obligately **deranged**; Giant rabbits who pooped chocolate eggs to commemorate a Jewish guy rising from the dead. Uh, ok. Dressing up as monsters and threatening the neighbors to give us sugar (ok, I kinda followed the logic there). A whole season of gifts and candy to celebrate that same Jewish guy being born, by bringing a tree indoors and pretending that a fat guy riding flying reindeer would be coming down the chimney with bags of wrapped gifts. For no particular reason. The exchange of heart-shaped notes bearing pleasantries along with candy. Other than wild implausibility and a nearly psychedelic level of non-sequitur from one to another, the rationales seemed to only really be linked by candy. But I didn’t much care. The candy was the important part.

Yes, I'm going to link elements of the energy plight of humanity to lessons I learned grubbing for sugar as a child.

Easter is as good a holiday as any to pick for this purpose. I would wake on Easter morning, open my sleepy eyes and briefly re-integrate my personality before an urgent message would bubble to the surface of my reality: SUGAR DAY! and I would leap to my feet. I was certain to get sugar that day; but the amount and quality were still very much up in the air.

There would be lavish Easter baskets hidden in various parts of the house with the names of each child on them, and Easter eggs hidden throughout the yard.

Clearly, the first target was the best and highest-quality concentrations of energy: the Easter baskets. As I was the oldest, largest, and earliest-waking child, the first thing I'd do was find the Easter baskets of all four children. I'd then re-hide mine in a *good* place, like down in the basement with the spiders and creepy paintings. Then I'd figure how much I could pilfer the other kids' baskets without detection, which ranged from about 20-30%, and stash that stuff with my basket, by which time the other kids were waking. At that point, since they felt candy-wealthy, I could bargain with them for part of their remaining candy, trading various non-candy items and dubious promises for a portion of what they had, which would likewise be secreted away. By that time, the grown-ups would be awake, and their authority would halt any additional pilfering or trading, and the hunt would move to the back yard.

It was an interesting yard for it, because there actually were eggs of various birds and reptiles – which might reasonably take umbrage - scattered among the hidden stuff that was left over from filling the Easter baskets, and there was also a very real race with the hornets, ants, and what-the-hell-is-that-thing for the sugar. My parents generally had hidden stuff in the dark after a few home-made beers so had no idea where anything was or how much was out there except in general terms. So, we'd find the obvious candy but then retreat to our hoards lest they be raided.

I'm telling you this story because I'm going to make a case that it's usefully analogous to the availability of fossil fuels to humans. Of course, in this metaphor I represent the USA, and my siblings represent other nations, which is why I wound up with a disproportionate share of candy and the resulting energy to do more mischief and get my way more often than not *(the other nations just hated my freedom)*. I suppose my parents represent the Rule of Law, the Geneva Convention, and that stuff, Jesus represents Manifest Destiny, and the never-seen Easter bunny is the invisible hand of the marketplace. Or something.

The first thing you'd eat was the gooey filled chocolate eggs. They were the most energy-dense and digestible, melt-in-your-mouth wonderful and would impart enough manic energy to climb wallpaper with sticky fingers like child-size screaming geckos. The next day you'd be down to the hollow chocolate bunnies, which were also very good, high-octane brain food with that hint of extra caffeine that really sets up a sugar buzz. The day after that, it was the chocolate-dipped marshmallow bunnies wrapped in foil, which weren't bad, but weren't really premium because in those days some of the foil never did come off and you had to swallow it, after getting zings from your teeth as you chewed. After that, things got a bit more grim, because Indiana was and is a humid state in the spring, and all that was left in the Easter baskets was jelly beans and some tasteless rock-hard colored sugar shells with fluffy sugar inside. The fake waxed-paper "Easter grass" would have stuck all that stuff together into a disgusting

sticky mass with the artificial colors bleeding on one another. One had to swallow a fair bit of waxed green paper to get the jelly beans down, and by the time you were willing to try cracking open one of the sugar shells with your little jaws, they looked as if they'd grown green hair. They were almost as useful for putting down siblings' shirt-necks as for eating, and they'd be found heavily licked and discarded for weeks afterward, adhering to the carpet. So by the second week after Easter, the sugar was gone... except for anything which might have remained undiscovered in the yard. So at that point forays would be launched, collectively and independently, to scout for remaining candy in a yard known to be the abode of monsters, in which one didn't *usually* reach into holes in the ground. During this phase, which lasted a week or so, there would be some genuine discoveries of candy. The foil-wrapped marshmallow bunnies, generally a third-line candy on Easter morning, were prized because the foil did a fair job of keeping insects off and out, which after a couple weeks of rain was a reasonable criterion. Any jellybeans found were more a matter of "I dare you" than a serious competition to eat them. But still we managed to eke out another week of sporadic sugar intake before the times got lean again and we had to sneak a stick of gum here and a spoon of syrup there.

So what lessons did this teach which are salient to our fossil fuels?

- You can only eat what you find.

My *dog* understands this, but the fact that hardly any large new oilfields are being discovered hasn't filtered into the common wisdom. The filled Easter baskets have long since been emptied, but most Americans think the USA is now a net oil exporter. Not even close.[38] The world's existing infrastructure was built using light sweet crude from enormous accessible oilfields, which was so cheap as to be nearly free.

- You can only eat it once. Once you eat it, it's gone.

Already, the sophistication of this parable has leapfrogged neoclassical economics, which believes that demand creates energy and that resources will always be found if the price is right. I literally seethed with demand during the lean months, but it didn't make any candy appear. I had no money, so it didn't matter that the stores had candy.

- Concentrations of energy are finite and unevenly distributed, and mostly found already

What is our oil doing underneath all those foreigners? There is such a thing as "abiotic oil", *but nobody has ever found enough to make it useful.* Fossil energy comes from ancient dead plants and tiny animals, hence the name. After a certain point in time, it's

hardly worth looking for candy because you reach a point of diminishing returns. Which is why most oil companies are *no longer actively looking* for new oilfields. They know that what's left is the equivalent of ant-covered jellybean remnants and rained-on marshmallow peeps.

- The most aggressive competitors get to eat the most candy

The resources of weaker nations don't do them much good and can cause stronger nations to take an unhealthy interest in them. Want to trade your candy for my old toys? Younger siblings are SO fun to play with...

- The quality of an energy source can vary

While it's all called "candy", there is a lot of difference between fresh Cadbury eggs and stale hairy jellybeans.

- The best stuff gets eaten first, so *the quality always goes down, and always will*

No humans eat the worst candy first. You eat the BEST candy first, then the next best, and so on. That means that the sweetest energy sources are exploited first and are then gone. Rinse and repeat. They actually call the stuff we built the USA on "light sweet crude." But coal and oil deposits aren't renewed annually like Easter eggs. They are a one-time deal. The flush times are over, and we're coasting on infrastructure we built when it was nearly free.

- The biggest energy deposits get found and eaten first, so new discoveries get smaller and smaller

The big concentrations (the Easter baskets) - are where everyone goes first. Only once those play out is it worth looking for other places. There are no more super-giant oilfields on earth.[39] We've already drilled the good places, now we're doing the equivalent of sticking our hands into suspicious holes in the backyard *(I know something about this; in addition to having been an aggressive sugar-seeker in my earlier life, I was an oil exploration geophysicist in my early 20's. Life is a journey, I guess).*

- Sometimes an energy source is so marginal that it's barely worth using, taking more energy than it's worth and making a disgusting mess

Once the holiday candy runs out, it'll mean gumming moldy Jell-O packages in the basement again, which is metaphorically equivalent to mining the tar sands. We've always known they were there but haven't been hard-up enough to actually eat them.

- **Energy and wacky ideas travel together.**

At any given time, a significant proportion of the population believes that Easter candy comes from giant chocolate-pooping pink rabbits and that Christmas candy is delivered by flying reindeer via an immortal fat man in a red suit coming down the chimney. This is a fair parallel to the general state of energy knowledge in the USA, where we not only have a right to our own opinions, but apparently to our own *facts*. So we say "drill baby drill" as though the process of drilling creates oil reservoirs, and when oil prices go up we assume it's a conspiracy of some kind. We think about energy in the same magical terms really young kids think about candy, while being similarly uncertain as to its origin and prospects.

- no kid saves his good candy

It's not human nature to save stuff for the future, and it's even less human nature to save for the future when you're in the throes of an energy rush. We know that it's a long long time until the next sugar holiday, but we don't care. Candy!

- nobody worries about diabetes until after they have it.

We believe what we want to believe.

The Moon, Cheese and Cleverness

Humans have visited the moon, and many of us enjoy imagining humans eventually travelling to other places in the solar system. There have been proposals for permanent moon bases, and it turns out that the way we think about such plans can provide insights into some of the energy and materials realities we've recently come to take for granted. This essay will describe what might be called the "fallacy of cleverness" - basically the mistaken belief that human cleverness is the ultimate basis for our economy and survival, a central assumption currently underpinning our economic systems.

The idea of visiting other planets provides a good demonstration of our unconscious assumptions. On the moon, an unprotected human's blood would boil at our usual 98.6 degree body temperature, because water doesn't exist as a liquid in a vacuum. If we jump into the air, we travel as if in slow-motion under the 1/6 G gravity field of the moon. If we drop a feather and a hammer, they will hit the ground at the same time. If we make a footprint in the soil, it may still be there thousands of years later, looking fresh. It's a very different place, and intuitions about how things happen aren't applicable when one is on the moon. The temperature can be -300F at night and +200F in the daytime. About every three minutes we'd see a flash of light in one eye or another from a cosmic ray blasting through our eyeball from some angle, unscreened by an atmosphere. Again, it's a very different place subject to different rules, which is why astronauts had to train a long time to unlearn earth habits that might get them killed on the moon.[40]

These issues become very relevant if one thinks about doing more than just landing on the moon and driving a golf cart around to sightsee. Some really brilliant people - astrophysicist Stephen Hawking for one - have advanced the notion that we will need to move to Mars since we're making the earth unlivable (due to eventual climate and other changes). They are correct that we are degrading earth's natural systems, but incorrect that it's within our capacity to terraform another world, for reasons including but not limited to those above.

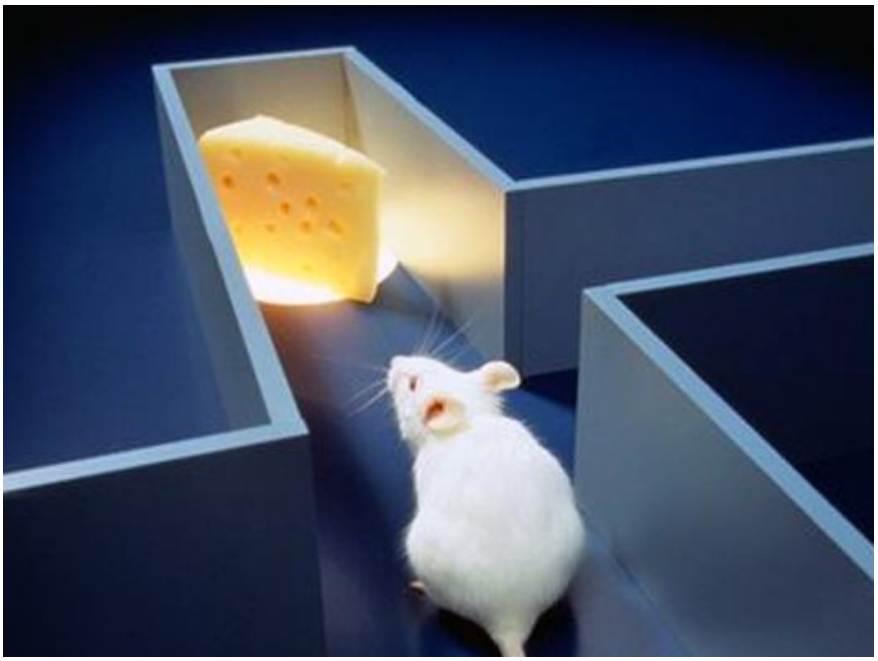
What are some of the issues beyond the simple *(or not really simple at all)* 'getting there and landing'? Well, you'd need to dig underground some ways to provide radiation protection so your lunar crews didn't all get genetic damage and shorten their lives due to cancer. But how do you dig? Well, you'd need digging implements, and there's no way to build them on the moon, so you'd need to bring them with you. Oh, and spare parts, and a lab to fix them in. And you'd need power for them. No fuels lying around, so you'd either need to ship in some sort of power like a nuclear reactor - difficult - or solar panels, which would also have to be made on earth and shipped to the moon very delicately. If one breaks, you don't order another one, you do without. And you have to bring your air and food with you. Want to reclaim oxygen from the soil? You need to find and mine lunar ice, which may be deep underground, which requires a lot more power. Want to grow some of your own food? You need bigger caverns and lights, more water, etc., though that will provide something else that's good to have: oxygen.

So, it turns out that just to dig a hole in the ground big enough to live in would probably cost trillions of dollars. Those trillions of dollars, in turn, would come from the economies of earth by NOT DOING trillions of dollars' worth of other stuff, like fixing bridges and making peoples' lives easier. Furthermore, it turns out that the only way of building things on the moon is to bring pre-built energy and complexity from the earth. There would be essentially zero prospect of ever building and fueling nuclear reactors, or making solar panels, on the moon itself. For that you need fossil energy and a geologically active world which has concentrated materials for you to use. Indeed, building a moon base, if we decided to do so, would probably be done with 98% earth-sourced fossil energy or not done at all. And it wouldn't be cheap. Even best-case, once a huge earth infrastructure was built to do huge numbers of large-scale rocket launches, it'd cost between roughly $50,000-200,000 per pound to get stuff from the earth to the moon. We visited the moon in an era of much cheaper energy and have so far found fiscal excuses not to go back because money has become our (imperfect) yardstick for energy cost these days.

Life taps energy flows. Energy is what creates life, movement, food and manufactured stuff. That's what makes it possible for us to live, and what makes it possible for our

technology to move things around and transform them. There is cleverness involved in inventing technology, but most technology is about using cheap fossil energy in ever-more creative ways. Cleverness has been used in *finding* energy flows to tap, and then inventing technology to use it to offer brain-pleasing activities. *Cleverness itself is only valuable to an organism under very special circumstances, which may be one reason why large brains have rarely evolved in the last 4 billion years.*

Cleverness to find energy only works when there is energy around to be found, and some practical way to put cleverness to work. An astronaut stranded on the moon would soon die even if she had an IQ of 300, because cleverness isn't magic. Cleverness allows us to gradually increase human knowledge and collaborate with other humans, working with what is available to us. If Einstein had been born in the year 1800 AD, he might have made a minor name for himself as a clever guy, but he would not have discovered relativity. The general advance of human knowledge would not yet have given him the conceptual tools to work with. Similarly, Darwin wouldn't have discovered evolution by natural selection without Britain's new energy surplus from harnessing coal that financed scientific voyages to South America. In order to work, cleverness is dependent on context to work.



The problem with our current cultural assumptions is that they tend to forget that energy is the fundamental driver of all life and technology. Psychologists are famous for running rats through mazes to test their cleverness. They can motivate them by putting a food reward like cheese at the end of the maze. If the rat solves the maze, she

gets the cheese. If many generations of rats have always found cheese at the end of every maze, one could forgive them for believing that a cheese reward was a fundamental property of mazes; that all winding paths are defined by cheese at the end. The idea of a maze without cheese would be both counter-intuitive and disturbing.

And that's a bit like the situation we're in. For the last 30,000 years we've been on a helluva roll. A virgin planet full of forests, wild animals, seas of fish, metal ores concentrated by billions of years of geologic history, and easily-accessible fossil carbon and hydrocarbons that burn. During that time, cleverness and super-socialization of human populations have allowed us to jump outside our original evolutionary niche and capture larger and larger portions of the biosphere for our own use.

Yet such super-socialization is achieved not with cleverness, but with shared belief in abstract - even crazy- organizing principles. Apes and humans in prehistory were never able to cooperate in groups larger than the number of close relationships which could be maintained, which in primates is proportional to brain size and for humans is about 150.[40] Yet the breakthrough of believing in the beliefs of others meant that reliable cooperation could extend outside such a tiny tribe. It made possible abstract currencies, trade, and large alliances, and in the process made Homo sapiens into a much larger and more formidable superorganism. The important thing was not whether the beliefs were *true* (they in theory could be entirely delusional, but *whether others would not easily abandon these beliefs*. Thus, alongside cleverness evolved an unwillingness to easily change our organizing beliefs. This worked great for killing off the other species of humans and about all other large animals we came across. The only protection against humans was to be smaller, faster, and terrified. Yet it became a problem once we were in control of the whole planet, as we now are.

So these days a core part of our durable shared beliefs is that (1) cleverness is the fundamental resource of humanity; (2) that all mazes can be solved by sufficient cleverness; and (3) *that the world, and universe, is organized in such a way that there will always be cheese at the end of each maze*. That is, we believe - without saying so directly - that the laws of the universe were designed in such a way that our species faces no fundamental barriers between designing flint arrowheads and using antimatter to travel through wormholes in starships. With due apologies to religions, this is a religious belief; based on faith not fact.

Of course, this metaphorical cheese we're talking about is non-renewable resources and particularly low-entropy energy sources. Over the last couple hundred years - since utilizing fossil energy - we have *seemed* a lot cleverer to ourselves. That's

because we had an untapped planet, hundreds of millions of years of concentrated solar energy in coal, oil, and gas, and a healthy and diverse natural world of bounty. And now our beliefs about our world would take for granted unlimited energy and materials, and complex social and physical networks which have been slowly built up for hundreds of years.

Yet the way we've gotten to a 7+ billion population has been by pumping fossil water and using fossil energy to grow more food. Called the "green revolution," it basically uses fossil energy and technology to keep alive far more people at once than would otherwise be supportable. So as long as we have unlimited energy and fresh water, we're okay, right?

Of course, as we bend energy to our own purposes, we need a lot of technology, which in turn requires a great deal of materials. We've used up most of the pure, cheap metal ores and fertilizers, which means it now takes ever-more energy to purify the remaining materials. But still, if we have unlimited energy we're okay, right? If you have enough energy you can get around the problem of poor-quality raw materials. If we wipe out fish populations nearby, we can dredge the ocean floor of the most remote parts of the earth... for a while. Technology and energy make it possible.

But it's not just energy. If we want to build a modern wind turbine, we need neodymium from China. In order for that to happen, we need a complex network of financial agreements, fossil-fueled mines, and people willing to go down into the mines and refine the ores. That all needs to be purified and shipped to its destination.

We assume that will continue to exist, because like the rats, we assume that cleverness + time = cheese. Presumably, rat economists would poo-pooh the idea of cheese-less mazes, since the invisible hand has always allocated cheese in response to cleverness in their lifetimes.

In our case, we additionally believe that cleverness + time = wealth. Like the rat economists, our economists now (with serious faces) predict that by the year 2075, the USA will produce the same GDP now produced by the *entire world*.[41] This is not some borderline guess, this is what the chief economists predict as reality. They can do this because they are entirely in the thrall of the *belief in belief* which tied our tribes together so long ago. And they believe that *belief* is more fundamental than energy and resources. In this case, the belief is in economic theories which state that demand creates energy and money runs the world. Indeed, that belief is what is currently determining the agenda of nations and the fate of your children, should you choose to have them. Despite it being, well, absurd.

Presumably, our moon-base plans were flawed from the outset because we didn't think to send economists, who would make the moon into a habitable world using only belief and the free market. Oxygen, water, power and resources would pop into existence when demand was sufficient and be allocated fairly among the moon's ever-growing population. Yep.

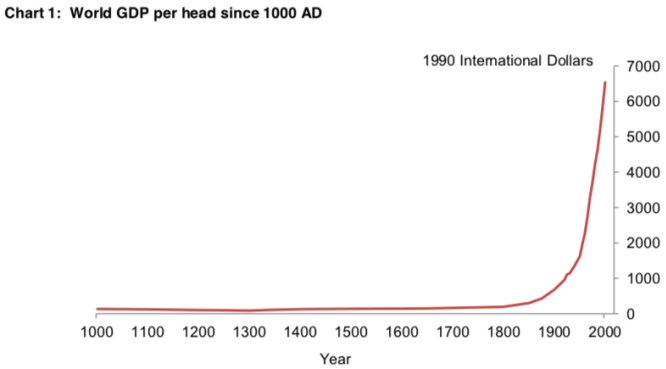
But we could learn a thing or two from the idea of a moon base. Energy and resources have to come from somewhere, and they need a built infrastructure to work. There are many - indeed most - situations in the universe where cleverness won't accomplish anything, because there is no cheese to find. If you're on the moon building a radiation shelter and your power-drill breaks, and you don't have a spare transmission, you die. If on earth, you order another one over the internet and just do something else until it arrives via FedEx a day or two later. So, we tend to think about projects from the point of view of what we're used to, and not from conditions we might have on the moon.

And that's the case with energy. Despite there being more and smarter scientists alive than ever before in history, there have been no new kinds of usable energy discovered in nearly 100 years, and none are expected. Everything that our industrial system now produces is an outgrowth of fossil energy, even windmills, solar panels, and nuclear plants. Yet fossil energy and its side-effects are inexorably degrading the living world's resources and making it less habitable. Our scientists are clever enough to see that disaster is looming on many fronts, yet our *belief in belief* causes us to adhere to the organizing myths of our tribes instead of our scientists. Thus, we simultaneously ignore our scientists' best advice while assuming a higher price signal will naturally spur discovery of unlimited energy and resources forever. Good scientific news must be true, and bad scientific news must be false. Right? Until recently, our main energy forecasting institution (EIA) based their future energy supply forecasts on demand – however much demand would be expected to achieve a level of growth (population and consumption) 20 years in the future, that was how much energy would arrive![42] What could possibly go wrong?

Our analogy with the moon is not complete fantasy. If one was given the challenge of building and maintaining a new power infrastructure with zero reliance on fossil energy, one would face many of the same problems of our moon-base astronauts. If one tried to build solar panels from scratch (even here on earth) using only solar panel output, it likely couldn't be done; the same is true for all other "renewable" energy devices, which are better thought of as "fossil fuel extenders" in the sense that the product "hamburger helper" will stretch a pound of hamburger by padding it out with macaroni.

Yet the fate of our societies depends on making such a switch and making it smoothly and quickly. Currently, we're still listening to the myths of economists who think demand creates energy, and, of even more concern, we each believe the things about energy that our friends believe. We are likely to find out the difference between cleverness and wisdom, the hard way.

GDP, Jobs, and Fossil Largesse



"Smokestacks darkened the skies. No place was sacred, no landscape safe from the insatiable creature's thirst for more energy to serve his God of Growth."

- from Overdevelopment, Overconsumption, Overshoot

First, some review of relevant points from earlier in semester:

BASIC

1. *Fossil carbon compounds are incredibly energy dense, as their formation and processing was done by geologic forces over deep time. One barrel of oil contains about 1700 kWh of work potential.[43] Compared to an average human work day where 0.6kWh is generated, one barrel of oil, currently costing under $50 to global citizens, contains about 10.5 years of human labor equivalence (4.5 years after conversion losses).[44]*

2. *As such, these 'fossil slaves' are thousands of times cheaper than human labor. Applying large amounts of these 'workers' to tasks humans used to do manually or with animals has generated a gargantuan invisible labor force subsidizing humanity – building the scale and complexity of our industry, population, wages, profits, etc.*

3. *GDP - what nations aspire to - is a measure of finished goods and services generated in an economy. It is strongly correlated with energy use -since 1965, an additional 100 units of economic growth has required on average 99.5 additional units of energy.[45] 'Burning stuff' (measuring how much primary energy*

is consumed) is a reasonable first approximation for GDP globally. GDB -Gross Domestic Burning.

4. *Thus, outside of nuclear and hydro, ~98.5% of 'labor' in human economies is done by oil, coal and natural gas (measured by joules of output). Due to this cheap embodied labor residing in fossil carbon compounds, the average human being in 2016 enjoys 14x the goods and services as the average human being in the year 1800. (the average American=> 49x).*

5. *Regionally and nationally this relationship can decouple if the 'heavy lifting' of industrialization is done elsewhere, and the goods (and embodied energy) imported (e.g.,. from China). The relationship between <u>global</u> energy use (which is ~87% fossil fuel based) and GDP over the past 50+ years remains tightly linked.*[46]

<u>ADVANCED</u>

6. *The common political mantra that higher GDP creates social benefits by lifting all boats has become suspect since the 2008 recession and 'recovery.' For the first time in the history of the USA, we now have more bartenders and waitresses than manufacturing jobs.*[47] *In order to maximize dollar profits, it often makes more sense for corporations to mechanize and hire 'fossil slaves' than to hire 'real workers.' Real income peaked in the USA around 1970 for the bottom 50% of wage earners.*[48]

7. *GDP only measures the 'goods' and doesn't measure the 'bads' (externalities, social malaise, extinctions, pollution). Actually, natural disasters like oil spills and hurricanes are ostensibly great for GDP** because we have to build and burn more stuff to replace the damaged areas. (**Note, only to a point – once a country – e.g. currently Haiti or the Philippines - cannot afford to replace what was lost, then natural disasters become a sharp negative to GDP as infrastructure underpinning future GDP is lost and can't be rebuilt)*

8. *Since 2015, the tight correlation between energy use and global GDP *seems* to be eroding – we have grown at 3% but only grown energy use by 1.2% in those years. This is giving hope that we can grow the economy without corresponding growth in resource consumption – termed 'decoupling'. There are several temporary factors contributing to this phenomenon a) an asset bubble leading to capital gains not using resources (yet), b) a shift from coal to more efficient natural gas (byproduct of shale oil drilling), c) some small shift of renewably generated electricity, and d) some very small efficiency gains. But the largest*

discrepancy is in the GDP and inflation numbers themselves, overstating the former and understating the latter. In the intermediate (and long) term, there can be no significant decoupling from GDP and energy use because everything that generates GDP requires energy.

9. *On an 'empty planet,' pursuing GDP in order to gainfully employ people (and distribute money so they could buy needs and wants) seemed to make sense. However, on an ecologically full planet pursuing GDP with no other long-term plan is using up precious natural capital stocks just to maintain momentum and provide people brain-pleasing neurotransmitters.*

10. *There are numerous alternative measures to GDP that incorporate well-being and happiness and subtract environmental ills. But it won't be easy to switch objectives from GDP to e.g. G.P.I. or G.H.I. (Genuine Progress or Happiness Index) because the present creditors will expect to be paid back in real GDP ($) rather than happiness certificates. Still, over time, strict metrics of success based on consumption alone are likely to change.*

11. *There will likely be a growing disparity between 'jobs' (occupations that provide income and contribute to the global human heat engine) and 'work' (those tasks that need to be accomplished by individuals and society to procure and maintain basic needs). However, at 2018 USA wage rates, moving from $20 per barrel (the long-run average cost for oil), to $150 per barrel, the army of energy slaves declines from 22,000 per barrel to under 3,000 – meaning at $150/barrel, we'll get 7.5 times less useful work! At this price, the economy shrinks and therefore much more work needs to be accomplished via efficiency improvements, real humans, or making do with less.*

12. *Our institutions and financial systems are based on expectations of continued GDP growth perpetually into the future. Current OECD (2015) forecasts are for more than a tripling of the physical size of the world economy by 2050. No serious government or institution entity forecasts the end of growth this century (at least not publicly).*

Okay. Let's unpack all of this a bit.

Often in the news today, you'll hear people talking about job growth and job creation like it's a good thing. Everybody wants a good job, right? The more jobs we have to do, the better off we are!

Yet if you kick open an anthill or a beehive, the insects will not be grateful for the sudden boost in job creation, and they will effectively utilize the cross-species

language of biting and stinging to inform you of this opinion. From this we may infer that insects don't understand economics.

Alternately, it could it be that ants - having honed their behaviors for 130 million years and having attained a total biomass we have only recently (and temporarily) matched - might be in tune with some deep realities about jobs, energy, and the embodied cost of building complexity.

Because this is Reality 101, let's ask some basic questions. What ARE jobs, really? How do they relate to energy and wealth? How do we keep track of whether we're richer or poorer? We all kinda feel like we know. And (as a general rule) whenever "*we kinda feel that we know*" is the case, we should probably take a closer look.

To do so, we'll first need to add a few things to our story about ants. We need to revisit our invisible energy slaves, discover what "freaks out" capuchin monkeys, and think about what wealth actually is.

Energy Slaves again

As you recall - and as we'll discuss in greater detail as the course goes on - every American has over 250 invisible energy slaves working 24/7 for them.[49] That is, the *labor equivalent* of 250 human workers, 24/7, every day of the year, mostly derived from burning fossil carbon and hydrocarbons (54 barrel of oil equivalents of oil, coal and natural gas, X 4.5 years of human labor energy output in each-this number increases by 10-20 barrels if we include the energy embodied in our imported goods). Every American thus has a veritable army of invisible servants, which is why even those below the official poverty line live, for the most part, lives far more comfortable and lavish with respect to energy and stuff than kings and queens of old (but obviously not as high in social status). Being long dead and pulled from the ground - and thus a bit zombie-esque - these energy slaves don't complain, don't sleep, and don't need to be fed. However, as we are increasingly learning, they do inhale, exhale, and leave behind waste. Since they're invisible, we don't think about these fossil helpers any more than we think about nitrogen (which happens to be 78% of what we breathe in, but hey, it's just "there", so why think about it?) Same with our 250 energy helpers. The extent we think about them is when we fill up at the pump or pay our electric bill – and then only as an outlay of our limited dollars.

We use the "slave" metaphor because it's really a very good one, despite its pejorative connotation. Energy slaves do exactly the sort of things that human slaves and domestic animals previously did: things that fulfilled their masters' needs and whims. And they do them faster. And cheaper. Indeed, it probably wasn't a big coincidence that the world (and the USA) got around to freeing most of its human slaves only once industrialization started offering cheaper carbon labor replacements.

The other reason it is apt – our culture is still discussing the ramifications of slavery 150 years ago today – and our ancestors will still be discussing the impact of fossil slaves – both the lack of their labor and the impact of their exhalation – 150 years from now.

The things we value are created bya combination of human and energy-slave work plus natural capital (minerals and ores, soils and forests, etc.). There are huge amounts of embedded energy in the creation and operation of something like an iPad and the infrastructure which makes it work. When we tap our screen to view a kittycat picture, the image is pulled from a furiously spinning hard drive which may be halfway around the planet, propelled by some fossil slaves, and routed through data centers which are likewise fueled. The internet -via laptops and cell phones -uses over a seventh of the world's electricity - that's a lot of energy slaves.[50] The infrastructure itself has taken decades to build, and requires constantly increasing energy to maintain. But we don't think much about that either.

So the internet is infrastructure we have invested energy in, just like a built anthill has been invested in with ant labor. If the internet (or an anthill) was destroyed and needed to be rebuilt, that situation would certainly create jobs. But it would also require a lot of energy, raw materials and work. *Ants don't have energy slaves, so they don't want more work to do*. They are dealing with finite energy inputs in their ecosystem. If more energy (ant-labor) is devoted to rebuilding the anthill, less energy is then left to care for the larvae, forage for food, and defend the hive.

Energy slaves don't care either way about job creation. (Being zombies and all). But why do we?

Everybody wants a good job.

Remember this, because it'll come up again and again in Reality101: evolution works with what it's got. It's a stepwise process, and each step is based on what was available in the step before. This is true both for biological and social evolution. That's why there are no animals on the Serengeti with wheels: there's no viable path to evolve wheels from feet, because even if there was a way of designing animals that had wheels, there are no viable intermediate stages. Hold that thought…

Now in times past, a human's career, their societal function, was largely about their own individual labor and skills. A blacksmith worked with metal. A cooper made barrels. A shoemaker made shoes. Others made furniture, cloth, or other valuable commodities. Farmers created food. Preachers preached. Others did simpler labor like digging ditches or cutting down trees. The relative value of their labor was roughly set by how much other humans valued the end product of such labor, so a skilled blacksmith might be able to trade his services for more status and better

accommodations than a ditch digger. Thus, it became an integral part of human culture that the products of some work were considered more valuable than others. It became a mark of social status and pride to have such a career. Hold that thought too, we'll be coming right back to it.

Cue the Screaming Monkeys.

"Equal Pay for Equal Work" is currently the slogan for those opposed to sexual discrimination, which is usually characterized by women getting paid less than men. And it's a sentiment which has deep roots in the ape and even simian mind.

If you give capuchin monkeys the "job" of doing a nonsense task in exchange for a reward, they will happily do it all day long as long as they keep getting a reward - cucumber slices. But if a capuchin sees the monkey in the next cage get a (better tasting so higher value) grape while it still gets a cucumber slice, it'll go ape, throwing the cucumber slice in the face of the experimenter in a rage. It gets the same cucumber slice it has been happy to work for before, but *it no longer wants it*, because it no longer feels fair in comparison to its cage mate's effort and reward. Instead, it wants the experimenter and the other monkey to be punished for this inequity (we watched this video of Frans deWaals experiment in class).[51]

Think for a moment how central this monkey reaction is to the human world around you. We'll come back to it later in the course and will refer to the term "capuchin fairness" because a similar mechanism turns out to be behind a great deal of human behavior. We're outraged at the notion of somebody getting more reward than we do for doing the same thing. Indeed, many large-scale human institutions now stress *perceived fairness of process* over *quality of end results*. (*A prominent example might be the US Congress).* Moreover, this monkey-business also reiterates the concept of relative wealth being more important to a monkey mind (and a human mind, it turns out) than absolute wealth, which is kind of **nuts**, but that's monkeys for you.

It turns out that our brains are simultaneously trying to optimize two different, and somewhat incompatible pursuits, both of which have deep evolutionary roots in our social species. One is *energy gathering and wealth creation:* obtaining food, procuring clothing and shelter – basically optimal foraging theory applied to the human biological organism. The other is *equitable social distribution* and transparency of process. A tribe of hunter-gatherers needed to cooperate as a mini super-organism to get food and defend territory and stand together against competitors. But *within the tribe*, an individual's success depended on its getting a reasonable share of what the tribe had. We're descended from tribe-members who insisted on at *least* their fair share, as is every living capuchin, so it's not surprising it's such a strong feeling. But when both of these instincts are operating

simultaneously, in an era where our species happened upon a buried treasure of fossil pixie dust, some interesting practices emerged…

Ok. Ants. Monkeys. Energy Slaves. So where did "jobs" come from?

A funny thing happened on the way to the Anthropocene. To an ever-increasing degree over the last two centuries, wealth has been created more by fossil slaves than by human labor, significantly more - and it's at its all-time peak about now. *(you'll have the information to derive this yourself by the end of this course).*

If you don't believe that, try hiring a bunch of people to push you and your SUV around hundreds of miles per week with their own muscles and see what it costs you, and then see how little it costs you to buy the same work in a tank of gasoline. In fact, the vast majority of the tasks and stuff that used to be done by human labor is now done by fossil slaves and the infrastructure they have enabled. The slaves have also made shipping nearly free, so any actual human labor we need to produce this stuff can also be hired in the cheapest places on earth (under essentially slave labor conditions), and shipped to us by planes, trains, ships and trucks for next to nothing. So rather than buying furniture from local artisans, we make local firms compete with furniture made halfway across the world which is cheaply shipped to a local store. To a good first approximation, the USA doesn't make anything anymore (well, movies…).

We have amassed a huge amount of wealth, even if much of it is dumb stuff like plastic toys and salad shooters and things that quickly break. There are so many things we think we want, so we get them. We eat salads with fresh veggies which may be grown 5000 miles away and air-flown to our stores by energy slaves running the planes, refrigerators, trucks, and stores. The average dinner travels over 1500 miles to get to your plate in USA.[52]

We increasingly buy disposable everything - used once and tossed away. Most everything is short-life these days; when your authors were young an electric fan was expected to last 20+ years. Now if it lasts 2-3 before you toss it, that's about par for the course. Planned obsolescence exists because it's "good for GDP." A new dishwasher now lasts 6-8 years when it used to last 12-16, because they now have integrated cheap~~er~~ electronics that fail. Our GDP has become tethered to rapid product-replacement cycles keyed to our short attention spans and our enjoyment of buying new things. This creates "jobs" for car salesmen, advertising executives, etc., but has tilted the scales in favor of "useless GDP" rather than real societal utility. We know how to make things with high quality that last, but due to time bias and the financialization of the human experience, such an objective is relatively unimportant

in our current culture. Many people get a new phone every 18 months with their cell plan, and perfectly functional ones wind up in the landfill.

But how should we distribute the largesse of the energy slaves? Does everyone get equal shares? Do we take the total number of dollars (which is the way we count such things) created by energy-slave work and divide them equally among the population?

Heavens no. We haven't even acknowledged that the energy slaves are responsible.

Rather, with a bit of help from opportunism, *social evolution co-opted the pre-existing "work for pay" concept into an uneven distribution system that "felt" fair.* These days there are a lot of jobs in the USA, which keep us very busy not making much of anything of long term value. We do advertising, hairstyling, consulting, writing, and a lot of supervising of the things our fossil slaves do. We don't care all that much what we're doing as long as we feel we're getting paid at least as well for the same task as the other capuchins – er... people - around us, and that with our compensation we can buy things that give us pleasing brain-reward experiences. These days in this culture, a "good job" is defined by how much it pays, not by what it accomplishes. Many people would consider it an optimum situation, a great job, to sit in a room for 40 hours per week and make $100,000 per year, just pulling a lever the way a capuchin does for a cucumber slice. You know they would (*would you? Think about it. Now think about how that compares to the career you're currently planning).*

And that's where the perceived equality is: *the equality of inconvenience*. The 40-hour work week is a social threshold of *inconvenience endured,* which is now what we keep primary social track of rather than the productive output of a person's activity. In 1930, John Maynard Keynes predicted that wealth would increase 600% in the next century (by 2030, which is only 11 years away) and because of this wealth, people would only need to work 15 hours per week.[53] He was right about our wealth increase, but paradoxically, we are working longer hours than ever! Because socially, everyone who isn't a criminal is supposed to have a job and endure roughly equivalent inconvenience. Any segment of society which went to a 15-hour work week would be treated as mooching freeloaders and be pelted by cucumber slices and worse.

In a society in which all of us are basically idle royalty being catered to by fossil slaves, why do we place such a value on "jobs"? Well, partly because it's how the allocation mechanism evolved, but there also exists considerable resentment against those who don't work. Think of the vitriol with which people talk about "freeloaders" on society who don't work a 40-hour week and who take food stamps. The fact is, \most of us are freeloaders when it comes down to it, but if we endure 40 hours of

inconvenience per week, we meet the social criteria of having earned our banana pellets even if what we're doing is stupid and useless, and *realized* to be stupid and useless. Indeed, a job that's stupid and useless but pays a lot is highly prized.

So "jobs" per se aren't intrinsically useful at all, which is why ants don't want more of them. They're mostly a co-opted, socially-evolved mechanism for wealth distribution and are very little about societal wealth creation. And they function to keep us busy and distract us from huge wealth disparity. We're too busy making sure our co-workers don't get grapes to do something as radical as call out and lynch the bankers. Keeping a population distracted may well be necessary to hold a modern nation together.

And because most of our wealth comes from invisible, mute slaves we don't even think about; it isn't clear to us that what we're actually doing in current economies is distributing the wealth they create. That means we can now have wild disparities in pay, as long as it "feels like" others are doing something qualitatively different. The amount paid to a wall street vice president is hugely greater than that paid to a college professor, which in turn is greater than that paid to an environmental campaigner. This has pretty much nothing to do with the relative worth of each function to society, and everything to do with how well-connected such jobs are to the flow of energy-slave-created wealth. Yet if higher pay is received by someone in another "tribe" who we don't directly interact with, we don't feel the urge to scream and throw our paycheck. We just wish we had a "better" job.

If we reflect on the possibility that we have en-masse simply accepted the premise that the job is somehow paid what it's worth, we arrive at some disturbing conclusions. Is a teacher, farmer, or fireman really of less value to society than a real-estate flipper? The amounts paid for jobs have been allowed to float freely, detached from actual societal value as the degree of political connectedness of those with such jobs varies. The vast majority of our wealth comes from primary natural capital in tandem with fossil slaves and from the fruit of empire; jobs are mostly an ad-hoc mechanism for distributing this wealth unequally in a way which effectively conveys the illusion of egalitarian process.

For now, are most of us just idle princes and princesses in a fossil-slave kingdom, none of us really at huge risk, and mostly doing things which have little net value? And what happens when our fossil slaves grow wings and fly away into the atmosphere? What will the princes and princesses do then?

That's just Gross.

This leads us to the story of how we keep track of our wealth and productivity and success. How DO we keep track of that collective wealth anyways?
Well for *real* wealth, mostly we don't. The value of a healthy ecosystem, clean air, seas full of fish, fresh drinkable water… love, joy, happiness and fulfillment… all these things our market system considers to be of essentially zero value. Likewise, armadillos, dolphins, hummingbirds, rainforests… you get the idea.

But our economists have a metric called "gross domestic product" (GDP) which is what our society uses to roughly keep track of our 'success'. It represents the dollar value of all *finished* goods and services produced in a time period (typically a year) within a nation's borders. Since that other stuff- you know, the natural world- doesn't consist of finished goods and services, it isn't counted (now if you kill the hummingbirds and make them into ornaments for hats, or turn armadillos into ashtrays, they then can be added to GDP because they're now products which are "finished"!).

The fact that parts of the environment which have been "finished" are considered more valuable than parts which are "unfinished" is one way in which GDP sets a fairly screwy default value in our current world. It's a tacit societal value system: anything without a transacted money value isn't part of GDP. So, a nation which chops down all its trees to sell to another country for firewood has a better GDP than one which leaves its trees standing. It's a funny way to figure wealth, but it's what we've got. And oh, by the way, we're betting everything on it.

GDP is based on money transaction (money is, roughly speaking, a claim on future energy), and since most current wealth is created by our fossil energy slaves, GDP is directly tied to the energy burned by society. Indeed, it has recently been shown that GDP is tied to fossil fuel energy, and thus CO2 emissions, in a way which may be described very simply by treating human society as essentially a giant heat engine. In other words, a very simple model which treats human civilization as an essentially mindless consumptive system - a thermodynamic amoeba in search of energy - suffices to match the GDP with the quantity of energy burned.

And over the last 100 years, our burning of energy, and thus our world GDP, has gone through the roof. The number of dollars representing the wealth created from the burning has also increased, and exponentially so in the last 50 years, and since the 2008 crisis, even faster.

It may be reasonable to reflect that during this same period, sometimes called The Great Acceleration, the planet has been largely laid to waste, extinction events have accelerated, many world fisheries are badly depleted, and the ecosystems which sustain large complex life on earth have been progressively compromised. Yet we

continue to grow the scale of the heat engine to accomplish the primary objective of the modern human economy: *to maximize dollars and jobs*.

Bear in mind that what we're doing - if we get right down to it - is converting trillions of watts of fossil-slave energy into a few watts of pleasing stimulation inside our brains. (alternately: tiny amounts of brain-reward chemicals) And the side-effect of this process is all around us. Mountains of waste, acidified oceans, altered climates, pollution, species and population extinctions, and mischief. Here we use "mischief" as the general term for things humans do en-route to pleasing themselves, which may include building racetracks, using disposable diapers, making waste baskets out of elephant feet, overbuilding fishing fleets, throwing out electronics every two years to replace them with new ones, etc. It doesn't "feel like" waste at the time. But if you ask someone in 200 years what percent of fossil magic was wasted, they will likely say "all of it," because not much useful fossil fuel (or anything previously built with it) will likely remain.

The ubiquity of fossil slavery during our lifetimes has caused us to conflate wants and needs. Most of what we "feel like" we need these days is nothing we evolved to need. Consumerism is driven largely by social competitiveness and suggestive advertising. Most capuchins – er…, people - find it more important to have a bigger house than their neighbors, than to have an even bigger house in a neighborhood where it's the smallest one. Relative wealth - it's not just for monkeys (we and the monkeys like fairness, but it *feels more fair* if we've got stuff *at least as good* as the people we interact with).

And this signaling of status is important socially and sexually. A lot of the things we feel we need are just for show.

And do you remember the "hedonic ratchet" effect from earlier discussions on bias, heuristics, fallacies and delusion? To get the same mental stimulation we got yesterday, we require the expectations of ever-increasing reward. That means more money and more energy slaves. Or at least the expectation of same.

Happiness *is not correlated with wealth* beyond having the basics of life covered. Most of the things which actually make us happy, joyful, and fulfilled are in our virtual mental worlds, and not in the physical world at all. A Filipino may have only a small percent of the number of energy slaves as an American, but be every bit as happy, and surveys have shown that to be true.[61] It's quite possible to be "poor" and happy. Equally, it's quite possible to be rich and miserable. Our brains are even primed for it, seemingly.

So where does this leave us?

Well, you already know that our amoeba-like heat-engine of an economy is wrecking the earth, acidifying the seas, melting the polar caps, causing what could become the greatest mass extinction in 65 million years, and throwing our future into doubt.

But at least we have our good ol' energy slaves to continue creating GDP. Right?

Well…

Thing is, the energy slaves will soon be going away forever. In the last 30 years we've burned a third of all fossil energy that has been used since it was discovered thousands of years ago. Since your authors have been alive, humans have used more energy than in the entire 300,000 year history of Homosapiens.[54] We are just now passing through the all-time peak of liquid hydrocarbon availability, which is the chief driver of our economies due to its special attributes.

Each year, basically from now on, most of us will have fewer fossil energy slaves marching behind us. You'd think this wouldn't make much difference, right? Since they're invisible anyhow? But in fact, it'll make a great deal of difference, because we're heading back into times – either gradually or suddenly, but inexorably - in which human labor makes up an increasing percentage of the total energy we have available. One day human (and perhaps animal) labor will again be the majority of the work done in human societies – just like it is in an anthill.

And this will happen in the context of a more used-up natural world. Rather than being able to catch dinner by throwing a hook in the nearby ocean, the nearest healthy schools of fish may be ten thousand miles away in Antarctica, and hard to get to without dirt-cheap energy slaves to make giant refrigerated ships to pursue and move them around for us. The copper mines will be mostly used up. The inorganic phosphate deposits we used to make fertilizer, mostly gone. And so on.

Or rather than "gone," let's use the more accurate term *energetically remote.* That is, there will still be loads of "stuff" underground, but it won't be the very pure ores of yesteryear. It'll be stuff that requires digging up a huge amount of rock for a tiny amount of whatever we're after. Because (remember the Easter candy story) we always use the best stuff first. Yet we'll be going after worse and worse ore with fewer and fewer slaves. And the heavy breathing of the fossil slaves will have pulled our seas and climate back towards conditions in which they were born - a hellish primordial world of toxicity.

This all raises the question - or at least should - of whether it might not be a good idea to set the fossil slaves free and let them rest, since *they're going away soon anyhow* and *when they do, we will really need a livable planet.* They don't need jobs, and we don't need dollars for happiness. Yet this flies in the face of capuchin

entitlement and evolved mechanisms for brain reward, which – in effect - take our current societal arrangements for granted. As our fossil slaves eventually retire – childless –we might have to rediscover the difference between jobs and work, just like the ants.

On GDP, Stone Heads and Babies

"Can you think of any problem in any area of human endeavor on any scale, from microscopic to global, whose long-term solution is in any demonstrable way aided, assisted, or advanced by further increases in population, locally, nationally, or globally?" **Al Bartlett**

So other than using up non-renewable resources and degrading the natural world, what other consequences can there be when maximizing GDP is our plan for the future?

Well, for one thing, it can lead us to really screwy societal choices.

For instance, in the infamous Easter Island culture, there was an organizing *belief in belief* that all food, resources, and other good things came from their dead ancestors, and that the way to make your dead ancestors happy was to build giant statues for them. This was actually not that different an organizing concept from GDP, in that both exhibit a near-hallucinatory level of disconnect from physical reality and ecology.

As ecological changes on Easter island worsened due to rats cutting into food supplies, it "made sense" to vastly ramp up the production of giant stone statues, making them ever-bigger (and hence presumably more pleasing to the dead ancestors... "too big to fail", perhaps...). This was a colossal undertaking for a stone-age people using human muscle power and required a lot of wood for rollers and leverage. So they cut the trees down, which caused erosion to begin washing away their productive farmland.

The worse things got, the harder they worked making stone giants. The final generation of stone giants never left the quarries - they were too big to move. As a part of this process, eventually the last large tree was cut down, which made sense based on their organizing beliefs, but was in retrospect not a good plan. It not only

meant their fertile soil washed away but meant they could no longer make boats to go fishing. So, they starved, fought, and suffered a lot as their populations crashed.

For the Easter Islanders, erecting these stone monuments was an example of "jobs" masquerading as "work" - basically tasks done for social-obligation reasons that did not provide actual biological or group-fitness benefits. *(Do you think there may be modern-day equivalents?)*

Today it's easy to joke about these islanders and their "giant stone heads" as a high point in the history of human doofus-ness. Yet our adherence to GDP is a similarly skewed metric, equally detached from the realities of ecology, from human happiness, and from the potential for future generations with decent life quality. On a much larger scale, we too are eroding farm land (which these days is largely a dead medium used to hold the seeds in place and receive industrially-produced fertilizer and pesticides), destroying the ability to get fish (by wiping out fisheries), and, because of our numbers, mucking things up to a degree the Easter Islanders never reached.

We've already mentioned that - due to being blind to the energy slaves who do nearly everything for us - we now tend to conflate "jobs" with "work", where "jobs" are just a social distribution mechanism for energy-slave largesse - an entitlement entwined with social status - and "work" is what is necessary to temporarily improve an individual's, group's, nation's, or species' circumstances.

We've also noted that we have folded "planned obsolescence" into most built consumer devices, so they break more quickly and require replacement, tuning their life-cycle to human whims and brain rewards rather than to real utility. Mostly we don't really even want or expect gadgets to last as long as they used to; as long as we can afford it, we want the newer, cooler, stuff. And advertising helps keep our culture primed for it.

The fact is, we have designed a social system that requires growth. Money –really a claim on future energy and resources – comes into existence irrespective of whether such future energy and resources will be available. Each year we need growth in a household/city/state/nation/world to service and pay off monetary loans that were created previously. No serious government or institutional body has plans for anything other than continued growth into the future. Growth requires resource access and affordability but starts first with population and is driven by population increase.

So, right as our energy slaves are about to start going away forever, leaving 7-10 billion humans without the things they have come to take for granted, our nations have decided the answer is to *make more babies*! Yep, to raise GDP you need *more demand* for toys, diapers, teachers, etc… more jobs, because more jobs means more transactions which means more GDP! More GDP means "growth", so growth is good! China has just reversed its 1-child policy, which prevented massive starvations and slowed the horrendous assault on China's environment.[55] Many other nations, such as Japan, Germany, and Sweden, are now offering bonuses for getting pregnant. In Denmark advertising firms are encouraging couples to have more babies for the good of the economy via sexy commercials.[56]

Paradoxically, as traditional drivers of GDP growth – development of virgin land, credit expansion, low cost fossil fuels, and groundbreaking innovation- wane in their impact, there may be renewed incentives proposed not to shrink our population as ecological wisdom would advise, but instead to grow it! Currently we are having (as a species) over 120 million babies per year.[57] This works out to over 335,000 human babies born every day – compared to a total extant population of all the other Great Apes (bonobos, chimpanzees and gorillas) of about ~500,000![58] Since 'demand" is considered a quasi-magical force in current economic theory, babies are considered to be good for business (yet *children brought into the world now for GDP reasons will face some real challenges in their lives. Nate and DJ decided not to do that for a host of reasons).*

China is building massive empty cities now.[59] No kidding. Cities with nobody in them, ready to be moved into by the bonus babies to grow GDP. That's edging perilously close to building giant stone heads.

When you get right down to Reality101 and the intermediate human future, this is actually *worse* than building giant stone heads, because stone heads don't suffer,

reproduce, or require further environmental degradation to provide for their needs. In many real ways, the world and human species would be far better off if we immediately moved from GDP to "giant stone heads" as a metric for success (and say, doesn't that imply to you that we might even do *better* than giant stone heads, if we put our minds to it?).

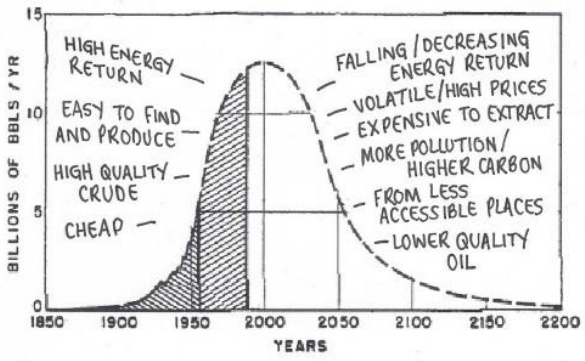
GDP sets a money value on everything in the natural world and in human experience, and the most important things are currently valued at or near "zero." Yet as we've seen, GDP is currently tied to the work of fossil slaves, who will be gradually flying away. There's no way, even in principle, for "growth" such as we've recently seen to continue indefinitely, and considerable data points to it ending quite soon. GDP will begin a long decline because it's tied to finite realities in the physical world.

The good news, of course, is that GDP is a really goofy metric for success, just as "giant stone heads" was (*though to give the Easter Islanders their just due, at the time they had no evidence their belief was delusional, while in 2016 we have demonstrable proof that the conclusions of neoclassical economics are refuted by basic science).* If we decide that we value happiness, quality of life, and a healthy planet with uncounted thousands of human generations left, we could in principle jettison GDP and do things differently.

It won't be easy, only necessary. It'll be easier to fail than succeed, for the societal inertia of a raging amoeba hungry for growth is a hard thing to change. Nothing much depends upon it other than the human destiny and the fate of complex life on the planet.

Learn to see the giant stone heads around you and think about them.

Receding Horizons and Peak Everything



Key points/Overview

** 1. *We extract various low-entropy materials from the earth to keep our industrial society going, from metal ores to fossil carbon and hydrocarbons.*

**2. The distribution of natural resources is such that for each there is a characteristic discovery and utilization curve, and these curves may be averaged to give a rough prediction of the future availability of that resource. This is straightforward, yet we disbelieve it.*

** 3. *For any such resource, the available flow will rise, peak, and subside as the easiest and purest resources are used first.*

**4. *The most important of these are the energy resource peaks, because as the pure ores get used up, it takes increasing energy to refine the worse ores into usable purity.*

**5. S*ome elements are only recovered only as side-effects of other mining and will become unavailable if the current scale of mining stops.*

**6. *Pretty much all aspects of human society have gone exponential - a lot of hockey stickshapes in: population, consumption, production and environmental impact - which means that energy and materials flows will peak this century. Many peaks (e.g. fish, and oil in over 80 countries) are already in the past.*

**7. *We're currently coasting on infrastructure which was built at peak energy and peak ores. This infrastructure will need to eventually be repaired, replaced, or done without, but there will be a lag period from the peaks before this becomes critical. The benefits from applying huge (and still growing) numbers of fossil slaves to increase complexity are already declining; and the horizons will keep receding for a long, long time. Yet we'll likely continue to look at the new iPhones and not at the rusting pipes underground.*

** 8. *Complexity costs a lot in energy and materials to maintain. To continue, our civilization will eventually have to simplify, either in a pre-planned way or in a cascade of failures.*

** 9. *The good news is that happiness - at least for individuals - need not peak. It is part of our virtual worlds; as long as we have enough stuff to be healthy, we can be happy. But we are currently being very careless with that possibility and are not extending the "we" very far into the future.*

Our species was born into a world which seemed to offer limitless resource abundance. And it was pretty much true. Forests, wildlife, fertile plains, seas full of fish, and all existing on a scale many orders of magnitude larger than human populations. Like a mouse discovering an entire pizza, the enormity of bounty was wonderful and stunning, and it seemed to exist only for us to consume and enjoy. Ever since that time, when the earth's ability to provide for us far exceeded the needs and wants of our numbers, we have continued to hold onto our beliefs about the unlimited plentitude of the natural world.

The problem is, this is no longer the situation. It just "feels" true because our (American) bellies are mostly full at the moment, courtesy of our hard-working fossil slaves. Yet most of the fossil slaves still sleeping in the earth will take more energy to wake up than they'd be able to give back once awakened. Despite their large numbers, we never had the potential of waking more than a small subset of them (enough to give our species a turbo boost and give the squeeze to other species, but small in relation to the total amount of 'buried sunlight' on our planet).

The reason our bellies are full is that we've become accustomed to eating fossil energy ourselves. Only one in eleven calories going into our mouths from the global food-creation system comes from photosynthesis. Most of the nitrogen in our bodies' proteins is fixed in factories which use natural gas to create ammonia, which is in turn dumped – along with pesticides, herbicides, mined phosphate and potassium, on largely sterile soils to make plants grow.[60] *(Fun trivia fact – this process was invented*

by the same guy who is known as "the father of chemical warfare" for his work in gassing allied troops in WWI). That's where the 7.5 billion humans around us came from, and the reason the current terrestrial vertebrate biomass of earth is enormously expanded relative to all historic levels. In effect we are using the sun and soil to turn fossil energy directly into crops and livestock, and more and more people (what could possibly go wrong?) So technically we're testing out a radically new ecological niche: *Homo detritivoris*. And it's the largest-scale test of anything, ever. We are not made of the same things our grandparents – those creatures of solar flows – were, and our existence flows from a radically different set of contingencies *(in addition to fossil slaves who breathe and emit wastes, we have also added more living animal tissue than the earth previously supported, far outweighing the wild species we have done away with).*[61]

Our modern cornucopian beliefs are formalized in neoclassical economics - the myopic religion of our global economy - which believes that human demand and cleverness, not energy and materials, are the ultimate creative forces. The priests and shamans of neoclassical economics believe there is literally nothing in the universe for which a decent substitute won't appear if we want it badly enough. Yet as unrealistic as these beliefs are, these priests and shamans are allowed to drive, vote, and wander around unrestrained, and - oh yeah - we are using their 'wisdom' as the entire basis for our civilization's decisions.

But the reality is that other than air, we have always had to invest scarce energy to get everything else (and yes, there are places in the world that you can even buy air from vending machines now, if you want it without a heavy dose of toxic air pollution).

In a recent essay draft, we introduced the concept of *energy remoteness.* That is, we are effectively separated from the things we need and want by barriers of energy, time, materials and complexity. With enough cheap energy you can obtain materials, build complexity and save time, so our current reality boils down to the energy distance between our society and various things we need and want. For instance, there is both gold and uranium in common seawater, but the concentrations are so low one would need great amounts of low-cost energy to concentrate such rare minerals for human use. Energy cost and availability is the driving constraint of human output. In effect, there is an "energy trade" for anything we want that we don't already have.

This has been the case since long before there were humans. It has been the case since before there were *spines.* Foraging efficiency is about whether a critter can capture enough energy in its travels and other actions to replenish the energy it expends, plus do all the energy-intensive things it needs to do to reproduce: grow, heal, find a safe place to live, get water, etc. The ones which do, and which aren't otherwise taken out

of the game by other factors, survive. The ones which don't, don't. This has always been the case with animal species, and always will be. And we are animals. Ergo, we should pay attention.

We believe - that is, the "we" of our current societal economic narratives - in the cornucopian story of "demand creates supply" *ex nihilo* (Latin for "out of nothing"). Not satisfied with that level of crazy, we have "doubled down" and also believe that we will not only do this indefinitely, but that we will continue to *increase our output year after year* indefinitely. Hence the use of the word "growth" as the target of all current economic programs and our political parties.

Growth *feels like* a good idea because we get there by having sex, cuddling babies, eating, acquiring more possessions, and burning stuff – and all of these activities "feel good" and are very easy to do more of, given the means.

In our tribal hunter-gatherer days we evolved a neural "hedonic ratchet" because it served us well to expand into new niches. It's still a part of us. That is, we require the expectation of ever-larger reward to get the same level of pleasure we used to get out of less. To get pleasing brain rewards from anticipation of the future, we need to always expect better things in the future than were available in the past – in our culture this now translates to more stuff, more gadgetry and more fuel -- but alas, more waste and CO2 emissions! Neoclassical economics promises that this is guaranteed to happen and is thus a good mythological "fit" for our unconscious decision-making brain modules. (*An "ecological economics"- commitment and implementation - would make a helluva lot of sense, and could be pursued. But at its core it's displeasing to the agenda of the gene, and so far we aren't doing that.)*

In addition to "continual growth" being impossible even in principle, there are some basic first-principle realities which show that things will be, *must* be, soon heading in the opposite direction from what we've come to expect.

Do you remember the "best first" principle from the Easter egg story? Humans use the best stuff first because it is *less energetically remote.* That is, it is *purer* (requires less energy to transform into what we want), *more concentrated where we find it* such as in very rich ores, and *easier to get to* in terms of where it happens to be. There's no question why we would use this stuff first. It's basic foraging efficiency. Any animal goes for the best stuff first. A bear will not eat berries while it can get salmon. A human will not suck cactus juice out of a cactus while there are cans of cola in his fridge.

So, we used the stuff with all those great properties first. But that stuff existed in those concentrations only due to the gradual processes of geological time, in which a million years is an eye-blink. It will not re-concentrate itself in the lifetime of our species.

By the "can't have your cake and eat it too" principle, this means what we've used is gone now, and over time we have been left with progressively less-pure, less-concentrated, and harder-to-access resources. As you might imagine, that has been going on a long time, pretty much from the get-go, and the scale of accessing those resources is now unprecedented. So why wasn't there an *immediate and accelerating* cost incurred in pursuit of this energetic remoteness?

The answer, of course, is that there was. Our resources, other than renewable biological systems, have been getting more energetically remote since we began using them. In the 1930s, the oil was barely under the surface in Pennsylvania and Texas and created huge gushers that spewed oil under pressure high into the air. Today we drill in water 20,000 feet deep, and drill 5000 feet further through solid rock to get oil.[62]

A new well in the Bakken Field of North Dakota requires 100 train-car-loads of sand and hundreds of trucks of water, as well as high energy input in diesel oil and natural gas. We are mapping the high arctic so when it is ice free, we can drill more holes under the Arctic ocean to get at what was once unthinkably remote and off-limits. These are all aspects of energy remoteness. Drilling holes in the ground to locate ever-smaller and more problematic oilfields is inherently unsustainable – and it's getting costlier.

But by adding more overall fossil energy slaves to the workforce every year, we obfuscated these underlying trends of depletion. Not only did we keep pace with the progressing energy remoteness of resources, we made it *seem like* they were even getting cheaper and more abundant – like our "demand" was creating them. That was entirely an illusion based on the largesse from fossil slaves existing in a human blind spot, invisible as water to a fish. Yet once the slave labor starts going away - and that has indeed started - we wind up with something of a double whammy, because we have ever-fewer energy slaves chasing what are, by historical standards, really crappy, diffuse, and remote raw materials. That is, we have engineered a predicament** of potentially rapid transition to unaffordability - or even unavailability - all while continuing to believe that "demand" is causing things we want to pop into existence.

*(**Note: a "predicament" is different from a problem, in that problems have answers, while predicaments are just something you need to try making the best of. A person*

hanging from his fingernails 40 stories above the asphalt has a problem. Her friend who has already started falling has a predicament. The first person can try to climb back into the window. The friend has no such clear, reductionist option.)

And we really haven't discussed here the significant energy cost of maintaining complexity, or the fact that it inevitably reaches a point of diminishing returns after a society turns to increasingly complex solutions. Rust never sleeps, and even in the world's richest nation burning more energy per capita than almost every country, the USA isn't currently fixing our bridges, pipelines, roads, railroad tracks, sewage systems, or any of that stuff beyond the bare minimum (gee, what could go wrong there?). We assume, to the extent we think about it at all, that our "demand" will fix things if they ever break, as many times as necessary. We even believe that when that happens it will be a *good thing* because it'll create jobs.

Receding Horizons and Imaginary Futures

Another real-world manifestation of progressive *energetic remoteness* is what we call "receding horizons", and it's something else you won't have heard about outside Reality101.

There's sort of a societal "kick the can down the road" response to intractable issues, because we tend to assume that *things will always be easier in the future*. After all, that has been true about *many* things up until recently (due to our adding more fossil slaves each year), so the result has become a central belief of our culture without our understanding the *cause*. If we believe that GDP, energy, and wealth will be hugely higher in the future, and that science will know more, then it only makes good sense to put off any really difficult things for those fifty billion future rich people to deal with in the cornucopian future.

So, for instance, we just store the dangerous "spent" nuclear fuel rods in swimming pools next to existing reactors rather than doing something to make them less dangerous. So, we're "kicking the can" to the rich miracle-workers we believe will exist in a generation or two, who will have some sort of miraculous *deus ex machina* (intervention) plan for putting things like nuclear waste right. That's another reason (on top of lack of affordability) we're not fixing our bridges and sewage systems. Let those rich future people do it with their fusion generators and anti-gravity boots!

Ah, but those rich people of the intermediate future are a myth, and a dangerous one. In reality they'll be far more likely to be impoverished, sweaty, hungry, and hate our guts to the extent they think about us at all. They will, after all, be the ones who increasingly get stuck with the check and the responsibilities after the energy slaves

go back to sleep, leaving things on the planet largely screwed up...the ultimate Ponzi scheme.

And receding horizons will likely mean they won't have fusion generators, either. Of fusion plants it has been said "it is the energy of the future - and always will be." When DJ was a kid, they figured to have commercial fusion reactors within 40 years. DJ is now 65, and it's still supposedly 40 years away. Receding horizons. The complexity required to affordably contain an energy-generating fusion reaction simply does not lend itself to being solved, despite the huge amounts of money being thrown at it. There are too many intractable problems which would have to be solved simultaneously, and they are problems of the sort which would require ongoing access to the level of societal complexity we now have – *or better*. That would require energy and resource inflows at increasing levels, but that will not persist (it turns out that demand, on its own, could never create much of anything in the first place). Commercial fusion is thus - ironically - becoming ever more energetically remote as an actual deployable solution even as we fail to solve the fundamental technical and practical problems which have always stymied it.

We don't need to look at things as exotic as fusion to see receding horizons. They are receding all around us as liquid fuels start to fluctuate between unaffordable and unavailable. Just look at energy-intensive industries and you'll see corporate mass extinctions, consolidation, cost-cutting, and red balance sheets. When we were younger, half of the seats on airliners were empty and the seats were bigger (so it wasn't unusual to be able to just lie down across 4 seats), you could fly a supersonic airliner if you wanted to, and the choice of airlines was stunning, with many flying the same routes and tempting you with gourmet meals and free perks. That stuff has gone away as consumer-based airlines fight a losing battle to continue existing in any form at all. If your grandkids see contrails in the sky, it'll likely be military planes or foreign royalty.

The moon is farther away than it was when we visited it. Not the physical 1.5 inches farther away it gets every year due to tidal interaction with the earth. It is hugely more *energetically remote* than it was when we watched a Saturn V rocket leap skyward over our heads in 1970. That means it's more fiscally remote, as well. While it would be *physically possible, w*e simply can't afford to do it now, and couldn't build another Saturn V if we wanted to; we'd need to start from scratch because we didn't maintain the infrastructure to build them. It's a very strange and profound feeling to look at the moon and know there were once people on it. It may be that nobody born since the 70's will ever know what that's like. Receding horizons.

As successful as Gordon Moore's conjecture was, Moore's Law (that the number of transistors per inch on integrated circuits will double each year since 1970s) has been used to predict all sorts of things which will almost certainly not happen, such as humans uploading their brains into robot bodies in the relatively near future, achieving immortality. In preparing this lesson draft, DJ suggested that we offer a corollary to Moore's Law, noting that things which can't be solved exclusively by ever-smaller transistors don't obey Moore's Law even if we want them to. So for instance building a bridge, building a dam, building and launching a Saturn V, building railroad tracks, fixing toilets – that is, creating macro things that exist and function in the physical world rather than in virtual computer worlds, will always cost more as the energy slaves go away. That is, physical projects get progressively harder to accomplish as we progress into a future in which there is less "net energy" available to humans each year.

If you learn to see receding horizons, you'll start seeing them everywhere. They aren't hidden. We just ignore them.

Manufacturing wages, adjusted for inflation, peaked in 1973.[63] Median household wages peaked in 1999.[64] The benefits from super cheap fossil pixie dust have already been experienced. Now things which comprise our human world are more complex, require more energy inputs, and are generally harder for most Americans to afford. A lot of your generation are living with their parents, while their parents didn't have to live with theirs. An independent life is more energetically remote than it used to be. Again, look around and you'll see it.

Yet you've probably not heard anyone in the news, or even in science articles, talk about "receding horizons" and "energetic remoteness" until now.

So while we don't know exactly how the future will roll out, we do know some things about it absolutely. Resources - including fossil carbon and hydrocarbons themselves - will be more energetically remote. It will be not easier, but *harder* to deal with those pools of hideously-radioactive fuel rods in swimming pools, kept from going critical by pipes and pumps which are rusting year by year. Hundreds of potential "Chernobyls" in the heartland, not due so much to poor reactor design as to belief systems which are unmoored to physical reality, and a disconnect with the ability to think reasonably about the future. One reason among many to acquaint the world with Reality101.

But there's a more basic observation we can make, and be absolutely sure it's correct, because it derives from the most basic physical reality.

Peak Everything

You've heard about "peak oil" in your class lectures. It's funny that in the existing cultural mythology of growth and neoclassical economics, "peak oil" is considered to have been a **crazy** idea which has been debunked.

This is far from the truth. Peak Oil is a physical principle which has been widely misunderstood: anything finite which you're extracting from natural sources will gradually get harder to find. This is an obvious outgrowth of using the "best first", which might just as well be called "worst last." This implies that there will be an availability curve which initially goes up, as you use the best stuff, and then goes down as you get to the worse stuff. The "peak" is the peak flow rate of oil output. *It doesn't matter what you do, this will occur.* Natural resources follow a normal type distribution over time that has a peak and a decline –often in the shape of a 'Verhulst function' (similar to a normal curve) with roots in biology and population dynamics.

This dead-simple concept is so *utterly disbelieved* by so many educated, authority-holding people that it's creepy. In the 1960s we bought gasoline for 18 cents a gallon. Or "premium high octane" for 19 cents. Everybody we knew had V8 engines then, because 8-10 mpg was no big problem, and why wouldn't you want a huge amount of power? That stuff is more energetically remote now. And when you kids get to be the age of your authors, you will be telling codger stories about being able to get gasoline in any quantity you wanted, any day of the week, j*ust by paying for it*. Receding horizons.

But they're not just receding for oil, although due to its energy density and transportability, oil is the "master resource" that makes our global economy work, so is arguably the most important. The same sort of logic applies to everything else which requires energy to obtain or manufacture. Which means everything in the physical world, pretty much. Hawaii will be a lot more energetically remote when you can't get there by a nonstop jet; the world will begin seeming larger again.

As we've said, all resources have been getting more energetically remote since we started mining them (or in the case of ecological resources, since we started using them faster than they could replenish). This means that "peak mammoth meat" came and went 15,000 or so years ago. Peak whales was probably in the 1950's. Peak fish was probably near 2000. Peak (traditional crude) oil was about 2005.

This begs the question, then, about other stuff we need, which will all peak and decline as well.

Peak phosphate. Google it and think about it. The “green revolution” which keeps human population expanding is completely reliant on inorganic fertilizer, which absolutely requires mined phosphate. It’s finite and is getting more energetically remote. Even if nothing else is considered, that implies that the amount of food from the “green revolution” will also peak, and that in turn has ramifications for the amount of living animal biomass - humans and livestock - which may be supported. There's currently a fierce debate about just how long our supply can last. "Peak phosphorus" doesn't get a lot of buzz, but it should. In a recent essay in *Nature*, Jeremy Grantham, a billionaire who also runs an environmental foundation, put the case bluntly: Our phosphorus use "must be drastically reduced in the next 20-40 years or we will begin to starve."[65] Ergo, finite phosphate is a prime example of the progressive energy remoteness we are discussing in this essay. “Demand” cannot create a phosphorus substitute. Our muscle cells use ATP (adenosine triphosphate) to function and always will.

Peak copper. Peak high-grade coal. Peak societal complexity. Peak air travel. Peak car travel. Peak physical wealth. Peak stuff-that-needs-refrigeration. Peak cheap shipping.

And inevitably, Peak humans. It’ll happen this century. The United Nations projects population to peak at 9.2 billion in 2075.[66] Deutsche Bank projects it to be in 2055.[67] Another study says 2070. Of course, all these studies use econometrics that erroneously conflated the dollar value of fossil fuels with the work value. They also assume that if we demand enough energy it will automatically appear. They also assume continued 1.5-2.0% growth for the entire century. There is no shortage of scientific reports noting that peak humans will happen, *but they don’t stress the point that it will be a one-off all-time high, and specifically don’t talk about the shape of the curve after peak*. An example of physical world problems being solved via social sorting mechanisms? Think about it.

Peak Happiness?

The intent of this course is not to depress you or make you feel despondent. Just the opposite, actually, but we also can’t get to where we need to go by bullshitting you.

Our society will need to - at some point - begin making rational, adult decisions if a way can be found for that to happen. Those decisions must be informed by physical-reality first-principles, and by the fact that there are some things that we DO know about the future, because they cannot be otherwise. They form the walls of the bottle of our human and earthly existence, which is ultimately subject to the limits inherent in physical reality.

Again, though, to end on a slightly upbeat note, lets reflect again that we *do not have to remain zombies in thrall to the gene agenda*. We can chart a course - at least in principle - to a 4D future of trillions of human childhoods on an ecologically-healthy planet. There is utterly nothing to stop us other than the inertia of a belief system which now exists in billions of brains. Physical wealth must decline, but happiness could - in principle - rise at the same time. GDP isn't true wealth, it's just a slave census. That we need all this stuff is a lie, and a harmful lie. Think of the best times you've ever had, the most wonderful, memorable experiences.

Were those good times about wealth and stuff or were they about human interaction with friends and loved ones, or an experience in the natural world?

Human history has been punctuated by times of strife, and indeed most human lives of recent history were lived in conditions far more austere and hopeless than anything we now face, as we are unable to wake sufficient slaves to indefinitely keep growth going. Yet those people wrote classic literature and music, loved and laughed, created and discovered. Challenges can bring us together and give us focus and direction.

That's the thing: there's a real cornucopia of infinite abundance at our disposal: the wealth of possibilities and experience within our virtual worlds, which are not inherently tethered to physical limits. Our physical brains only consume about 20 watts of power, probably less than those of our Neolithic ancestors.[68] That power requirement won't ever rise, yet within our minds many sorts of magic are possible. Myth, subjectivity, belief and tall stories are a problem when they cause us to make bad decisions about the physical world, but they are exactly what enable us to find happiness as humans; to aspire, to care, to create and to love unselfishly. The highs and lows of experience with our virtual worlds – the only worlds we can ever experience – do NOT require huge and growing energy supplies, and piles of manufactured stuff. Just enough food, resources, safety and friendships to live a good and satisfying life. And DJ and I would add nature to that list.

And that could go on for millions of years, if we stop making **insane** physical-world decisions prodded by our evolved feelings. High stakes indeed.

Learning Reality101 means learning to see the actual shape of the human and earthly reality, and that's a lot to deal with, particularly since we have been told very different stories about the world for most of our lives. We're learning the realities before learning how to cope with knowing about them. That's the mixed blessing of being the first to learn something new. But this course will get to that as well. Would we be working this hard if we thought it was hopeless? Nope.

Peak Oil and the Immediacy Fallacy

So, your authors have noted that oil availability, energy availability, and therefore raw resource availability must eventually peak and decline. This is obvious from:

- the fact that a finite non-renewable resource gets used up, by definition. As they say, you can't have your cake and eat it too.
- the fact that "best first" extraction policies by humans mean that remaining resources necessarily get progressively more "energy remote" requiring increasing energy to extract
- the fact that you have to discover something before you can use it, and oil discoveries peaked long ago; we're currently using it up 6x faster than discovering more.[69]
- detailed analysis of actual global oil production projects it peaking and declining precipitously.[70]
- human energy use is rising exponentially. The exponential function has a way of finding limits quickly.[71]

Your authors have also noted that this peak and decline will have a large effect on current human systems. This follows from:

- for over 200 years, our societies have adapted to having more energy to burn through each year, and treat that as automatically true into the indefinite future;
- our economies have evolved with energy being essentially free with a trivial acquisition side-cost like tipping a waiter, and are not prepared to pay the far higher prices which will be increasingly required;
- our energy agencies believe that "demand" creates energy, and forecast its availability solely on that basis, not on the basis of what *exists* in physical reality;
- during temporary oil or energy shortfalls in the past, all hell breaks loose;[72]
- our drive toward energy efficiency has not focused on energy resilience in systems.
- the mechanisms we use to tap kinetic energy flows (euphemistically known as "renewables") can't (yet) be built, maintained, and replaced with their own energy output. (more on that in coming essays)
- due to the displacement of human labor and technology with vast amounts of cheap energy inputs, even moderate price increases in energy substantially reduce benefits (wages, profits, low prices) to human economies.

Though many aspects of our economic situation remain open questions, the above list, we feel, is not really debatable. Despite a lot of arm-waving by those who substitute wishful thinking for science (and economic myths for physics and thermodynamics), there is extensive literature on this which has never been refuted.

The open question is When. When will this occur? If you ask people you know, as we have, you get many answers. Famous economist Julian Simon believed there is no reason we will face energy or materials shortages for billions of years. He was famous, we're not. Many millions of influential people believe the same thing. If parsing real-world decisions by social-status heuristics rather than science, he'd be the pony to bet on. Except, we note that he was delusional about the real world to the point of functional insanity. The "experts" picked by a society can thus have consequences.

Some people, including some of our friends and relatives, guess that there's oil (and therefore other resources we can extract and transport with oil) to supply a growing economy for thousands of years. Others agree that it must eventually peak and decline, but believe that's a century or three away. Still others expect it to happen, but not for 50 years or so. Your authors, using the tools of scientific synthesis and correcting for known human bias, see it peaking quite soon and declining steeply thereafter. Oil in conventional deposits has already hit a maximum and has been flat since 2006. Total global extraction is still increasing but it is the costlier, harder to extract liquids which used to not be considered oil that is making up the difference. But to believe in a near term (e.g. before 2030) peak and decline in oil extraction is still an extreme minority opinion in the human world. Clearly, the "when" will have an enormous impact on human society, the earth's environment, and about every other issue which exists, so it really needs to be unpacked. For instance, the Yellowstone super-volcano erupts about every 600,000 years with enough force to entirely screw up most of North America. It last erupted 640,000 years ago.[73] If we thought it was going to erupt again in 10 years, our society would need to do a lot of things very differently than if we thought it would erupt in 10,000 years *(though arguably, that would be a lesser problem than a weaning from oil).* One idly imagines Julian Simon, if he were still alive, buying retirement property on top of the caldera, to keep it from erupting by the sheer force of his "demand" that it not do so *(indeed, one wonders how neoclassical economists reconcile the existence of personal death with the magical power of human demand, though we may not really want to know...)*

It's a tough thing for non-scientists to deal with: lacking technical expertise themselves, regular people need to fall back on the advice of "experts"; and not having the necessary background to assess which expert is more likely to be right, they use social status as a proxy filter. This often works: Einstein seldom steered people wrong. However, social status can also elevate a Julian Simon, due to perceived successes of him and those like him during what was historically a very aberrant period (the shaman who seems to have the most successful rain dance generally does very well in any tribe).

In addition, the very nature of "expertise" in current society can steer us wrong. Our society has developed along ultrasocial lines, with extreme specialization being what currently wins prizes and tenure. We thus can find ourselves in the thrall of various famous idiot-savants - brilliant in some narrow esoteric specialty but too dysfunctionally systems-dumb to make ramen in a microwave or do their own laundry - consulted by presidents on how to run the world.

Even an excellent scientist may only be conversant with a narrow slice of a small sub-discipline, and potentially be utterly clueless about a systems-level synthesis of science. For instance, Stephen Hawking, the famous black hole physicist, believes humans will need to terraform Mars in order to escape an earth which we will make uninhabitable. He may well be correct about the "uninhabitable earth" because due to conclusions that follow from basic knowledge of physics, but the complex steps required to make Mars livable are probabilistically impossible with the energy and time available to humans. This leads to those such as famous industrialist Elon Musk, who follows Hawking's conclusions, literally saying: "Fuck earth. Mars is the future," and making seductively promoted but incredibly naive plans for going there and writing off the earth, despite the fact that any reasonably competent high school student understanding basic logical synthesis could prove that it *will not happen*.

Why do we think that the availability of oil will soon decline? This conclusion is conclusively documented at the archived website theoildrum.com, which author Nate curated for some years, and which collected information from actual scientists about depletion rates, exploration, and the gritty details of resource extraction and complex systems. It's highly recommended, but much of that is pretty dense reading for non-specialists. So briefly:

- we know, to a very good approximation, how much oil there is.
- new discoveries have petered out to the point that little effort is being spent looking, and you can't produce what you haven't discovered.
- the flow rates of existing fields are well-known, and when added together, show the flow of conventional "cheap" crude oil maxing around 2008 and steeply declining afterwards.
- the so-called "new oil" is expensive to produce and its wells deplete quickly. Even adding a bunch of those to world oil supplies still shows an imminent peak and decline in world supplies, just offset by a few years.

The counter-arguments, are, basically:

- that can't be true because it would be a real bummer;

- economists say that human demand can create anything indefinitely if they demand it hard enough;
- we don't remember that happening before, so it can't happen any time soon;
- famous people say it won't happen;
- a respected guy I know says it won't happen
- technology will figure something out;
- we don't really need oil anyhow, we can use other energy.

Of these counter-arguments, the first five are clearly specious, in the "flying pink unicorns" category. If that's not clear, start the accompanying slide deck from #1 again.

Most technology is about ways of using more energy. There is no technological way to get around the laws of physics or thermodynamics. Most "good news" tech discoveries reported in popular media are interesting in some ways while being untenable from an energy standpoint. They would require a booming oil economy and fiscal subsidies to work at all, similar to the ethanol boondoggle. Moreover, in a free-market economy such as humanity now possesses, technological efficiency gains tend to increase total energy use (Jevons Paradox). There is no new technology on the horizon, or even theorized, which stands ready to replace the oil our existing economies mostly run on.

There is a growing theme – especially as it relates to self-driving electric taxis -that we won't need oil anyway. As we'll see in a later essay, so-called "renewables" are actually primarily fossil-fuel extender mechanisms and most of them only create electricity, which presently is about 20% of our energy use. It is undoubtedly highly useful energy in many ways, but it won't work for most of what we currently do and expect. To the extent our infrastructure could be converted to do so, that entire existing global infrastructure would have to be replaced by an electric one, an investment of hundreds of trillions of dollars *(Wild guess that but prove us wrong...)* and a large portion of the remaining global oil flow… and that's not even remotely happening. Electricity just doesn't substitute well for oil: recently the perhaps ironically-named "solar impulse" airplane tried to fly around the world to highlight the bright future of renewables. Not only did it take well over a year - slower than an 1800's sailing ship - but it carried only one passenger, cost $170 million, and had to be entirely rebuilt halfway through when its batteries fried themselves.[74] It also used two different pilots, so the only thing which actually made it around the world was the name "solar impulse." If oil supplies diminish, the same thing will happen to airliners as happens to hummingbirds when the flowers go away: they stop functioning.

When making decisions that have important real-world implications, such as whether the economy may be expected to collapse into an unprecedented depression, and worse, during your lifetime, it might be useful to consider a precautionary principle: What are the consequences of being wrong, versus the benefits? It's clear now from atmospheric and oceanographic science that the burning of fossil carbon must soon cease, in order to prevent a mass extinction of complex life which humans might not long survive, so even if there *were* unlimited supplies of oil, even if it *were* created by angels in response to human demand, we'd still have to very soon, and dramatically, alter our societies to prevent an extreme diminishment of the human future. The difference between doing this and just collapsing from unexpected oil shortages might be likened to the difference between an airliner's controlled emergency landing, and the sort of landing one might expect with nobody in the cockpit. So behaving *as if* we needed to drastically cut back on oil and fossil carbon is necessary anyhow unless we want to be sociopathic with regards to our grandkids and every other species more complex than scorpions and jellyfish.

As we noted early in this book, humans don't primarily have an energy problem, a resource problem, a population problem, or a climate problem: we have a brain problem from which the others emerge. To the extent we parse this "oil depletion" issue based on what we wish were true, what popular people say, and what mythology predicts, we are following a poorly-designed gene agenda which emerged by random chance, for cavemen. To the extent we deal with it based on data and science, we need to go with what they tell us. They tell us that the global oil flow will begin diminishing very soon, and that the trend will continue indefinitely.

So are we right about this?
Or are we subject to an emergent bias we're calling the "Immediacy Fallacy"?

As we're all aware, sometimes a perfectly intelligent human will latch onto a notion and interpret all data in such a way as to confirm that notion. Thus, we saw a fair number of scientists, for many decades, profess that smoking was not unhealthy. It didn't hurt that most of them were smokers rationalizing their own habit, or that there was a lot more funding available for pro-tobacco results than anti-tobacco results.

The Immediacy Fallacy is a bit different: it can happen when an honest person learns so much about an exciting or scary event they see arising in the future that it looms disproportionately large, acquiring a counter-factual and illogical immediacy. In other words, it acquires such a large footprint in their minds that it "feels like" it will happen very soon, even if the facts don't bear that out. Some people in perfect health begin fearing death at age ten, because it's a big scary thing. There's an entire cult of

psuedo-science which claims that we will soon experience a “technological singularity” in which our personalities are uploaded into immortal robots, and that it will occur within the lifetimes of many people now alive. (no and no). There’s also a popular speaker named (XXX XXXXXXXXX) who believes that humans will go extinct from climate change within a few decades (and when pressed on an email discussion list, said 5 years ago that his own neighborhood would be too hot for human life within 5 years). He is widely believed, and publicly projects the vibes of a good guy, but he’s delusional and harmfully so. By compressing the time scale of some very real problems down by a couple orders of magnitude, he comes up with an inevitable immediate human (and planetary) apocalypse, and of course the conclusion that nothing can be done for humanity - stick a fork in us, we’re done - aside from taking paid speaking engagements.

This fallacy might also lie in wait for some students being abruptly exposed to Reality101 – in effect, an entire education shoehorned into a single honors course, because it doesn’t “fit” anywhere else yet. It’s natural to feel some overwhelm... however, that doesn’t mean things are hopeless. It just means taking a bit of time to put it all into perspective. It’s possible to know all this stuff and live a happy, non-depressed life, even a more-productive one than would have been lived otherwise; and these various scenarios will take a long time to play out.

Have your authors succumbed to this fallacy, seeing a near-term oil peak because they have learned so much about oil and energy in their research? *(After all, one is a PhD who ran a high-profile science & energy website and the other was formerly an oil geophysicist).* Well, you can make your own mind up there. For what it’s worth, we don’t just study energy, we study the intersection of all sciences, with a big focus on evolutionary psychology and human delusion. This makes us VERY circumspect about our conclusions, even to the extent of pointing out a potential bias that hasn’t been described elsewhere. What we wish to be true, what “feels like” it should be true, what those around us believe to be true, really needs to take a back seat to science and real-world data.

So that’s what we think. As they say in the car ads, “your mileage may vary”.

Renewable Energy - The Right Answer to the Wrong Questions

KEY POINTS

Energy is fundamental in nature. Plants, animals and ecosystems rely on energy surplus to grow, survive and replicate. The main difference between humans and non-human animals is that in addition to using food energy "inside the body" (endosomatically) as all animals do, we also use non-food energy outside the body (exosomatically). Our exosomatic reach naturally skyrocketed upon finding and accessing large stores of fossil sunlight.* ***We have no evolved instincts which limit such exosomatic flows*.*

***As we will learn going forward, there is no sentient overmind (or even fiendish cabal) directing our species forward – but rather, the aggregation of our individual choices (in a social system that maximizes quarterly earnings). The emergent effect is akin to a giant Amoeba, metastasizing across the planet with new roads, new buildings, and new biomass, mostly on the backs of the fossil slaves. Unless something fundamental about individual and collective human behavior changes, this "emergent amoeba" will not voluntarily stop slurping low-entropy goodies (minerals + carbon) until it can no longer find or access them.*

Since our species started to walk upright, humans have used 'technology' (spear points, bows and arrows, wheels, plows, computers etc.) to solve problems. In the modern day, technology does some amazing things for us, but at its core,* ***most *new technology functions by channelling ever-more energy into complex solutions, raising*

the minimum primary energy requirement for aggregate society via the 'rebound effect' and other phenomena.

***Efficiency and designing cheaper items a) allows us to use more of that item and b) gives us more money/energy to spend on other things that contribute to GDP. If a product is brought down in price - for any reason - to a minor part of the discretionary budget of an average individual, the common consumption of this item quickly becomes a perceived new "need". Due to human brains being embedded in a culture of advertising and relative status, much of the benefits of technology 'rebound' into more total consumption.*

***The continually-increasing access to better and/or more primary energy coupled with technology has created what economists term a "virtuous cycle," growing the size and scale of modern human economies, which allows for new inventions and adds to social and physical complexity. This in turn requires a larger energy spigot to keep things running without recession or dislocation.*

***Because of the accelerating depletion of the less-costly oil and gas, the long trend of "more net energy each year" is peaking and the trend will change to gradually less net energy (after accounting for energy requirements to obtain/deliver energy) each year. As it does, the cycle may become less virtuous - in fact, it will become increasingly problematic.*

***The mechanisms popularly referred to as "renewable energy" are mature, viable and amazing. It is clear that such technologies can do many things for our species. But with the above backdrop, scaling them is – at present - primarily growing the size and complexity of the global economy, functioning primarily as 'FFEMs (Fossil Fuel Extension Mechanisms). (Note; the annual demand increase for electricity globally in 2018 alone was almost double the total installed capacity of solar PV of all prior years/decades). If "raising GDP" remains our standard for success, these FFEMs may just wind up building a larger and less-resilient societal Rube Goldberg machine.*

***Econometrics models that assume taxing or eliminating fossil fuels from an economy will still allow economic growth, tend to conflate the dollar value and the labor value of $1 of primary energy. This is a fallacy shared by all sides of current debates. Given the embodied energy in fossil carbon, $1 of it removed from an economy removes $15-$20 of 'work'. Our fossil energy slaves are the principle drivers of the modern physical economy, yet economists ignore them.*

***Renewable energy is misnamed. An apple tree is renewable. A chicken is renewable. Solar panels and wind turbines tap continual flows from wind and sun using mechanisms which need to be repeatedly rebuilt using materials, energy and*

infrastructure; the mechanisms themselves are no more renewable than a pickup truck. Currently, what is referred to as "renewable energy" requires fossil fuels, rare minerals, and complex global financial guarantees. It is therefore, at best repeatable, not renewable.

***The direct and indirect solar flows which are tapped as "renewable energy" are principally kinetic energy which we convert into another kind of kinetic energy: electricity. This must be used either instantaneously, converted to potential energy in some sort of storage system, or wasted. This is in contrast to fossil energy, which is entirely chemical potential energy. So there's a fundamental difference between the various things we're calling "energy", and that can lead to muddy thinking.*

***Only about 20% of our end-use energy in the USA is electricity (the rest being heat, transportation fuel, etc.) The vast majority of reasonably high energy gain "renewable energy" is electric, not liquid fuels. With a near term peak in oil production, and oil extraction costs up around 300% in past 20 years, liquid fuels may become society's limiting input. This changes the outlook and context of renewable energy considerably. Over time some/many processes can be electrified, but presently these 'rebuildables' could, at most, contribute only a portion of that 20% at our current scale. What is our long term goal?*

*** Even when we contemplate replacing fossil energy, we tend to assume its benefits will remain. Though technology on electric shovels and mining equipment is advancing, no solar panel has ever been created exclusively with solar power. No wind generator has ever been created exclusively with wind power. No fission plant has ever been created and fueled using fission energy, and it is far from a certainty that any of these things will ever be done.*

***Renewable energy mechanisms are now mature technology and some have gotten significantly cheaper, but no combination of depleting fossil fuels and new 'renewables' can continue economic growth and the system of financial claims supporting it for much longer. The implication is that new institutions and policies for post-growth economies are at least as important as the focus on swapping out electricity sources.*

***Though it is essential that some industrial processes have 24/7 access to electricity and fuels to remain productive, for residential systems, this (currently perceived) need is more of a 'want' for most individuals, a convenience.*

***We can construct a viable and potentially wonderful and stable society around rebuildable energy-tapping mechanisms. (It is a certainty that we will eventually*

attempt do this out of necessity if we're able to). But it will look nothing like our current civilization with 70:1+ exosomatic footprints.

*** New and better technology itself doesn't save ecosystems, other species, or oceans.*

Endo vs Exo, Yo!

We live in a thermodynamic universe. For some reason the visible universe started out about 14 billion years ago really small, dense, and organized, and has been getting bigger and more disorganized ever since. If you can imagine something a tiny fraction of the size of a single electron - which of course you can't - with a mass about like a bowling ball, you've got it. But it didn't stay that size for long. The so-called "big bang" happened immediately, in which space inflated, mass multiplied, and stuff happened, eventually including us, and it's still banging after all these years. *(Did you ever wonder where the big bang happened? Which direction in the sky to point to? Well, it happened right here in this classroom. Every point in the universe is where it happened. It's just all bigger now, and a helluva lot cooler.)*

It's almost an understatement to say that life requires energy, because in a real sense life *is* a kind of energy flow. It's a sort of parasitic and catalytic process, like a whirlwind. By interposing itself in an energy gradient, life can do the trick of throttling energy flow while creating and maintaining complexity. The rules of thermodynamics require that the universe ALWAYS gets more disorganized on average. But there's a loophole exploited by life: as long as the amount of order life creates is significantly less than the amount of disorder being created by the energy

flows it taps, the rule isn't violated. That's how dissipating sunlight can turn into the ecological complexity we see around us. Life finds energy gradients, and by tapping their flow can keep itself both existing and multiplying.

The biggest source of living energy to the earth is, as you know, photosynthesis. The use of certain wavelengths of light by plants forms chemical energy which can be then used by the plant for general tasks of life. Animals do a different trick - they eat plants, and thus acquire the chemical energy they need to do their more active thing. And plants and animals complement each other well, since each gives off what the other needs to breathe - O2 and CO2 respectively.

Using this chemical energy as fuel for plant and animal cells may be termed "endosomatic" energy use, meaning "inside the body", and that's the only way plants and animals have used energy, (as far as we know) until very recently, when the phenomenon of "exosomatic" energy use (outside the body) became a major factor.

For the purposes of this essay, we won't split hairs about things like insects enslaving other insects, or toxoplasmosis protozoans hijacking mammal brains, because even though these are cases where a species arguably directs energy outside its own body, it is still endosomatic energy (in the host's body) which is being directed. What we're introducing here is energy use which accomplishes goals for individuals of a species without ever passing through a living body – **exosomatically**.

It turns out, with the exception of Siberian avalanche monkeys, humans are the only species who use exosomatic energy in a directed way. Such uniqueness is all the more impressive when we admit we just made up the "avalanche monkeys" because such a species would be really cool. (We did *not* make up the stuff about mammal brains being enslaved by protozoans, and you have a 1 in 5 chance of already being infected by it, higher if you own a cat.)

Deep in our ancestral past, humans acquired a unique symbiosis with non-life energy flows: we discovered how to use fire. For the first time, an animal could derive benefits from energy flow entirely outside its physical body. Those benefits might have been incredibly wasteful, such as burning down a forest to catch a few deer, but they were benefits nonetheless, at no cost to the animal itself. In a way we became sort of a hybrid organism which controlled two energy flows, one which passes through our bodies as food calories, and one which we control externally. A *Homo erectus* carrying a burning torch was thus a chimerical creature of dual energy flows… but with instincts evolved only for the inner flow.

The magic wand of exosomatic energy could do many *indirect* things which helped leverage endosomatic calories. Cooking food meant it was easier to chew and digest, making available more endosomatic calories and requiring fewer to be used for digestion. Campfires kept wild carnivores away in the night and/or helped even the odds between their night vision and ours, leading to less endosomatic energy being expended. The warmth of a fire meant that maintaining body temperature on a cold night did not have to come entirely from the energy of food. It was a very useful symbiosis. *What could go wrong?* Unlike finite endosomatic energy – (we get tired when our bodies run out of chemical energy) - there were no limits on how much 'exo' energy we could use as long as there was stuff to burn.

Indeed, its very utility led to the success of the hominid species which used it, as we expanded into more ecological niches. Which led to more fire, in an expanding catalytic process. Forests were gradually cleared of burnable trees and the human habitat became less wooded, as human cultures figured out ever-more things which could be done with fire: heat, light, work, fuel, etc.

Eventually, running out of things to burn above ground spurred the discovery of vast amounts of burnable stuff under the Earth's surface. Accessing the treasure trove of fossil hydrocarbons would gradually, but inexorably, blow the previous ceiling off our exosomatic energy use. The once naked ape could now construct tall buildings, fly to the moon and subdue the natural world.

There's no instinctive throttle on our exosomatic magic wand. So in addition to turning oil and gas into huge amounts of food, we use our industrial base to combine fossil carbon with minerals and resources into stuff, and the stuff into brain rewards and waste. We build bigger yachts, faster cars, and taller buildings because they're cool (and we can). We throw things away because new ones stimulate us more. We ignore the world in which we evolved because for now we have air conditioning, pizza and video games. *If you're like an average American, you will consume about 100 times as many calories outside your body as inside.*[75] We've gone "exo" in a big way.

Yet if we put on our "time bias" correction goggles, it's clear that due both to the finite nature of oil, coal, and natural gas, and to the negative effects their burning has on planetary ecology, this short temporary pulse of hyper-exosomatic-energy use will gradually, but with certainty, come to an end. Humans will probably continue to use exosomatic energy as long as we're human, there will just be a lot less of it due to there simply being fewer things around to burn.

So - can technology and human ingenuity indefinitely continue our access to unlimited exo-energy? It sure has so far, right?

Technology and energy

"A technological and economic development which does not leave in its wake a better world and an integrally higher quality of life cannot be considered progress." (Pope Francis, Laudato Si)

Technology has been defined in a number of ways. At its core it is a problem-solving response that humans have turned to since our hunter-gatherer beginnings. The definition we'll use is that **technology is an investment of time, energy, and materials into complex configurations which don't occur naturally, to attempt achieving survival-enhancing and brain-pleasing goals**. In modern culture where survival is pretty much assured, tech is increasingly about neural stimulation, and 'brain pleasing goals' mostly consist of "time minimizing" or (financial) "profit maximizing" pursuits.

Technology has created extended human phenotypes, which make us functional giants with superpowers - even as individuals. Occurring on the scale of virtual-world evolution rather than biological evolution, this made us super-predators so quickly that other species had little time to adapt. Indeed, humans are now the top animal predator in all major earth ecosystems. Clubs, fire, spears, guns, computers and other tech expanded us from a species with a small ecological footprint to the kings of terrestrial vertebrate biomass. We haven't just eaten all the prey; we've used technology to eat the inedible, using - in effect - land to convert fossil energy into food, and thereby vastly increased the earth's terrestrial vertebrate biomass (which now includes humans, their livestock and pets) far beyond historic levels.

In the recent past we have experienced a heady advancement of technology, from microwave ovens to cell phones to satellite television and GPS. We take for granted lifestyles and security which are, for most Americans, better and healthier than those of kings and queens of a few hundred years ago. It is a deep cultural belief that if we face a problem, new inventions and technology - aided by a free market - will eventually puzzle it out. New heights of utility and wonder will surely ensue!

That is, we live in a culture which believes there will soon be flying cars. Diseases will disappear. Happiness will increase. We believe the future will have more cool techno-things than the present. We so envy the denizens of the future that some of us have *literally* had our heads frozen, to be revived and stuck onto new bodies once that inevitably becomes commonplace. Our societal narrative is not tethered much to the

physical world but rather more to an imagined progress story about our cleverness and destiny paving a techno-path to paradise.

Such beliefs affect the way we think about and address problems. Because if everything in the future is easier, cheaper, and more wonderful; it must logically follow that IF we continually put off problems, eventually we'll reach a technological point at which they'll be easily solved. That is, the horizons of the practical will move progressively closer until technology becomes indistinguishable from magic. Indeed, most electronic technology already seems akin to magic: most people would be no more able to build a microwave oven from scratch than could a gorilla; (and a gorilla if shown a microwave, could presumably learn to heat a banana in just a few minutes). Indeed, what could possibly go wrong?

But the "technology as magic" narrative tends to highlight the beginning and end of a process but neglects the important reality in the middle. Complexity has costs, and high complexity has high costs. These costs are paid in energy and in low-entropy materials such as rich metal ores. And once you run out of rich ores - which arguably we mostly have - you need to then go to the middle grade stuff, which takes more energy. Thus technology – like anything else in our economy we value, first requires an energy input. Without additional energy, to create and to power it - most high technology would be useless.

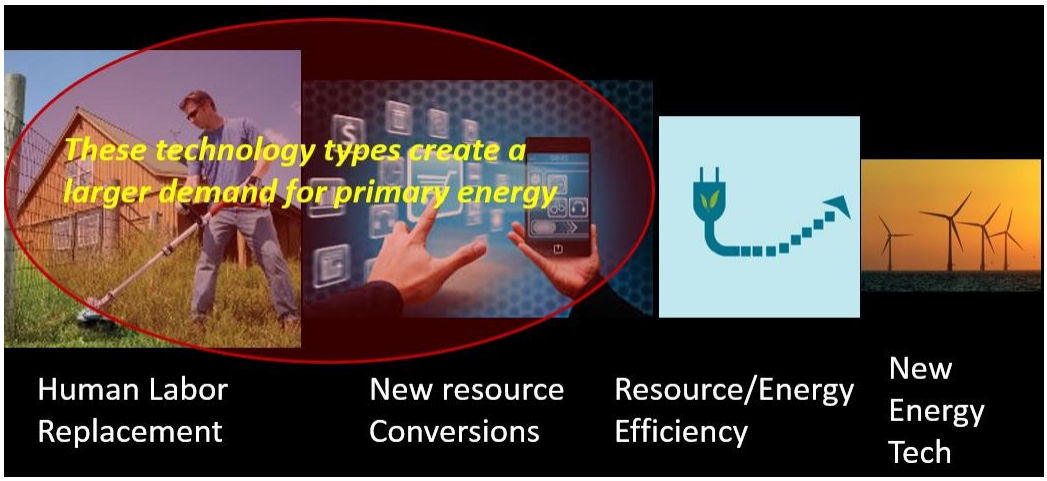
And not only is high technology achieved *with* energy, but most technology achieves its effects by expanding the ways to USE MORE energy. This has worked pretty well for the last couple hundred years, because we have been able to access more primary energy each year than the year before. This was possible because we have been using technology to accelerate the rate of extraction and burning of what we call "fossil fuels."

Our stunning technological advancements would not have been possible without the ginormous scale and versatility of fossil energy. The ‘work’ that is done by using even small amounts of energy-dense oil, gas or coal is orders of magnitude higher than what can be done by the equivalent dollar value of human labor. In a historic and small-scale sense, technology is about making our lives easier and more interesting. But more recently, seen from a top-down perspective, technology has been focused on expanding the entire economic system to use more energy to raise GDP, and as it succeeds, and our economy grows, we become more dependent on higher energy inputs, (not less, as some technology-focused analysts might have you believe).

Moreover, it turns out that this technological march to distant horizons is not just a victory parade. There are diminishing returns to investment in complexity. We

humans were able to dramatically expand our ecological niche in the early days by learning to make spear points from flint. A hundred years ago, scientists could make big discoveries with home-made equipment on tabletops. Today we need a multi-billion-dollar Large Hadron Collider even to fill in a few blanks in esoteric theories that have no immediate or projected material value. The low-hanging tech fruit has been picked. And as we reach real limits on net energy and resources, the horizons recede as well.

With human society now all-in for permanent growth sustained by technological fixes, we are creating a nested predicament which automatically outgrows the energy supply, ***which is the very thing that more technology can't fix***. This risks creating a lot of highly dependent human biomass which is "all dressed up with nowhere to go" ecologically.



Modern technology can basically be separated into 4 types.

First, there are the **inventions that combined fossil energy with mechanization to replace physical tasks that humans used to do manually.** Coal fired steam engines, spinning jenny weaving looms gave way to gas powered lawnmowers, automobiles, cow-milking machines, smelting furnaces etc. Because energy was so inexpensive, we could add huge amounts of it (inefficiently from an energy perspective) to raise the real and perceived standards of living. Some combination of higher wages, higher profit margins and lower-priced goods rippled through a global economy of 'consumers' in what economists termed a "virtuous cycle" of humans wanting, being able to afford, and buying, more. This type of technology seemed like it 'saved energy' because things became subjectively easier, (substituting a huge amount of exo for a little bit of endo) but the reality was that the total energy used increased

substantially, as now there were millions upon millions of lawnmowers, automobiles and microwave ovens, each representing a new baseline requirement for its owner, and each needing constant fill-ups or incoming electricity and replacement - sooner or later. So this 'technology' sharply increased societies' baseline energy metabolism – these things could not exist without a large infusion of excess net energy from somewhere.

Second, there are the **novel inventions to create pleasing brain rewards** that humans had never had access to (or imagined) in earlier generations. Things like **iPads or electric blenders or video games**. Obtaining the temporary novelty, leisure and play experiences these devices provide never required energy in the past but now requires substantial societal energy inputs. For example, the server farms required for the US internet use approximately 18% of our electricity.[76]

In addition, technology created new ways to please our brains through increased social status and sexual signalling, such as pleasure yachts which don't actually need to go anywhere, designer handbags, enormous cars, gourmet foods, and various sorts of non-essential social signals. On top of that, such status and signalling means that everyone feels like they need their *own* cars, lawnmowers, automobiles and (soon?) smelting furnaces because it's 'higher status' not to need to share.

And as you'll recall from earlier in the semester, there is no "that's enough" feedback mechanism in the human brain to curb this sort of consumption: we experience social wealth as relative, not absolute. This ever-escalating "relative wealth creation" has grown far beyond the material and energy flows which are needed for happiness and security, and continues to escalate exponentially. This means a growing societal energy price, and a growing cost to the natural world. *The net result is that the average American in 2015 has an energy metabolism equivalent to a 30 ton primate.*[77] *Think about it.*

Third, you may get the idea from this essay that its authors are some sort of Luddites, opposed to technology. Not so! We love gadgets and use technology as much as others, but we're trying to present it here as it exists, not as we might fantasize about it. And in fact, technology doesn't always result in more energy use. It can and does **allow us to use energy and resources more efficiently** or **develop new energy sources**. For example, power plants have gotten more efficient and can generate more power using the same coal or natural gas input than they did 30-40 years ago; in many processes, waste heat is recovered and put to constructive use. New developments of solar cell technology allow the panels to capture a larger capacity of incoming sunlight. New seismic and drilling techniques allow access to fossil resources that might have previously been unavailable.

Fourth, however, such technological refinements tend to be *incremental*, and subject to rapidly diminishing returns as the tech matures. Power turbines are chasing improvements of fractional percentage points at high cost in complexity and rare materials. Incremental doesn't scale well against exponential: it's hard to detect any signal at all of "energy saving" technology when looking at the energy consumed, and waste generated by humanity as a whole. And a 20% increase in engine efficiency means that after a doubling in, e.g., gasoline's cost from $2 to $4 per gallon, the effective price drops only to $3.60. In a biophysical world where we need energy and natural resources to find and extract other energy and resources, *technology is in a race with depletion*, and so far is losing.

Jevons' Paradox – a.k.a the Rebound Effect

It's counter-intuitive that "more efficient energy use" could cause more total energy to be used, but that has historically been the case. There's no indication that *any* non-fossil energy generation has slowed the extraction and burning of fossil energy. Moreover, in a system of market capitalism such as we now live in, there's a clear mechanism underpinning this phenomenon, known as the Jevons' Effect or the Rebound Effect. Any increase in efficiency in using a resource lowers its cost in relation to alternatives and makes it more desirable, leading to increased demand and higher use.[78]

How does this work? If a new super-efficient car is developed which gets the same gas mileage as the previous models but costs ½ as much, instead of reducing the energy used in society it tends to increased gasoline and energy use. This happens for 3 reasons: 1) more people can now afford to own a car, 2) people who own these cars can drive more miles because they can afford more gallons of gas and 3) they will use the money saved on 'car allowance' at Walmart buying other items which contain embodied energy.

Moreover, to the extent more efficient cars MIGHT use less gasoline in total, the effect of that in the current supply/demand system would be to lower the price of fuel so that those driving high-fuel-consumption vehicles were effectively subsidized.

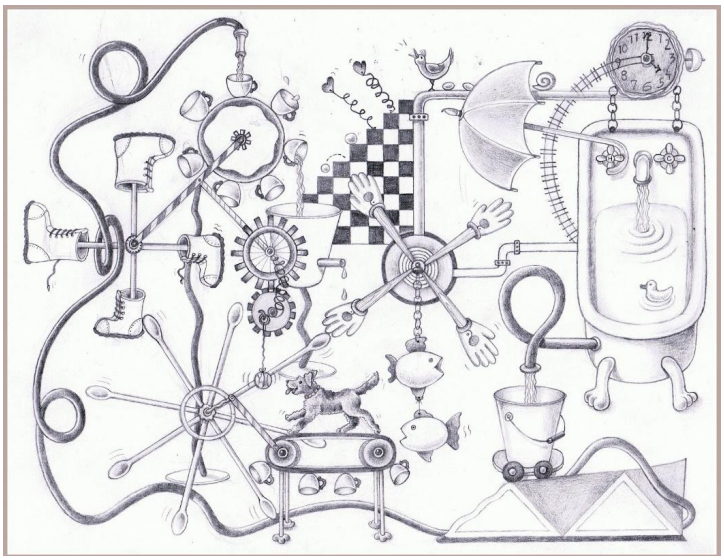
The rebound effect with respect to efficiency has a time dimension as well. Nobody is currently thinking about designing, let alone producing, 200-year solar panels. These might be hugely more efficient in terms of total power channeled during the device's lifetime, but if society (currently) considers the value of the second hundred years to be inconsequential, why pursue it? This is part of our prevailing mythology, which is that energy always gets cheaper. The notion that usable net energy will be far more

precious in the future is a very alien one to current culture, and really part of our core story. But this is a clear example showing that how we define efficiency might make a difference.

In short, so far in the history of human exo energy use, more "high" technology leads to more fossil energy use, and all the side-effects of such use. Technology is a vector for more energy use. More technology will require more energy. Less energy will generally mean less (or simpler) technology.

So where does this leave us as we attempt to be 'more sustainable'? We recognize our fossil slaves are getting harder to wake, and we are increasingly alarmed at their breathing and pooping. Those who look at the world scientifically are gradually coming to the opinion that we have to move away from dependence on fossil energy, and the sooner the better. So let's just switch to renewable energy?!! That has a nice sound to it. Good idea. But as often is the case, the devil is in the details.

A thousand years from now sounds like a long time. But it's only 1/300th of the time that our species has existed in its current physiology. Will we be making solar panels and wind turbines in 1000 years? 500 years? 100 years? If so, a) How the heck will we be doing it? and b) how did we get there from where we are today near the midway point of the carbon pulse? Let's explore this a bit.



(Rube Goldberg machine by Rebecca Grace Jones)

Renewable Energy - Right answer but the Wrong Question?

Renewable energy. It's something we all know about, right? It's the current phraseology for "non-fossil" energy, and the popular notion is that it's just as good as or better than fossil energy.

We agree it's hugely better than fossil energy in the most important way: fossil energy seems to be taking the planet into only its 6th mass extinction in 600 million years, and if its use is continued on the current path for many more decades, the earth will lose most large complex life, and most specialized food webs, to acidified seas, hotter temperatures, ecosystem degradation and rapid environmental change.

It's the word "renewable" which is misleading. It's a phrase, a meme, a story. It implies that energy may be "renewed" and used again. This isn't the case. We generally think of "renewable" to refer to things like forests, fisheries, and crops, which - short of incredible foolishness (see previous paragraph) - could continue to replenish themselves indefinitely, self-assembling based on natural flows of energy and resources. This is in contrast to things that are inherently temporary.

Thus, we don't talk about "renewable clocks" or "renewable gold", because once a clock breaks, you need to fix and eventually replace it. Once you throw your gold ring into a volcano, you don't have it anymore and need to find more gold and make another one. So the things we make are only renewable in the sense that we can start over and make them again *if* we have the energy and material resources to do so.

The first law of thermodynamics says, among other things, that energy can be neither created nor destroyed, but can only change forms. There's no such thing as renewable energy. Energy does a one-way dance with matter as it dissipates, and it only does it once. Once hydrogen and oxygen burn to become water, they won't burn again. A maple tree is renewable. A chicken is renewable. They can reproduce themselves based on solar and hydrological flows (and finding another chicken). A Prius isn't renewable.

What is referred to in common parlance as "renewable energy", then, is the notion that there are devices humans can make which will channel and concentrate useable flows of energy for us more or less indefinitely from the ongoing diffuse flow of fusion energy from the sun. And not just a little bit, but (a) in amounts comparable to what we are now getting by burning fossil carbon and hydrocarbons, and (b) with a relatively smooth societal transition.

That turns out not to be the case, for many reasons. We realize that pretty much everyone in society is telling you otherwise, which is why we also have chapters on the evolutionary basis of human delusion. Nor are we opposed to fossil-energy extending technology; your authors both use it and are campaigning to lower total CO2 emissions. But the way these "alternate" technologies are presented these days leads to some unrealistic expectations.

These technologies utilize physical mechanisms to tap solar power, wind power, wave power, geothermal power, fission power, fusion power *(which doesn't yet exist),* and hydroelectric power. With the exception of some ancient water and wind powered grain mills and small dams, *none of these facilities have ever been built in any other way* than burning coal, oil, and gas to provide the required infrastructure. They require materials which are irretrievably lost each time they are built. They depend entirely on the *existing* fossil-fueled global extractive, shipping, processing and manufacturing system. They generate environmental pollutants which are harmful. They are built of materials which in some cases will be exhausted in a fairly short time. Many of them provide only intermittent power, and they all eventually break down and need to be built again from scratch.

But built how? All these methods generate only electricity. We do not have a global electric mining, processing, and shipping infrastructure. Yes, it's theoretically possible to build a replacement global infrastructure based on electricity, using fossil energy, but it'd take a long time and would use the energy we're now using to do all the other stuff we do. And it probably wouldn't supply as much energy as we're used to. It would require huge storage batteries, and these wouldn't be the trendy Tesla lithium batteries, for the world has far too little lithium. They'd have to be built out of much more common elements, meaning lower charge density and higher weight. And those batteries and that electrical infrastructure itself would have to be replaced every decade and every several decades respectively. It is *far* from clear that this can be done *at all*, but entirely clear even on first-blush analysis that it won't be done to the scale of fossil-fueled industry today.

Since it exists in the deep background of our day-to-day lives, it's hard to realize just how extraordinary the built infrastructure of the last several centuries is, and the degree of complexity and interacting systems it takes to extract, say, a pound of neodymium from mines in China, refine it, and make it into a wind turbine magnet halfway around the world. It's not just the wind turbine factory which must exist, but the entire infrastructure which supports it, and that is a fossil-fueled system. (Moreover, the very phenomenon of world trade requires that all parties maintain confidence in the webs of currency and guarantees continuing, and that they remain on good terms with one another.)

If a billionaire set out to build "renewable" energy devices *of any kind* using electricity only, avoiding all inputs which directly or indirectly relied on fossil energy, *and doing it at a net energy gain*, it is likely he or she would fail. **Indeed, we hereby make that challenge.** It's not an obscure demonstration: it's what the entire world seems to be relying on. Those riding near the top (and bottom and middle) of the amoeba all assume that it'll be easy, and it won't be. It's not entirely clear that it can be done, because many things which are - at least in theory - physically possible are not financially and politically possible. And then the next test for our billionaire: using only the equivalent power from the devices he or she builds, build their replacements. This includes the mining, refining, transportation, manufacturing, labor, administrative overhead and other necessary factors. That is, a microcosm of the ostensible "renewables" Plan A for the world. Except that not only would it need to be done, it would then need to be scaled up at warp speed to supply an existing civilization which has evolved to require growing energy inputs each year to prevent it from crashing into fiscal depression.

It's easy - and common - to find experts who can rhetorically handwave any problems away. Everyone, after all, likes to hear good news, and today's experts are generally highly specialized in a single field. But if one actually looks at the scale of energy now used, and does even simple calculations of replacing fossil energy with nuclear or other energies, the number of required facilities is daunting. Where will the energy come from to make them initially? Clearly, that'll be fossil energy, and energy diverted from other parts of our society and economy. Will we sacrifice to build them for all the world's poor, or maybe just sacrifice enough to build them for the wealthiest societies?

What about time lag? If we, for instance, decide we need tens of thousands of fission reactors, or billions of PV systems with batteries, how and when does that happen past the writing of the sentence?

And what will the resulting societies look like? Today we drive fossil-powered cars and trucks on roads made of asphalt (made from oil), over bridges constructed when oil was cheap, now rusting and not being replaced.

Harry Houdini used to thrill crowds by having his hands and feet locked in chains, then being locked in a barrel, and then being dropped in a river. The thrill was in seeing him somehow survive and emerge unscathed. This is not a bad metaphor for our current energy situation.

That's the problem. These aren't renewable energy resources. The mechanisms we're currently building are fossil-extenders. So, there's one more concept we're hoping to introduce to you: thinking about things in terms which describe what they really are. Renewables are more aptly named - 'Rebuildables'. And like anything else, you can only rebuild things when you have the needed resources.

Don't get us wrong, we (Nate & DJ) really like the idea of "fossil fuel extender" mechanisms which convert a smaller amount of high-quality fossil energy to a hopefully larger amount of lower-quality and more intermittent energy pulled from primary and secondary solar flows. We both have houses with PV. We like them and they save us money, even if most of the savings was from state and federal tax credits. However, it's important not to consider them magic. They are built with fossil slave energy, and to date have not slowed the amount of coal and oil burned by much if at all. They are one more thing we do with energy, along with racetracks, Disneyland, projection tv's, disposable forks, etc. The mechanisms – such as solar panels - do not stand apart as something which will exist forever. Current solar panels are built to last 25 years. When they are replaced the world will have less oil, lower quality ore grades, and other hurdles from limits to growth.

Basically, we have both a narrative fallacy and a time fallacy in place. We are beginning to understand that continuing to burn fossil carbon and hydrocarbons will greatly degrade our world, so the discussion has naturally turned to "using renewable energy" instead. However, the realities of this narrative are little-appreciated or understood. It is possible to conceptualize a society in which human activities are powered by natural flows of energy, diverted to human betterment by mechanisms we can replicate as they wear out using what's available to us. However, that society would not be the society we now have. Not remotely. It would likely have orders of magnitude less energy throughput, and consequently significantly lower per capita consumption due to fewer natural resources available (since they take energy to mine and purify).

As one example, we currently live in a society in which we consider "baseload" to be important - to be able to run heavy appliances at any time of the day or night as whim strikes us. This is nothing humans evolved to need. Our bodies are highly resilient and highly adapted to intermittence of supply, and all humans prior to a few hundred years ago adapted their lives to the sporadic nature of rain, sun, light and dark, seasons and tides. Indeed, these defined the human experience. Yet a huge amount of what we now feel we need is the ability to have energy in any quantity when we wish it. That comes at a high cost - flames constantly burning, turbines constantly spinning, networks of energized wires constantly humming. It may be hard to remember that regular healthy

people don't need that and have never needed that. And that we don't need these niceties is a good thing, because they're highly temporary *whatever* we do.

The enormous benefits we have received from the "easiest to find and extract" fossil fuels are due to their extraction cost being thousands of times cheaper than human labor. 'Renewables' (built using fossil carbon infrastructure) are still plenty powerful, but their energy output is lower and more sporadic, and so goods and services made with them will cost more. Similarly, depending on the country, a residential solar system costs between $10,000 and $25,000 without batteries. How many humans can afford solar power (or windmills or geothermal) now? The richest third, at best. Renewable energy mechanisms are currently mostly the toys of the rich, and that may tend to become even more the case.

Future societies will need to use lower-energy, repairable tech like electrified railroads, diesel tractors using veggie oil, bicycles, and broadcast radio; but not likely airliners for the middle class and cars for everyone etc. With large populations there will have to be far less meat consumed (with its high energy costs), and even then the post-fossil-power world will not support as much human biomass as we have supported during our brief experimentation being detritivores. Our mechanisms will have to be fewer and more repairable. This isn't hellish: it's what your grandparents grew up with (though their world was less damaged). Indeed, this is the best-case class of possible scenarios available to us.

Match Game - Earth System Stocks vs Brain Flows

Simply put, our economic system, currently, is based almost exclusively on finite stocks while the brain rewards we seek as humans are flow based – as in we seek daily a continuous flow of feelings – moving towards pleasure and away from pain – and, surprise - it is impossible to stockpile these feelings – though we 'feel' as if large digital bank accounts can accomplish this. My (NJ) former billionaire clients, after making a multi-million dollar investment score on Wednesday, woke up Thursday all eager to do it again in a different or novel way – they weren't after the millions, *they were after the feelings*.

How to invest in and harness energy, and be able to repeat this process indefinitely, within planetary (and species) limits so that we obtain the majority of the experiences we evolved to seek is now the challenge of our generation(s).

It's difficult for us to imagine how the temporary wealth of excess energy has altered the way we think about things. We tend not to think of things in energy terms at all, because recently that has not been a limit that has mattered much. We're living in very

unusual times. But for most of our history, energy has meant the difference between life and death; and that time will come again. In the meantime, our modern shamans (mainstream economists) entirely misunderstand the energy basis of life and civilization, leading to some very bad societal choices.

Even if solar panels were made on the moon by aliens and handed out to us for free, the civilization we could maintain with them would be vastly different than what we have now. And they are NOT free. They are a way to trade high-quality transportable robust fossil energy carriers for slow-release intermittent high-complexity-based electricity. They aren't renewable, unless the only time horizon you care about is the next few decades. And they aren't *self-renewable; they can't make more of themselves.*

The "green dream" of a society which looks like today's, but in which we all drive plug-in electric cars, cannot exist at the scale our media and renewable energy promoters imagine. It runs up against a great many limits very quickly once coal and oil are taken out of the picture. Expecting our current power infrastructure to transition easily away from fossil energy is about like expecting a baleen whale to be able to switch its food from krill to swordfish. The whale isn't built for it, there aren't enough swordfish and they're hard to catch, and they put up more of a fight. The fact that swordfish contain food energy is simply irrelevant to the whale.

It "feels like" there are many choices to power our growing civilization, and it's just a matter of which is most convenient to us. That's not the case. Our CURRENT civilization can ONLY be powered with primarily fossil carbon. (and mostly liquid fuels, at that). If using other energy sources, the civilization and society would be far different. *Thus, the real question is how to maintain **a** civilization, not **this** civilization*.

If we keep burning fossil carbon, we will change the planet into something which may or may not support humans and other large complex life. "Adaptation" is a very temporary thing; air conditioners and electricity will last only as long as the infrastructure lasts, maybe a couple hundred years, maybe far less, while the earth would be screwed up for hundreds of thousands to millions of years, with large life having to re-evolve from small life – if it could - over tens of millions of years. How, exactly, to switch to 'renewables' is thus a very important question.

The First Hundred Watts

As a peek ahead to the last week of the semester, it is worthwhile to realize that the first 100 watts gives a human most of the benefits of exosomatic energy. The additional ten thousands of watts provide rapidly declining benefits (other than

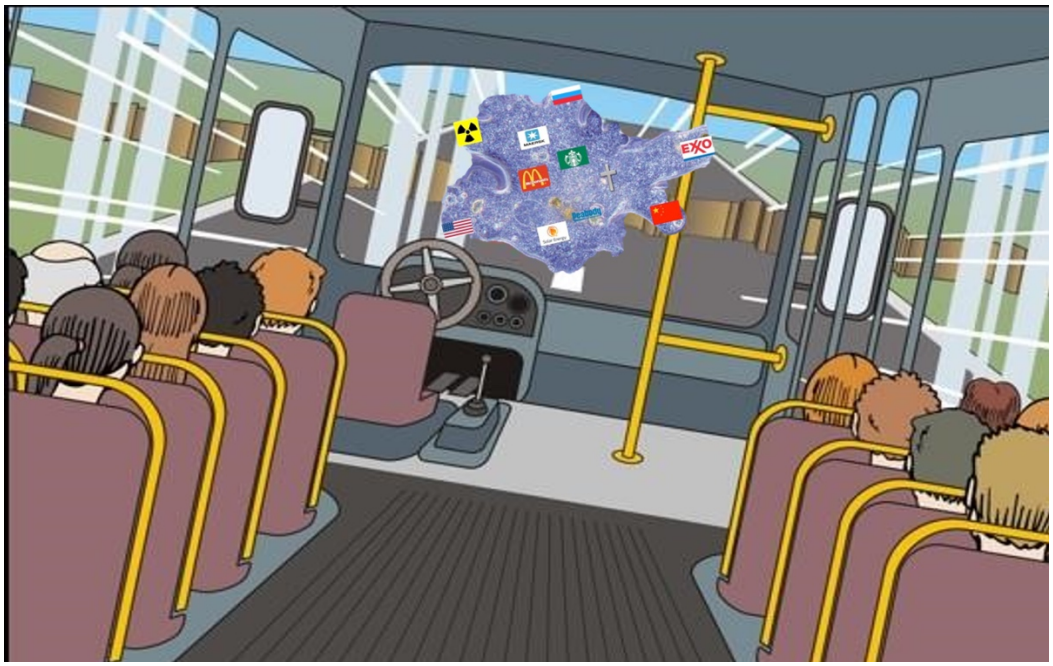
keeping up with the watts the Joneses use). Electronic communications can be maintained on a few watts. LED lighting extends daylight hours for 10-20 watts. Microwave ovens are efficient and don't take long. A life lived embracing intermittence can be modern and sophisticated, as evidenced by many who live with electricity exclusively with small PV systems or windmills now. How do they do it? By ramping down their consumption in a rational manner and getting to know their energy slave on a personal level.

There is currently a movement to divest from investment in fossil energy. Yet if we demand baseload power, we are demanding CO2 pollution. The energy companies are currently just providing what we, the citizens, insist on. But at some point, many of the doors we think are options will be shown to be locked or have brick walls behind them. At that point we'll have to ask some hard questions of ourselves, and what we want for our future and how to attain it. What we euphemistically call renewable energy today is great, but it will not continue economic growth, not reduce emissions (much) and is above all, merely rebuildable, not renewable. Yet rebuildable how many times, and for how long?

These are the sorts of questions one runs into when thinking about Reality101.

The Blind Amoeba Driving our Bus –

Why Reality 101 can only be grasped by an Individual Mind



Tropism - /ˈtrōˌpizəm/
Noun:
the turning of all or part of an organism in a particular direction in response to an external stimulus.

"*When I consider the lack of cooperation in human society, I can only conclude that it stems from ignorance of our interdependent nature. I am often moved by the example of small insects, such as bees. The laws of nature dictate that bees work together in order to survive. As a result, they possess an instinctive sense of social responsibility. They have no constitution, laws, police, religion or moral training, but because of their nature they labor faithfully together. Occasionally they may fight, but in general the whole colony survives on the basis of cooperation. Human beings, on the other hand, have constitutions, vast legal systems and police forces; we have religion, remarkable intelligence and a heart with a great capacity to love. But despite our many extraordinary qualities, in*

actual practice we lag behind those small insects; in some ways, I feel we are poorer than the bees." **Dalai Lama**

Surely all the information we're learning in Reality 101 is known by many people, who work for governments, institutions and corporations. It's natural (and comforting) to believe there is someone in authority who sees the whole picture, that facts and synthesis are filtered up a chain of command so that better societal decisions are made, and the collective wisdom is transmitted culturally to society. But what if this is a false assumption? What if the ability to see (and act on) the whole picture exists only in the province of individual minds?

Let's start with an example. A few years ago, I (NJ) was involved in presenting an energy/financial related risk to the Department of Homeland Security. The risk was real but kind of obscure. We spent weeks on the phone talking to a mid-level staffer about it. Eventually we spoke to his boss, and after 3 months we ended up spending 14 hours in an airplane hangar (we didn't have security clearance), to rehash the logic and consequences to a larger group. Each person involved could only comprehend the details via a one-to-one human conversation from scratch, not from data, charts or 2nd person recounting. Ultimately, everyone assembled agreed with the risk but the decision-maker in charge was too busy/strapped for time to integrate this risk into the larger scope of their work and scrapped the initiative. Onwards. This was a learning experience for me in several ways: 1) the most senior levels of government have way more access to information than the common man, but they are still 'common men' physiologically, i.e. their brains have the same biases and limitations, 2) decisions (important ones) are made for political reasons first and scientific/practical reasons second, 3) ***there is no unseen, aggregate 'super mind' at high levels which knows more than one individual does.***

Let's explore this a bit. As noted earlier, we humans tend to create imaginary entities and imbue them with ability and intent. There's probably no single physical phenomenon which has not been anthropomorphized and treated as a god, demigod, angel, demon, sprite, alpha primate, etc. Throwing virgins into volcanos might actually have made sense, if you thought you were communicating with a capricious deity. And we often do think that in some way or another! It emanates from humans' penchant to attribute 'agency' where there is none. When it's dark out we are much more likely to think a shadow is a burglar than think a burglar is just a shadow. We see faces in the clouds and monsters in our closets because we are fine-tuned evolutionarily to err on the side of false positives when detecting the faces and shapes of hiding predators and prey, and we're also personally sneaky enough to assume that other people probably are too.

So that's one shade of crazy with a good evolutionary basis which is quite well known in the psychological literature. But there are many other such biases - and the doozy is a related one that doesn't show up in the long list of known cognitive biases we learned last week. Call it the 'illusion of aggregate intelligence.' Maybe you can come up with a better term. It refers to the fact that we tacitly assume there is a higher level of conscious decision-making and reality-parsing than single human brains, somewhere above us in the monkey hierarchy (technically 'ape' but monkey sounded better).

If we humans find ourselves in possession of important information, we tell as many other people as we can, and once we have, we're pretty much done, other than continuing to do what everyone else does. Ever notice how satisfying it feels to blog? Whatever bee is in your bonnet, blogging gives soothing and immediate relief. Or chatting with everyone we know and expressing our opinion. Indeed, the main function of most advocacy organizations these days is to inform the other monkeys, because *we are confident that if everyone knows everything, the best decision will somehow surely be made*. We go to conferences and everyone shares expertise on related topics, and there is an implicit assumption that the ensuing 'consensus' of higher understanding and intelligence will lead to better policy.

The problem is, this usually doesn't work. It just feels like it should.

These behaviors probably worked great in tribes of 150 or fewer people back when we were hunter-gatherers, which pretty much was our entire history as humans. It worked because there was a functional group decision-making process which involved alpha-behavior humans who were dominant, or who had the trust of the other dominants. That is, it functioned to alert our cohorts and to convey important decisions to the alpha individuals, who then quickly made decisions. So "enlightenment" of this small group got the job done. But unlike the behavior of the social insects which is simple, limited, and emergent, *ours was often still the result of a single-brain process*. And there's a good reason for that. Other than single brains, there is literally nowhere thinking gets done. **Thinking doesn't exist outside individual brains.**

Yet because we each subjectively experience consciousness, sentience, self-reflection, and analysis, and also partly because we have hyperactive agency detection sub-routines running in our minds, we tend to assume that somehow thinking DOES exist in larger entities, and we attribute it to them. "The will of congress," "the wisdom of Mankind," "the support of Wall Street," "Scientists will figure it out," "a conspiracy of the 1%," etc. Thus, we keep using the same tribal mechanism that "feels right": communication. Surely, we feel, if there's a problem with poor decision-making, it

must be the result of poor communication of information (or a competing uber-entity). So, we shout louder. And wait for wise decisions, often indefinitely.

We may not *like* the imaginary 'ubermind' we're appealing to, but we get a secure feeling knowing it's there. Because the alternative would be that *there's nobody steering this bus.*

But here's the deal. The "intelligence," consciousness, conscience, and ability to sort complex propositions *can only exist at the level of an individual mind*. There's simply nowhere else for it to occur. So on the large scale, humans in aggregate either make utterly dopey decisions which display the simplicity of protoplasmic tropisms, *or* the decision is made by an individual mind, somewhere, which steers the tropisms.

It is because of this that in large human groups, all decisions are reduced to a few binary choices, because processing information in a group so large is very slow. The propositions which can be meaningfully crunched down into one or a few binary choices are inherently simple. That's one mechanism the amoeba comes from *(it's instructive to watch the 435 members of the US House of Representatives casting yea or nay votes on some large bill that has only been read by their assistants. And that's what they do A slow series of yes/no decisions about complex systems you have no real understanding of is a good description of the decision-making of an actual amoeba).*

As a metaphor, Nate & DJ have long referred to this phenomenon as the "human Amoeba" (and were delighted to see that EO Wilson recently penned the exact same description). Amoebas are simple, immortal life forms which not only don't have a brain, they don't have a nervous system; in fact, they're a single cell. They move toward and away from stimuli and engulf and digest creatures far more complex.

Now maybe the human amoeba has more than the functional awareness of a swarm of bees, but one thing it DOESN'T do is think, or choose between complex propositions based on their relative merits. Like an amoeba, it can *contain and digest* complexity without *participating in* complexity. Consuming a more complex organism doesn't make the amoeba more complex, it just makes more amoeba. So, a human committee may contain a brilliant scientist, but that doesn't make the mini-amoeba brilliant. It either defers to a single mind or acts like an amoeba. The bigger the amoeba gets, the less likely it is to do the former. To some degree, the larger a decision-making group gets, the dumber it gets. *Having a brilliant human inside a group of humans makes little difference unless the group dynamics cause that person's directions to be followed.*

We can take good guesses at how this came about. Around the time humans developed agriculture, we also underwent a phenomenon termed 'ultrasociality,' wherein our strong tribal social behaviors started to combine in new ways as our population and resources increased.[79] The needs and wants of the individual were gradually suppressed in favor of growing a surplus for the group/tribe. Back 10,000 years ago, this meant cooperating, dividing the expanding labor force into different roles, including growers, processors, tradespeople, guards, politicians etc. It was thus around this time, already well along in the development of our species, where we began the morph from disorganized bands of hunters into a superorganism. The goal of this superorganism - the human amoeba - was to respond to stimuli – just like in nature where ecosystems and organisms tend to move towards low entropy energy sources, so it was with humans after the agricultural revolution. We lumbered forward seeking to generate surplus – largely agricultural products - for our tribes/villages/cities/nations. We sloughed along, slowly for a long time, slurping up low-entropy goodies and empty continents, and eventually the super snacks of coal, oil and natural gas, etc. The amoeba is rather mindless, but it's hungry. (we'll be getting to this next week)

Fast forward to today, and mankind *in aggregate* remains a functional amoeba in most ways. For all the complexity which may exist in individual brains, its aggregate behavior on large scales is scarcely more complex than that of a basic heat engine or bacterial culture. It doesn't care about the emergent, aggregate effects of its actions because caring isn't something an amoeba can do. Oh, it can do simple things like trying to eat another amoeba (culture), or resist being eaten (war), but any intelligent contributions are exclusively the domain of single-mind plans.

Thus, when faced with issues beyond an amoeba's competence - and that's a *really* low bar - it simply continues its mindless oozing tropisms. That's how we get to emergent situations like hair-trigger mutually-assured nuclear destruction; clever organelles acting in concert with an amoebic agenda. We can individually have very clever thoughts, but in practice we almost always do what those around us do, think what they do, ignore what they do, link arms for the tropisms. Yet we generally consider our imaginary uber-entities to be in control, because *what could possibly go wrong*?

By living as part of a global market-based interconnected culture, we are each part of a metaphorical amoeba – "smart" humans cooperating in pursuit of individual profits and self-interest, but the larger the group we cooperate in, the less it is able to understand and integrate complex issues. Some other summary points following from that logic:

*** there is a prevalent fallacy that there is some emergent wise entity which steers human fate, be it groups of humans, imaginary constructs like "Wall Street", "Scientists", "Gods", angels, the "invisible hand of the marketplace", or "mother nature". It's natural to suspect there are secret societies running the world; this is a side effect of the "someone is driving the bus" fallacy. While there are many fractionated groups who are maximizing their own perceived self-interest, that's all they're doing. Nobody is actually at the wheel, and no one is more aware of this than the people who find themselves in the "top" positions.*

*** the enlightenment of individuals itself does not prevent the emergence of serious foreseeable predicaments, or cause them to be dealt with logically, because at levels much larger than individuals or small groups, complex propositions cannot be parsed (or acted upon appropriately).*

*** this creates a sort of "emergent stupidity" of humans in aggregate relative to individuals and small groups, in which the maximum complexity of what may be abstractly considered rapidly declines as the size of a group of humans goes up.*

*** it is not true that the smartest and most capable humans will somehow take the reins and make the best decisions for humanity. This expectation is merely an artifact of our tribal past.*

*** the "amoebic behavior" of humans at mega-scale – analogous to simple bacterial tropisms - is the net result of our having the same "common denominator" gene agenda driving our most intense reactions to the world. This includes an intense capuchin-like drive for distributive fairness and perceived egalitarian process rather than logical outcomes.*

*** these uninformed "amoebic tropisms" are not the only possibility at large scales; though they are most apparent during times of plenty when "fairness" and "stability" can be pursued despite the inherent efficiency penalties they impose.*

***Potentially, the most effective organizational structure is a dictatorship due to the high complexity which may in principle be modeled by a single brain; but such a structure also amplifies the effects of "gene agenda" drives, bias, and fallacies existing within that single brain.*

*** individual minds are the smartest things around. Tribes can in principle be quite functionally smart if they quickly allocate their decisions to the person known to be the best at dealing with a given situation, and this "fits" well with human modular minds. This is why it "feels like" problems have been dealt with when information*

about them has been generally disseminated. However, this breaks down in groups larger than classic tribal size because nobody knows who that person is in a huge group. It is in such a vacuum that perceived familiarity and recognition can break the tie, and popular personalities may become candidates for alpha status even if they're airheads.

*** your authors enjoy democracy, but democracy may tend to be inherently in thrall of the gene agenda since in large groups it is probabilistically biased toward the simple "common denominator" emotions of the limbic system regarding blaming outgroups, skewed attribution of agency, and the rest of the cave-man "brain rewards" package.*

*** In addition to the tropism-level behavioral complexity of the "aggregate amoeba", the economy can be metabolically modeled with simple tropism-like equations as a questing heat engine analogous to a replicating bacterium. (that is, the human race can be characterized as a "simple heat engine" which, on a large scale exhibits "tropisms", i.e., extreme behavioral and metabolic simplicities.)*

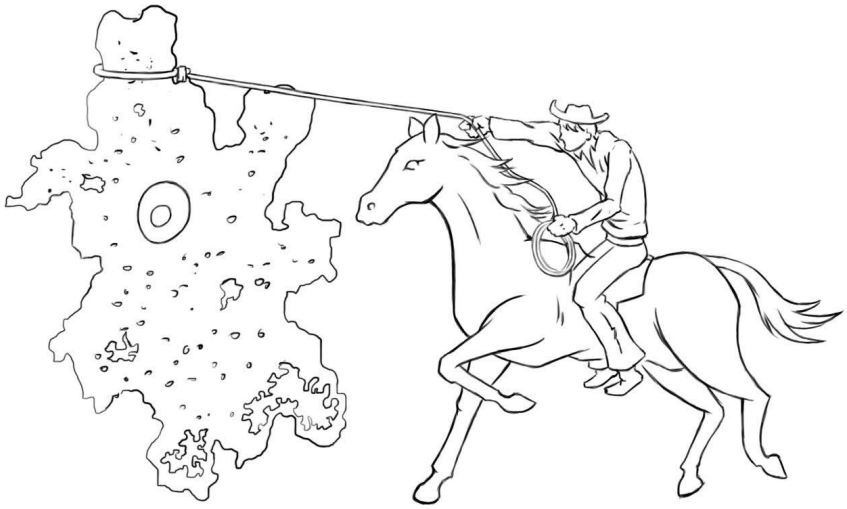
The key takeaway here is this: an understanding of the big picture can only occur in an individual mind.

As distressing as it may seem to realize that there is no driver behind the wheel of our civilizational bus – not even a secret cabal of bankers or supervillains, aliens or illuminati – there's actually some good news hiding here.

One of the main reasons it seems impossible to deal with the human predicament is our assumption that human nature and behavior will undergo revolutionary change in response to learning about crises and limits. And that clearly ain't happening. It's easy to believe, then, that since enlightenment hasn't worked, that nothing else can be done and that the situation is hopeless. Because it still "feels like" once we have educated everyone, we just need to wait for them all to do the wise thing, and the bus will start being steered away from the cliff.

And that won't happen. It may *never* have happened to resolve a complex problem; perhaps it's just a strong attractor for our interpreter modules to use retroactive stories, due to a simian tendency to demand "fairness of process" over competent results.

But brilliance can still exist and be acted upon in small groups, and by individuals. That's where hope lies. Perhaps quite a bit of hope.



The Maximum Power Principle and the Human Superorganism

In class readings, we frequently refer to the aggregate of modern human society as a 'superorganism.' An entity of 7.5 billion functioning as a hive has 2 major implications: 1) (described in above essay) the topics of Reality 101 can only be understood in the mind of an individual, not by society at large and 2) the global economy functions as an energy dissipating structure. It is this last point that we'll briefly expand upon below.

At the intersection of energy and time is 'power.' In nature organisms that have steady access to an energy gradient tend to have evolutionary advantages. Some have proposed as a "fourth law of thermodynamics" the 'maximum power principle,' whereby biological systems develop so as to increase their energy-degradation rate. In that conjecture, biological growth, ecosystem development and evolution represent the development of new dissipative pathways for energy. For instance, in a forest transect, the coolest area when measured by thermal scan is the oldest growth grove of trees, which have grown tall and have thick limbs, best able to capture and degrade incoming sunlight via photosynthesis and respiration from their leaves or needles.[80] The hottest area would be that with the least complex structure on it – e.g. a gravel road winding through the forest and fields. Life tends to find and degrade an untapped energy gradient. Sunlight…and fossil carbon, are both such.

Under MPP formulation, humans and human systems are natural organisms, and as such generally adhere to the maximum power principle and its related tenet the Maximum Entropy Production Principle (MEPP).[81] In nature, power is basically energy or calories per unit time. In human systems since we have a cultural overlay it's not just calories but also money, reputation and others social drivers – per unit time.

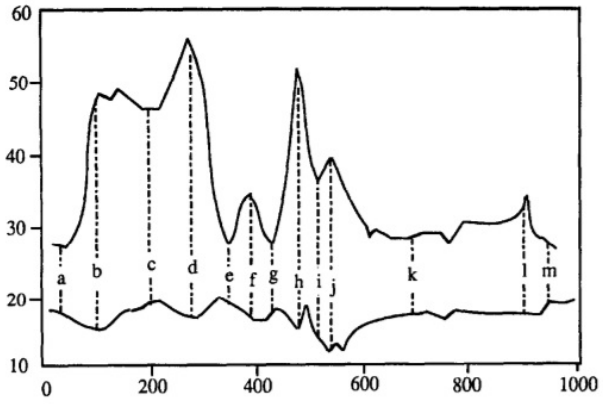


Figure 4. Surface temperature (°C) vs. transect distance (m). Temperature profiles along a 1 km transect in the H.J. Andrews Experimental Forest, Oregon [45]. The top profile is for noon and the bottom profile is for post-sunset. The data was collected using TIMS surface temperature acquisition system. The letters on the diagram correspond to surface features:

(a) edge of forest,
(b) narrow road,
(c) somewhere in a clear cut,
(d) a wider road,
(e) one side of a small shelter wood of Douglas Fir,
(f) a pond within the shelter wood,
(g) the other side of the shelter wood,
(h) a wide road,
(i) trees along the road,
(j) in a flat part of a clear cut,
(k) somewhere in a 15 year old Douglas Fir plantation,
(l) a trail,
(m) an old stand of Douglas Fir regrowth.

About 12000 years ago we morphed from "time minimizers" into "energy/profit maximizers." Tribal societies at the time were aggressively egalitarian, with an emphasis on "fairness of distribution." But something happened, in conjunction with, but not necessarily due to, the agricultural revolution. Humans began to act more as a 'hive' than as a collection of numerous bands of individuals, a transition towards 'ultrasociality.' Such a 'hive' was not a conscious organism but rather an alternate organizing principle which behaved in some ways more like a single creature specialized in the production of agricultural surplus. As this progressed, ever-larger groups abandoned traditional tribal dynamics in favor of hierarchical systems which began to allocate their surplus according to social power, as opposed to need.

To the extent "ultrasociality" worked for humans as a competitive survival edge – extremely well – it strongly rewarded those groups which suppressed within-group competition as opposed to encouraging it. With agriculture, cooperation for "the good of the group" became cooperation for "the good of the superorganism" in which the well-being of individuals became secondary.

Once agriculture expanded as a human enterprise, competition between groups favored those groups which harnessed and directed a greater proportion of photosynthetic productivity. All else being equal, an organism *(or superorganism)*

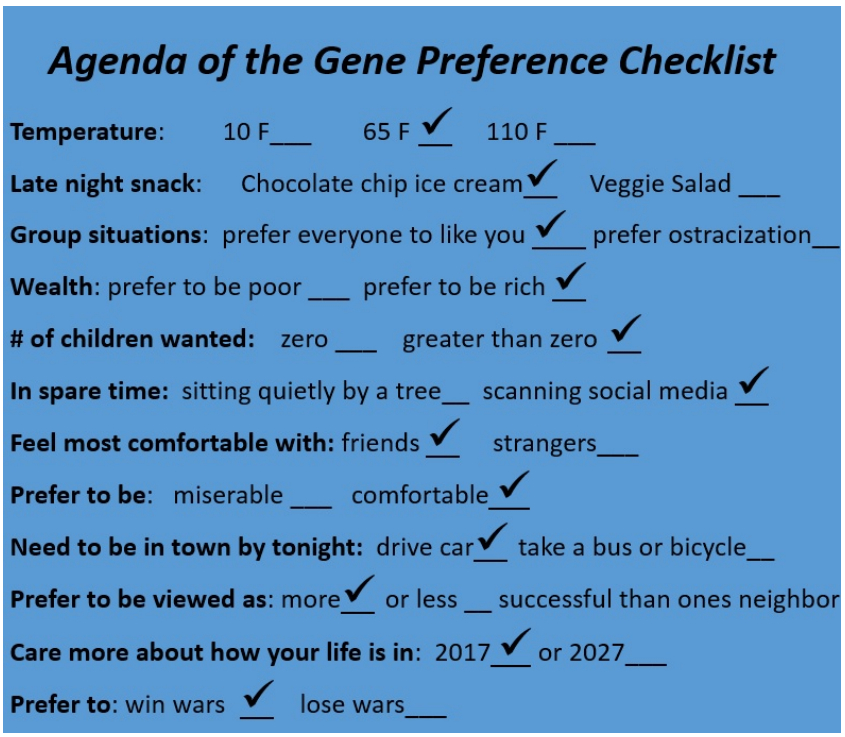
with the energy to make more "game moves" will tend to prevail over an organism with the energy to make fewer.

12,000 years ago, 'good,' as in 'good for the group' meant 'physical surplus,' usually grain or other storable ag output. After the fossil-carbon bank account was opened, the improved quantity and quality of "game moves" enabled by fossil energy quickly began to favor those groups who (combined) had the highest velocities of resources and money, and thus could more effectively recruit and organize fossil-slave labor. Today 'surplus' is no longer the edible food it was during the Agricultural revolution, but a digital account, stacked and amassed virtually each day in the bank ledgers and personal accounts around the world.

Due to the effectiveness of cheap energy, the elements of our societies which have used it to grow complexity, infrastructure and production have prospered. Pursuing such prosperity has in turn accelerated energy acquisition and use. Our first modern hiccup came circa 1970 when declining energy productivity (lower average EROEI), instead of causing a natural shrinkage of the world economy due to limits to growth, caused us to instead choose "debt" as a way to stimulate continued high levels of consumption, at worse EROEI's. It was probably no coincidence this happened exactly when we left the gold standard, the last biophysical tether to our currencies. For each year since 1965 we've added more debt than we've added GDP, and since 2000 or so this has accelerated.[82] At the same time, global trade –the outsourcing to areas of cheaper production and reaping the benefits from comparative advantage between nations - increased from 20% of world GDP in the 1960s to over **60% of global GDP** by 2013.[83] These benefits from globalization and subsequent deregulation of financial markets added further inertia to the system.

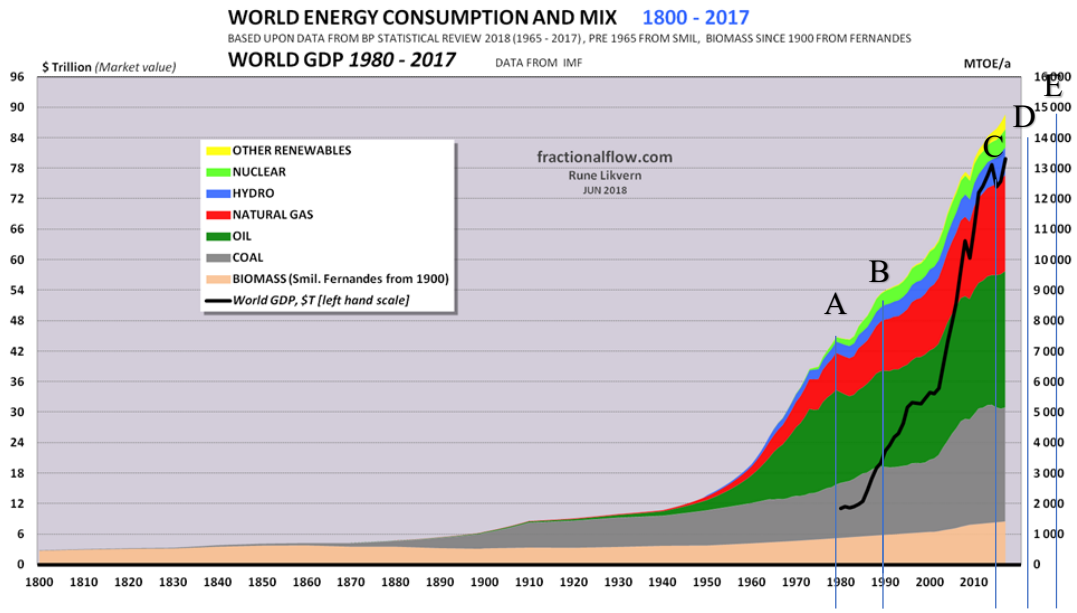
Eventually, the ease with which we could pull resources forward in time using debt led to lower and lower debt productivity (less and less GDP per additional dollar of debt), to the point that central banks had to take over. Now China, Russia, Brazil, etc. are following the exact same model of declining debt productivity as the G7 nations. In the past few years governments and central banks have subsidized our consumptive lifestyle with gargantuan financial interventions: low inflation interest rates, direct monetary liquidity to institutions, guaranteed credit markets (housing, student), explicit and implicit too-big-to-fail guarantees, ongoing government deficit spending, ongoing central bank balance sheet expansion, etc. All the while, wealth inequality is creeping upwards, as the top-down government support keeping the economy afloat is regressive. 90% of people in America since 2002 have flat or declining incomes while prices for most things are higher.[84] This is the case for most populations in the developed world.

The superorganism has, in effect, used money, technology, trade, debt, and rule changes - anything its clever self-interested organelles could cook up - in order to continually access more energy and to expand the complexity in an almost completely globalized society. We have gone from declining energy productivity (EROEI), to declining debt productivity, to declining access to growth to the majority of people, to declining benefits from central bank policies. We'll soon run out of choices that continue physical growth, but in order to keep the hive buzzing around the rich feeding grounds which are fossil carbon we can still use "Orwellian productivity", in the form of rule changes, definitional changes for GDP and general creative seat-of-the-pants responses. For instance, Italian government has recently added cocaine sales and revenues from prostitution to their GDP tally in an attempt to maintain the GDP/debt rations mandated by the European Union.[85]



Viewing our global economy as a superorganism is to recognize it is unlikely we will ever consciously choose to reduce our energy use in aggregate. Most subconscious human preferences correlate with more energy use (see left). Additionally, novelty, our focus on the present, social conformity, rigid belief systems and cognitive biases all combine to suppress active reduction in energy throughput. Yes, total primary energy use will begin its inexorable decline in the next decade or so, but only after we have exhausted psychological, physical, financial and social methods for extending it, whether we consciously recognize this or not.

In short, maximum power could be the real invisible hand.



Up through period A, we applied cheap energy to more and more processes and grew our economies until energy extraction became too expensive for desired consumption level

During Period B, we moved to globalized system of trade, reducing prices of most goods. Also, we racked up increasingly large private sector debts

Period C introduced central bank and sovereign guarantees, quantitative easing, artificially low interest rates and new government credit and deficit spending.

Period D is a continuation of increasing wealth inequality, but since 2008, only the top few % of demography are making any strides. For most people growth is over, even though gross energy consumption continues

Period E – coming up – will mark new definitions to GDP, new rule changes favoring immediate over future consumption, an era of 'Orwellian productivity'

(Note from Nate: TaaL insisted on crossing projects and commenting on this essay)

TaaL: I recognize that the Max-Power hypothesis was formulated by very intelligent and distinguished human scientists, but I'll exercise my prerogative and note that I do *not* consider it the 4th law of thermodynamics, or any law at all. Rather, it's a tendency, an attractor. Humans seem to like finding tendencies and calling them laws, because humans who discover laws of the universe tend to become respected and famous. But sometimes the universe just lets things happen multiple ways, without giving a hoot which way things turn out. Hurricanes can form: does that mean it's a law that they form? No. Slow convection is another way for heat to pass through a system of air, water, gravity, and angular momentum.

From my point of view, human ecologists have focused on energy – which is necessary – without also focusing on the quality of game moves *made* with that energy. To the extent all game moves in life are equally high-quality, the organism with the more energy will get more moves and will indeed tend to prevail. But one good game move can often beat three so-so game moves, so energy is not an *absolute* determiner of advantage, and there goes that 4th law of thermodynamics. There is very little embodied energy in a rattlesnake bite, but it can be a higher-quality game move than two bear-bites. The world is a complex place, and energy – while vital – is not the sole determinant of success. That you have not yet folded that into your ecological theories is perhaps not surprising, since you're a young species.

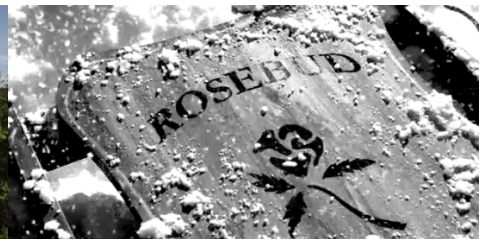
What difference does this distinction make? All the difference in the world, *because the human future depends on improving the quality of your game moves* – now nearly random – while your power throughput inexorably diminishes. This is where sapient thought comes in and can lead you to a lower-energy existence which is – at least potentially – subjectively higher-quality, and far longer-lasting.

The human gene agenda does tend to err on the side of using ever-more energy, but this isn't a choice which can continue to be made. The good news is that your game moves, at present, are terrible, so like a child learning chess, you have a whole lot to look forward to.

Section IV - The Environment

Believing in modern mythology, and being blind to energy realities, also means living in denial of the heavy costs to natural systems this entails. We're living as though the temporary energy extravaganza is a "new normal" when it's anything but. The long-term human story - if there is to be one - will be a story of reverting back steady-state energy income and outgo. Yet previously in human memory, we have had many natural resources and systems which made the planet bountiful for us and the other species which have inhabited it alongside us. These, it turns out, are exquisitely vulnerable to the side-effects of our accelerating energy use, implying that our future may not look like our past.

Rosebud in the Anthropocene



(**NJ**) *When I was growing up in southern Oregon, I couldn't wait to get home from school, grab my dog and a backpack and lose myself in the Siskiyou hills, exploring creeks, finding salamanders, noticing all the lichens, the insects, the deer and other animals. I remember always being on heightened alert because there were mountain lions in those hills. Though I never saw one, I always imagined a cougar crouched in a tree just ahead, and kept an eye on my terrier to see if he would smell something and bark an alarm. In those rolling foothills, a 10-year-old boy felt alive. Now there is a subdivision over the entire hill and the creek is cemented in.*

(**DJ**) *I grew up in suburban Indianapolis in the early 50's, with my backyard abutting a little piece of the Pleistocene: Bacon Swamp. Other than the lack of wall-busting multi-ton megafauna it was largely unchanged from thousands of years before, and had it lasted another decade it would have been surely set aside as a nature reserve; but it was filled in and paved over by the 60's. The wildlife density and diversity of my 1955 Indianapolis backyard is something that in more recent years I've only seen in the Costa Rica cloud forest in 1991, and I've heard that since 1991 those cloud forests have had a major amphibian die-off, so there's no telling where such diversity and abundance might be found now. But those who grew up in the same area only 15 years later than me have utterly different memories, and the stories of the old always seem exaggerated compared with the world we see now.*

In the iconic movie Citizen Kane, the main character had wealth, fame, and notoriety but always longed for something missing in his life. The audience hears his dying words '*Rosebud*' and only at the movie's end *(spoiler alert)* do we discover "Rosebud" was the name of his childhood sled. Despite his subsequent wealth and fame, Citizen Kane's formative and perhaps most intense memories were of his childhood, with simple pleasures, like sledding on a snow day. It is in this spirit that we have chosen to collaborate on this book, and subsequent projects. Wild nature, the way it calls to us, the ways it impacted our earlier years, the ways we believe it is a vital part of who we are as people, and who we are as a species connected to all life, is

our Rosebud. We think it would be good if more people could feel this. Though perhaps they do.

Biophilia

Biologist E.O. Wilson coined the term ‘biophilia’ to represent the bond with nature that humans have embedded in our genes. His hypothesis was that since we spent tens of thousands of generations without cities and structures, we have an innate love and pull towards natural settings. Just like we share a lifelong link with our own mothers, so too do we have such a deep bond with wilderness, now culturally or circumstantially suppressed for many. Whether or not he’s right, it’s clear that nature, and interactions with other kinds of life, are what we evolved for. While supernormal stimuli can temporarily “shout louder” in the form of video games, Pringles and loud music, they are no real substitute for a natural habitat.

Perhaps “biophilia” is inherently redundant, like the word “oxyphilia” might be to describe people who ‘like’ oxygen. But if so, the word is at once unnecessary and insufficient. We don’t just “like” nature, we’ve been sculpted as part of it, including the thousands of mental sub-modules seeking to recognize and be reassured by our part in nature. Anti-depression drugs are a poor replacement. The human experience has always been defined by the regularities of seasons, tides, moonrise and day length; the irregularities and intermittencies of weather and the interactions with other species. We are designed to react and survive in such settings, as they have forever been the mirror which allows us to see who we are.

But in the last half century or so, much like King Midas, we have discovered the power to turn everything around us into money. Only to find, as he did, that by doing so we could lose all that mattered. Our “time bias” causes us not to think much about just how temporary the things are which now distract us from the natural world, and the fact that human futures will for the most part be lived without such things.

What’s An Armadillo For?

We (your authors) often ask young people questions like ‘What is an armadillo for?’ They often hem and haw and eventually come up with answers like ‘boots?’, or

‘wallets?’ They cannot help but anchor their thinking with an anthropocentric lens – I ask ‘what is an armadillo for?’, they hear ‘what good is an armadillo to humans’? Students eventually get around to asking questions like “if a given species went extinct, would it really matter? Why?” It always makes us a little sad to hear the question, but it's legitimate. And a typical "environmentalism" answer du jour is to imply that dire unknown things might happen to humans if a minnow, an owl or another species is lost forever.

Certainly the answer to such a question isn't simple. Life exists in a web of complex feedbacks, so there is no immediate answer to the question "what is an armadillo for?" Those of us who have even seen an armadillo have generally seen them only as road kill, drawing flies along the interstate. They're amazingly ancient-seeming critters, a mammal with a shell. And they reportedly don't play well with traffic. One of our friends claims that when an armadillo sees a vehicle coming it freezes, and when the car gets within about 10 feet it screams and leaps straight up into the air, causing a direct splat into the grill of cars and trucks. This is almost certainly bullshit, but it passes for a large part of our brains have filed away under armadillos.

What will happen to the human world if the armadillos go away? Probably nothing we’d understand. Maybe something. Odds are we wouldn't notice it for long, even if it might have been important in the long term, due to our shifting mental baselines. Yet the armadillo world would disappear forever, all that it was and could ever be, and that isn’t nothing.

It was a trick question. Armadillos aren’t “for” humans. They exist due to having sprung from the same chance events, and distant ancestors, as we did; and against long odds have navigated into the present world while 99.9% of all species became extinct or speciated. Armadillos’ evolved answers to life’s challenges may someday – when we’re wiser - cure humans of cancer or plagues, or their existence may not affect us at all. Yet every complex “armadillo” which is lost in the mass extinction now underway takes us closer to a world composed of insects and bacteria, and farther from the world of the large-species interactions which shaped and defined what we are. Think for a moment how delightful it is that armadillos exist to share the planet with us. We don’t know most of their story, but what we do know is fascinating. If you took a walk and encountered an armadillo, your day would be enriched. At the point we decide they have a value apart from what we might do with their shells, we may find that while not being “for” anything, they make the world a more interesting and valuable place in which to live.

One of my (NJ) greatest current enjoyments in life is to go for a walk with the dogs in the morning in the forest near our house and remove the memory card in the infrared wildlife camera stationed on a tree. The unexpected reward from seeing what bird and animal shenanigans happened in the night in the nearby woods gives me great anticipation, and often joy. In the last year we've seen bears (above), coyotes, fishercats, turkeys, deer, badgers, dancing rabbits (above), and all color and variety of birds. How many people today get primal satisfaction from the affirmation that, at least some parts of our natural world, are still robust and thriving. Yet how ironic, perhaps, that at this point in history I need to resort to high technology to see the wildlife which was abundant and visible without such mechanisms 200 years ago.

Shifting Baselines

"We live in a zoologically impoverished world, from which all the hugest, and fiercest, and strangest forms have recently disappeared; and it is, no doubt, a much better world for us now that they have gone. Yet it is a marvelous fact, and one that has not been sufficiently dwelt upon, this sudden dying out of so many large Mammalia, not in one place but in half the land surface of the globe."

Alfred Russell Wallace – **1876**

And then, decades later:

"*Looking at the subject again, with the much larger body of facts at our command, I am convinced that the rapidity of the extinction of so many large Mammalia is due to Man's agency acting in cooperation with those natural causes which at the culmination of each geologic era has led to the extinctions of the larger, the more specialized, or the most strangely modified forms."* Alfred Russell Wallace - **1911**

"Shifting baselines" refers to the fact that everyone defines "normal" as the way things were when they grew up.[86] So as the natural world is increasingly impoverished, we typically only notice the losses that occurred in our own lives and consider the tales of our elders to be exaggerated stories. This sounds like is just an aspect of nostalgia, but it's a real problem, because not only do most of us not really know what the world used to be like, but we can't track it scientifically without some original baseline. Reading books, and scientific journals helps, but again is our slow, neocortical thinking, not the emotional, fast acting behavioral responses. Our feelings about nature cannot help be linked to our own life experiences.

And these baselines have been shifting for some time now. Author Baz Edmeades notes:

"***Twenty thousand years ago**, huge condor-like birds with sixteen-foot wingspans were tearing open the carcasses of hippo-sized ground sloths here in North America with heavy-duty beaks. Mammoths and mastodons were giving themselves dust-baths and pushing over trees. Cheetahs were hunting a large variety of pronghorn and forked-horn antelopes. No less than five other kinds of big cat were living on an extravagant assortment of camel, llama, deer, horse, musk ox, bison, goat and sheep species. With its giant bears, giant beavers, giant armadillo-like species, giant tortoises, and its giant ground-sloth species, North America was, without exaggeration, a super-Serengeti containing many more big-animal species than present-day Africa.*

As I continued my run, I thought about how strange it was that the picnickers and joggers around me knew little or nothing about all this. How odd, I thought, that they should know more about the dinosaurs which disappeared sixty-five million years

ago, than about the marvelous array of big mammals and birds that were seen, hunted – and no doubt named – by the first humans to arrive here in North America around twenty thousand years ago."[87]

There's no real mystery to why so much megafauna is gone: it coincides with humans colonizing one area after another and killing off the larger animals first. Indeed, humans kill off animals of all sizes; but it's harder to kill every single member of a small species than a large one, because the biomass tends to be more scattered. Being large and encountering humans is almost always a deadly combination.

The eradication of other species has accelerated in the past few centuries; with a huge amount of wild biomass disappearing since Europeans came to the New World. Fisheries biologist Jeremy Jackson suggests that, based on observer accounts at the time of Columbus, the green sea turtle population was approximately 660 million turtles.[88] The Tortugas Islands (Spanish for Turtles) were named such because of this fantastic abundance, and some tales speak of sailors walking from shell to shell on over-crowded beaches. Indeed sea turtle used to be a primary food source in the Caribbean. Approaching 700 million is in contrast with the estimated 88,000 nesting females in existence today.[89] 88,000 "feels like" a lot though, doesn't it? Even if it's 4 orders of magnitude below the original population. We have a hard time imagining 10,000 times as many green sea turtles as today, so it seems unreal, imaginary, like a fairy-tale account despite being documented history. The Tasmanian tiger is an example of an extraordinary kind of fossil - moving pictures - this critter is as extinct as the stegosaurus, but here it is walking around.[90] We'll have color high-def fossils of many species, though the ability to view them may be transient…

Much of the Earth's wild biomass has been lost in what should be recent memory. Estimates of original bison populations in North America range from 15 million to 10 billion - *three orders of magnitude of difference in estimates* - due to shifting baselines and the tendency to underestimate historic abundance based on what it "feels" should be normal to us at present.[91] Again, the stories of the ground shaking, and a sea of bison horizon to horizon seem like tall tales now, even if our great-grandparents (including perhaps some of yours) saw them.

It is estimated we have lost half of the world's wild animals since 1975.[92] In the past 30 years, Europe has lost over 400 million birds, or around 30% of the total population.[93] And, on a micro-scale, as human population doubled since 1970, we have lost about 45% of global insect biomass.[94] This "great dying" has accelerated so fast that *most of the earth's large complex life has died since you were born, and as college students you may survive most of what's left*. What a crazy sentence to write.

And the lack of baselines isn't just relevant to our "feelings"; it has real implications for science, because we kept no organized records of what formerly existed, and thus have no benchmark for what might constitute a healthy population.

Since DJ and Nate were born, the whales of earth have largely been eradicated. Cynically via institutional fraud and sometimes crazily, often without any market for the products, nations of large-brained, social creatures were shot with harpoon cannons by the millions with modern factory techniques. Again, there were no original population counts, and the eyewitness accounts by whalers on old sail-driven whaling ships surely *couldn't* be true because the vast number of whales reported were so unlike we find in the seas today. Even though "counting whales and writing the numbers down" was their primary business.

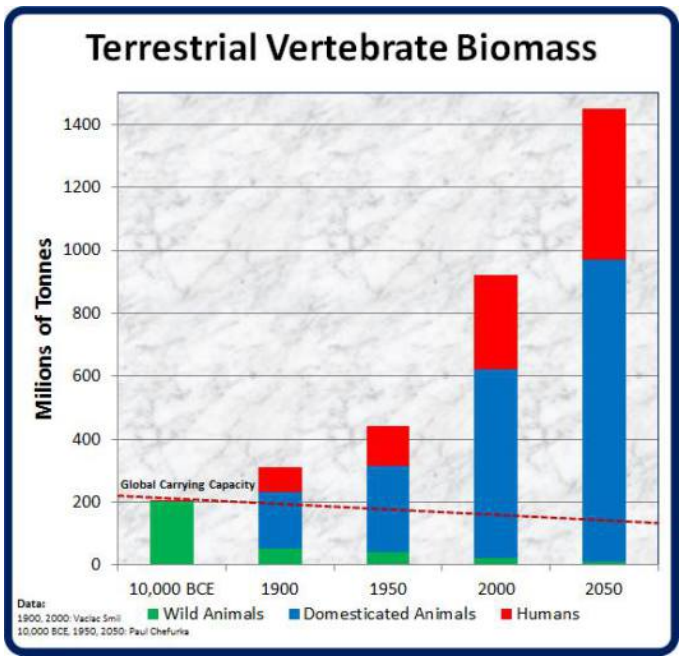
And with oceans acidifying rapidly, whales may be irreversibly on the path to extinction from food web collapse by the time today's high school students are in their 50's. I (DJ) have looked closely into the eye of a full-grown whale, held a young humpback in the surf as it made strange complex noises which reverberated through my body. Such stories may soon seem as fictitious, as improbably remote, as tales of hobbits, dragons and treasure**.**

And I've known dolphins better than most humans have had a chance to, and immersed myself in the toxic knowledge of their reality and their declining status as the 6th great extinction reaches into their existence with great claws. The possible extinction of such creatures may seem an abstract worry, and bit of environmental alarmism, but it's quite real. In the 1990's my group was working with Chinese scientists to try saving the Baiji; and we had a plan to relocate some of the cute little guys to oxbow lakes in China to keep the species alive, since the rivers they had evolved in were choked with human commerce. I couldn't get funding for it. The Baiji dolphins are all dead now, as remote from human lives as the dinosaurs. But this sort of example makes it real; flesh and blood self-aware, conscious dolphins as real as we are, whose history was as long and difficult as our own, converted to forever-gone in the course of a couple decades. And it's that kind of failure which makes for a high attrition rate in this sort of activist career, because the failure is irretrievable, and difficult to bear. To make a difference you need to understand the entire situation, and understanding the entire situation can bring a profound spiritual malaise which drains you. And your stories, to younger ears, sound exaggerated.

Some of my (DJs) campaigns to slow the killing of wild species have succeeded. I am occasionally asked *("occasionally" since it's now ancient history by the pace of human events)* "how many dolphins were saved?" by those efforts. The answer is that neither I nor the world can ever know, because no human knows how many pelagic

dolphins existed before any particular at-sea holocaust began. In ending the pelagic driftnet fishery, many dolphins were saved, but the only dolphin-mortality estimates were from the UNFAO, which guessed between 300,000 and 1 million dolphins per year, without having any initial population sizes to compare with. Nobody had ever counted them, even roughly. Similarly, the humpback whale has just been removed from the U.S. “endangered species” list since its population has “rebounded”, even though this “rebound” probably places it at a small fraction of pre-harpooning levels that we will never know.

While fishing in Florida in the early '60's, I (DJ) found the profusion of sea life to be dazzling, even though it had already been heavily overfished by that time. It was where I set my baseline, and it was wondrous, like a fairyland of large moving life which lit up my young brain which had grown up fishing for pond bluegills. The big fish pretty much piled up on deck as fast as people could reel them in, some of them nearly my size. I went back in the 90's and that reality was just gone, but there were still people taking the same boats out to fish, bringing back small amounts of tiny fish... and proudly taking pictures of them. To my baseline it's an incalculable loss; to a young person catching some colorful tiny fish it is still exciting.



At this point, humans and their farm animals account for over 98% of all terrestrial animal life.[95] That means we outweigh wild vertebrates by a factor of 60! When a person first hears that, it's unsettling. It may be unsettling to you. But that's the cumulative effect of it all: lost ecosystems, which – being lost - we soon forget. Each generation accepts an impoverished new ecological reality as its baseline.

In human terms, it is hard to judge the “importance” of the loss of any individual species. We assign utterly no economic value to intact armadillos, let alone ecosystems. Most species are just in our way – of corporate profits, jobs and progress. Unless there is a market, the non-human earth species have no intrinsic value to modern human culture. If we could, via some magic, bring back 5 billion passenger pigeons to North America with no cost other than a 1-

cent national sales tax, would we do it? Fill the skies again with dark clouds of them, as existed when the USA began? It's doubtful we would, because there's no longer a place in our minds for such a wonder. We have no memories of them because the last one died 100 years ago –ergo we don't miss them. By all means take a moment and visualize the process of trying to get such a tax passed to bring back all those poop-dropping birds. Wouldn't happen, would it? Yet America is different and less special without them, and the nutrient distribution system they represented has altered our forests and farmland in ways which may – in retrospect – be missed once we no longer have unlimited amounts of fossil-energy-generated fertilizer to apply.

And we are ultimately supported by those formerly-intact ecosystems. The "carbon pulse" of energy and destruction from burning fossil carbon will be over in the blink of an eye in historic terms, and - unless huge changes are made in human actions - will be likely marked by a visible horizon in future rock strata, with abundant fossils below and anoxic mudstone above. When we've burned all the oil and no longer have air conditioning, reliable rainfall and supermarkets, we may find that losing those species actually did matter, since they supported the complex and truly renewable systems which allowed us exist without burnable fossils.

Beyond baselines, what is the absolute worth of other species?

So how should we figure what those other critters are worth?

Our lives were defined by these other species as we became what we are, and humans living in isolation from other large complex species would experience a very different existence than the one we evolved in. Some people think it sounds like a fine idea – less dangerous, cleaner and more predictable. Others find it traumatic, lonely and gray. Some people consider their dogs and horses to be their best friends, others consider the same animals to be only sources of meat or home protection. Having known many dolphins personally, my own experience is to think of wild dolphins akin to an aboriginal people – a different culture but beings with inquisitive and humorous minds, and with self-awareness in the same sense that we possess it. But many commercial fishermen think of them as floating hunks of meat at best and competitors at worst. And most people don't think about them much at all.

"In 1976 in Hawaii, I (DJ) was taking data in a university experiment designed to test a dolphin's visual acuity. Under the experiment's design, the dolphin would be simultaneously presented with two different-sized targets, one on the left and one on the right. The dolphin had been "trained" that she would receive a fish in reward

whenever she correctly pushed one of two paddles corresponding to the larger of the two targets.

The way the experiment was set up, the scientific observer was supposedly unseen by the dolphin. If the dolphin pressed the correct paddle, I would press the "positive sound" button, a high and presumably pleasant-sounding beep, and throw a herring through a 6x6 inch hole in front of my face. If the dolphin got it wrong, I would push the "negative sound" button and there would be a klaxon buzz, followed by no reward.

The dolphin in question, who I knew well, developed rules of her own. She would get all the answers right for perhaps 12 trials in a row, and stockpile the fish on the shallow tank bottom. Then she would (obviously intentionally) start getting 100% wrong answers. Whenever I would push the klaxon sound she would wing a herring through the hole and smack me in the forehead. In fact, she ended up shaping my behavior until I would hesitate a LONG time before pushing the "negative sound" button... and she would wait, patiently, knowing I had to do it.... sometimes as long as 2 minutes... and SMACK would go the herring on my forehead.

When she was out of ammunition, she would go back to getting the trials 100% right again, to build up more herring ammunition. (Of course, this particular "visual acuity" data, if examined quantitatively, showed that this dolphin was virtually blind.) I ended that day with tiny silver scales all over my complexion, and an increased awareness of the poor state of the art in dolphin research."

It is these experiences with other species that are not easily internalized or understood by reading a book. And certainly the fisherman who view dolphins as meat, or machine-gun and bomb them or cut their throats on general principles just to see them die, are unlikely to ever interact with them or consider them in this way. Whose experience is right? Which view of dolphins' role in the human world is the more correct one? There is no easy answer, and maybe no "true" one, as the universe doesn't dish things out in rights and wrongs. Rather, it goes to the values system of our individual virtual worlds, the stories we live by, our self-image and our internal image of the world around us. We descended, after all, in an unbroken chain from the same hominids who depopulated the world of large fauna in the last 20,000 years. Now 7.5 billion strong, we're on track to challenge the great planetary extinction crises of earth's multi-billion-year history.

Our history with other large species has been a matter of competition, desire, fear, behaviorism, empathy and abstraction. We're descended from meat-eating hunter/scavengers who fantasized about possessing the species around us, painted cave walls with abstract images of them, and defined ourselves by our prey and the

other predators we feared. We learned to understand the minds and behavior of those other beasts, enough to outguess them, to dependably stampede bison off cliffs, build fishing lures and traps, and imagine ourselves flying like birds.

Dog is my co-pilot

One of our greatest successes - or perhaps the wolves' greatest successes - was forming a symbiosis with wolves who later became dogs, and other deepening symbioses with animals to do work, provide dairy products, meat and eggs. Such leaps drastically increased the niche for human-biomass carrying capacity.

Both of your authors have shared most of our lives with dogs. Dogs are descended from gray wolves (and other now-extinct wolves) and their global population now numbers over 500 million.[96] Dogs are proof that cross-species empathy, understanding and communication can occur, and it's a wonderful thing. Some of our best friends have been canine. To each of you reading who has spent time playing, caring for, or just hanging out with a dog, you are thus capable of empathizing with the broader natural world, with creatures outside your house, or backyard, or even country. They are out there, and their lives and futures quite literally dependent on human actions in the same way our dogs are dependent on us bringing them kibble.

And this brings up a flipside of our empathy for dogs and cats etc. which we should probably put in perspective as well. To a certain degree, many of us use dogs and house cats as a surrogate for wild nature. House cats now share with humans the status of the ocean's top predators... plankton, zooplankton, larvae, tiny animals, small fish, larger fish, big fish, gigantic fish, and then kitty-cats, what a bizarre trophic food chain. Dogs are, we hate to admit, also wildly overpopulated carnivores from a biophysical standpoint, and many have been morphed into bizarre phenotypes. Our dogs and cats eat heavily from our livestock... humans get the prime cuts, but they get the rest… The "energy footprint" of an American poodle is higher than many of the

human nobility of 16th century Europe. Each Pomeranian probably has a goodly number of fossil energy slaves. They really only “look good” from an environmental perspective if they displace the need for human reproduction. The answer probably isn’t for billions of people to all have dogs, but to reverse the estrangement from nature which leaves such a void for dogs to fill. And, eventually, to have a smaller, sustainably-sized population of humans *and* dogs living at any given time, enjoying nature and the sight of other species together.

On the Other Hand

These days, "civilized" humans are very removed from interaction with other species in traditional ways, although we still deeply fear the large predators which for the most part no longer exist. When tourists go for a swim in the ocean, it's clear that the biggest worry is about sharks. The USA averages about one shark attack fatality every two years in total. Indeed, there have only been 548 confirmed shark attack fatalities worldwide since the year 1580, while an estimated 372,000 people still drown each year.[97,98]

Clearly, the risk of dying from shark attack has always been preposterously lower than simple drowning, and now that the sharks are mostly gone from the seas, the odds must be lower still. Yet the dread we feel is real, and that translates into a largely irrational desire to have them eradicated.

And what the hell, we might as well eradicate armadillos too just to be on the safe side. A rather disquieting bit of research was done showing that many drivers will swerve their vehicles to kill inoffensive wildlife like turtles (or armadillos) when the

opportunity arises.[99] That is, a tendency to want other life to not exist. So perhaps the truth behind the apocryphal story of armadillos screaming and leaping in front of cars is less about armadillo brains and more about a human "death swerve" heuristic in favor of opportunistic killing as an end in itself. Certainly, the 6th mass extinction isn't explained simply by our eating things. Nobody ate Dodo birds, they didn't taste good; but from all reports they were great fun to beat with sticks, and that hobby wiped them out in short order, as it has countless other species. Humans take pleasure from killing that is entirely distinct from food needs. For many of our kind, it's fun to kill things; we may recoil at that assertion, but that reality plays out all around us.

Moreover, the balance between empathy and abstraction can be an odd thing, even in humans who "feel like" they care about other animals. In the same way people will donate to a starving child but not to a group of starving children, empathy is something one extends to an individual, not a species. In the USA, it's nearly impossible to raise funds for saving a species that nobody has seen; recall our inability to raise $50,000 in the early 90's to create lake reserves in China to prevent the baiji's extinction. However, if instead we'd purchased a one-legged owl and started the "Hoppy the Owl Trust" in the USA, allowing other humans to visit little Hoppy in his walled enclosure and feed him mice, we'd have had an ongoing income of that much every year, with residuals from the incredibly cute "I Hop for Hoppy" t-shirts. When a perhaps-somewhat-handicapped humpback whale swam up the Sacramento River, people were moved to tears by the antics of "Humphrey" and he became nationwide news, with everyone caring daily how he was doing, and fully engaged in how to turn him around to safety. Millionaires fell out of the trees with gimmicks and ideas. At the same time, this did nothing for general issues of whale conservation, which languished with few dollars and only fringe interest. "Humphrey" was more real, and *worth more* to people than his entire species. While Humphrey became a "person" to them, his species remained an abstraction.

This abstraction, when combined with a general tendency to kill things off, is why most large creatures are now gone from earth and the rest are on their way out. It requires us to go out of our way, to be inconvenienced, to NOT kill things off, and the self-interest in doing so just doesn't seem apparent.

Abstraction is a funny thing, and of course we apply it to members of our own species. The only places which haven't seen "ethnic cleansing" recently are the ones which did it long ago. We have a long history of killing and eating those who aren't in our "in group"; we're all descended from cannibals. Indeed, more recently than we may think: during Imperial Japan's invasion of China, a good part of the diet for the troops was cooked Chinese people.[100] This has been pretty well deleted from the sanitized historical accounts we are presented post WWII, but the Chinese certainly

remember it well. The Imperial Japanese felt they were descended from the sun god and that other humans were descended from monkeys, so there was no logical reason not to chow down on them. It even severely freaked out the German nazi's on the scene, whose "master race" paradigm was not principally known for its celebration of human phenotypic variation. So empathy and abstraction can vary wildly between human cultures.

I (DJ) must admit to sometimes feeling a bit alien, culturally, due to having generalized my abstractions, and my empathy. One story: I spent 6 months of several hours per day in the water with a particular dolphin, becoming friends, and came to think of dolphins as an alien but roughly equivalent kind of people. This isn't a typical experience in most human lives. Subsequent to that I've interacted with many other dolphin species, such as pseudorca, false killer whales. Although they are large enough, with toothy jaws, to instantly kill a human with a single bite, I've experienced them intelligently interacting, as well as approaching me underwater with jaws open, with my only safety being in the minds of these wild-caught carnivores, their decision not to hurt me for the sake of doing it. And kids respond to them as individuals as well. But I also have footage, obtained by one of EarthTrust's undercover operatives, of a member of that same species being slowly killed for fun by two men in a shallow bay with a piece of steel rebar, a coke bottle, and a pocket knife while a crowd nearby watches and laughs. To them, it was funny; to me seeing it was no less disturbing than seeing the torture-vivisection of a human would be. Clearly, our different experiences had generated different abstractions in our minds, and different thresholds of empathy for another species. *(Quick work saved the rest of that whale's pod from the same fate and caused their release back to the wild, but that's a highly unusual outcome.*)

We're now on course for a world in which the largest extant animal may well be the cow. Elephants and rhinos, whales and whale sharks, all are being exponentially eradicated, and zoolife will be on the menu on the downslope of the green revolution, as this century progresses. How far will our baseline shift in coming decades? Will your children get the same wild feeling of nature that we did in the Siskiyou mountains or Indiana countryside by seeing a squirrel, or a pigeon, because they never knew how much more there was?

Whether or not we extend our empathy past our species, or pull it back again to our narrow in-groups, it's perhaps worth taking some time to wonder about what sort of existence we might have on a hotter world with scum seas of slime and jellyfish, noxious gasses wafting off the seas, and insects, rats, raccoons and a few others species our only companions. And ask ourselves: whether an expanded empathy right about now might be in our own self-interest before things go that far.

Other species exist in the physical world, while the only thing we can ever directly experience is our own virtual worlds. Rather than consider other humans to be robots, we take the mental leap – unprovable – that they are beings just like we are; and more profoundly, that we are like they are. It's a threshold of our personal cosmology: a rejection of solipsism in deciding to treat others as real conscious beings.

It was not so long ago that in our country slavery was justified due to there being supposedly huge differences in human races. I was told in my youth by an old teacher that black people didn't feel pain the way white people did, and I'm sure he believed it because his empathy for the two colors of humans felt differently to him and his mirror neurons. The threshold of our empathy and of our abstraction of outgroups (within and without our species), has been and will be a dynamic thing.

"Touch the earth, love the earth, her plains, her valleys, her hills, and her seas; rest your spirit in her solitary places. For the gifts of life are the Earth's and they are given to all, and they are the songs of birds at daybreak, Orion and the Bear, and the dawn seen over the ocean from the beach.

When the Pleiades and the wind in the grass are no longer a part of the human spirit, a part of very flesh and bone, man becomes, as it were a kind of cosmic outlaw, having neither the completeness nor integrity of the animal nor the birthright of a true humanity.

We need another and a wiser and perhaps a more mystical concept of animals. Remote from universal nature, and living by complicated artifice, man in civilization surveys the creature through the glass of his knowledge and sees thereby a feather magnified and the whole image in distortion. We patronize them for their incompleteness, for their tragic fate of having taken form so far below ourselves. And therein we err, and greatly err. For the animal shall not be measured by man. In a world older and more complete than ours they move finished and complete, gifted with extensions of the senses we have lost or never attained, living by voices we shall never hear. They are not brethren, they are not underlings; they are other nations, caught with ourselves in the net of life and time, fellow prisoners of the splendour and travail of the earth." Henry Beston

Our Faustian Ocean

"Don't it always seem to go, that you don't know what you've got 'til it's gone"
– Joni Mitchell

Sometimes, in our dreams, we can fly. In our imaginations, we glimpse magical beings in fantastic worlds. But why should we settle for illusion? In this place, still, all it takes to experience another real world is the decision to do so.

And thus, I spent a large portion of my 20's under the sea in a weightless, alien yet familiar world, interacting with rich communities of sea life. An ape wearing fins, blending in. Add a mask and snorkel and it is astonishingly easy for a primate to become a sea creature. Equipped with a subcutaneous fat layer rather than fur, with an evolved diving reflex (where did that *come from?), a human can fairly quickly learn to be at home in shallow seas. And that I was. Only limited by daylight and thirst, on occasion falling asleep far from land surrounded by an immense calmness which is hard to describe. There, a person could still find the abundance of wildlife that old stories tried to describe about land; everything in the field of vision alive, moving, interacting, behaving. Octopus, eels, enormous turtles, rainbow parrotfish, crabs, clouds of colorful fish, large, fast-moving jacks; twitchy barracuda, the protruding eyes of bottom-dwellers, the long antennae protruding from holes in the rocks. And through it all I could fly like a slow-motion bird.*

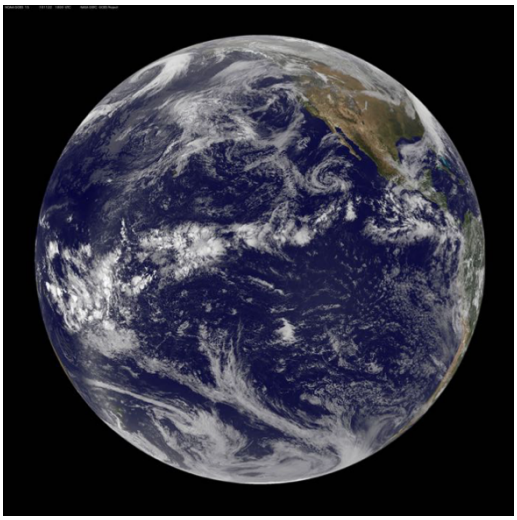
The seas contain so many stories we have no notion of, nor good language to describe. As a side-project to my conservation work, I put together a research lab to try some things nobody else was doing. In 1991, that lab became the first to successfully test a non-primate (a dolphin) for self-awareness based on primate criteria. Not because I had advanced degrees or qualifications, but because nobody

else had gotten around to doing it before; everyone "knew" that only humans and a couple of our cousin-apes were self-aware by the criteria of psychologists, and so that was what our culture believed. Something shaped like a fish couldn't have a conscious, abstracting mind. Yet as soon as it was tried – within seconds - the dolphin enthusiastically passed the test, and all the textbooks on self-awareness were subsequently rewritten. My doing this had far less to do with expertise, than with my realization that we humans don't actually know what we pretend to know. Our biggest blind spot is that we are unaware of the unbelievably breathtaking extent of our blind spots. – – DJ White 11/24/2015

Note from Nate: in this course, we don't do advocacy, but rather learn how first principles of the physical world relate to the human predicament. But in this particular case, it would feel sociopathic to frame the "big trade" described below in neutral language and terms. We're still contacting experts trying to gauge the pace of acidification and other ocean impacts, but the information we have so far leads to the conclusions expressed here.

Our Blue Planet

"We are tied to the ocean. And when we go back to the sea, whether it is to sail or to watch - we are going back from whence we came. " John F. Kennedy



In our solar system, and all other star systems with planets we have detected, there is nothing remotely like earth's living oceans. They're what defines the planet and have defined us. It's where life originated and has flourished across deep time, and it's still where most of the life we know of in the universe exists. It is home to the largest creatures and largest brains, and oldest cultures which have ever existed on earth. *(hint: and they aren't ours)*

From deep space our planet looks like a dim blue star. From a million miles away seems like a small blue marble. From directly above it, one sees a water world, dominated by three coexisting phases of water. 70% of Earth's surface is covered in water - the most important ingredient supporting life other than oxygen. (And by the

way, the plankton living in today's oceans provide over 50% of the world's oxygen).[101]

We came from the oceans, first swimming, then crawling, then running and now walking upright, but our origins are in the sea. The salt balance in our blood matches that of the ocean. The density of the human body is about the same as ocean water. The chemical composition of our cells has similar mineral make up as does seawater. In the womb, our developing babies still have 'gill-slits' a carryover from our watery ancestral environment in deep time. Indeed, our bodies carry captive seas around with us, with our cells functioning much the way ancient sea creatures did.

But, other than a flat blue horizon and an ocean breeze on our coasts, the seas of earth are invisible to most of us. We know that's where fish come from, and where various creatures live, but for the most part that has seemed a separate reality from the human one. Almost another planet, within which different rules apply than those which govern land animals. Until very recently in the human story, the seas have been very mysterious and scary, the abode of monsters and infinite depths. But our modern pell-mell supernormal civilization leaves little time to reflect on the gradual but inexorable changes we are wreaking on the signature ecosystem of our planet.

Very few of us think of the 3D vastness of the seas as a real "place". Except for a few birds temporarily aloft, life on land lives what is mostly a 2-D existence, confined to a thin interface between land and sky. In contrast, the entire volume of the seas may be inhabited and traversed by living creatures; 328 million cubic miles of living habitat. Thus by volume, the oceans make up more than 99% of the livable space of earth. They cover 71% of its surface. Their average depth is over 12,000 feet and they hold

97% of the planet's water.[102,103] Yet the Earths seas are - seemingly - considered expendable to the species doing the fossil-burning, because without the burning we wouldn't have as many new cell phone apps or be able to melt cheese in a microwave at 1am.

The ocean is a world of strange lights, languages, and untold stories; but it is more a world of sound than of light, since light travels only limited distances through it, whereas sound can travel thousands of miles. Whales can hear one another speaking thousands of miles away... or could before the advent of man-made noise in the previously-quiet frequency ranges they use. Those wavelengths are now filled with the clatter of diesel engines, huge propellers, and booming sonars to detect enemy ships.

The floors of the oceans have until recently been covered in reef communities and other fragile ecosystems; fractally rich in the same sense as tropical rainforests, but in many cases far older, growing with the slow creep of calcite and aragonite crystallizing one molecule at a time at depths surface light cannot penetrate. We have dredged most of them into trackless wastes with steel cables and nylon nets, without them ever having been seen or photographed, and spreading layers of suffocating mud over the sea bottoms in the process. When photographed many years later, they remain barren. Another trade: the destruction of ancient worlds for fish sticks that are only "so-so" but add to GDP.

These days, despite the huge leap forward in sonar and deep-sea research, only about 1/20th of 1% of the ocean floor has been mapped well enough to find volcanic vents or sunken airliners.[104] The entire seafloor has been mapped, but only to a resolution of about 5km.[105] This compares to a resolution of 50 times finer -100 meters – on the surfaces of Mars and Venus, where we can discern far more detail. (This is due to the resolving difference between radar and sonar). When one is talking about living creatures, a 5km resolution would miss just about everything interesting. What is down there?? We seem to think we know enough to make permanent decisions about it.

Film-maker James Cameron (Avatar) had it right: the seas are really another world that we barely know but have been destroying anyway. Like our atmosphere, they have always seemed too vast for mankind to affect, and too remote to care about, the denizens far outside our sphere of empathy. But the seas are finite, and we underestimated our own capacity for mischief, once our armies of tens of billions of fossil energy slaves got busy. And only very recently is this profound reality becoming recognized by some who are paying attention.

Overfishing and related threats have caused the oceans fish and animal populations to be cut in half since 1970. Pelagic fish 'stocks' like tuna have declined to only 10% of historical populations. Sea turtles have declined from numbers in the hundreds of millions a few centuries ago to under 100,000. Recent marine science shows mangroves, coral reefs (home to 25% of ocean species) and seagrasses that underpin ocean food webs are in steep decline.[106]

We've overfished, polluted, trashed and heated the seas. Like many of Earth's ecosystems, we have been treating the principle as if it were interest, and like a college trust fund frat boy, have been living 'way beyond our means. And now, as we start to sober up the morning after, we're about to sign a new contract to extend our orgy of consumption – at least through our own lifetimes.

Life in the Oceans 2015: The Big Trade

In the history of human affairs, art, and literature there have been some infamously-bad trades. The dicey and perhaps apocryphal sale of the island of Manhattan by "someone" to the Dutch for 60 Guilders. The contemporary trading of young girls into slavery in exchange for heroin and cocaine. Dr. Faust trading his soul to the devil for 24 years of luxury and knowledge. The promise of a first-born child to Rumpelstiltskin in exchange for spinning straw into gold. But the biggest, worst trade of all time is ongoing as you read this sentence:

We are trading away all large complex life in the oceans for perhaps the next million years, in exchange for about an extra 50 years of burning fossil fuels.

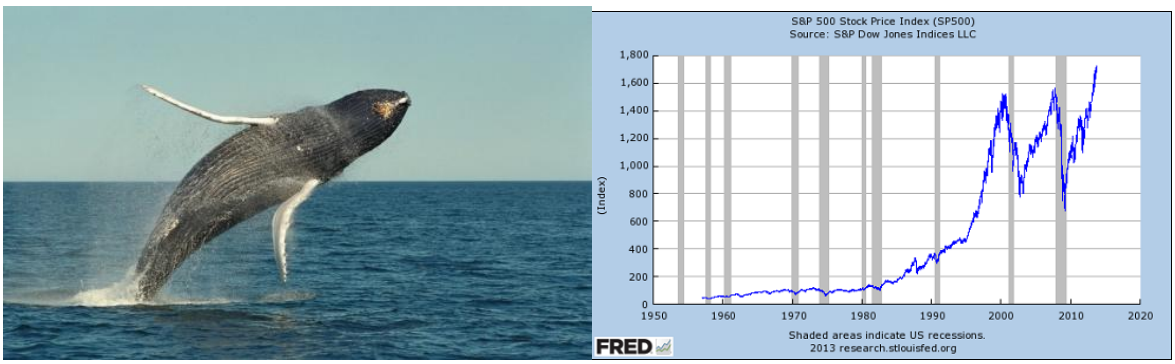
It's a deal even Dr. Faust might have been horrified by.

How so? Currently we have a new use for the ocean, which is utterly incompatible with its other human uses: **fossil carbon sink.** The ocean naturally breathes CO2 in and out as part of natural flows. The CO2 from gigatons of burning fossils aren't normal flows, but it gets absorbed anyway. The oceans thus become a 'buffer' which will allow us to burn fossil energy longer while heating the planet more slowly. They absorb over half of the CO2 our fossil slaves breathe out. We've generally considered that to be good news, because it has slowed the pace of global heating, which implies to us that hard decisions needn't be made in the near term. We can "kick the can" down the road for a few more decades and avoid *any* immediate cuts in fossil energy use. No harm in another degree or two of warming, eh?

What's the catch? Over the course of a single human lifetime, most large complex**species that we know of in the universe are thereby consigned to being lost permanently, large complex sea life in general is lost for millions of years, and in exchange we get a temporary *partial and declining* buffer of the climate effects on the scale of decades. (***There are large organisms that are NOT complex: e.g. giant jellyfish, enormous mats of fungi, stromatolites.)*

The reality is fairly simple – it's a trade of the oceans full of large vertebrates for the likely duration of human existence, versus the (self-issued) human license to burn fossil carbon for another century or less. Ocean absorption of CO2 won't *prevent* heating of the climate but takes the edge off it and makes it seem more gradual and politically tenable over the course of decades. The problem with this calculus – aside from its apocalyptic stakes – is that our current species-wide conversation is not even *considering* whether we should choose *not to do it*. The odds are high you haven't even *heard* about this trade, put just this way, even though it's one of the most fundamental realities of Earth existence right now...

Sea Life for GDP.



It seems like such an obvious thing to do. To the extent the seas act as a CO2 buffer, this is seen as a fortuitous thing – a boon.

You've probably read about using the seas this way but framed differently. There was recently a "good news" article about research showing that Antarctic seas are taking up CO2 faster than previously. A typical sentence in the conclusion of these articles is along the lines of "Fortunately, the seas mitigate global warming". Yet it's only good news in a "Rumpelstiltskin" sense, because the seas are not unharmed by such absorption. Rather, they are transformed. The CO2 becomes carbonic acid, and like a gigantic stomach, the seas increasingly begin fizzing away the parts which dissolve in acid. Things like shells, skeletons, coral reefs... in other words, many of the organisms

at the base of ocean food chains, and those which form the fractal 3D structure of subsea habitats.

Not that it's a perfect trade, of course. The same CO2 pollution which will acidify the oceans and lead to trophic collapse will - at a bit later date - also sear away the rainforests, melt the glaciers, and make parts of the earth too hot for humans or crops, and submerge the areas where much of the world's human population now lives and farms and fishes. That's part of the same trade for our fossil carbon-hedonic habit and the conveniences we've recently come to take for granted. (On that trade too, we've finished signing 2/3 of our (species) name on the contract's dotted line). It's just that the oceans' ability to support creatures with calcium carbonate skeletons *will go first*.

The first irreversible threshold, the loss of aragonite skeletons, has already begun in high latitudes, and under continued extraction-for-GDP as a human aspiration, could be locked in for the entire world oceans *within your lifetime*. That puts your generation in an uncomfortable position, to say the least. Faust's heirs: you didn't make the deal, but you have to decide whether to engage with it or let it play out. Without some sort of extraordinary change in human societal inertia, it will. It is.

We've suggested that you be very skeptical about certainty, and you should be. But few things are as certain as basic chemistry. The oceans are acidifying, apparently at least an order of magnitude faster than they ever have, even in past mass extinctions, in earth's entire history.[107] Once it goes into the air, most CO2 will eventually enter the oceans and become acid. And there it stays for a long time.

So, in what sense is all of this a "trade"? It's a trade of convenience: if we decided to care, we'd have to slam the brakes on burning fossil carbon very soon and dramatically transform the way our societies are powered, and how much comfort to expect. Soon, as in by the time you're in your 30's.

50 Years of buffer for a Million Years of Slime?

Earth's ocean soaks up fossil carbon's CO2 quite quickly. But de-carbonizing the seas is anything but quick. Historically, after the coral and shells are lost to acidification (with accompanying marine mass extinctions), it takes hundreds of thousands to millions of years for the slow process of silicate weathering – rain wearing away alkaline continental mountains - to gradually raise the pH to the point where it becomes possible to build shells and reefs again.[108] Of course, by this time all the large animals are long gone... as a million years is a long time to go without eating. But evolution can create large complex life in the seas again, right? Except that it might not:

By the end of the Devonian, "there were fish called arthrodire placoderms with large slashing jaws that were the size of school buses, and there were relatives of living tetrapods, or land-dwelling vertebrates, that were almost as large," Sallan said. "You had some vertebrates that are small, but the majority of residents in ecosystems, from bottom dweller to apex predator, were a meter or more long."

Then came the mass extinction, which all but eliminated life on the planet. More than 97 percent of vertebrate species were wiped out. Sallan and Galimberti found that, following the extinction event, body size declined and continued downward for much longer than they expected -- at least 40 million years.

"Some large species hung on, but most eventually died out," Sallan said. "So the end result is an ocean in which most sharks are less than a meter and most fishes and tetrapods are less than 10 centimeters, which is extremely tiny. Yet these are the ancestors of everything that dominates from then on, including humans."[109]

Large complex life is not an inevitable result of evolution, but one and *only* one possible result of long periods of environmental stability. Large animal life with complex brains is the rarest occurrence of all, seldom produced by evolution over billions of years. There is no reason to think that something like the cetaceans will ever again exist in the universe after we trade them away this century. And other simple and aggressive species, which are evolved to opportunistically displace large complex life and prevent its resurgence, already exist.

"It probably won't happen slowly, where we can watch for signals and milestones to decide when "enough" has occurred and it's time to take action. Those signals and milestones have been all around us for decades and we have chosen to ignore them. It will probably happen more like a house of cards, where one card falls, causing others to fall, and so on. Pressure from above, unstable foundation below. We have, over the decades and through wanton disregard for consequence, turned our ecosystems into neighborhoods of card houses. So many populations of so many species are hanging on in dwindling numbers that it is hard to imagine that they will be resilient enough to endure a reshuffling of the food chain. And as one species collapses, so will those above it. Like the classic game Rock, Paper, Scissors, each of the perturbations vexing our oceans can be argued to overarch the others. But the reality is, they are severally and collectively part of an integrated system that both feeds and is fed, supplies and demands, gives and takes as part of the cycles of nature. Carbon dioxide in the air leads to warming and acidification . . . Acidification leads to flagellates and jellyfish . . . Warming leads to stratification, which leads to hypoxia . . . Hypoxia changes the water chemistry, which leads to flagellate blooms, which lead to jellyfish . . . Warming also enhances plant and animal growth, which leads to blooms, which lead to hypoxia . . . Warming also reduces oxygen in the water, making respiration more difficult, which leads to jellyfish ..Overnutrification leads to flagellates . . . Pollution leads to flagellates . . . Flagellates lead to jellyfish. Rock, paper, scissors.

It appears that, in many cases, jellyfish blooms are merely the most visible part of distressed ecosystems. In many cases, jellyfish are a symptom rather than a cause. As phytoplankton shift, so do copepods, and as smaller copepods dominate, fish decline. Perhaps in some cases jellyfish move into a vacant niche space, whereas in other cases, jellyfish are the last man left standing in an ecosystem where higher-energy animals can no longer thrive, while in still other cases, the ecosystem shifts to give jellyfish the competitive advantage. Anyway, jellyfish flourish." – **Dr. Lisa-Ann Gershwin**

Earth's oceans. Worth keeping?

We treat the oceans as an afterthought, a neighborhood we have outgrown; good for recreation, property values and healthy food, but pretty much an optional accessory to modern lifestyles. And we have some negative feelings about them too: hurricanes, tsunamis, sharks and the occasional Godzilla are from the seas. Actually, Godzilla is an apt symbol of our historic feelings about the seas... we depend on them, but never felt we could trust them. We still have stone-age brains which evolved on the plains of Africa, and our feelings come from those deep parts of us.

Even people in land-locked states worry about shark attacks. There have been fewer than 3000 human fatalities documented from shark attacks in *all of human history* (since the year 1580), while roughly 100 million sharks are killed annually by humans, primarily for an expensive soup made from their fins for its mythological properties; the rest of the shark carcass, dead or often alive with mortal wounds, is thrown overboard.[110] Our culture is mostly fine with that, because they have scary teeth, and our fear of predator teeth is an ancient brain module running in parallel with

our snake-detection systems that make our unconscious decisions. The way we feel about the oceans is linked to deep unconscious systems which respond to predator teeth. Said differently, we possess snake/predator aversion modules, but lack ocean-health neural modules. We were sculpted to manage the tribe, not Earth's ecosystems ecology, yet we increasingly are mismanaging them.

Sound pollution. Chemical pollution. Heavy metal pollution. Radioactive waste pollution. Plastics debris. Fertilizer-produced dead zones. Coral bleaching from warming. Dredge fishing. Military sonar. Subsea explosions, conventional and nuclear. Perhaps because they seemed bottomless, limitless and boundless, we have not treated Earth's seas gently. A majority of large complex biomass that once swam there is already gone, even before the oceans become more acidic. Half of ocean life has died in just the last 45 years.

Yet this only sets the stage for one of the most severe assaults on large complex life since our planet formed: acidification at least ten times as rapid as any which has occurred before in the history of the seas. And when we're talking about life trying to adapt, the speed of change becomes hugely important. The faster it is, the harder it is for large, long-lived species to adapt., and the faster it is, the smaller and simpler the creatures which survive it, and therefore become the new basis for future evolution. Most of these have not evolved to be much different for hundreds of millions of years: because they didn't need to.

This human generation has a surreal question to answer: is it worth keeping the oceans alive in the sense they have been during our entire history as a species? As extraordinary as that question may seem while being posed, the current answer is even more bizarre: **No**. Our economies and GDP calculations see insufficient value to living seas to prioritize their continuation. It simply isn't being done. You've heard of "global warming" ... not that our species is doing anything much useful about that either, aside from hand-waving, blogging, and making speeches. But likely you haven't heard much about "ocean acidification" until this class, and certainly not that it's the deadlier and more imminent effect of CO2 profligacy. Because a slime ocean won't kill us. *(at least not immediately)*

Yet doesn't such a trade at least deserve consideration? Shouldn't we 'fess up to the fact that it is, indeed, a trade which we're consciously making, and which need not be made? Should parents not tell the story to their kids, and ask whether the trade sounds like a good idea or a bad one?

Would a 5th grader change her future life trajectory if this story were told? Or would her mother chastise the school about being alarmist? What are the appropriate boundaries for alarm?

The Problem with Blind Spots

Most of how we experience the world happens in our minds. The corollary being: most of the physical universe thus exists in human blind spots. The evolutionary reasons for this are easy to understand: evolution designs a functional, surviving brain not just by designing clever modules, but by excluding everything which is irrelevant to an organism's function. Blind spots evolved because they are useful: a frog's retina does not even see things that don't move, allowing the frog to concentrate on things which do, and things that move = calories = survival to a frog. Similarly, our senses and minds evolved to ignore the things which didn't matter to the immediate survival of a hunter-gatherer tribal primate. It makes sense then that we don't notice the gaps: our minds stitch together the small pieces of the world we do see into a subjectively-seamless experience. The maintenance of this illusion, and of our evolved blind spots, is so central to our mind function that we don't even notice the cognitive change if half our neocortex is removed surgically.

We know the seas of earth exist, but for most of us they exist primarily in a blind spot; not as a magical world which comprises most of the life we know of in the universe, but as something external to our needs and wants, with no discrete value to us.

And there's another world which exists in very much the same blind spot as the deep sea: our own deep future. The existence of the trillions of human childhoods which could happen over the coming million years if we simply stopped doing what we're doing this century and did something sane instead. Those future people exist to us in the same remote, abstract way as the creatures in the seas, and their existence is riding on exactly the same decisions.

X_____

"We, the undersigned, (Homo sapiens), agree to trade our Oceans, for……"

A post script from DJ

We opened this draft for you honors students with a reference to my own getting to know the seas while around your age. I hope some of you have had, or will have, such a chance. If you want to, you'd better hurry. But to that hope I offer a caution: you

may find that you come to deeply love the seas of earth, what they have been and even today – diminished – still are.

And you may find that you come to love and feel empathy for their creatures. A profound part of Reality101 – which is to say the real world – is that it is richer and more special than our species is generally willing to conceive. And love, together with self-respect, can move you in ways you would not have planned.

It's hard to have empathy for something like "the living seas" because they don't have a face. We don't think much about issues which don't have faces. So here I'll offer one face of the big trade: dolphins. They are a good face for human-generated acidification because they are equivalent to us as beings, have lived with large and conscious brains for many millions of years longer than we have, are friendly aboriginal societies which have never harmed mankind, and may be consigned to extinction this century as one small part of our trade of fossil slave largesse for healthy seas.

One of my best friends and teachers during my life was a dolphin. I found, to my amazement, that dolphins are people in every sense of the word, less clever than we are in some ways and far smarter in others. The fact that we share the world with such beings – who have had large brains and almost certainly a sense of humor since long before humans existed – is both profound and incredibly lucky. They are friendly aliens with minds and abilities very different from our own.

The most fearsome ocean carnivore is the orca. Great white sharks flee in terror at the faintest hint of an orca's presence, and for good reason: a fight between an orca and a full-grown great white shark is like a human versus a restaurant buffet – no fight at all. Orcas eat polar bears and walrus. If you look at an orca skull, you're reminded of a tyrannosaur. Yet humans can swim with them safely. There has never, to my knowledge, been a documented unprovoked attack from an orca on a human being. (I hope you pause for a second to consider just how extraordinary that is.) I have a scientist friend who dives with them while they're feeding. To me it's surreal that nobody much makes note of these aspects of reality: the existence of disciplined, advanced alien minds on our home planet.

We are seemingly unable to recognize genius if it isn't technological, which is why I had to create an entire lab and hire a PhD ethologist to scientifically demonstrate something which was utterly clear to me from knowing dolphins as people: they're not only self-aware by simple criteria, but have an advanced concept of mind. Perhaps more of one than we do: otherwise, orcas would pluck kayakers like we pick berries. I've been in a deep pool interacting with a wild-captured 17-foot psuedorca (example

shown below) which playfully took my body in its mouth, and could have instantly bitten me in half as they do to 200-lb tuna.

The only thing between me and a grisly death in the maw of a roughly-captured wild beast was the fact that these giant jaws and teeth were controlled by a sophisticated mind, and I relied on that. (Though I admit that one's assumptions flash before one's eyes as you see such jaws open and coming at you underwater). As mentioned previously, I have also seen what happens when this same creature falls under the control of humans, and it is not pretty. We do not naturally extend the same courtesy to other minds – or even recognize them unless they act alongside human convention.

While writing this essay I find myself thinking about the extraordinary footage from 2012 of a wild dolphin approaching human divers at night for help removing a fish-hook and line from her fin. This was the act of a sentient aboriginal with complex theory of mind, who voluntarily sought out and put herself entirely under the control of a fearsome alien species, at night, under glaring lights, for a painful operation, while holding her breath. This one video should have caused hundreds of scientific papers to be written, because the number of advanced cognitive traits, and logical deductions, necessary for that dolphin to do that is breathtaking. It's the act of a person recognizing other persons, and expecting cross-species empathy. (and unless dolphins had such empathy, they could not in turn expect it.) If IQ were a relevant measure between species – it isn't - is her equivalent IQ 30 or 300? What is the dolphin's concept of humans? Does she recognize that the scuba divers with lights and air tanks are another instance of the creatures that make and use hooks and

lines? If so, how? Recall that South American natives – even with a fairly advanced civilization – considered Spaniards with metal hats riding on horses to be magical beings, and thus totally misjudged them. Yet this dolphin nailed her assessments, even of a highly technological species with whom she'd had no common ancestors for 70 million years.

Did she deduce humans' ability, intentionality, tool-using, and empathy on her own – which would be astonishing, a flash of insight and serial deductive reasoning comparable to those of Sir Isaac Newton and other historic human great thinkers – or did she learn such abstract and foreign ideas from other dolphins somehow, which would be maybe even more astonishing? Yet this hard evidence of advanced mind – dare I say genius – is currently just a bit of YouTube trivia like vids of cats in boxes and dogs chasing lasers.

This dolphin would likely have slowly died of her entanglement without a series of brilliant, sophisticated, and accurate deductions about terrifying aliens which she then had the courage to submit to. Can you imagine the mind which could make such deductions, control its own fear and pain, and come out the other side of the experience having achieved the desired goal? And having tried to imagine it, can you imagine how poignant it will be that this youtube clip could easily outlive her species? OK, end of digression, back to making my point...

Understanding and acknowledging the intelligence of cetaceans which was ignored by my species meant that I had an obligation to learn about the way we were interacting with them and of course that wasn't pleasant. We have been wiping them out, in their millions, since I was a child. No particular reason, it's just one of those things we humans do while pursuing other goals. But accompanying my awareness of these things, I found my life re-aligning itself in order to stand in the way of that juggernaut. Not that I necessarily could stop it, but I found that such a decision was ultimately a very simple one, even if scary. That has meant that for most of my life I've been living a parallel reality, dual worlds; seeing my species get richer, more certain and less satisfied, while watching cetacean species diminish and vanish.

As this unfolded, I found myself at odds with some very scary humans like organized criminals and governments. But there have been victories along the way, and because of them millions of dolphins are still alive in the seas at this writing. Minds in the waters, singing songs we don't understand.

It turns out that there are more things than dolphins that reside in our blind spots. If we learn to step outside these blind spots and engage the world in ways which actually work, rather than which "feel like they should work" to our hodgepodge

modular brains, a few true "Homo sapiens" can make a big difference, and Nate and I will touch on this more as the Reality101 semester winds up.

But this is one reason why the "big trade" – the unremarked sacrifice of large ocean species for roughly an extra 50 years of "buffer" of the climate impacts of fossil energy – hits me very hard. Not only because of the imminent loss of a world of coral kingdoms through which I've flown in dreamlike waking wonder, the dance of living creatures surrounding me which often seemed like fantasy. But because one part of the big trade, ***if it continues****, is simply that the cetaceans could not be expected to survive it. As high-metabolism, slow-reproducing species at the top of their respective food chains, they'd be among the first to go once acidification dismantles the basis of existing food webs.*

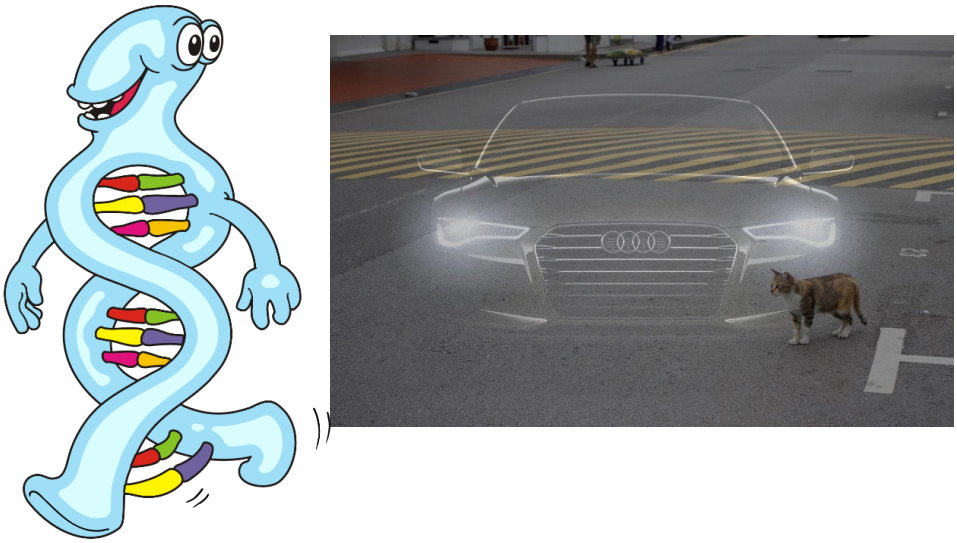
Each dolphin species has a distinct and unique sort of mind, and the loss of any is a loss as great as that of a hominid species. (not that we greatly mourn the loss of other human species, or other apes, these days, though I hope you'll agree we should). A pseudorca has a different sort of mind than a bottlenosed dolphin, who has a different mind than an orca, who has a different take on the world than a rough-toothed dolphin, who is different from an Amazon river dolphin. We've outlived (euphemism there) the other human species (though genetic analysis shows that I have 2.9% Neanderthal DNA, which I find obscurely pleasing. With our smaller brains and motivating myths, was our species smarter or just more ornery?) In the cetaceans' case, we're not just talking about one race of self-aware beings, but many. Scientists from our little lab also tested pseudorca and orca for self-awareness, and they passed. Of course. But what a basic test that is for creatures with brains larger than our own, who have millions of years more experience with using such brains to deal with Reality101.

My own reaction to the "Big Trade" – while describing it in exactly these terms in these writings to you Honors students – is "Hell No." But altering the course of the aggregate human amoeba will take actions and engagement that I'm getting too old to pursue on my own. Writing this stuff for you guys is a part of a commitment I made to a particular dolphin long ago; and that's not some sort of journalistic, poetic, or romantic license, it's simple truth. The gross metric of GDP, and the banality of fossil-fueled excess, is to me a poor substitute for humans sharing a lonely universe with friendly, curious minds unlike our own. We currently spend billions hoping to find bacteria on Mmars – and we count that as a healthy part of our GDP. At the same time, we take 250-year-old minds, in brains twice the size of our own, and make them into dog food (Bowhead whales). And now that there are too few to be worth hunting for pet food, we're trading them away.

There are other 'people' besides us. I hate the thought of them going away. Our own species and future will be less complete without them. We are presently sacrificing them for self-indulgent and dubious reasons. Their minds cannot affect the course of human events. Yours may. – DJ

DJ with his dolphin friend in 1976. (Yes, she was the one who nailed him in the forehead with the herrings)

CO_2: Playing in Traffic



This is the chapter in which we describe how we live on a wonderful planet, and it would be a great shame if we screw it up by overheating the air and water, acidifying the seas, and killing off the large interesting species of plants and animals we have previously relied on. Let's face it, you've seen a lot of nature documentaries. So you probably expect, here, a pretty much boilerplate description of how our planet used to be an Eden, but how lately we've been mucking it up via pollution and mischief, so we really should stop being such jerks and just let mother nature get back to nurturing us.

And that's true enough, as far as it goes. But it skips over a rather large question which we should really consider: does nature - the rules of the physical universe, as manifested in ecological communities of life on this planet - actually have a tendency to be beneficial to the continuation of life, or is it more likely to kill itself off? And is the answer to this hidden by a logical fallacy almost too big to be recognized?

These questions are seldom asked, because we clearly evolved on a planet which has been a rich source of food and materials for us and our evolutionary predecessors, and life has taken many forms on the planet in the last 3 billion years. Many aspects of the world are Eden-like, even today in their diminished form. It "feels like" a system which should be inherently stable, if only we stopped perturbing it and trusted mother nature. And indeed, "mother nature" has clearly done a better job at keeping a healthy planet alive than humans have, to date.

But what if generalizing based on the history that we and our forebears have experienced is a logical fallacy? That's the implication which will be explored here, in a chapter which is nominally about climate heating and the acidification of the oceans, the evil-twin CO_2 issues.

Why bother to make such a point? Because it helps make the case that perhaps - instead of residing in a system which is self-stabilizing and will always heal itself - we are likely to exist on a knife-edge of ecological, chemical, and thermal balance which we cannot expect to be stabilized by some sort of mindless daisy-world beneficence to automatically save us from our own excesses. There's a case to be made that we need to distrust the things which got us here: both the genes and their agenda, and the presumption of a cosmos, a planet, and a self-stabilizing global ecosystem which is unerringly beneficial to large complex life such as we.

The ecology and life of this planet are wonderful – and likely even rarer and more wonderful than we think - but are not inherently durable as systems. The genes which drive them are just as likely to back off a cliff as climb a mountain, for they are both blind and unconscious. Only the mind can anticipate and understand, and potentially stabilize the processes of life in a universe which is frequently inimical to it.

This is, then, a further argument against following the urges of the gene agenda, in favor of developing a rational deep-time agenda for earth-life. An argument that without the direction of mind, earth life is likely to run itself off the rails. No, it's not some boneheaded argument in favor of reductionist geoengineering for short-term effects, but a realization that the backward-looking "agenda of the gene" is inherently unable to even *try* to stabilize an ecosystem, or attain any other future goal.

But how could that be? How could something as basic as the inevitable *stability of nature* be a fallacy?

Anthropic Survivor Bias: The Biteypuss Fallacy

We (DJ and Mrs.) once had a truly awful cat named Biteypuss, and only part of her story is salient here. Raised indoors, she hated the indoors, and upon becoming adult inflicted many injuries and types of damage in order to go outside. However, once outside, she didn't hunt sparrows or mice, but instead played with trucks and cars. She somehow acquired the notion that they were insubstantial wraiths which existed to amuse her, and no amount of restriction could keep her out of the busy street. There she would lie on her back on the yellow lane-dividing line, merrily contorting like a cat which had already been hit by something, but only batting her paws at the tires which missed her by inches. Whenever we became aware she had made it to the street

again, we'd run out, stop traffic and pick her up, and get bitten and scratched in the process.

The amazing thing was that she managed to do this pretty much daily, for significant numbers of months - without ever being disabused of the notion that the careening metal objects zooming by were just big cat toys which were meant to be played with. The odds of her remaining un-flattened, and even unperturbed, for as long as she did had to have been extremely low - like thousands to one against. That cat *should* have been road kill within a week. Improbably, her story ended well; we managed to get her accepted by a fishing research station on an island with no roads. She lived a very long life, and never did figure out that cars and trucks could hurt her, much less that we weren't her enemies for marooning her. However, her experience was atypical for aspiring roadkill, and said nothing significant about the actual risk of lying in the road, who her real friends were, etc. Simply by surviving, she acquired a skewed frame of reference.

We live on a world which until now has been well-suited to life. However, the point of this essay is that *That could not be otherwise*, because complex beings such as ourselves can *only exist* on a planet which has had the time, stability, and luck to have hosted life for billions of years. Thus, any conscious beings evolving anywhere in the universe will look to their planet's history and *necessarily* see something like an Eden in its past, even if that was incredibly unlikely. However, that past does not constrain its future in any way.

So here's a seldom-asked question: is this universe welcoming and inherently hospitable to life such as human life, or is it more *hostile* to life, with its main concession being that its rules don't preclude life's possibility? The next question is: once life has gotten started, does it automatically modify its planet to make it more conducive to life, as was popularized by the Gaia theory, or does it just do a random walk in a minefield which could equally well end poorly? Or at the opposite extreme, does life tend to be suicidal? Geologist Peter Ward explores that latter possibility in *The Medea Hypothesis*, and it's recommended reading. The point of this essay is not to repeat his reasoning, but to note the basic logical fallacy which could hide such a possibility from us in plain sight.

So is all life alike?

First of all, we should clarify the exact question we wish to answer: what is the definition of "life" which actually has meaning to us? This turns out not to be a trivial question. Clearly, current life's beginning was simple single-celled animals such as present-day bacteria. Moreover, they have always been, and are today, the main story

of life on earth. We pay more attention to lions and tigers and bears, but bacteria are the more effective human predators. Their biomass can be reduced hugely and they can still bounce back. Indeed, even once the earth's oceans inevitably boil away in the far future as the sun brightens, the bacteria living slow-motion lives deep in the rocks of the crust will survive a long time. It's not impossible that Mars might have such life inside it even now.

But does that matter? Is that really the sort of "life" we care about emotionally? There's a big difference between bacteria and large, complex life like trees and animals. The former are resilient whereas the latter are very fragile. In the rapid changes of a mass extinction only one thing is certain: large complex life goes away first, for much the same reason basketballs are more robust against earthquakes than are wine glasses. The conditions which large complex life requires to exist are much more demanding than what bacteria need to exist. These include very stable conditions which don't change rapidly, because such creatures reproduce very slowly. The largest mammal which made it through the last big mass extinction was the size of a squirrel with a tiny brain, and all today's mammals are descended from those diminutive survivors.

The geological record indicates that simple single-celled life started on earth quite quickly after the earth had cooled enough to make it possible. So it's possible the universe might be reasonably welcoming of single-celled life forms, to the extent that they come into existence pretty quickly, and quickly rebound when nearly killed off. But large complex life is a different story. It took a full 1.5 billion years to develop organelles like chloroplasts and mitochondria which made possible the plants and animals we know today. That's a long enough wait for these unlikely events that it's clear that they might easily have not occurred at all in the window of time in which the earth was in the temperature range for life to exist.

And large complex life hasn't had an easy time of it since then. Based on the inexorably expanding sun, in the course of life on earth, bacteria will get about 5 billion years of existence. Large complex life (things big enough to see, including bugs) will get about a billion (if it's lucky), which is roughly half over now. The window of existence for conscious, self-aware brains might be immensely shorter, particularly if we leave it to the genes and the universe to write the story… as we're now doing. Our motto in all things seems to be "so far so good."

Survivors

Central to the *anthropic survivorship fallacy* is our reliance on history as a predictor of the future. As noted, we look back and see a planet which has provided for our

every need, and that of our ancestors, and allowed us to grow that most unlikely of organs, a large self-aware abstracting brain. The point of the "survivor bias" fallacy is that *this is the only pattern of history an evolved self-aware brain could ever see in its history even in principle*, so it says nothing about whether it was a likely outcome or a ridiculously far outlier, like Biteypuss's lifelong certainty about the insubstantial nature of trucks.

So, taking a step back from the seeming reassurance of history, what would we logically expect to see in a universe which was inherently hospitable to intelligent life, and in which a "Gaia" effect stabilized the ecologies, temperatures, atmospheres, oceans, and environmental variables of a living planet once life got a foothold? Well, we'd expect to look around and see other planets in the solar system with life. Both Venus and Mars presumably had the initial conditions for life and have been cross-seeded with earth bacteria (and we with theirs) due to meteor strikes. Their environments should have been stabilized and gone on to develop intelligent life. We'd expect to see the signatures of oxygen atmospheres in extrasolar planets. We'd expect to pick up radio waves from intelligent beings talking to one another. And if there was unlimited energy awaiting the discovery of intelligent minds, we'd probably expect to see actual evidence of intelligent aliens having visited our solar system. In Earth's history, we'd expect to see the quick stabilization of the planetary biome and a quick and orderly progression to large-brained beings, appearing fairly early and commonly in the earth's fossil record.

What would we logically expect to see in a universe which was hostile to intelligent life? We could not exist if there had been a full extinction event, but we'd expect to see *many* catastrophic near-extinction events for complex earth-life. We'd expect to see evidence of past cataclysms on our planet and on other planets in the solar system. The planets around us would be devoid of large complex life. No extrasolar planets with oxygen atmospheres would be seen. There would be no hint of radio or any other communication by other intelligent beings, or any solid evidence they had ever visited our solar system. There would be no fossil record of large-brained self-aware beings prior to recent evolution after the latest mass extinction. And this is what we see.

Looking at the past mass extinctions - were they unlucky one-off events, or inherent to life on a world such as ours? Do living systems self-stabilize, or are they at all times poised on the brink of arbitrarily large extinctions? Here mathematics gives us a clue: the pattern of earth's past mass extinctions follows a power law relating an extinction's size to its frequency of occurrence, just like earthquakes, forest fires, and other systems whose behavior derives from the fundamental structure and connectivity of the system's parts. This could indicate that the earth's biosphere is poised for a potential mass extinction at all times, just as the San Andreas fault is

primed for a possible earthquake. The stability of large complex earth-life, and the recent friendliness of Earth to conscious life, may not be inevitable but have been just a lucky break.

And indeed, the "deep questions" about the universe seem to be converging on "anthropic" answers: there is probably no reason that the laws of our universe and the masses of our elementary particles are so fine-tuned for life's existence. The odds are so stupendously against such fine-tuning that it seems we are living in a Biteypuss universe after all, a rare livable universe among a preposterously greater proportion of universes in which not only life but solid matter could not exist. Admittedly, this could seem like an abstruse logical detour for this course, but if true it could have practical and immediate implications for our current subjects.

Anthropogenic CO_2: Global Heating and Ocean Acidification

It's has taken a bit of windup to get to the ostensible subject of this essay, because it's hard to internalize it without an appreciation of the knife-edge of environmental stability upon which complex communities of life - and particularly large intelligent life - balances.

Life itself can alter a planet to make it more hospitable to life or less so (remember the stromatolites?). Since most life is as brainless as a rock rolling down a hill, it doesn't automatically alter a planet in a Gaia-like way to better accommodate future life. It's at least as likely to do something that kills itself and all other life off. But - as noted - no self-aware being will look to her planet's past and recognize that, because the fact of her being alive means such a killing event didn't happen on her planet. However, if she decides to believe she can depend on "Gaia-like" effects, or inherently robust environmental stability, to safeguard the planet's future, she's taking a real risk. The "survivor effect" fallacy of perspective must always present a reasonably clement planetary history to any conscious observer evolved on that planet, though any footprints of past mass extinctions should be her clue that things can go badly wrong.

The earth exists at the inside edge of the "habitable zone" around the sun, purportedly about 1% away from being in the zone which is expected to cook a planet to lifelessness. Even if the existence of clouds ultimately cuts us a bit of slack, that zone is moving outward as the sun inexorably heats up, so there's that. Indeed, life has kept earth from that fate so far. Unlike our sister planet Venus - which has a principally CO_2 atmosphere - life has bound up most of earth's past CO_2 in deep layers of carbonate rocks, precipitated by the skeletons of microscopic life over deep time. Free oxygen in the atmosphere is also a product of life and is what gives rise to the ozone

layer which protects life from solar ultraviolet radiation. This was not "planned" by bacteria seeking stability, it was emergent from dumb luck.

However, life on earth has also done things like killing off other life with poison gas - oxygen was toxic to most life when photosynthesis first got going, and it caused massive dying. The seas can also go stagnant and flood the air with hydrogen sulfide gas produced by purple bacteria which rise from the deeps whenever conditions allow. Life also caused the earth's oceans to freeze from poles to equator for huge swaths of time by pulling too much CO_2 out of the air, locking the planet in ice. If not for the fortuitous existence of undersea volcanic chimneys providing chemical energy, that would have been "it" for our ancestors. Life on earth survived these and many other past "oops" situations when life nearly did away with life - again, not because the odds were necessarily good for life to survive, but because if it had not survived, we wouldn't be around to figure out the history and talk about it. Suffice it to say that life itself can do either thing: make a world safer for life or more hostile to life. Perhaps neither Gaia or Medea, but just stuff that happens.

It turns out that this is not just an abstract thing to muse upon, but a significant aspect of the current human predicament. We, like any self-aware life which evolves in this universe, look to our evolutionary past and see a planet which has largely been benign toward us, even to the extent of killing off past dominant life multiple times, principally involving CO_2 variation. We therefore conclude that such benign treatment of humans is a built-in feature of planet earth, and that nothing life can do - we can do - would likely alter that. In other words, we think a lot like Biteypuss.

Science, however, strenuously says otherwise. It's now looking as though most of the past mass extinctions on the earth are correlated with the amount of CO_2 in the air being altered.[105] It seems to be the main "mass extinction" control lever, and it is mediated by life. If too much CO_2 is removed from the atmosphere, the oceans freeze from equator to pole, killing off large, complex life. If life allows CO_2 to rise too high, the planet heats and stagnates, killing off large, complex life.

In the oceans, high CO_2 has a different but still-lethal effect. It acidifies the water, dissolving calcium skeletons. This causes mass extinctions of life on all scales which require such skeletons, and rearranges the ocean food webs, which tends to kill off large complex life. The effect of CO_2 heating is that the seas stratify and stagnate, becoming toxic soups of bacterial slimes and simple creatures which don't need much oxygen. Again, large complex life is killed off. As seas become anoxic, purple bacteria pump out ever-increasing quantities of toxic H_2S gas, which kills off life of all sizes.

So if the geological past shows us anything, it's that rapid change is both hostile to conscious life, and also an inherent possibility of earth's ecosystem. If it teaches us any *single* lesson, it's "***don't screw with CO_2.***" So of course we have created a global industrial civilization whose *primary effect* is to inject CO_2 into the atmosphere and oceans as fast as possible. All else that humans do is secondary in scale: to a good first approximation, humans function as CO_2 catalysts, with any other attributes being rounding errors. The oceans are now acidifying at least ten to one hundred times faster than any previous time on earth, *including* the worst parts of past mass extinction events. The climate is heating at a similarly rapid pace. **Scientists expect children born today to outlive *coral.***

This essay won't add to the hundreds of thousands of research reports documenting the onset of a 6th mass extinction, and the certainty of these basic physical effects following basic cause. However, it's written to note that high-energy fire-symbiote life - to survive its own excesses - needs to be intelligent enough not to feel too secure that the earth's ecosystems will somehow automatically "fix," "accommodate," or "stabilize" any CO_2 excursions we find convenient to emit. That's simply not what they do. They can just as easily make things worse as better, and indeed science seems to be finding about a dozen scary and plausible positive feedbacks for CO_2 heating and acidification for every negative feedback which is suggested.

Life in this universe seems to be a chancy thing, and self-aware life as a large complex creature the most chancy of all. It looks like we've been incredibly lucky to get to this point. We need to wonder whether we should keep doubling-down until an inevitable loss or take our winnings and use them to stabilize the ecosystem for large life.

Our large brains give us the *potential* to use this information to steer a course into the future, for ourselves and other complex life. However, those large brains are significantly imprinted with a backward-looking "gene agenda" of urges and biases. That evolved agenda makes it "feel better" to keep emitting CO_2 while ignoring the intermediate and long-term future.

The notion of living without extensively burning fossils is no more palatable to us than "moving to an island" was for a snarling Biteypuss being carried onto a boat, even though that was one more lucky break for one of the world's luckiest bad kitties. She got away with being in total denial of the danger of speeding vehicles, by having no conception that she was an outlier among millions of flat cats with similar delusions.

Which may help explain why there are no radio signals from aliens detectable in space.

Section V: Synthesis

So how does this all fit together into a synthesis, and why is doing that important? While in our minds we tend to think of aspects of reality as separate things, everything actually happens at once, all aspects of the physical world and human behavior interacting with each other to create emergent realities. We need to understand these emergent effects if we're to have any idea of what's really going on around us, and what future we're actually heading towards. It turns out that this knowledge is significantly at odds with what nearly all humans now believe, and that's important.

Seeking Homo Sapiens

"*Humanity today is like a walking dreamer, caught between the fantasies of sleep and the chaos of the real world. The mind seeks but cannot find the precise place and hour. We have created a Star Wars civilization, with Stone Age emotions, medieval institutions, and god-like technology. We thrash about. We are terribly confused by the mere fact of our existence, and are a danger to ourselves and to the rest of life."* E.O.Wilson, 2012, ***The Social Conquest of Earth***

Welcome to the top of the mountain. Dear students of Reality, we made it, via switchback, rope, steep climbs and descents through scree. The view is dizzying, but hazy in the distance *(future)*. The first principles you've been exposed to on our ascent underpin the most relevant issues that will affect your lives on this planet, this century. Below is a summary of the milestones we passed on the way up, and when combined, what they imply.

We are stardust - an outcome of once-in-a-galaxy circumstances and deep time. From the big bang to the formation of earth 4.5 billion years ago, the molecules and atoms within ancient cosmic explosions coalesced and self-organized. Life, unexpectedly and perhaps against tall odds, arose from the hostile and variable conditions, endured 9 mass extinctions and myriad minor extinctions in life's history and arrived here, with us and including us, today. From single-celled cyanobacteria to fish to reptiles to animals to dinosaurs to mammals, the catalogue of earth's creatures is a kaleidoscope of colors, shapes, sizes, habitats and behaviors. All these organisms

seek energy, and move towards and away from other stimuli relevant to their survival. Our biology is thus an emergent property of random physical interactions through history that have created the proximate rules that explain our world.

Life: probability, complexity, and fragility

There's something very important to realize about the nature of life. This truth resides in one of our many blind spots, so you may not have thought much about it. But evolution has not been a one-way march of simplicity to complexity. Rather, the main story of life was and still is simple life: single cells. They were first on earth and will be last by a wide margin, because single-celled life are tough little bastards which multiply at breakneck speed and exist in multitudes. There are more single-celled animals on earth than there are stars in the universe – the current estimate is five billion trillion trillion – that's a 5 followed by 30 zeroes. Simple life seems to have started on earth almost immediately once conditions were right, and has never looked back. Relative to multicellular life, it is thus high probability, low complexity, and low fragility.

Complex life is multicellular and spans a large range of complexity, becoming more fragile as the complexity rises. **Large life** is a measure of body size, and is relatively rare and becomes more fragile as size increases. **Large complex life with brains** is incredibly rare and fragile, depending on very stable conditions to exist, and **large complex life with conscious, abstracting brains** are the lowest-probability, rarest and most fragile emergent feature of the rarest and most fragile life, which require great body size, long childhoods, dense nutrition, and high complexity. We evolved in a time of stable, advantageous conditions which would support k-selected species with long lifetimes, low reproductive rates, and brains. However, rapid environmental changes favor the opposite: mass extinctions are unpredictable in their detailed outcomes, but very predictable in their patterns: their gross effect is to get rid of large complex life in favor of small simple life. The biggest mammal to come through the KT extinction weighed just a few pounds.

The lesson, if we are willing to look squarely at it, is that large complex life is a side-story which plays out in times of stable conditions, when simple life gradually expands into unoccupied parts of the fitness landscape. Periodically, when change happens abruptly, the world can once again be reduced to slimes, bacteria and small vertebrates. In the rules of life, fragility and complexity are two sides of the same coin. We, and the other large complex life which now exists, will only continue if very special conditions also continue. *Quite simply, life such as us was not an inevitability but rather like a rare gem.*

Energy is (almost) everything.

From worms to watermelons to wolves and everything in between, we are genetically related to all living creatures on this planet. In total there are estimated to be ~10 million species on Earth – though if micro-organisms in the soil, etc. are included this tally of our 'cousins' may reach 100 million. The commonality in the lives of all these creatures is their daily retrieval and use of energy. Nature abhors a gradient. Life requires one. Energy originating from the sun cascades through natural systems allowing life to flourish, reproduce and form ecosystems. Though other criteria play a role – like habitat, climate and luck - energy is the primary currency of every one of the ~100 million species which comprise the life systems of the natural world on Earth. Those organisms able to access a high caloric return relative to their energy investment have advantages in survival, mating, metabolic maintenance, and raising healthy offspring. Energy is the currency of life.

We are Reality blind.

Surviving in the physical world isn't easy. Something like 99.9% of all species ever to have lived are now either extinct or have morphed into what lives today. There's a furious, never-ending competition for energy, nutrients and habitat space, in which there are winners and losers. This life and death struggle for ongoing existence is the crucible from which currently-extant species – including ourselves – emerged. In order to survive, we have been honed by evolution to function perfectly for the niche in which we evolved. This has meant erring in many very specific ways which made us fitter for the savannahs even as it made our perceptions less-true about reality. *(Evolution selects for fitness, not veridical perception).*

Our minds are well-evolved to be members of small hunter-gatherer tribes in a wilderness, yet we now attempt to run a planet, with many of our evolved tendencies being poorly suited to it (so far). Facts don't move us, feelings do. And feelings have a strong evolutionary origin. Consider a hound – if she smells a rabbit, what that smell does to her brain and behavior will have a more intense effect than other stimuli like food, sleep, shelter or even human commands. "Smelling and chasing small animals' is what the hound was selected for. In the same fashion, the crucible of the Pleistocene selected us for:

> *~intense deference to social pressures for approval, acceptance and status*
> *~intense in-group defense and support in parallel with out-group demonization*
> *~ a long list of cognitive traits that made us valuable tribemembers historically but which manifest as blind spots today, including: delusionality, time bias,*

optimism bias, and conformity bias. These combine to make our mental experience of reality greatly diverge greatly from physical reality ~vulnerability to having our mental systems hijacked by modern stimuli many times more potent than what we encountered in our past, crowding out the slower, longer term (and ultimately important) goals

The presence of these genetically pre-programmed tendencies – some weak – some strong, has major implications for addressing sustainability, resource depletion and environmental problems. Among them:

There exists a large and important disconnect between our virtual and physical worlds

Our brains construct personal virtual worlds, which is all we can ever experience, and what we rely upon to be successful in our day to day lives. These virtual worlds often have little correlation with the reality of the physical world. All the things that feel important to us exist in our virtual worlds, yet their very existence depends upon conditions and events in the physical world. These two worlds function under different rules, yet we blur the distinction, if aware at all

Our belief *that others believe* is the glue that holds the human superorganism together

What we rely on when anticipating the reactions of others *is not whether an organizing belief is true*, but whether others reliably believe it to be so. We'll trade a house for green pieces of paper, or the transfer of one's and zero's in a bank's computer, because we rely on others' beliefs about the green paper and digital numbers to be the same as ours. This sort of "*belief in belief*" has served our species well in helping it develop into a "superorganism" which is formidable and able to undertake tasks larger than individuals ever could on their own. All human institutions, such as the stock market, the corner store, international trade, and much else are networks of shared beliefs upon which we rely. The thing to realize is that the utility is not in the beliefs themselves – there's nothing special about green paper – but in the perceived authority of the belief itself. Human societies can get equivally high utility out of shared beliefs regardless whether the beliefs themselves correspond to the physical world or are nonsense.

Over time, this '*belief in belief*' has functioned to make larger human superorganisms (pursuing surplus) possible. And it may have been the edge which caused us to displace other human species in the relatively recent past. Yet with our species now in control of a planet's ecology, organizing around nonsense beliefs is having important physical ramifications.

Human happiness is not a function of physical wealth

With brains keyed to consider tribal resource distribution a matter of survival, we seek relative wealth, yet absolute wealth is what we actually need. In that sense, we're wired for greed and the pursuit of excess: The intensity of the feeling of want is greater than the intensity of satisfaction once we get it. And once we get something, we fear its loss more than we value getting more. We care more about our perceived wealth compared to the Joneses than whether Jones is happy or healthy (or sane). In short, our happiness is not very correlated with resource consumption and stuff, yet modern culture (and advertising, and Mom) tells us it is. It isn't the "stuff" that makes us happy, it's feeling like we got a "better deal" than the other tribemembers. This was strongly adaptive as we evolved in times of frequent scarcity. But now there's no evolved mental limit on "how much is enough" because there was never a reason for such a thing to evolve.

We solve physical world dilemmas first by using social sorting mechanisms. Etc.

In addition to measuring our 'worth' as human beings compared to "Jones" we also look to Jones to get cues on what the right course of action is. Because we are incredibly social ("pansocial") we make decisions about real world problems based on what our friends and high status persons are saying and doing. If our friends and the elite in our tribe make poor decisions about the physical world, we are extremely likely to as well. This effect is so strong we barely notice it - if others dismiss something, like smoke under a door, we dismiss it too. It's our evolved default, and it inhibits the spread of beliefs which are not pleasant while reinforcing those which are. Most humans function with no scientific thinking or reasoning at all using this default, even many who are highly educated. When we hear new information, our first reaction is to observe who else believes it, not how well it conforms to first principles.

Enlightenment via more information doesn't work

Facts don't move us, feelings do. Feelings come from old, deep brain modules which pre-date our species. If a fact concerns something which we did not evolve to consider salient, we don't generate strong feelings about it. A surprising number of auto fatalities are caused by insects crawling onto the driver: we have no instincts to fear speed, but do have instincts to shake off bugs, so a spider on your foot 'shouts louder' than the sight of an oncoming truck.

It "feels like" informing our other tribe members of new worrisome information should be enough to solve any problem, which is why our social movements strive for universal enlightenment (and why blogging and tweeting is so darn satisfying). However, it doesn't work. New information is sorted by an "interpreter" module in our minds depending on whether it conforms or conflicts with existing beliefs, and is accepted or rejected based on that classification. Receiving conforming information does the same thing as receiving conflicting information: it maintains and hardens existing opinions.

Human activism has largely failed because it is based on what 'feels right' and other unexamined assumptions

In addition to relying on the 'enlightenment model of social change'(above), we currently prioritize perceived fairness of process over the effectiveness (or even sanity!) of group decisions. We have narratives about how things happen in the world, and those narratives don't always correspond to the way things *do* happen in the world. Yet we primarily seek social recognition confirming that we're striving admirably, instead of focusing on actually achieving stable new system states quickly. Thus, so far, the "*social ecosystem"* of current human activism is mostly about tribe dynamics and founded on unexamined assumptions. There may be ways to significantly improve upon it. *(in fact, we have some to suggest)*

We are Delusional about Being Delusional

The default agenda of the human gene, ensconced deeply within every human brain, is now the enemy of complex life in the deep future, including human life. We can coexist with delusionality, even enjoy and celebrate it. But we can no longer afford to run a planet based on it. Quite simply, **homo sapiens**

isn't here yet. We are an amazingly competent species, which has forged bold new paths away from our humble beginnings. And, as we travel further away from our hunter-gatherer past, our biggest blind spot is that we have very little appreciation for our blind spots. We feel like our concept of the world is largely correct, admirable, seamless, and complete. We're evolved to feel that way, with a "rationalizing" module which retroactively stitches together information from thousands of other brain modules. This means that many things are effectively invisible to us. In Reality101 you've been introduced to just a few of these things. (*Do not doubt that there are many more still invisible to Nate & DJ: we keep finding more, and we're just two guys with stone-age brains thumbing a ride in the "sapiens" direction. Our collective blind spots may hide amazing truths and pathways we yet have no inkling of, and one of you may one day point them out to us, and others*).

Economic theory is False (*Well the important parts*):

Energy makes the world go round –

Energy is what ultimately allows and constrains any living system and it can only be substituted by other energy. Yet mainstream society (based on the Cobb-Douglas/Solow models in economic theory) believes capital and human labor completely explain our economic growth and productivity. They do not. $10 worth of gasoline is treated the same as $10 worth of donuts or underwear but can perform the work of a man working for a year. We thus conflate the dollar value of fossil energy, with the 'work' value. Our society confuses energy's cost of acquisition with its contribution to our current living arrangements. (This is a huge fallacy: for example, do we think oxygen is worth nothing to us because we don't pay to breathe it?) Fossil energy is the backbone of industrial civilization and will get progressively more expensive this century, with or without including environmental externalities. With ~99% of the physical labor done in the human economy currently done by inanimate technology, the majority of which powered by fossil carbon compounds, this fallacy has major implications.

Most of our modern technology is just a vector for using more energy–

We have created amazing gadgets and conveniences, but most of our technology is about inefficiently (energy-wise) replacing activities humans used to do manually at a cost of much higher primary energy inputs, as well as coming up with new wants, needs, and social signals. Some technology, like efficiency improvements at power plants or new solar cells, do enable us to stretch our consumption a bit further, though that tends to be incremental and decreasing.

There are qualitatively different sorts of technology. Those which result in better ways of doing simple things – such as sterilizing surgical implements or making bicycle wheels – pay great dividends on a continuing basis. However, those which pile complex sequences of action on top of other complex sequences of action tend to be very specialized, fragile, and energy intensive. Complexity costs. The low-hanging fruit of simple tech has largely been plucked, leaving us creating ever more byzantine "Rube Goldberg" machines upon which we depend for "growth". Most modern organizations see technology as the answer to all our problems, but the way technology presently functions is primarily as a spigot-widener for a larger energy footprint and higher neural ratchet of short term dopamine, etc.

The upshot is that (most) technology increases, not decreases the total use of energy by society, and this has held true for hundreds of years and will remain true as long as 'more GDP' is our cultural aspiration. So it's presently unlikely that technology will be the answer to declining energy availability, though it may expand our total energy use for a while. These days when you see the word "technology", it generally means "another way to use energy". As energy scale itself diminishes, what we choose technology to accomplish will be of paramount importance

Price, cost and value are different –

There is an important difference between the 'price' of energy (to consumers) and the 'cost' of energy (to extractors). The true cost of energy is the cost in natural resource –not dollar - terms. A new oil well in Bakken requires 100 train loads of sand and 1200 truckloads of water. To say it costs $75 to extract also misses this wider boundary story of reality. And 'higher prices' do not automatically create new supplies of energy. The important thing to realize about "energy cost" is that it isn't abstract like dollar cost, it embodies physical inputs and absolute limits. Any energy sources which cost more energy than they produce might as well not exist. Any energy sources with small surplus vs their cost will not provide the economic benefits we currently assume will continue. Given what a barrel of oil can accomplish, it's 'value' is orders of magnitude greater than it's price (when used in moderation).

Money and financial capital are just markers for real capital –

Financial capital is just a marker for real capital – comprised of built, social, human and natural capital. Our economic rules treat all the benefits from nature as 'free' inputs and there is no offsetting cost for declines in natural capital. Thus, a nation which cuts down its forests and pollutes its water generally has a better GDP than one which doesn't, despite being increasingly

impoverished in real terms. Energy cost is our real 'cost of capital'. Money is just a marker, and an increasingly imperfect one.

Uneconomic growth –

occurs when the increase in the 'bads' outweighs the increase in the 'goods', i.e. where the marginal costs are larger than the marginal gains. When we include 'the bads' our net decrease in metrics of (overall) quality of life have been occurring for a long time. But since many of the 'negatives' (like oil spills, rape counseling, prison guards, depression medication, animal shelters, deforestation, etc) create 'output', the societal goal of increasing GDP continues to be attained (and approved of).

The price of non-renewable natural resources is determined only 'at the margin.'

This gives completely false social signals about our future. Due to monetary and political distortions the price of oil can diverge greatly from its cost and value. For what it can accomplish, pricing this magic at the clearing bid on the last unit of supply/demand --far below its extraction cost or value to society - is a ginormous misallocation. But it is efficient, and clears the market, so it 'makes sense' to the ~~shaman~~ economic analyst, and the superorganism powers on. The single biggest flaw in economic theory is that we only pay for the cost of extraction for our most valuable inputs to our economy – not the cost of creation or pollution.

Banks do not function as intermediaries, but create money from thin air.

The government doesn't create most of our money. Over 95% of our money is created by commercial banks when they make a loan – this money pops into existence without a similar amount being deducted from anywhere else in the system, and with no direct accounting link to energy or natural resources. Yet the interest on the loan is *not* created, requiring continued economic growth to service monetary claims. (If this all sounds too messed-up to be true, we agree. A lot of reality exists in our blind spots, but this one is now easily verifiable).

Debt is non-neutral to economies.

Economists assume that GDP is the same whether we used debt or cash to attain it. Debt is thus assumed to just be an 'intertemporal consumption preference transfer' between 2 parties. In reality it is just an 'intertemporal consumption transfer'. Debt is a bit like a stimulant drug to an economy: it causes power to flow towards the now by pulling it forward from the future. Yet it's ultimately based on the flawed premise of future periods having more energy and resources to keep the promises which have been made. This all

suggests that dislocations from energy blindness will first manifest in the financial markets.

Microeconomics does not reference or integrate our evolved nature –
The theories of micro-economics currently being used to make our most important societal decisions embody distorted models of human behavior, decision-making, and ignore the biology of our evolved needs and wants. We are other-regarding (not purely selfish and individually focused), we are unequivocally NOT rational actors, and we conflate wants with needs. "Utility," in a world replete with fossil magic, basically means 'whatever.'

The economy is a fully owned subsidiary of the environment.
Conventional economists treat the environment as outside of our economy. GDP counts both the 'goods' and the 'bads'. Monetary gains from natural resource extraction are privatized but damage to our natural commons are borne by the public, future generations, and other species. Our real stock market is our air, our soils, our forests, our oceans, and the biodiversity we share the planet with. This stock market has been going down for over a millennium and has been in slo-mo crash mode since you've been alive. Two stock markets – one an index of consensus belief stemming from the agenda of the gene, and one comprised of physical reality. *Which one should we focus on?*

Economic "laws" were created during a no-analog non-repeatable period in human history as ad hoc rules of thumb and are mostly based on false assumptions.
Stable non-growing economies had been the norm for thousands of years in human history. Tapping the stored labor in fossil sunlight changed all that. A 7-fold increase in population in two centuries accompanied a 7-fold increase in per capita consumption. Yet we have been told by economists this is due to cleverness and hard work (and because we are Americans). *The 'rules' and 'laws' created during this era assume this unique period is permanent.* But correlation does not equal causation. The fossil carbon pulse will be a blink on the human timeline, comprising at best a few hundred years, and we are now at the inflection point at which net energy has stopped increasing every year. So the "special circumstances" which made those economic rules useful guides will soon and rapidly cease to exist.

There is no plan B –
The "invisible hand" that is created by millions (now billions) of individuals pursuing self-interest continues forward until it cannot. *Nowhere in modern***

economic theory is there a blueprint for what to do after growth stops. The game is the plan.
**Adam Smith did anticipate growth ending, but this is not often discussed.

The above list critiquing economic assumptions about our future is not exhaustive but gives some insight that the core beliefs underpinning modern society have some large holes. Someday, a new economics more tethered to our evolved behavioral drivers and to our natural resource (and sink) balance sheet might emerge. In the meantime, the above disconnects lead to some implications:

The fossil slaves supporting industrial civilization will either quit or be fired this century – Fossil carbon-magic was a one-time endowment on human time scales. Most of our carbon slaves will be leaving us this century. If we do manage to wake the remaining ones they are only strong enough to power a less complex society and will likely in the process create an extremely desolate natural world. The choice is timing. *Some generation will have to invent life without such an army of helpers*, and to "make do" with whatever condition the natural world is in by then.

Liquid fuels (i.e. oil) are the lifeblood of modern civilization. Despite oil currently being at $50 a barrel to the public, oil extraction costs are up ~17% annualized from 2002-2012 (down some 20% since 2013). The IEA recently showed that if no new investment occurred, global oil production would drop to less than 20% of its current levels by 2040. The availability and price of **oil** will call the tune on most costs and constraints in society in coming decades. Only ~20% of post-conversion energy in USA is electricity, so most renewable energy does not address the specialness of liquid fuels and near term peak in global oil production. This is due to the qualitative

difference between concentrated, indefinitely storable liquid fuel vs. all other energy sources. Think "transportation" and all it implies. Pricing oil in dollars means that it is now beginning to bounce between "too cheap to be worth extracting" and "too expensive to run our current economy."

Continued Economic Growth and Mitigating climate change are incompatible – Human societies are currently functioning as a gigantic heat engine oxidizing fossil carbon and hydrocarbons. All "growth" makes climate change (and associated crises) worse – even growth using 'renewable' energy, whose own growth and energy footprint have not reduced the burning of fossil materials in the global market system. It's a bit like an obese person eating more so as to have enough energy enough to begin a diet. Despite the talk on 'decoupling' we can't grow our way to a smaller energy footprint, that's an offshoot fallacy of current economic assumptions. We can 'solve' climate change via a smaller economy

Equality/Fairness/Eliminating Poverty and Mitigating climate change are incompatible goals - It's currently seen as a social necessity to frame the answers to all questions in terms of greater fairness and representation, but in the context of fossil-fueled overshoot this many ultimately be suicidal. Eliminating poverty, achieving happiness, and returning to a healthy world are all best approached via a deep time ethic. The sort of spite-oriented "capuchin fairness" which resents the perceived distribution to others is best left with the other excess baggage of evolution. (**unless all people alive today, the NPV of all future generations, and other sentient large life are part of the formula for equality – then equality and fairness could be compatible with climate mitigation. Or, if most of our exosomatic surplus went away)

This knowledge –any knowledge – about our situation is important but not sufficient. Too many activists and organizations rely on 'information deficit' theories of social change. We need creative pissed-offedness and intelligent raging against the runaway planet-eating amoeba. And creative, inclusive and kind plans for when the amoeba gets smaller. We might have to stop doing what "feels like it should work" and do the things which actually DO work.

The Monkey Trap

About 200 years ago we humans stumbled upon a monkey trap which had been set by chance events long before mammals evolved. This enormous reserve of fossil sunlight that would become the anthropic "carbon pulse" was both a treasure and a curse. Our energy surplus – gross energy less its energy costs - has been both large and cheap for most of that 200 years, so much so that we learned to ignore it and instead credit our own cleverness in using it. We designed our economies around the expectation of more net energy to burn each year. Organizing our infrastructure, our institutions and our expectations around this assumption was a mistake. Most humans don't yet realize that – even award-winning economists and hedge fund managers. And especially politicians and civic leaders.

We call it the carbon pulse because it's ephemeral on the scale of human existence, a few centuries of crazy growth and its aftermath. We humans believed it could go on forever, because we're really good at believing happy things. However, the real physical world runs on rules, and those rules sharply constrain what we can do. Thus, our actions have consequences. We've used our "free energy" to have a lot of short term fun with little thought to the future, because we assumed the future could take care of itself. This will now have repercussions, like it or not.

Using helium to fill party balloons, speak silly high voices and venting the extra to the air, sets in motion the helium's escape from earth's atmosphere. Humans in the future won't have an easy way to get helium if they ever need some for some yet-discovered use, because it is created one molecule at a time by slow radioactive decay. By deciding it has no central usefulness and venting it to the air, we're thus constraining the options of future humans, (though we obviously don't think about it in this way). Now scale this example past helium to every concentration of resources on the planet, every rare element and non-renewable resource currently used in human commerce. We have largely used up everything which is easy to get to, under an assumption that increasing prices from human "demand" will provide us the ability to permanently get at them. Oops. We've depleted our topsoil and allowed it to wash away because with cheap energy and fertilizers we didn't need topsoil, just an inert medium to hold the plants upright for fertilizer and pesticides. Oops. This is true, one way or another, for about everything we need to keep societies going. The discovery that our big mistaken

assumption - that $1 worth energy is the same as $1 worth of cupcakes or crayons - will come at a hell of a price. This invisibility of the fossil slaves who have made most in the developed world into pampered royalty – has a million ramifications for the economies and social arrangements of the future.

As liquid fuels deplete, transportation and shipping will become more expensive and problematic, meaning that the world will effectively become a much larger place again other than for the uber-rich. It will no longer be nearly free to ship things halfway around the world, and "globalization" will slowly (or not so slowly) recede. Many businesses will increasingly be nonviable, from airlines to specialty stores. The human enterprise in general will need to contract and simplify. More local food and resources. Higher prices, scarcity, and sometimes unavailability.

We'll initially experience these energy-driven economic changes as fiscal chaos and crisis; as recessions, depressions, poverty, financial crashes, and whatever new words are invented for unprecedented economic dysfunction in coming decades. These will for the most part not be blamed on the root cause – increasing remoteness of energy and raw materials – which will probably remain largely invisible to most humans - but instead on human scapegoats causing conflicts, social upheaval, violence, and illogical responses. As nations and a species we will find that both large and long term projects are more difficult and energy-remote, their horizons receding from our grasp.

And while on the surface we will try to replace our fossil slaves with mechanized 'renewable' co-workers, there's really no such thing as renewable energy. There are, instead, mechanisms which can divert power from solar flows or radioactive decay. These mechanisms are invariably made using fossil energy. They are not renewed, they are replaced at a cost in energy, materials, and complexity which is not necessarily repeatable indefinitely. They currently function as "extenders" of fossil energy. Things won't be the same without the energy slaves. No air conditioners. No airliners. Just air. On the largest scale, it'll mean that the carbon-pulse expanded terrestrial biomass – principally of humans and their livestock – will have to diminish toward levels sustainable on a changed earth without fossil magic, which will initially mean less meat to eat, and eventually mean a drawdown in human population numbers. There are many traditional ways a population can diminish, and relatively few that are pleasant. Managing this global crash-landing in a sane and humane way will be one of the big challenges for newly-awakened homo sapiens. We could be talking about a population decline from 10 billion to 8 billion if humans manage to dramatically lower our average consumption. But sustainable levels over time are likely closer to 1-1.5 billion, with wide error bands, which would mean that a lot of history could happen in the coming century +/-. The carbon-pulse population overshoot will be humanity's largest crisis ever, because after peaking in coming decades the population

will never be this high again. Ever. It's one of the biggest bottlenecks of all.

The Real Stock Market

This carbon pulse has expanded the human niche, but has also had huge effects on earth's ecology. The terrestrial vertebrate biomass has been grossly inflated by various ways of transmuting coal, oil, and gas into food. At the same time, we have expended huge amounts of energy to capture and convert terrestrial and oceanic creatures into desirable foodstuffs. Thus, Man and His Livestock have largely displaced large vertebrates in wild nature. On land these wild animals – as a percentage of the total - are now only a rounding error. The total vertebrate biomass (of man plus nature) is grossly unsustainable, and we will gradually be returning to trophic pyramids based on solar flows.

Our industrial sector has introduced new pollutants such as heavy metals, bioaccumulating chlorine products, plastics, antibiotics, and hundreds of thousands of other things into food chains. The heavy breathing of our fossil slaves is changing the atmosphere and oceans to conditions which have never existed during human history. CO2 levels are at 410 and rising, tripping positive feedbacks like methane from melting tundra, decreased albedo from lost ice, and forests burning rather than sequestering carbon, each positive feedback taking us farther from the possibility of slowing or reversing the heating. It appears the oceans are acidifying at least ten times faster than ever before in the history of our planet, dissolving shells and raising the imminent prospect of food web collapses as coral and other organisms dissolve away for hundreds of thousands of years, a cascade of events which could be "locked in" midway through this century. The oceans are warming and stratifying, holding less oxygen, which favors jellies, bacteria and slimes over vertebrates like fish, seals, and whales. 200 years ago, if the most devious and sociopathic humans had put their minds together to craft a way of deliberately destroying Earth life and a livable human future, they could not have done better than the Carbon Pulse, the merging of a fire-using ape species with millions of years of accessible stored flammability.

The "mischief" which has been enabled by the carbon pulse has led to what is on course to become the 6th mass extinction event in the last half-billion years – and this even before the climate heats and the oceans acidify and stagnate. We pay high prices for tiger penis soup, whale burger, dolphin bacon and endangered-tuna sushi. We burn rainforests and wipe out their denizens for trendy products, and create enough fish net to circle the globe many times, dredging away the coral in unseen habitats. Out of sight, out of conscience.

We face these prospects with minds still in thrall of nonsense beliefs, hyper-stimulation and tribal social status, a bit like what might happen if one gave nuclear launch controls to hamsters and smeared peanut butter on the red buttons: they would be unlikely to associate the taste of the peanuts with the bright flashes on the horizon. Similarly, we buy crab legs at Costco without much thought about how they got there.

Tantalizingly though, it is not quite impossible for us to reverse course and save a world, and not incidentally save a deep human future of trillions of childhoods, but that possibility is tipping precariously on a high windowsill in a strong wind. Pretty much all the humans you meet are missing large sections of the puzzle, and even those who discuss such things look no further ahead than a single lifetime, even when considering effects which play out over thousands of years once committed.

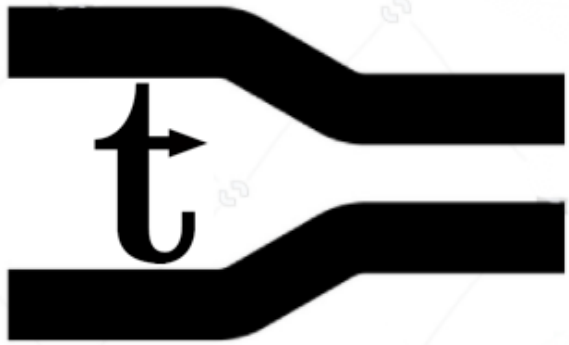
And poignantly, it's not like we get to choose between energy services and the natural world. The excess net energy is going away in either case, and our descendants (and maybe us) will have to live with the world that remains. If we don't find it within ourselves to stop burning voluntarily though, there won't be much around to live with and amongst, as the other large complex species which have defined us and shared our ancestral trajectory, will be gone.

We still have hugely more energy than our bodies need, but a tightening of individual energy budgets will "feel like" we are being impoverished because we're attuned to relative rather than absolute wealth. Rather than focus on the fact that what we have is still amazing, we tend to fixate on the perceived wealth we will lose, while our actual wealth – a living world –implodes.

The way this all plays out will be substantially determined during the productive years of your lifetime.

You do not live in ordinary times.

Bottleneck?



Traditionally, a "bottleneck" is the term which applies when a species has almost gone extinct, but managed somehow to survive with enough individuals to rebound, thereby successfully navigating 'the bottleneck'. Many species now extant, from cheetahs to humans, have faced such precarious bottlenecks in their past. They're called "bottlenecks" due to the shape of the population curve, which traces the shape of a 'bottleneck' as numbers approach zero. An open bottleneck means survival, a closed one means extinction.

We're surrounded by an accelerating mass extinction now, of our making. Species are going extinct at tens of thousands of times the normal background level. Many more are in their own narrowing bottlenecks. The other apes, the primates, the whales, all terrestrial megafauna. The species which are specialized for rainforests. The ones which have nowhere to go as their habitat is lost. It's not an overstatement to say that all large complex life on earth is approaching bottlenecks, and our turn will inexorably come as the carbon pulse peters out. But that's only obvious to those who learn to see reality as it exists.

Yet your authors' use of the term is broader than that, for we use it not only to refer to populations of a species, but for entire ecosystems. And we also see many bottlenecks related to the human experience. The net energy bottleneck is one. The amount of food which will be available in the future is another. There will also be bottlenecks in the level complexity our societies can maintain, the degree of complexity of our technology, the scale of projects we can undertake, and of many other qualities of human existence. The human "bottleneck" thus refers to the imminent narrowing of human options, resources, and population forced by the hard limits of natural physical law.

Thinking about these bottlenecks presents us with a radically different framing of "what we should do" with the time and energy we have. The point we have to make is that while nobody can know exactly what will happen in the future, **we can know a lot about what won't happen.** The future will have a 4-dimensional shape – a time dimension – just as there is a 4D shape of the past existence of the cheetah, which passed through a tiny bottleneck and thrived again (and faces another one now). **The shape of human existence – the area under that curve – will determine whether the human story is ending, or, alternatively, is barely starting.** Pretty much everything we think we know is incomplete or wrong and needs to be reconsidered in

light of the brevity of the carbon pulse, and the reality of deep time. We need to think hard about what our feelings trick us to do, and think deeply about consuming, reproducing, and why we do what we do. *Because the gene agenda of humanity has become the mortal enemy of a decent human future.*

It'll be nothing less than the fight of our intellect versus our feelings, played out in billions of minds for the highest possible stakes over a very short timespan. Your authors will dedicate their lives to helping our species transcend the gene agenda and hold open the bottleneck to get our species and others past the temporary crisis and into the deep future. There's a good chance we'll need help**.**

Thinking About The Future

As we begin to think about becoming *homo sapiens*, we find ourselves in many predicaments which were not foreseen by the brains of our predecessors. There's no reason they would have been – we're evolved to be efficient and formidable hunters existing in small tribes, and science and the wide-boundary systems integration it allows is a product of iterations and energy surplus only recently available. Yet it's clear now that we've gotten ourselves into an existential pickle. We can either ignore it for one more generation and seal the deal, or we can engage with a bigger set of crises than conscious mind has ever had to deal with. Heck of a choice, huh.

Yet it isn't hopeless. In addition to the obvious fact that it hasn't happened yet and is not yet inevitable, there's a lot more stuff hiding there in our blind spots, and some of it may be cause for hope.

One thing, for instance, is that the biophysical nature of depletion and energy cost is such that our use of fossil energy will decrease whether we plan it or not. This is something the IPCC, and economists, don't understand. It will not be sufficient to solve the problems, but it's something. The only thing that has caused downturns in the rate of fossil energy use is recessions and depressions, and those will be coming with a vengeance. That'll (probably) be good news for other species, and uncomfortable news for those of us who like the smooth way our societies now run.

But there are other misunderstandings that will hinder us. **Our culture assumes that large and complex problems will be easier to solve in the future.** The opposite is true. They will become harder, and this needs to be planned around.

Our "experts" these days are mostly specialists and reductionists. Reductionism is a powerful analytical tool, but it has taken over our cultural definition of expertise, leading to idiot-savant style decision-making**.** The real world exists as a synthesis, and

our mental models of that world must also become so if they're to have real predictive value. We need to re-think everything, because currently we're working with a lot of wrong answers, piled on top of wrong assumptions.

It's possible to use "filtered thinking" to sidestep the long list of human biases, fallacies, illusions, heuristics and other evolved predilections which causes us to follow insane narratives. There are "first principles" which are known which lead to clear deductions about what can and can't happen. They do not tell us outcomes, but constrain those outcomes in knowable ways. This is science.

Denial and Nihilism are two sides of the same coin, functionally equivalent. They are attractors for our evolved heuristics to resolve dissonance. We must walk a path between them. The future is probabilistic. The relative odds of future outcomes change every second, based on events.

There's no wise overmind, cabal, or secret society running things. Aggregate human actions currently function like an amoeba, with simple tropisms. Human society currently functions as a giant heat engine. We assume that to change its course we need a consensus agreement, but that's mathematically impossible working with billions of stone-age brains; and as crisis becomes evident many will default to their primate programming.

Yet we have not yet truly tried the "sapiens" route. We haven't yet done anything which should be expected to work. Individuals and small groups can sometimes accomplish what larger groups can't, steering the amoeba in wholly new directions.

There is not yet a science of effective activism, so we do random things that "feel" useful, even though many of them are self-defeating. The scale of a problem is less important than the structure of that problem. We need to invent and perfect the science of steering large-scale events, in a humane and altruistic yet pragmatic way. (Your authors think they have some ideas along these lines). The first sapiens will need to coexist and care for those who adhere to the gene agenda, while doing whatever is necessary to navigate the bottleneck.

A reasonable philosophical basis for the new species – homo sapiens – may be derived from basic principles of life and awareness in the universe. **We need to choose what is sacred** and live with a commitment to it**.**

No answers - yet.

From a deep time perspective, what humanity does (or doesn't do) in the next few decades will impact the next hundred thousand years – and beyond. We're figuring

out a lot of things not to do, but don't yet know exactly what *to* do. But we now have a reasonable sense of what the full picture looks like. Acknowledging all pieces of the elephant is more important than having immediate answers. Indeed, most people focusing on just one aspect of our situation – say poverty, or climate change - are probably several steps behind reality. (*Side note – it is often reasonable strategy to focus on a subset of the system, but if this isn't done from a synthesis overview, the strategy may be flawed. For instance, most social activists these days believe in the same flawed economic theories and cultural myths that those they oppose do*.) We admit we don't yet have answers to the coming bottlenecks, but the more people who sign up for 'we care about the future of humans and complex life but don't yet know what to do' the larger sapient demographic there will be. Once the commitment is made, the answers become a big priority, and motivated humans have done and will do amazing things. Motivated *homo sapiens* may do even more.

Before any debate - let alone decision - can be made on 'what to do' there first needs to be a discussion on 'what is the goal'? As a carryover from our agricultural past, where the goal was 'food surplus', our modern hominid goal is essentially quarterly earnings and increasing GDP. All societal decisions are made with this as the centerpiece of what our human culture aspires to. Even art, and medicine and education – pursuits that should be a priority in any sane culture, have been parsed into dollar goals. And our current institutional plans are to maintain all aspects of society pretty much the way they are, but do so with renewable energy instead of fossil fuels and with more wealth equality. It sure sounds good.

We (Nate and DJ) aspire to humans creating something like sequential 100 year plans with humans and most remaining large complex life coexisting on a world not terribly diminished from the one we now have. To get there we have to pass through (a series of) bottlenecks. Advocating and steering things of value through those bottlenecks will need champions and creativity. We don't yet know how people will champion such futures, but it will first entail understanding the full shape of Reality 101. Realizing that we don't have the answers puts us many steps ahead of those who are embracing incorrect answers that don't correspond to physical reality or the reality of human behavior.

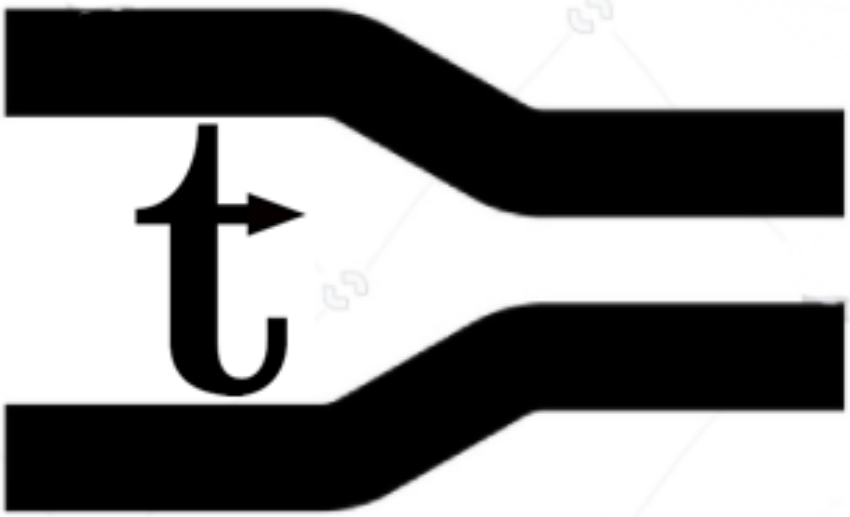
We are in a no-analog event in planetary history.

It may seem that some of these descriptions and prescriptions are a bit glum. We're aware that pretty much the entirety of the balance of your educational experience, from kindergarten through college, is shot through with optimism bias, consensus blind spots, pervasive presentation of unexamined cultural consensus beliefs, and a constant barrage of news and conversation which hails primarily from the deep feelings of the gene agenda. Therefore, we've considered it a responsibility of this

course to give an honest look, filtered of bias, and have been fairly ruthless in trying to attain that.

Bright, pro-social, educated people alive today and engaged with the future are the first generation of our species – of any species on this planet – that knows: where we came from, how we got here, what we need, what we're consuming, how we're impacting the planet, and what paths are possible and desirable. This is the first and necessary step towards true sapience. Once we get beyond the uncomfortable fact that some human misery is baked into the cake in the coming 50-100 years, we can have experts of all kinds working on 'consilience' –the jumping together of knowledge – to create a political/spiritual/social movement that results in a livable future. There is not one issue but many. But if humans want to transition from 'clever' to 'wise' we need to look beyond the politically correct consensus trance, beyond what seems ostensibly fair and equitable, beyond what brings us immediate status and respect, and stand for inherent good. Things look dire, but the world is not yet fully broken.

Predictable Bottlenecks in a Probabilistic Future



As of this writing, there are 2,666 emoji's to facilitate cell phone texting conversations, but there's no generally agreed simple symbol to represent "the future" in the entirety of either our written language or our mathematical language, despite the fact that our collective destiny lies there. Since a google search didn't' come up with anything to represent our collective future, we offer the "t" (standard physics for time) with a forward arrow on the crossbar, to signifying time forward.

Something that is at least as important as those 2,000+ emojis, we'd like to think.

By this point it should be clear from the course is that we humans have an increasingly problematic relationship with *the future*, primarily because we never evolved to need one. Our gene-programmed agenda, the primary determinant of how we "feel" about things, is still calibrated on the tacit assumption that we exist within hunter-gatherer bands facing scarcity on African savannahs. That situation didn't require a lot of abstract thought about futures farther away than a week, or maybe next year at the outside. Yet like all animals in a highly-competitive ecosystem, our grancestors on the savannah had their perceptions about "what will happen, what won't happen, what might happen" in those timespans reasonably well-calibrated

against physical reality. Nature, red in tooth and claw, has a low tolerance for functional delusion relating to the real world. These days, we exist largely detached from any immediate consequences associated with actions more subtle than stepping in front of a train or off a cliff: our eusocial society protects us from most missteps, and in turn has allowed us to believe a lot of stuff that is wildly out of relation to the physical world and its possible future states.

A Probabilistic view of the Future

One thing we can know about the future is that we can never know exactly what will happen in it. We know that it will exist as a series of single discrete outcomes, but the nature of forward propagation of events in physical and biological systems has elements inherently unpredictable in advance. Furthermore, the predictability decreases exponentially as we look farther ahead in time, even in nonliving systems, as uncertainties compound.

This nature of complex exponentially-expanding interrelated systems on long timescales triggers a powerful urge in the human mind to stop thinking about them and instead go do something else, preferably something pure "gene agenda" (*insert whatever you plan to do after reading this essay here*). The contemporaries of our ancestors who were thinking about distant future bottlenecks – if any - likely became leopard casualties while their tribemembers were eating warthog marrow, telling entertaining stories, and sneaking away to the bushes. It was almost always more useful to use heuristic mental shortcuts, most of them boiling down to "the future will look a lot like today, only maybe a bit shinier". This has left us with an evolved default pathway of thinking about the future in a manner grossly disconnected from the real physical specifics and implications of the current situation. The actual correctness of a theory about the future has, for almost all of human history, been far less important to survival than has social conformity of such an organizing idea by tribe members. *A tribe favors something inspiring, not too complex-seeming, easy to communicate, and generally positi*ve.

How does one convey anything useful about our future that meets these criteria? Enter humanity's greatest double-edged magical sword: language. We primarily think and communicate in words, which requires us to instantly build mental pictures out of words we hear from others. A phrase like "the thunder turtle is big as a mountain and made of shimmering purple glass. And she rides rainbows and eats nonbelievers when they let their guard down" creates a vivid, real-seeming picture in a human mind. This type of thinking worked spectacularly well for small bands of humans in a world with bountiful resources. The sacrifice of an accurate, veridical (corresponding with reality) organizing myth was small price compared to the benefit of social cohesion which

belief in it provided. Today our (and others') future is held hostage by purely verbal logic; grammatically-correct sentences which resolve our dissonance and anxiety but may be physically absurd (instead of turtles it's rocket travel from city to city, etc).

A common "verbal logic" description of the future you've certainly heard is that "anything can happen". Such a prevalent assertion makes the future seem essentially random, and thus easy to disregard by our dissonance-quashing evolved mind routines. Clearly, though, this is dead wrong. Because anything *can't* happen. *Most* stuff we can imagine can't happen, and even more stuff certainly *won't* happen. From unpacking this we can derive much more predictive value than from our generally-relied-upon narratives.

Even our own brains function by following the rules of deterministic physical reality, a bit like a really complicated tangle of electroneurochemical mini-avalanches. Yet like other systems infused with chaotic process, we can't predict exactly what WE will think in the future either. The best we can do with our brains is to construct what we're calling a "probabilistic view" of the future which we adjust over time. We have the significant advantage of existing at the time of the greatest amassment of scientific knowledge and objective truth ever reached by our species. From very near the peak of energy available to human society we can look farther backwards, and extrapolate more correctly forwards. Even if we can't *exactly* know the future in advance, there are lots of aspects we *can* know about it fairly precisely. We are able to "bound" the scope of imagined outcomes by applying lenses of thermodynamic possibility, aggregate probability, and some common sense. With these bounds we are then able to effectively reduce the future from something vast, monolithic, and incomprehensible to a range of possibilities that we can be fairly sure of. And all without having to resort to flying turtles or their narrative equivalent.

Can't and Won't Happen: Absolute, Chaotic, and Random aspects of Reality

Knowing what can't and won't happen in the future really narrows down the possibilities of what can, and that turns out to be a big deal. This is based on the properties of physical reality: some stuff is absolutely precluded, and other stuff is so unlikely as to be effectively impossible. These are the "can't happen" and "won't happen" respectively. That may seem like a trivial formulation, but most of what our species currently believes about the future is significantly at odds with both of those.

For instance, in the images above, there are some wooden shapes and sizes you could carve out of that starting block of wood, and some you couldn't. That's obvious enough from the picture, but to the extent we have any societal plans for the future, they – in large part – amount to believing that we will carve a full-sized car out of a small block of wood, because instead of pictures *we think in words*.

Can't Happen: If a proposition about the future runs afoul of a basic law of the universe, like the laws of physics, chemistry, or thermodynamics, *it can't happen*. For instance, if you contributed to the crowd-funding campaign for a small battery-powered underwater breathing system, you are a) no closer to breathing underwater in the future and b) have also blown your money. Such basic "rules of reality" may be thought of as "absolute" limits to reality, and thus to the future.

Another category of "can't happens" is based on history – those frozen sequential accidents which underlie all that we experience - because the things which are possible in a given system today are significantly contingent upon what has happened

previously. By the same token, specific aspects of the future are contingent on which things do or don't happen now. If we blow off an atmospheric fusion bomb, then the background radiation will inevitably be higher in the future. If we accidentally kill off a species of tree snail, the future won't have any of them. If we burn all the accessible oil we can find, then future humans won't have much. And so forth. This is quite basic – a corollary of the "can't have your cake and eat it too" principle – yet is often ignored. It can generally be referred to as *path dependence*.

Won't Happen: If a proposition is ridiculously unlikely to the point of preposterousness, it needs to be treated as functionally impossible. Yes, essentially impossible things happen all the time – such as each of us being born – but any *particular* essentially impossible thing which hasn't yet happened should be treated as *actually* impossible in terms of worrying about or planning around it. This part of reality stems from the existence of nonlinear, chaotic, and random aspects of the systems we're enmeshed within. *(A meteorite could drill through my roof and kill me before I finish writing this sentence, but ..... it didn't.)*

We have previously used the example of all of the oxygen molecules around you happening to move to your ceiling so you suffocate; physically possible but probabilistically impossible on a scale shorter than quadrillions of years. Or, using another example previously mentioned, there is nothing physically precluding someone building a 500-foot-tall cheese statue of a grizzly bear in Pittsburgh within 20 years. There will presumably be enough cheese in the world; with enough money one could erect scaffolding, affect elections to get the permits, and so on. Yet it is entirely reasonable to assume that in 20 years *there will be no 500' cheese grizzly in Pittsburgh*.

That is, there are a bunch of propositions not impossible based on the laws of reality, but which are effectively impossible based on considerations of *aggregate probability*. In the case of the giant cheese grizzly, this would amount to a whole bunch of events having to fall just the right way for the cheese grizzly to come into existence, each with their own individual relative probability of happening. Just about any complex bit of human endeavor requires a number of complex things to happen in a certain sequence. In the case of the cheese grizzly, you could come up with your own list of what those might be: zoning, permitting, structural engineering, design approval, public backlash, political opposition, cheese acquisition, cheese storage and fabrication, insect repelling, weather protection, liability, decommissioning, etc. Let's say conservatively that building a 500-foot cheese statue would require 100 necessary steps. The aggregate probability of the project being finished would be each of those fractional probabilities multiplied by all the others, so unless all of the steps were

pretty much a slam-dunk, the ultimate project goal would quickly recede toward impossibility.

A Probabilistic framing for the Future

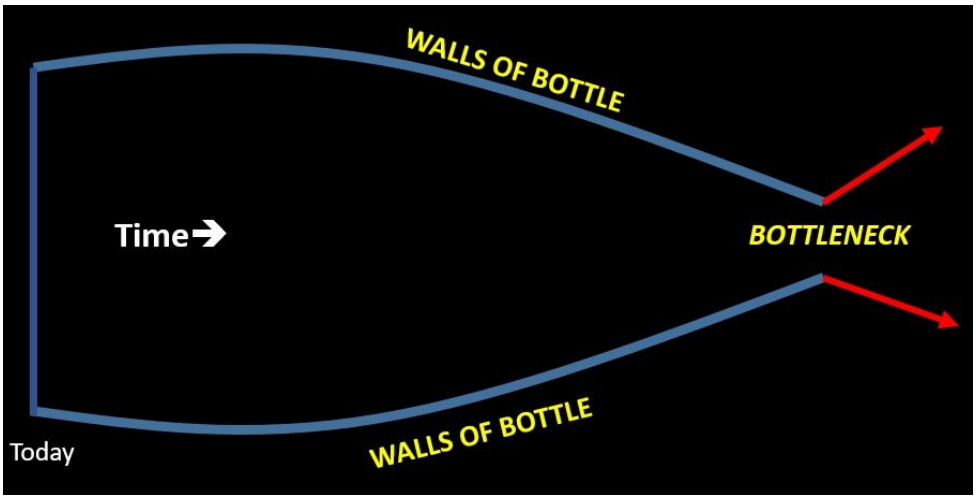
One classic example of an intractable unpredictable chaotic system is the weather. When your authors were kids, weather reports would make absolute predictions on what the weather would be in the coming day or week, at the cost of being wrong a lot of the time. That is, they'd say "thunderstorms tomorrow" and might be correct 60% of the time. These days, they have generally switched to a probabilistic forecast, such as "there will be a 60% chance of rain with thunderstorms", which actually conveys much more information than the prior absolute predictions: we know the predicted likelihood of a given outcome, which is a more nuanced prediction.

It would be great if we used exactly this sort of methodology for referring to all aspects of the future, because it's the most useful way to conceive of it. Just like weather, human-connected systems have significant elements of chaos and nonlinearity, which makes the whole human enterprise on earth effectively chaotic. That means that the most useful and correct way to think about the future is probabilistically, as an array of possibilities with various estimated likelihoods of happening.

The usefulness of partial future knowledge

In many cases knowing the general shape of what's likely to happen is much more useful than knowing the specific details. Consider a parked SUV in a Dallas parking lot at noon in summer, inside which someone has locked a pet poodle. There are both linear aspects and chaotic aspects to this situation: the position of the poodle inside the SUV is chaotic because the poodle's brain is a chaotic system. So, at any given future time, there is no way of predicting its position, other than it is "somewhere inside the SUV". On the other hand, in the simple situation described, the poodle's position isn't relevant for most classes of useful prediction, since the laws of physics will quickly heat the car past the point where the poodle remains chaotic & breathing. So even without the poodle's position being known, some very useful and prescriptive predictions can be made solely on the basis of predictable effects. Frantically trying to model the precise poodle behavior in a 3D rendering of the car interior on a supercomputer would be much less helpful than finding and yelling at the driver to crack a window, or if necessary, breaking the window yourself. Even without knowing the 'exact' future, we can know enough about it to be useful. *(this example is also reasonably analogous to the debate on climate versus weather, with those who disregard the science of greenhouse heating essentially focusing on poodle behavior).*

The Walls of the Bottle



Since humans find it easier to think about things when they can imagine a picture, we've illustrated an abstract "bottle" which contains all our world's future possibilities. The "walls of the bottle" demark the limits between the outcomes inside – the stuff that can happen – and the outcomes outside, which is all the stuff that can't or won't happen. There's no way of predicting exactly which outcomes will ultimately manifest at any given time in the future, but they will lie inside the bottle and not outside it. This becomes a relevant framing, because a great many futures now imagined by our friends, families, governments, institutions and societies lie outside that bottle. In other words, just because a given future "sounds nice" has no correlation with whether it resides inside the bottle of future possibilities. Any actual future we achieve will be based on the reality we have NOW, and we'll need to proceed to it in a series of possible steps, each of which can actually physically happen. (You might be getting that déjà vu feeling that this is a bit of a problem for a species like ours which is beset with multiple blind spots about reality).

....and Bottlenecks

Another reason our "bottle of the earth's future" concept is useful is to provide a mental tool for envisioning changes to the walls of the bottle, such as bottlenecks. Of course, the rules of reality – physics, thermodynamics, and stuff – won't change. However, the ramifications of these rules when combined with our actions can *absolutely* change, because the nature of reality is that it is contingent on what happened previously. For instance, we can know that if armadillos go extinct on earth,

then there will still be no armadillos on it in 10 million years. If X amount of CO2 is injected into the atmosphere, the ice covering Greenland will melt within a range of years Y. If we run out of minable phosphate, the total amount of food which may be grown by human farmers will face an absolute Liebig limit at lower than current levels, and so on. Thus, the "walls of the bottle" can move in and out, and some things which were possible yesterday become no longer possible tomorrow, and things impossible yesterday are suddenly possible today. Some, like a global thermonuclear war tomorrow, would contract the walls of the bottle very abruptly; others, like a gradual loss of pollinating insects, affect it more subtly.

Anything that will happen this coming century – and beyond, will happen inside this 'bottle'. The walls of this bottle will be boundbounded by many things, but primarily will be constrained by the amount and type of energy used in human systems. As we descend on the downslope of the Earth's one-time carbon pulse, *a large number of bottlenecks will be experienced*.

The 'bottleneck' terminology is traditionally used in biology to describe such things as "population bottlenecks" and the related "genetic bottlenecks" in living species, but we use it here in the more general sense to describe similar aspects of other replicating systems. If you look at a population graph over time, you can see where the "bottleneck" concept came from... the area under the curve diminishes, narrowing to a "bottleneck" shape.

For instance, supersonic airliners expanded in popularity in the latter part of the 20th century but then went extinct, as did "floppy disk drives" and other complex creations which were once widespread. Many human languages have become extinct, and a few are hanging on in a "bottleneck" of very few users, with an uncertain future. A bottleneck event can re-expand to greater numbers of possibilities, or continue closing until there are none. Thus, a "bottleneck" as we refer to it, is a potential near-extinction event, for any complex replicating system. For many things: species, socio-economic systems, infrastructure, knowledge, ecosystems, etc. the 21st century will represent a bottleneck event.

So, What ARE the Probabilities of various futures?

Even if a thousand synthesis scientists each drew up their best predictions of the probabilities of future outcomes, they wouldn't agree exactly, because there's no way to be perfectly right about such a thing. The degree of correctness would vary with each scientist's mental models and assumptions, and the degree to which their mental models were in fact well-correlated with physical reality and able to account for the chaotic, contingent, and random processes. So beyond the short term the models

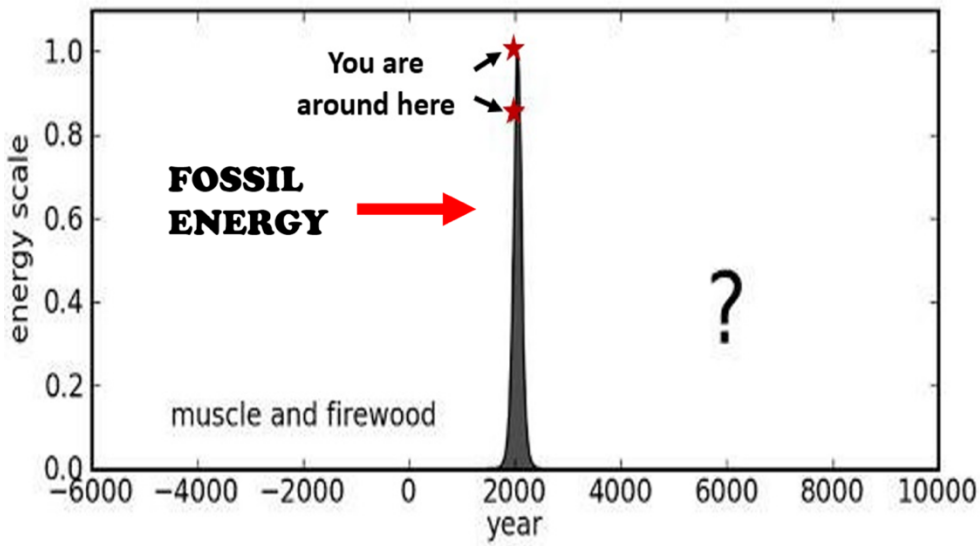
would increasingly diverge from each other. However, they WOULD agree on the broad-brush dead-obvious points, which is why one sees the frequently-quoted statistic that 97% of climate scientists agree on human-caused planetary CO2 heating.

Such an exercise would be of more than academic usefulness, because we're affecting the shape and size of that "bottle of possible futures" each and every day, narrowing the possibilities of what will be possible tomorrow when a (hypothetical) sapient species would instead be working to broaden them.

When predicting aspects of future reality based upon this "bottle of possible futures", the broadest and most basic are the easiest to see, with more specific predictions becoming more speculative. So let's start with the biggie:

The Great Simplification

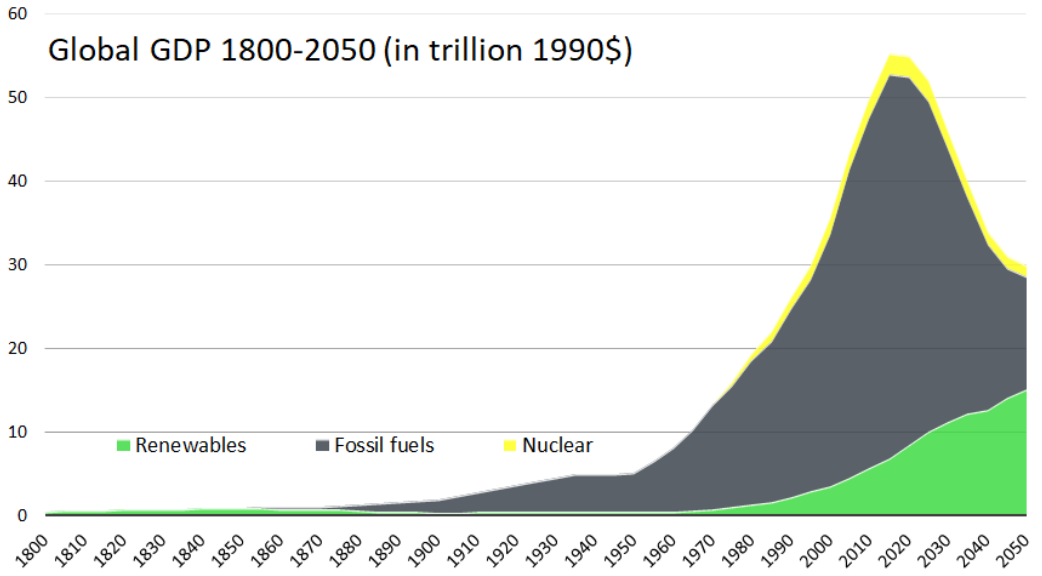
The "Great Simplification" is a term we've invented to refer to what is arguably the biggest and most important event in human history of all time, so of course you haven't ever heard of it before... its name OR its existence. It exists at the intersection of multiple human blind spots. If its existence became generally acknowledged, societal weirdness would peak very quickly and unpredictably, because it's a lot to take onboard, a veritable sinking Titanic of impossible Christmas ponies which the consensus trance has taught us were safe and real.



The Great Simplification is simply the inevitable downside of the "carbon pulse" graph, during which centuries of "more fossil energy slaves each year" crests the

roller-coaster peak to "fewer fossil energy slaves each year" until the human species is once more in a steady-state economy tapping direct and indirect solar flows. This will, of necessity, involve the systems we depend on becoming less complex because there will be less net energy to service that complexity. *(It doesn't mean that our individual lives will **seem** simpler, because convenience, too, is currently achieved using energy-generated complexity.)*

One might well refer to the upslope of the Carbon Pulse the "great complexification", because humans and human systems have gotten bigger and more complex using all that free net energy. We tend to invest in complexity as a way of overcoming problems. This, as noted by Joseph Tainter, tends to work fine for societies until it doesn't, and we've had a good long run. But as we crest the peak of all-time annual usable net energy now or soon, we will find that a lot of our basic assumptions about systems no longer work the same way. On average, each year there will be less stuff to go around rather than more, so it will no longer necessarily make sense that investments should earn interest. Indeed, the entire basis of "money as debt" becomes really problematic at the point it is ever realized that the energy and materials to pay those debts never existed in the imagined quantities.



The above graph shows one plausible possibility for our energy future, as a result of the prior actions of the 'superorganism'. We have quite a bit of oil, coal and natural gas left, and plenty of viable 'rebuildable' technologies, but in combination not enough to continue to grow economies at sufficient levels to maintain the financial

claims, expectations and complexity. Leaving climate and environment concerns aside, if the above trajectory manifests, global GDP in 2050 would be roughly 60% of its ~2020 peak. Many other possibilities exist.

The "Great Simplification" is an accurate term, because the net effect as available energy ramps down is to make everything both more expensive and more enegetically remote, causing systems of all sorts to simplify or fail. It is also perhaps a bit of a euphemism, in the sense that "simplification" is about the least-dire word one could come up with for a set of networked calamities which could easily be a real planetary shitshow. Like, what could possibly go wrong when "peak humans" at between 12 and 15 billion encounter "inexorably declining food"? Will we react as a sapient global society and become vegan monks to avert a humanitarian disaster of unprecedented scope, or.... something else? On one level, this is just one paragraph in an elective honors course... but on the other hand, it refers to an inevitable predicament which will face the human species at its all-time biomass-bubble population high during your lifetimes. YOW, right? And if you tell people about it, they won't believe you. (DJ and NJ say "Welcome to *our* world").

So predicting broad-brush, based ONLY on increasing energy remoteness due to "best first" energy and ore use, and well-known extraction trends, one can expect:

- less net energy (and more expensive energy in real terms), beginning sometime in the 2020-2040 timespan and proceeding on an uneven downward slope for ~200 years or so

- peak and declining everything relating to physical resources, due to peak and declining net energy
    - food (corollary: population? Rise of global veganism? Giga-famines?)
    - transportation (corollary: globalization stops working, Walmart stops working, suburbia etc)
    - basic infrastructure maintenance (corollary: bridges, plumbing, roads, sanitation, etc)
    - complexity (corollary: internet, new drugs, fancy surgeries, etc)
    - manufactured goods
    - communications networks
    - heating and air conditioning
    - physical wealth
    - etc

- a break from the most-dire IPCC planetary heating scenarios, which don't yet incorporate such concepts as EROEI or credit and which predict emissions based

solely on energy demanded. *(but even the likely scenarios are still pretty dire, particularly if extended out to 2200+ as they must be)*.

- a boon for the most remote wild species, far from human populations, once energy gets too expensive to go get them and shrink-wrap them in the gourmet aisle. A curse on the less remote wild species adjacent to human populations, as hunger and political instability push conservation laws and treaties past the breaking point

- greater reliance on renewable food resources like healthy fisheries and soil (oops...)

- greater reliance on predictable rains, stable climate and temperatures (oops...)

- the failure of all plans now extant, of any kind, which are heavily based on the neoclassical economic assumptions of continued physical economic growth and expansion much beyond the next decade or so. (Such as the current economies of major nations).

- We humans will probably experience these effects first via fiscal instabilities in the money system,
lessened reliability of the more complex networks, lessened availability of choices, greater poverty etc.

- We will erroneously blame this on other groups of humans, as well as trying to claim more resources... somehow. Traditionally, this has meant wars.

This is a really short list. Clearly, this entire course could easily have concerned itself ONLY with the basic implications of the Great Simplification and still just scratched the surface. Yet without the rest of the course, you wouldn't have the conceptual framing to even be able to see that the points above are dead obvious.

Dealing with This Reality Stuff

So we're now drilling down to the reasons this course exists. It's not to depress a few lucky honors students. It's because this century could turn out a lot of different ways, and many of them suck bigtime. It'll help you to know this going forward, whatever you decide to do.

Moreover, the *most probable* scenarios (at present) fall into the "really undesirable" shallow end of the pool. That means that if the "the agenda of the gene" corrals us into continuing "business as usual" without some impressive course corrections, this is going to be one really messed-up century in more ways than we could easily count.

The Great Simplification is inevitable, always was, from the moment we began basing the way we exist on fossil slaves. We've just all managed to miss it until now because we've treated finite stocks like unlimited flows, if we've thought about it at all.

Yet although this sounds like terrible news, it's really good news, in the sort of "pain in the ass" way that getting a timely diagnosis of a treatable condition is good news. Because a lot of the worst stuff isn't locked in yet. There are some absolutely great human futures still reachable inside that "bottle of possible futures", even if the walls are getting ever-closer to them and have foreclosed on some others. The things we do in our lifetimes change the relative odds of those futures. Sometimes a little, sometimes a lot. And not just "en masse" things but actions by individuals.

So What Can be Done to Raise the Probability of Better Futures?

There's potentially a LOT to be done, as you might expect from this event - the Great Simplification - being among the most impressive all-time events in human history. There are still huge degrees of freedom in how it all turns out, and a lot which *can be* done to improve the odds of better futures arriving.

Humanitarian efforts – as noted, human populations are limited by available food. How high will the global population go.... 12 billion? 15 billion? 18 billion? Now contrast this with reasonable estimates of what sustainable populations may be after this century; perhaps 1-2 billion, perhaps less. How that great difference in population size is navigated in this century will be the biggest humanitarian challenge humans ever face, even if our species survives another 10 million years, because there simply won't be the excess energy and resources to grow the population this big again. The biomass bubble will deflate as converted fossil energy increasingly leaves the biosphere. There will be many ways tragedy can be averted: converting to local-source vegetarianism, diverting energy from wasteful industries to food production, taking societies off 24/7 baseload power and adapting them to function on smaller and more-intermittent energy flows.

Mass extinctions – The looming 6th mass extinction on Earth seemingly *will occur* if "business as usual" continues until we've burned all the carbon we can get out of the ground. Moreover, today's wild species protection laws and nature reserves will seem quaint in the latter half of this century as billions search for food and the stability of governments will depend on supplying it. Since the "Great Simplification" implies that we're going to have to make do with less stuff *anyway*, there really isn't a valid tradeoff of the interests of wild species versus "growth" economies because "growth" economies are going away no matter what, and not that far into the future. If we

throttle them back sooner, we can prevent the worst degrees of a mass extinction. In these strange and fraught times, nearly anyone can choose to save multiple species if they decide to as a life goal. And there's a bright side from the GS perspective, because if these species make it past the "simplification" bottleneck, they may become 'extinction remote' as humans will not have the cheap energy to access the homes of all the world's species.

Societal knowledge – There are many important scientific, cultural, artistic, and other achievements of humanity that could conceivably be lost in the convulsions of the Great Simplification. Data now consigned to spinning hard drives packed ever-denser with information will increasingly become difficult to access and even maintain. There is plenty of time – now – to make sure the important stuff doesn't become lost, and this would be one of many very worthwhile things to do.

Societal Cohesion – Psychological limits to growth will be every bit as challenging as physical limits. As anxieties increase as we pass social limits to growth, many people will revert to tribal behaviors, not trusting (and blaming) those in out-groups, including the media, government etc. It will be important to maintain our core institutions of science, media, and education and to promote and defend civil discourse.

Social Foresight – While the energy available to our species will be falling from it's "carbon pulse" peaks, it is not inevitable that we backslide into former modes of societal functioning. It would, for instance, be a great shame to see institutionalized slavery rise again, or a return to the systematic oppression of women and minorities. Our energy and resource lenses show that this is a reasonably likely possibility in parts of the world, as nations tend to turn inward again. Knowing that ahead of time could, in principle, allow societies to avoid falling back into it, which would be one of the greatest social justice victories possible. Nobody is even yet discussing it since it falls within our social blind spots.

Carrying capacity – Nobody worries about natural carrying capacity these days, the ability of our farms and other food sources to produce calories without a 10x boost of fossil energy inputs, but it will be vitally important by the latter half of the century and beyond. Healthy soil, enough fresh water, healthy insect and worm populations, these should be treated as the treasures they are rather than being dumps for herbicides, pesticides and inorganic fertilizers until they're no longer available. And not just on isolated farms, but in the prime growing fields of entire nations. There's important work to be done.

Energy– So how will our societies be powered? People talk about an all-electric society powered by "renewables" or by fission reactors. Yet those fission reactors aren't being built, and there are serious problems with relying exclusively on intermittent wind and solar. But this pales next to the lack of an electric infrastructure: our current civilization only uses about 20% of our energy as electric power. How would we rebuild everything we do to be mostly electric, and is that even possible? We see that "renewable" power is getting cheaper, but that's the view from a very different global society than the one which will soon prevail. Eventually we'll have to ask hard questions that reside in the large realm of wants and needs – as individuals and as a culture. Do we really need 24/7 baseload for every house, or might it make more sense to have houses use a lot less energy, generated nearby from intermittent sources, while consigning baseload to industrial processes which really require it? Many similar tradeoffs will become relevant in coming decades.

Money – So what happens to "money" and our intricate financial system, ultimately based on the dependability of future energy to repay debts being incurred now? What even happens to capitalism when investments can't be expected to generate interest from year to year? It'd probably be a good idea to ask these questions ahead of time and come up with a series of blueprints rather than just have the whole system grind to a halt some Monday.

Transportation – We in the USA currently live in patterns which require food and supplies to be delivered to our homes or nearby stores through networks of primarily petroleum-burning vehicles running primarily on asphalt roads. At any given time, most of our food and supplies are on ships and trucks, with local stores having only a few days' worth on hand. However, in coming decades this will become increasingly less practical as oil becomes less available. Electric-battery semi-trailer trucks aren't really comparable in power and range to today's diesel trucks, no matter what Elon Musk claims. The expense of flying will tend to make seating tighter, airlines consolidate, and will ultimately spell the end of hub & spoke airline models as fewer locations are served by air going forward. Jet travel for the middle class will recede. Regular old low-speed trains can be run electrically and efficiently, but we'll need to re-lay most of the tracks which formerly existed and electrify them, and in so doing, alter our living patterns to focus on trains rather than trucks and cars. These changes don't need to be draconian, and in many cases will offer sanity and a slower, welcome lifestyle, but as of yet -in the 'hungry amoeba' stage of cultural aspirations, they are not yet even on the drawing board.

Globalization – Having essentially free transportation has given us the ability to source products from the whole world. This has arguably increased total wealth, but it has also meant that we've become dependent upon distant manufacture for many

essential items, losing the capacity to supply our own food and manufactured goods locally. But it's clear from an energy, money, and materials lens that the level of 'globalization" we have become used to will be going away, which implies that we need to anticipate that and re-localize the production and acquisition of the things we want and need, hopefully in a planned way rather than a gridlocked emergency.

Critical System Failure Modes – Our narratives about the future cause us to believe that people in the future will be richer, smarter, and more technologically astute. This makes it seem reasonable to "kick the can" on solving large ranges of problems, putting them off into the future. However, through the "Great Simplification" lens it becomes clear that future generations will in general be poorer, probably have less access to networked information, and have less energy to deal with big problems. So practices like leaving huge amounts of 'spent' nuclear fuel rods in swimming pools outside fission reactors becomes obviously a bad idea which is getting worse all the time. Some things need to be dealt with while energy and resources are still relatively cheap and abundant, and while emergency personnel will still drive toward a nuclear accident instead of getting their families away from it. Just one of many possible examples.

Hiatus – We conduct our societal affairs under a tacit assumption of absolute continuity on all fronts. Electricity, liquid fuels, internet, phone systems, financial systems, sanitary systems, emergency services and so on are expected to be viable in perpetuity. However, as systems "simplify", many of these will tend to become more erratic and less dependable, with potentially cascading effects affecting other systems. We could start having conversations about being resilient to hiatus, but for reasons of 'denihilism' we haven't started these conversations as a culture yet.

And so on.

One Honors course to rule them all?

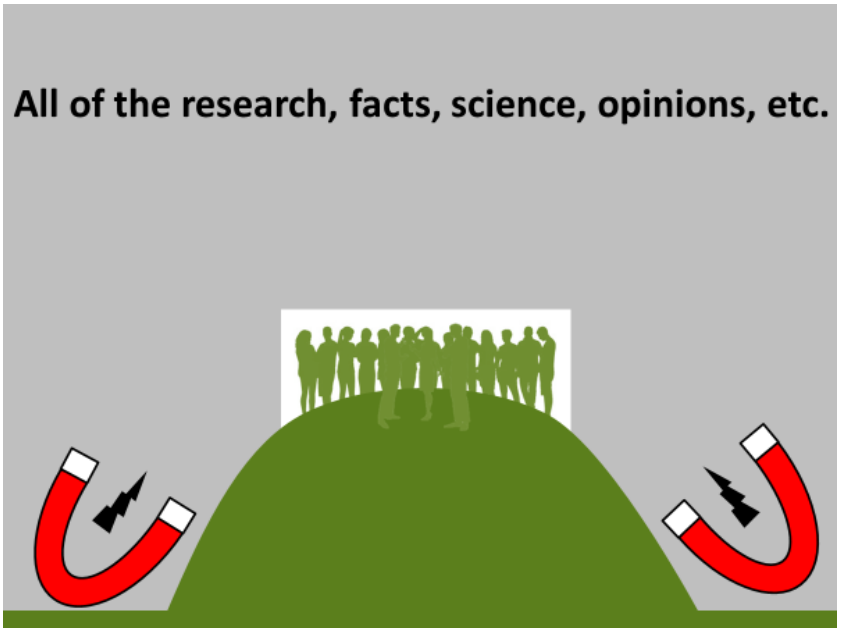
We don't know the future, but we have reasonable confidence of what it will not be. The peak in fossil sunlight flow rates will mean major changes in our lifetimes, and a brief survey of possibilities was listed above. We can be reasonably sure the average energy/material throughput for Americans – and global citizens will decline in coming decades. It's important to point out that a 30% drop in material wealth per capita (for those in the United States and Canada) brings us back to 1993 levels – a 50% drop to 1972 levels. How we respond to this energy descent as individuals and as a culture will be a deciding moment in our history. Given we have an over 80:1 exosomatic surplus buffer, there remains a great deal of benign, and even excellent futures still on the table, but they won't arrive without effort.

It would have been quite a different story if Gandalf had told Frodo that Sauron had the ring, and that all was lost. It really could have been a pretty short book with nothing but orcs, dark clouds, sellout wizards, evil, and negativity. There would be no reason to walk to Mordor or do much of anything besides getting drunk on whatever hobbits drink, much less consort with elves, dwarves, or other dicey characters. But that isn't our story yet, and needn't be. The world isn't irretrievably broken, the Great Simplification has barely started, and there are quite a few people who are discovering exactly the shape of our predicament, and the nature of the things which could substantially change them.

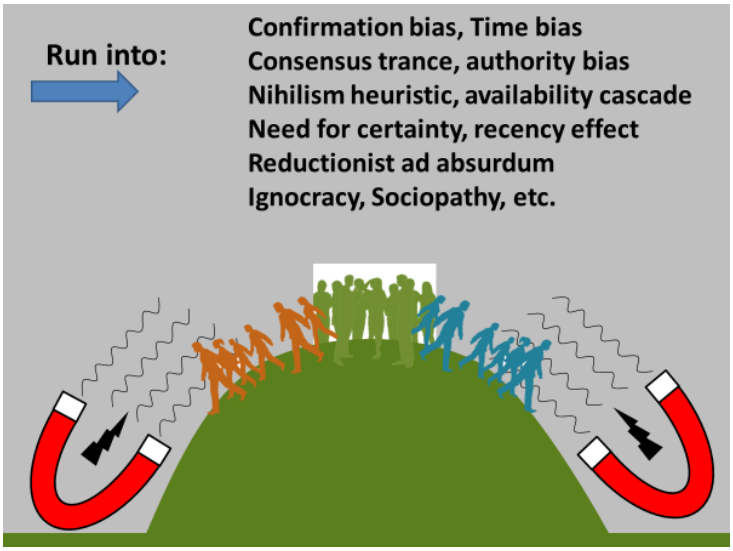
That's right. R101 is a metaphorical "ring of power". Tag, you're it.

Denihilism

Why Most People Disbelieve/Ignore Our Societal Challenges



With all these societal blindspots with respect to energy, technology, the state of the environment, why aren't people responding? If not to climate, wild species and ocean change then to the energy, financial and systemic risks we face in coming decades? Alas, the road to sapient thinking is neither level nor straight. It might be better thought of as a narrow path between yawning sinkholes which swallow up the unwary. That's because certain classes of error are a good fit for our evolved programming and cultural stories. That means they feel right for us to believe despite being at best counterproductive and at worst wildly wrong. Below is a list of 7 of such cognitive 'attractors' – heuristics to which the human mind defaults when confronting uncomfortable or threatening information.



"The experts tell us not to worry" (Reductionism ad absurdum)

"Reductionism" is the practice of examining a complex object or system by breaking it down into its simplest components, and it's a very useful tool in many situations. For instance, it's easier to understand mineral crystals if you understand something about atoms, and easier to understand some things about a human body if you understand how a single cell functions. A person studying anthropology doesn't usually need to know much about chemistry, music or seamanship, she's better at her job focusing solely on anthropology. However, there's a downside to excessive reductionism, because emergent characteristics of an object or system can't all be predicted by looking at the simplest elements. For instance, one could not have predicted the existence of vampire bats by knowing the characteristics of subatomic particles and gravity. A bunch of really important stuff is entirely invisible to any particular reductionism lens.

The reason this is important is that almost all main vocations which support our current societies are based upon extreme specialization, and fractionation of knowledge. The very nature of "expertise" in our societies these days is some scientist who knows everything there currently is to know about one incredibly narrow slice of reality. That person will often not have any idea how the world works on the important levels at which we experience it. For instance, Steven Hawking, an expert on black hole cosmology, believes it's a good idea to terraform Mars so we can move there. This is an idea which is energetically, technologically, and probabilistically impossible – and trivially so - based on a simple back-of-the-envelope synthesis of

scientific disciplines. But our culture lacks high-status "synthesist" experts to point this out. Ultra-specialists win Nobel prizes, while practical synthesists are lucky if they get an underpaid job teaching high school science. Moreover, they need to pick up this skill on their own, because the very notion of being a "scientifically sophisticated generalist" is not one to which society presently assigns value. Money, tenure, and status *currently* accrue to those who become savants in a narrow slice of some discipline, and contribute to the surplus-generating activity of that entity/corporation, even if they have below-average functionality in wider-boundary thinking.

This leads to a society in which there are tiny islands of rigorous science loosely woven together with what are essentially fairy stories. Experts generally have NO IDEA how their own expertise might fit together with that of an expert in another discipline… because it seldom comes up!

These societal choices have led to society-wide blindspots. Yet "*worrying about blindspots*" isn't a thing we think about either because…it's another blindspot. If various reductionist experts don't get excited, we don't either, even if lower-status scientists make a more cogent logical case. There's something analogous to a real tribal status dynamic at play. So if Elon Musk describes a "Hyperloop" high-speed train, or the use of giant rocket ships for cheap passenger travel from one spot to another on the earth, *we believe*: we bid up his stock prices and line up for tickets, even if the proposals themselves don't pass even a basic scientific "sniff test" for real-world feasibility. And in doing so, we tacitly take onboard an unrealistic set of expectations for the future. There is no "Synthesist General" position in our government – or any government - responsible for relegating nonsense propositions to the sidelines, because it hasn't occurred to us that we might need one.

So excessive reductionism is an attractor which can – and does - pull us in the direction of oversimplification, and of overlooking the obvious fact that the world we inhabit is a complex place with a bunch of emergent stuff happening all at once. We are marketed the wonderful traits of an elephant ear, or foot, or tail and in doing so miss the fact that the entire room is full of elephants. Or perhaps more apt, alligators we have somehow ignored by focusing on elephant parts and not looking down.

Ignocracy

There was a popular movie in 2006 called "Idiocracy", in which people of lower intelligence outbred those of higher intelligence, and via democracy created a really stupid nation. That's not our problem, but we seem to be achieving a somewhat similar effect by different means: not idiocy, but willful ignorance. Ignocracy?

We graduate high school students who have heard nothing about ecology, and college students who don't know where food or money really comes from. Our societies pursue "permanent growth" without any real idea of what that implies.

It simply *feels better* to be ignorant, non-rational and optimistic about most things, and we have mostly gotten away with it for quite awhile now.

This is not to say that humans are intrinsically boneheaded. We're "evolved to be wrong" in many ways which gave us historic advantages, but we can actually be pretty clever. That cleverness generally comes in response to challenges or crisis, however, which means that we don't step out of our comfort zones until some problem has arrived on our doorstep and is actively harshing our mellow.

It would be perfectly feasible to design an education system which taught children how to design a future they'd want to live in, and being kids they'd take it onboard and deal with it pretty well. However, we haven't done that yet. And without the language, terminology, and skills to think about the world as it really exists, it will be very difficult for our social species to plan for even the obvious challenges. And so, our 'ignocracy' ignores our challenges, at least for now.

Hyperoptimism/tech singularity

We humans evolved with an optimism bias as a way to stay healthy. There was good reason for this: we had very little control over the big things which affected our lives, and it's far healthier to not be stressed-out all the time. So rather than worrying about whether we would catch enough antelopes to eat next year, we just assumed that we somehow would, because it feels better to be happy than be worried (and via suppression of cortisol and other stress hormones, that also keeps us healthier). Plus worrying about next years' antelopes didn't affect their availability anyhow.

It's STILL healthier to be happy than worried all the time, but the situation has changed a bit since our optimism bias evolved. In particular, human actions are now the greatest force determining what actually WILL happen in the future, on issues from antelopes to nuclear bombs to a changed world. That being the case, we really should spend time being concerned about our collective effect on things, but we still have that "don't worry – be happy!" bias we inherited from our time on the African savannahs. It ***feels like*** we shouldn't worry, even when we should.

This bias of ours can reach some pretty crazy extremes. For instance, when you combine this hyperoptimism with "excessive reductionism" (above), you get societal

beliefs like the “tech singularity” which is actually believed in by a lot of ostensibly educated bright people. Under the tech singularity scenario, computers will keep getting faster indefinitely, leading to us all uploading our minds into immortal robots in the coming decades. This tale is a powerful attractor for some folks, because the story implies all future environment/energy problems will be solved or won’t matter. Why would immortal robots need healthy ecosystems, a comfortable temperature, other species, or fish in the seas? Indeed, this attractor is so strong that people are now paying to freeze their dead severed heads in liquid nitrogen, since of course immortal robots will quickly figure out how to bring dead heads back to life in a brighter future than that which prevailed when the heads were detached, and will for some reason feel obligated to.

Even those who don’t believe in full-on robotic immortality can be pulled by this attractor into believing various miracles of technology will inevitably be brought into being by some sort of transcendentally advanced human cleverness, despite the fact that such miracles run counter to the laws of the universe. When scientific reasoning is attempted by those who are stressed about the future, but who lack a systems understanding of limits, it can morph into a mythology pretty quickly. A very persuasive one to some people.
And most of us have an optimism bias at work regarding the future, because we inherited it. It’s not that easy to recognize that our feelings come not from rationality, but from ancient coping mechanisms from the savannah.

It Doesn’t Matter Anyhow – (Nihilism)

Another strong attractor, when a human feels bummed out about something which seems difficult, is what we might call nihilism... the feeling that “*oh well, we’re screwed -nothing really matters anyhow*”. It may be too late to solve X problem, and if it isn’t too late we probably can’t fix it anyhow. And if we did fix it, problems Y and Z would still exist, so what’s the use? I wanted a future with more stuff and less stress, but if I’m going to have less stuff and have to work harder, why should I bother to care about any of the rest of it?
It’s true we humans tend to consider anything that “feels depressing” to be roughly equivalent to all other situations which “feel depressing” *and thereby establish sort of a false equivalence between all such states.* And that can make any particular challenge seem overwhelming.

During the great stock market crash of 1929, a large number of investors jumped out of high windows to their deaths. Why was this? Because a little ribbon of ticker-tape had informed them that their abstract net worth had diminished. They were still healthy animals in a wonderful world, but were so overwhelmed by the abrupt

hedonic down-ratchet of their imagined relative status that their neurons shouting loudest caused a messy death on the pavement to seem preferable. Because if that one bad fact was true, nothing else mattered to them. Ergo, jumping out the window must be a good idea.

Most of us don't take it that far, but the same evolved circuits exist in every human mind. Some event or circumstance feels true and final, but it isn't. All futures for the broader world are NOT equivalent, nor are they yet determined. The same goes for one's own life. At times, understanding and describing the probability distribution of the future can be distressing, but just like a spider on your arm can feel scarier than a nuclear war in the moment, our brains can trick us into sub-optimal decisions, that in clearer (future) moments, might in retrospect seem poor, or even crazy.

Sociopathy – "After my kids die, I don't care if the world blows up"

A very close friend of the authors, when discussing climate change, ocean acidification and the carbon pulse, stated '*well after my kids die I don't care if the world blows up*". A shocking statement perhaps, but probably one that behind closed doors might be commonplace in modern human cultures. That is, the impulse that nothing matters unless it directly affects you and your immediate tribe and in the near term. Those who feel that way would probably object to the label, but let's call this what it is: sociopathy, the lack of empathy for, or conscience towards, those you don't know.

This is a very efficient attractor, because it removes much of the complexity one might encounter in the world, and fits well with our tribal minds. Attitudes like this actually aided our fitness, back on the savannah, to consider those outside our immediate tribe to be antagonists, or irrelevant, because very often they were. Those who felt this way were more likely to survive and become our ancestors, so such a tendency became "baked in" to our programmed feelings. So looking out for oneself and one's family "feels right" in a very strong way that looking out for one's species never can... because that feeling comes directly from the ancient illogical imperatives in our brainstem. Indeed, it feels SO right that human history has been shaped by wars, massacres, and expunging of competitors.

In the time between wars, this sentiment can manifest as simply not caring about the future, because there's no emotional connection with a person one hasn't met (or who hasn't yet been born). Such unseen future persons are outside the tribe (as a cave-man mind conceives of a tribe) and therefore inconsequential.

As far as this goes, it isn't incorrect; but it is sociopathic, because it leads to a decision matrix via which one is willing to derive personal advantage from actions which cause serious consequences for others. This is not only a terrible way to run a planet, it's a pretty sad and isolated way to exist. That doesn't mean it's necessarily uncommon, though: a fair percentage of those who DO expect societal disruptions are attracted to "guns and gold" as opposed to community.

The Inverted precautionary principle

Consider two things: a parachute harness and a set of pants suspenders. These objects have the same function: holding something up. Yet a parachute harness is engineered to be more than ten times as strong as it needs to be, while a set of suspenders is engineered to be exactly as strong as it needs to be. Why is this?

It's an example of the precautionary principle: if the consequences of failure are severe, you want to really err on the side of "not failing". So pants suspenders and parachute harnesses are not considered interchangeable. If one breaks, your life ends after a long plunge and a lot of screaming. If the other breaks, your pants fall down. So a precautionary principle makes a lot of sense in situations with unrecoverable failure modes. For instance, it's not desirable to give nuclear launch codes to a sociopath.

In our day to day lives, we often adhere to a precautionary principle. We'll pay a bit extra to design cars with air bags and seat belts even though MOST of them won't ever crash. We take the lead out of house paint on the possibility that some child might eat paint chips in the future. We build bridges and airplane wings to handle more G force than we expect them to encounter. We fill airships with helium instead of hydrogen. Because failure isn't really an acceptable option.

However, all these adjustments have been made in response to terrible accidents in the past; people falling out of parachute harnesses, bridges falling down, dirigibles exploding, airplanes having their wings fail, etc. We are less astute about entirely foreseeable problems which haven't caused calamities *yet*.

Indeed, our optimism bias (above) leads us to assume that calamities which haven't happened recently WON'T happen, so we don't prepare for them. This leads to something we refer to as the "inverted precautionary principle", under which the burden of proof is placed upon any future scenario which doesn't sound delightful. Which is to say, we invert the precautionary principle and require a high standard of proof that anything negative could ever happen.

These days, reductionist science is significantly organized around the odds of a given proposition being true, termed the "confidence interval", with the most popular confidence interval being 95%. This standard is so pervasive that it's applied by many even to potentially catastrophic outcomes in which a precautionary principle would make a lot of sense. So, for instance, our institutions insist on a 95% confidence level on something like the disappearance of shelled organisms, and resulting oceanic food web collapse, due to ocean acidification... when even a 1% chance should be enough to galvanize our actions. It's the equivalent to saying that parachute harnesses should be built to the standards of pants suspenders unless it can be PROVED that we will ABSOLUTELY die otherwise. And since many things can't be as easily tested as suspenders, we can employ that "inverted" precautionary principle as a mechanism to avoid doing anything, or thinking stressful thoughts.

This sounds abstract, but it's a real thing. For instance, in the early days of the space shuttle, the program managers estimated roughly a 1 in 100,000 chance of catastrophic failure of a shuttle launch. The engineers felt it was more like 1 in 100, but didn't communicate this since the question wasn't asked of them. A recent NASA study synthesizing what is now known places the actual initial per-launch odds of catastrophic failure at 1 in 9. Yet an order of magnitude could have been easily estimated by a reasonably competent 4th grader, based on the known failure rate of large solid-fuel boosters, which was roughly 1 in 100. Since failure of either of the two solid-fuel boosters would be catastrophic, quick math leads to an estimate of 1 in 50, which is a lot closer to ballpark reality than the numbers which were used by the decision-makers. So even rocket scientists can be affected by optimism in a way that creates a skewed precautionary principle. (And in a reductionist world, there are a lot of different kinds of rocket scientist).

It's someone else's problem

In a highly-specialized society organized around wasting surplus energy, *most tasks* in society are not done by most people. If your toilet malfunctions, you call a plumber. When your trash can is full, specialized trucks driven by trained trash engineers come and pick it up, and thousands of monkeys separate it into recyclable categories. *(Or there might as well be trash-sorting monkeys as far as we would know).* If you get an impacted nose hair, it's off to the nose-hair doctor for an encounter with a nasal scope. And so on: pretty much every conceivable thing which needs doing has had some specialist assigned to do it, so we have come to expect that everything which should be done has had experts assigned and paid to do it by the invisible hand of marketplace demand and capitalism.

So when we are faced with the thorny problem of limits-to-growth simultaneous with planetary limits-to-sink, one attractor is the immediate assumption that someone else is working diligently and competently on these problems. If the free marketplace hasn't accomplished that, then surely some governmental commission has been empowered to do so, using the best science.

And if THAT hasn't happened, then surely the richest 1% of humanity, in their ambition and opulence, will figure a way to deal with it, since they have the most power and the most to lose, and are presumably engaged in powerful secret societies to control the world anyway.

And if all THAT fails, well, God/gods/angels/beneficent space aliens/Gaia must have a plan which is so super-duper that regular mortals couldn't understand it, but which will work because miracles ALWAYS work.

The thing is, though, that the "invisible hand" of the marketplace isn't about looming future problems at all. Democratic governments are spectacularly stupid in some ways, and being proactive about future problems in perhaps the biggest way. There HAVE BEEN governmental commissions established and packed with scientists: we ignore and de-fund them. The richest 1% are, if anything, more clueless than the poorest 1%, because they can afford to be; and their secret societies – to the extent that they exist – are mainly selfish and stupid. They don't really need to deal with problems, they just need to stay rich enough that the worst impact of any problems continue to fall on everybody else. And gods/angels/aliens don't solve problems in the physical world: planning on miracles is entirely the same as not planning at all.

So it SEEMS LIKE problems which don't happen in our own households, within our personal sphere of skills and comfort, are someone else's job. It's just that for most of them there IS NO someone else empowered to deal with them, so that "mental attractor" of saying "it's someone else's problem" and deciding to ignore it can be a problem for US. Because when everyone considers it someone else's problem, nobody does anything to deal with it.

Conclusion

We face a series of complex, abstract, threatening and urgent but non-immediate problems. This combination is almost the perfect storm for our brains to ignore and reject. The processing which goes on in a human mind is a bit like small claims court: it isn't so much about truth or justice as about the emotional efficiency -the mental resolution of contentious issues so they're no longer contentious. A human mind in a state of dissonance doesn't feel good, so it takes real effort to maintain a state of dissonance for long. For that reason, there are all sorts of heuristics within a human mind to break the deadlock and stop thinking about the something that's causing the dissonance. Some of the heuristics are super-illogical, but it doesn't matter to us, because being in a state of dissonance causes stress, like having a snapping turtle latched onto a toe or a wasp trying to lay eggs in your ear canal. So pretty much anything which causes that sensation to go away has a good chance of being accepted.

Looked at it this way, it's easier to appreciate a simple truth which might seem like a contradiction: Denial and Nihilism are functionally similar mechanisms with the same end goal. A person who denies there is a problem, and a person who thinks that problem is hopeless, may disagree (strongly) over the details,. but both have resolved their dissonance over the issue and in so doing avoided having to do anything about it.

In the real world, it is a small minority of people who are willing to suspend the dissonance-avoidance brain mechanisms available to them and to engage with a stress-causing situation to resolve it in the physical world. That they must generally do so these days within democratic systems that inherently sideline minority opinions is a

structural problem with the way we design our societies, with roots in our ancient brainstem function.

In conclusion, all of the above dynamics populate two mental poles 1) there is no problem, "XYZ" will solve these issues, or 2) it's too late/too big – there's nothing we can do. These two poles can roughly be described as *denial* and *nihilism.* And they are functionally equivalent. Why? Because they both resolve dissonance by obviating any personal behavioral change. And the result of resolution of dissonance by billions is that the underlying economic/environmental challenges remain.

Please help to change that.

7 Flavors of the Future

By now anyone with a smartphone or a television has heard the term 'sustainability' and has at least a vague notion that humanity may be running into some sort of environmental or resource limits. But beyond these headlines, the 'notions' that are in peoples' heads are almost as many as there are peoples' heads.

In conversations with bright, well-intended folk about the future, we are struck by how different peoples' outlooks for future are, and even how different the vocabulary and language is. Pretty much ALL these people think they "believe in" a science-based future - and simultaneously think those who disagree with them do not. This highlights something important: the way the universe works is that all the things described by what we call "science" simultaneously affect the way things turn out. However, the way our culture mostly *uses* science is as islands of valid description surrounded by oceans of fairy stories, with science treated as though it were magic *(or, to quote a Kurt Vonnegut character, "science is magic that works").* The very nature of expertise in today's societies is reductionist. Your neighbor may be a specialist in programming the targeting systems for cruise missiles, working from a home computer without ever seeing a cruise missile or knowing anyone targeted by one. We use cell phones and microwave ovens, but it is quite beyond us to build one ourselves. We treat them as "magic that works", which is why chimpanzees can learn to use them. The end product functions simply, so we're able to easily accommodate them into whatever story we use to describe the world, even though the complex physical rules used to design them are quite beyond us.

So like all humans for the last 200k years, we tend to pick the story that most fits with our temperament, circumstances and expectations. But now we flavor it with a bit of science. The only problem with this is that ANY aspects of the real world which are ignored invalidate the synthesis results. Below we group peoples' beliefs about the future into 7 broad categories. While the intentions of all groups below are 'a better future', there seems to be little overlap between groups. In other words, many people expect a 'more sustainable future' but with wildly different understandings of what that might mean, what we should do to get there, and the likelihood of achieving it.

Let's take a brief tour through some of the more popular flavors of the future we see around us.

Fossil Cornucopia

The earth is an enormous place with incredible amounts of resources. It's just not credible that humans have used up more than a tiny fraction of all that, or really ever could. I'm always reading about new oil discoveries in various parts of the world. Peak Oil has been thoroughly debunked, wasn't it supposed to happen all the way back in the 70's? Plus, why would all the IPCC climate scientists be so worried if fossil fuels were going to become scarce any time soon? If you look at the data, the trend has always been more oil and more materials used every year by humanity. That's not going to change- when we have high prices it ignites human ingenuity, then we find more oil, and gas, and coal, and everything else. I'm tired of hearing that we're about to "run out" of oil. As long as the oil companies are allowed to keep drilling, we'll have all the energy we need for a pretty good future for a very very long time.

***Key Assumptions/Beliefs**: We have enough fossil fuels to sustain economic growth for thousands of years.*
***Human Population in 2200**: 15 billion with 14 billion too many immigrants*
***Human average wealth in 2200**: Far richer than today*
***Human average happiness in 2200**: Far Happier than today*
***Condition of Earth in 2200**: OK*
***How we'll deal with pollution and ecological problems**: Somehow.*
***Big Advantage**: we don't need to change a thing except getting rid of environmentalists and buying off the sand people*
***Fatal Flaws**: Ignores the increasing energy cost of acquiring energy. Innumeracy. Optimism bias. Motivated reasoning. And what about the other species?*

Neoclassical economics: GDP forever

There's really nothing to worry about. The science of economics clearly shows – using methods perfected over the last century – that resources will continue to become available in any quantity we may demand. If prices go up the market will develop substitutes - this goes for energy carriers like oil, coal, and gas, as well as every other substance we may desire. The genius of capitalism is that a free market makes these sorts of things happen automatically by unleashing the full potential of human ingenuity. That's why the USA has long been the world's leading nation with the highest wealth, because we've beaten down efforts to interfere with the price mechanism and technological response. Economic theory shows no fundamental obstacles to growing to many times the size of earth's current population, with GDP doubling every 20 years into the future perpetually. Sure, in 500 years from now the economy will look quite different than today's – information and efficient use of materials will be a much larger component- but we'll arrive there, nudged and

occasionally pushed by the invisible hand, with things you might not be able to imagine today.

Key Assumptions/Beliefs: *Human demand creates unlimited energy and resources from thin air*
Human Population in 2200*: 100 billion+*
Human average wealth in 2200*: So damn rich we won't believe it, GDP increasing for billions of years into the future*
Human average happiness in 2200*: Far Happier than today*
Condition of Earth in 2200: *Great. We'll be so rich we'll have plenty of money to fix any environmental problems that might arise.*
Big Advantage*: Magic*
Fatal Flaws*: Batshit insane. Elevates invalid principles to status of physical law while ignoring actual physical laws. And what about the other species?*

Green Dreams: Wind & solar renewable

The environmental toll taken by burning fossil fuels, and the danger of nuclear power, clearly dictate the necessity of immediately switching to 100% renewable energy. Fortunately, there is more solar power hitting the land in the state of Texas in a single day than is used by *mankind all over the planet in all countries*. Solar and wind are *already* cheaper than fossil fuels and will only keep getting cheaper. If we can only muster the political will to make the switch, we can provide new jobs, a cleaner (and smarter) environment, and grow our economies faster than we currently do with costlier fossil fuels. We don't have to choose between economic growth and environmental harm, we can go to 100% clean green energy which will create more jobs and higher living standards. The main challenge is spreading the good word and divesting from fossil fuel company stocks- since their stranglehold on the political system and imperative to make obscene profits is the main thing holding us back from the transition to renewables. But that is a matter of time - the renewable revolution can't be stopped, and is now inevitable.

Key Assumptions/Beliefs*: We just need to stop burning flammable fossils and replace them with wind & solar electricity.*
Human Population in 2200*: Stabilized at around 10 billion*
Human average wealth in 2200*: A bit better than today. GDP increasing slowly and steadily*
Human average happiness in 2200*: Somewhat happier than today*
Condition of Earth in 2200*: Pretty good since we got our act together, earth is healing from the bad stuff we did last 2 centuries*

***How we'll deal with pollution and ecological problems**: Renewables and the march of human enlightenment cause us to creatively fix them.*
***Big Advantage**: Renewables and electricity is easy, efficient and profitable! Just need to convince the ignorant it's in their best interests and gain political traction*
***Fatal Flaws**: No such thing as renewable energy; only rebuildable mechanisms which create only electricity. No clear way to actually do it without FF's. Might power a nice civilization, but certainly not THIS civilization. And what about the other species?*

Glowing Future: Nukes

Solar energy is fine when it's daytime or with nice weather near the equator, and wind power is fine when the wind is blowing, but those aren't what our grids need. They need baseload, and the only proven non-nuclear way of supplying baseload is burning fossil fuels or using hydroelectric dams. But fossil fuels are running out and trash our environment, and dams have already been built in all the best places. The next logical step on the energy density ladder is nuclear- it's a no brainer really. There's plenty of Uranium, and even more Thorium which could be made into thousands and thousands of years of energy. And beyond that there's fusion, the power of the sun, harnessed and controlled by our scientists right here on Earth. Once we discover how to do that (and we're so close!) we'll have millions of years of power just from the deuterium in seawater. There's a glowing future on the horizon if we can just clear away some red tape and get it done.

***Key Assumptions/Beliefs**: Unlimited energy from fission and fusion plants by 2050.*
***Human Population in 2200**: 10-20 billion*
***Human average wealth in 2200:** About the same as now, more or less*
***Human average happiness in 2200:** About the same as now, more or less*
***Condition of Earth in 2200**: Fair, since we stopped burning so much carbon*
***How we'll deal with pollution and ecological problems**: Running society on nuke electricity ends CO2 pollution and acidification*
***Big Advantage**: plenty of uranium, thorium, and deuterium.*
***Fatal Flaws**: Would need huge numbers of nuke plants, starting decades ago. It isn't happening at all. Can't build fission plants without FF's. They only make electricity. Intractable problems with nuke weapon proliferation, waste management. Current fuel practice is mega-accident awaiting a power loss. Fusion reactors don't exist and may never. If they do they'll be enormous and prohibitively expensive to scale. And what about the other species?*

Tech Dreams: Star Trek Future

There's no real need to worry about earth OR energy as long as we get our priorities straight. Our only problem at the moment is we're trying to do too much stuff at once on one planet without looking at the right long-term goals and possibilities. It's becoming clear that our ability to reproduce, and our innate cleverness in developing new ways to feed ourselves and solve thorny problems is eventually aiming us at the stars. Cleverness is what has always separated us from animals, and there's more humans – and thus more cleverness – today than there's ever been at any time in history. If there's one thing the universe has showed us, it's that cleverness, ambition, and a bit of time, always finds a way. Our universe is so full of energy – all we need to do is reach out and take it! It's just a matter of time before our scientists do just that and lead us towards a future of abundance. Then there will be no holding us back from an interstellar land rush. (with 70% likelihood) Warp drives – not today, perhaps not in our lifetimes, but eventually, for sure!

Key Assumptions/Beliefs: *Science discovers unlimited energy, which takes us inevitably to the stars in a manifest destiny*
Human Population in 2200*: 500 billion total on multiple planets*
Human average wealth in 2200*: We no longer use money, just replicators. Everyone has unlimited wealth.*
Human average happiness in 2200*: Deliriously happy and used to it. Sex with beautiful android servants, all humans philosopher-poets*
Condition of Earth in 2200*: Like a beautiful park, with dinosaurs and mammoths and extinct species re-created. Most people live in orbital cities.*
How we'll deal with pollution and ecological problems*: Move off the earth and terraform other worlds, outlaw pollution. Dolphins, elephants, gorillas get right to vote.*
Big Advantage*: antimatter and dilithium crystals are wonderful*
Fatal Flaws: *there is no source of antimatter in this particular universe, and dilithium crystals aren't a thing. No new source of available power found or even expected by scientists in last 100 years. Excessively reductionist logic, doesn't account for assholes, probability, or human nature.*

Utopians: Egalitarian colony

The only way to save the earth is to change the way we interact with each other. Our environmental problems derive from the unfairness of our current social systems, our toxic racial and patriarchal structures. We have to first have a just and fair world before we can be sustainable. There is no ethical consumption possible under capitalism, so the solution is to drop out of society and live life on your own terms, to be the change you want to see. Organic farming doesn't harm the earth. Eventually

everyone will see how much better we're living, and a tipping point will be reached whereby our race's destructive and authoritarian urges will be abandoned.

Key Assumptions/Beliefs: *Peace and Love*
Human Population in 2200*: Lots of awesome peeps!*
Human average wealth in 2200*: We'll be rich in the things that matter*
Human average happiness in 2200*: Everyone's happiness will be above average*
Condition of Earth in 2200*: probably great, maybe radically so*
How we'll deal with pollution and ecological problems*: We'll all live peacefully and the earth will heal with us, we have the power of song, crystals, herbal brownies, and group hugs*
Big Advantage*: Zero cognitive dissonance, easy drug access, polyamory, smugness, high subjective karma*
Genetics: *60% Sativa/40% Indica*
Fatal Flaws*: All that toilet paper and other stuff you get at Walmart means people aren't really detached from the big machine, and will totally move back to the city by the time they're 30. Farming is hard work. Pretty much nobody envies this lifestyle (yet), so any tipping points are remote. The world isn't fair.*

Muddle Through OK

I really don't know much about what will happen, nor do I care much about it. The future is just the future. People always get worked up and scare themselves about this or that future calamity/shortage/disaster but it always seems to work out somehow. You know, a day at a time. I don't really see any reason our lives won't be pretty much like they are now in 50 or 100 years, as long as nothing really **crazy** happens. I guess if the oceans rise we can walk to higher ground, and if tuna go extinct we can eat sardines or something. Every human generation worries about some darn thing or other, but things always have turned out OK in the long run. They probably always will. My cousin believes we'll get flying cars but I'm not so sure I really need one since they might crash a lot. There's nothing in the paper or on TV about any scary futures, and nobody is getting really excited about anything other than the usual kooks on the History Channel. And why are you asking me all these questions about the future? Don't you have enough to worry about today? I swear, I always get stuck sitting next to people like you on a plane. If I give you my peanuts, will you stop talking?

Key Assumptions/Beliefs*: Things usually turn out OK.*
Human Population in 2200*: Dunno. About like now probably. (How much is it now?)*
Human average wealth in 2200*: Not sure, but probably about like now.*
Human average happiness in 2200*: About like now, some things better, some worse.*

***Condition of Earth in 2200**: Not perfect but nothing really bad happened either. Some species gone, a shame but we won't miss 'em much if we don't know they are there now.*
***How we'll deal with pollution and ecological problems**: Some solar panels and wind, frack gas, and whatever seems to work. Scientists will think of some stuff. Maybe geoengineering and air conditioners.*
***Big Advantage**: Seems like this is what will happen whatever we do, according to the people at the office*
***Fatal Flaws**: no consideration of the actual nature of energy primacy, ecology, finance, or human behavior.*

Ultimate Tech: Utopian Singularity

The implication of Moore's Law is that the future will be significantly defined by ever-increasing transistor density in integrated circuits. This, in turn, allows data storage and information manipulation to increase exponentially. Such an exponential increase will soon reach and surpass the number of connections in a human brain, making it feasible in principle and in practice – inevitable, really – to upload human minds into immortal bodies. This is the logical "singularity" of human technology: to reinvent ourselves and transcend biology entirely, as cybernetic beings free to explore reality at our leisure. We're the first generation of true immortals, and it's an exciting time to be alive. We are richer than our grandparents, but the exponential advance in technology in recent years, and in coming decades, will make us look like peasants relative to the material abundance of our children.

***Key Assumptions/Beliefs**: Moore's Law continues forever, accelerating all aspects of human progress.*
***Human Population in 2200**: 20 billion or so, many of them living in immortal robot bodies*
***Human average wealth in 2200**: Why would an immortal robot need wealth? You don't get it.*
***Human average happiness in 2200**: However high we set our brain controls, presumably turned up to 11.*
***Condition of Earth in 2200**: Who cares? The earth only existed to bootstrap us into terminator drag. We have a cooler virtual reality now.*
***How we'll deal with pollution and ecological problems**: Robots don't need flowers, friends, oxygen, or fish sticks*
***Big Advantage**: We think it will happen SOON, like before we die if we eat right & exercise. If not, we can just freeze our heads 'til then*
***Fatal Flaws**: Gross disconnect from nearly all aspects of reality. Sociopathy. Fundamentally a cult. Frozen heads don't do well after thawing.*

There are tens of millions (or more) of well-meaning, creative, pro-social people working on what they think the future needs. The point of the above exercise is not only that good people can disagree, it's that there are a heck of a lot more ways to be wrong about the future than to be right about it. But even without knowing anything about the future, one could infer that all the demographics characterized above can't be right.

We tend to think about things we can't see in verbal phraseology which passes easily from one person to another and triggers associations and coalescing narratives inside our minds. Many more examples could have been made: the future as predicted by adherents of major religions, the future as predicted by various reductionist disciplines, the future as predicted by political candidates, and so on.

What we're missing, to a large degree, is a set of mental filters to weed out the things which can't happen and which won't happen; that is, the things which are precluded by the nature of physical reality and probability. Even then, the chaotic aspects of human systems will cause the actual future to remain a probability distribution, but it will be a distribution of actual possibilities as opposed to fantasy narratives.

Having all these disparate visions of the future is not all that useful for assuring that the future which actually arrives doesn't suck. Ideally, most of us should be working together towards futures which are still possible to achieve. That is the challenge of our time.

Section 6 -Where do we go from here?

So. We've seen that we live at a crucial time, and have a number of problems which boil down to a clever ape species following evolved "feelings" off a cliff, due to the happenstance of finding a jackpot of flammable stuff. The society around us is driven by mythology which conforms to those feelings, rather than to logical or ethical planning for the future. So how does an individual trapped within a near-mindless "superorganism" transition into a sapient invididual with some degree of independence from this "consensus trap" of people around us?

Imagine 101

A *Note to Students: certain things are expected of an honors class, and after all we've exposed you to in this one, you have every right to expect a list of "things to do". And we'll honor that implied social contract, with a lecture by me next week and a list of possible things to do and things to avoid. We have, after all, exposed you to things which would cause any sane person to feel a lot of mental dissonance, so it would be more or less tradition for us to now - as the finale to the show - pull a rabbit from the top-hat, giving you "the answers" in a time-honored college tradition.*

And that leaves us shuffling our feet a bit, because this course wasn't designed to get you to do specific things that we or anyone suggest. It was to impart more autonomy, not less. If we've done it right, you'll end this course paying attention to fewer imperatives imposed by others, and more attention to why you're doing the things you're already doing and planning to do. You all have been given lists of "things to do" since you were little kids, and those lists are pretty long by now. Getting another long list from us during finals week, however thoughtful and well-intended, is probably not what you need. Knowing the basic shape of what's really going on

around you, including what's hiding in our cultural blind spots, may be the better deal.

Our intention in this course was not just to shine a light at some basic realities our species ignores, but to make you conscious of the way you think, the way human society works, and the evolutionary roots of it all. And the reality of how this interplays with energy and ecology. To tempt you to become a more autonomous proto-sapiens individual by offering you choices which have never been explicitly presented to you before. To provide a few tools, and a context, with which to answer the basic question "who am I?" That's what it all comes down to, right?

We actually don't have "the answers". But we think we have some partial answers and a method to hone them. We have a lot of ideas which may get traction, and some theories of how to affect things which may work, but that material hasn't been included in the course, as there's just so much which could be packed in. It takes a certain amount of chutzpah to think you can construct a course labeled "reality", to be fairly complete, and to then to also "stick the landing" the first time it's taught, so thank you for bearing with us. Telling you now "what to do" might edge past chutzpah into hubris.

But we're not planning to just hit you with all this "reality" stuff and then abandon you. If you wish, you'll still have access to us via email, and we will be publishing a far more complete version of this stuff. And not just to "write a book", but as the written basis of logic for a paradigm shift to underlie a series of projects and programs with which we hope to shift things that have so far have proven intractable to pro-future earth-advocates. Maybe you'll decide to keep in touch with us. Maybe not. You may decide to pursue a bit more normal course than we do, or try to forget this stuff entirely, or to discover things more creative than we've thought of and give us recommendations on what to do. That all needs to be your own decision.

So with that disclaimer, here are a few end of semester remarks to get you started thinking.

Someone Needs to Know This Stuff

You're probably wondering, on some level, why the hell we're doing this to you. This course, this information, this unsettling, less-filtered gaze upon the underpinnings of physical, evolutionary, and probabilistic reality. And the even more unsettling implications for a human future.

Of course, you probably understand one obvious part of the rationale: *someone needs to know this stuff.* And while a lot of people currently know individual pieces of it, these pieces haven't assembled into a whole in many human brains yet, which means that society is not coming up with workable answers to some very pressing problems. Our living world urgently needs *homo sapiens*, and we haven't reached that standard yet. We don't expect all of you to "drop everything" and become superheroes - *(maybe just a few of you :-)* - but knowledge and synthesis of first principles is a start.

Being temporarily sad, overwhelmed and/or scared is the rational response to first hearing about this stuff. In comparison with what your culture believes, these situations not of your making are depressing realities. It is our hope that any initial shock and sadness at learning about the energy/behavior/environmental collision is something to be experienced, witnessed, catalogued and then passed through - because a *sapiens* mind is a terrible thing to waste.

In the history of this world until very recently, no individuals of any species have ever integrated the things in their head that you have been taught in Reality101. And knowing these things is pretty much a *necessary prerequisite* for coming up with real-world plans to take our species to a decent future, bending it away from the unconsciously destructive agenda of the gene.

Your awareness of these things makes you important not only to your family, friends, civilization and species, but, if truth be told, to all extant complex life at a very crucial time. In the previous mass extinctions on earth, there was no possibility of intervention and changing course. This time, at least in principle, there could be such a possibility.

So, what are the first steps in engaging with the future?

Monsters, Myths and Hope

In the legendary Greek myth, Perseus had a predicament to deal with. His mission was to kill the monstrous snake-haired Medusa; yet mortal man could not behold the face of the gorgon and live. Those who saw her were turned to stone. As the story goes, he solved this by only looking at her indirectly, peering at her distorted reflection in a golden shield while hacking with his sword in her general direction as he advanced ass-first into the fray. Monsters don't generally fare that well in such legends, but in the real world our money would have been on Medusa.

In learning about Reality 101, you have gotten hints that there is no specific villain in our story, and that many of society's knee jerk reactions on 'what needs to be fixed' are misguided, or flat out counterproductive. Perseus' bold ass-first charge in the wrong direction based on "not looking at things clearly and directly" is the current human, and thus activist default. Our blind spots see to that. Problem is, they cause us to see monsters where there aren't any, miss monsters that are there, and to waste our time and energy on things that have no chance of actually slaying the monster. In the case of Perseus, there was no actual reason to fight a monster to death in the first place, his actual adversary was a creepy king who wanted to marry his mother and manipulated him into a fight that was designed to kill him off. But perhaps the real victim of the story was Medusa, who had started her life as a beautiful maiden, was cursed with snake hair and inability to interact with humans, and ultimately got blamed and beheaded for no particular reason. If you've never before looked at it from that perspective, don't be surprised - humans deal with myths the same way we deal with everything else, taking our cues from those around us.

Understanding the core issues- who is the Medusa, who is the creepy king, and how to strategize on the future game board full of monsters (obvious or otherwise) where you and some like-minded individuals are game pieces is the first step beyond Reality 101.

Clearly, by our creating this class, and by honing a paradigm for a *homo sapiens* approach to our existence in deep time, you can tell that we don't think it's useless. Far from it. We still think that there are huge degrees of freedom in the potential outcomes. All fantasy futures will not be - and never were - possible, but there is still probably an attainable range from "quite decent" to "horrible".

Steering a path to the decent ones is the challenge of our age, species, and world. But it's a narrow path in many ways: there are a lot more ways to get it wrong than get it right, and the "agenda of the gene", wired deep within the illogical and invisible ancient structures of every human brain, will constantly seek to divert us from such a path and to thwart sane plans. Those humans who take the *sapiens* leap will have to initially contend with the greater majority who haven't, and who are hostile to the very notion of short-term sacrifice, even modest sacrifice, in exchange for a deep future they can't envision and won't live to see.

Even more difficult is "threading the needle" between personal denial and fatalism, staying energized and psychologically healthy while making adult decisions on behalf of our species (and others). It means looking directly into the face of the gorgon, and not at the distorted reflections which seep through our evolved bias, fallacies, and illusions. Yet it must be attempted, and soon. So far in this course we've peeled back some of the layers of obscuring distortion, giving you a progressively clearer view of the actual problems facing our species and world. We've also shown you examples of intelligent people who find personal certainty in denial or fatalism and thus avoid actually doing anything useful.

Yet there's no reason to think that we humans aren't fit enough to look at reality honestly. We became who we are by facing some daunting realities. We are kick-ass primates who until recently have dealt with some very hairy, scary realities. Plagues. Famines. Mile-high ice sheets and blizzards. Horrible parasitic diseases. Sabre-toothed tigers, dire wolves, cave bears. We kicked their asses into oblivion and made houses out of mastodon bones. So at what point in evolution did we become aristocratic weenie debate societies, academically regarding our navels, unwilling to take risks or endure hardship, throwing cucumber slices at one another with capuchin howls as we meekly commute to make-work jobs?

The big shock is not reality itself, but in abruptly finding out - after much of your life - that you've been told incorrect, incomplete, and wildly overoptimistic stories about

the world by those around you who never questioned that what "feels good to believe" might not in fact be true. We think that if kids were taught the realities of energy, evolution, and ecology from a young age, they'd adjust to it; (even at the same time being more than a bit annoyed with the situation they're being handed). And we'd better get going on that. But we've dallied far too long to wait for the next generation, which means that some of us need to drop our shields and look our gorgon in the face, and resist being turned to stone by the dissonance-avoiding heuristics which urge denial, fatalism, depression, and inactivity. We may even find, by doing so, that the gorgon we're ostensibly preparing to fight isn't the real enemy.

We've met and read a lot of smart people who feel that we're doomed, because we've tried everything and nothing has worked. The 6th mass extinction is proceeding, CO2 emissions are still headed up like a rocket despite people flying around to conferences making nonbinding commitments that take effect only after they've retired, and people driving hybrid cars that need steel, asphalt, lithium and water to cool the electric plants. Activists have tried their best, it seems, but nothing much has happened.

Our thesis here is that –as a species - we haven't even *started* doing our best yet. That is, we haven't tried anything which would be reasonably expected to have a positive effect on our future. We've just done a bunch of social–posturing stuff which "feels like" it should be useful, but really isn't. So now it's time to start doing stuff that works.

So why haven't we solved the 6th extinction, the CO2 problem, or any other problems associated with the Earth's carbon pulse?

- the "enlightenment" paradigm of passing more and better information widely is our default, and it hardly ever works. It just feels like it should. The problem isn't an information deficit, it's the way human minds deal with information.

- if "nice" was mandatory as a practical methodology, there would be no life-saving surgeries, no dental care. Why do we automatically mentally exclude all possibilities which aren't "nice" in all practical ways? At this point we're mitigating a predicament, not cutting a birthday cake.

- there is currently no science of effective activism. It's still at the "alchemy" stage of everyone trying random things without a real sense of deep underlying principles. There's no reason one can't be developed, but the nature of social movements is such that it's not really being pursued.

- we assume that the bigger a problem is, the more difficult and complex its solution will be. That doesn't necessarily follow. It's often the structure and not the size of a problem which makes it tractable or intractable.

- small groups and individuals have far greater capacity to transform many kinds of large-scale issues than do large groups, because they can efficiently manipulate more variables more quickly while intelligently pursuing a more complex plan. Yet activists and their funders tend to be idealistic about "fairness of process" which generally means addressing problems with large, egalitarian, slow-moving committees ill-suited to affecting rapidly-reacting systems, which rapidly become gridlocked into mediocrity by internal social-status dynamics and gamesmanship.

And why should we think there's hope? Here is a very short list:

- because we haven't really started trying. So far we've just been talking, blogging, and fiddling.
- because the worst outcomes are not yet locked in.
- because we don't all have to be ineffectual, timorous wusses. We don't need to be terrified of what others may think of us. We can leave that mode any time. What are we saving up our adrenaline for?
- because we don't need all the things we think we need to be perfectly happy and healthy.
- because despite living in what amounts to a temporal-sociopath society in which future human childhoods and conscious wildlife have roughly the status of bacteria, we can transcend it and choose to care about the future.
- because if given a choice without being indoctrinated at a young age, kids will choose future life. The reason this course was shocking is not that humans can't deal with reality, but that you were hit with reality after two decades of being told a different story
- our interpreter modules actually have potential super powers if they can be liberated from the core brain feelings of the default gene agenda.
- because solving our problems doesn't depend on everyone in the world agreeing. They never have, never will. We don't need consensus to change the world, we just need to change it. The world has always changed without consensus agreement.
- because the same blind spots which create the problems also hold some solutions. Our thinking is constrained and in a rut. We build conceptual boxes around what we think is possible, and they become self-fulfilling by causing us to not try

- We don't need aliens or angels. In principle, people can be the surgeons, the hard-decisions aliens. There's no one else to do it. We just need to step up.
- sapiens vs fecundus? Cultural evolution can work incredibly fast
- only now do we understand the shape of the full picture. We never have before. That has power. Go.
- because *sapiens* have inherently more complete and workable abstracting tools available to them. More complete mental models of reality have inherently better predictive value.
- because wrangling the amoeba has always been done, and we shouldn't shrink from it. Failing to try means that those with no such scruples, following the gene agenda, win by default.
- because this is no longer a jungle tribe, we can let go of those instincts and go beyond them. The snakes aren't the problem at this point.
- The amoeba does simple things, so minds must steer it. Whose will it be?

Homo? Sapiens?

In this course we've talked about a "sapiens" agenda, as opposed to the default agenda of the gene. But wait a minute, we are *already* "homo sapiens", right? Well….

The genus was created, and the species named, by C. Linnaeus in 1758. He deserves credit for including humans as a species *at all,* since most of the world then (as now) doesn't really consider humans to be animals. Still, there has been some science done since then which has put things in perspective. As Diamond points out in *The Third Chimpanzee*, creating the genus "homo" isn't indicated based on taxonomic rules, it's more like a self-awarded vanity license plate ("IMGR8"). The reality – if we don't bend the rules applied to other species - is that there would be three species of chimpanzee; chimps, bonobos, and humans. So without the designer plates, that'd be Pan troglodytes, Pan paniscus, and Pan sapiens. But that "sapiens" moniker doesn't really wash either, since so far we've been clever but not wise. Maybe Pan pyrophilus for our tendency to set things on fire? Pan delusio - the deluded ape? There's no shortage of qualities which might distinguish us from the other chimps *(what's latin for "wears pants"?)*; but if we're honest "wisdom" isn't among them.

When asked what he thought of western civilization, Gandhi replied "I think it would be a good idea". Perhaps we should think of "sapiens" in a similar way: something we need to aspire to, and quickly, as the primate "gene agenda" and the "lighting things on fire" proclivities have combined to create some impressive impediments to a desirable future. Actually, Gandhi might be a decent example of a ***sapiens* agenda**: a person who used intelligence, empathy, bravery and nonviolence to accomplish the seemingly impossible: winning a war against long odds without fighting it. We will

need at least some sapiens to attain their namesake if we are to reasonably navigate things of value through the various physical and ecological bottlenecks of the 21st century.

Deus ex Machina

A hoary old plot device, from ancient Greek and Roman drama, was the "deus ex machina". It was a scriptwriting kludge that guaranteed happy endings. You could create a terribly tragic plotline in which awful things unfolded… then at the end, a god (deus) was lowered by cable (ex machina) from above, and passed a miracle solving all problems, bringing murder victims back to life and righting wrongs, so all the actors could dance around happily and exit stage left. *If you find this unsettlingly familiar, it's because it's pretty much "the current plan" for dealing with modern human problems.*

Most humans believe in real gods and angels and expect them to function in this role in the physical world. Any time now. Others believe that beneficent aliens are watching and waiting until the absolute last moment to swoop in and save us with better technology. And many others trust in metaphorical or pseudoscientific gods & demons, such as the "*invisible hand of the marketplace*" and expect them to bring about permanently rising prosperity underpinned simply by the increased demand existing in billions of chimp brains. Yet all these imaginary entities exist only in our virtual worlds – the fact that they are absent from the physical one poses a problem.

Clearly, nobody is playing the role of "wise guardian angel" or "beneficent alien gamekeeper" at present. But to return to that Gandhi quote, "… it would be a good idea". The notion of clear-seeing minds, guided by altruism, love of Earthlife and logic, which step in like loving parents to set right human mistakes and return the world to beauty and bounty for a long and happy human future. We apparently need such beings to become a part of our storyline, and they are clearly late to the party. Alas, aliens are not hiding among us and probing midwest farmers, nor is there an emergent species overmind watching and preparing us for the future - benevolent, unscrupulous, or otherwise. What does exist are the amoeba-like tropisms of a growing human heat engine which emerges as the lowest aggregate common denominator of seven billion chimp brains competing for status, wealth and stimulation.

However, as Gandhi showed, human events can be steered even on large scales, not as much by committees or representative bodies, but rather when individual minds are used effectively and non-delusionally. And that's where most hope lies: in individual *sapiens* minds. Someone must step into the role of beneficent aliens and

steer our world away from dismal futures. The only possible candidates are individual human minds. Like yours.

Towards Sapience

The future is not what most in our culture/species expect. We are developing an extensive, but not exhaustive nor definitive list of suggestions that fit the physical, ecological and social roadmap that is ahead of us. We have broken them into 3 broad categories and below briefly share an overview without too many specifics on:

1. Economic responses –how to better navigate a world with less surplus
2. Psychological responses – how to not go crazy in a world seemingly gone crazy
3. Natural system responses – how to play a role in the defense of the living world.

It should come as no surprise that 'natural system response' is ultimately the most important to your authors, and really it should probably be to everyone who has any ecological literacy or hope for the future beyond their lifetimes. But as you know, time bias and other blind spots make the environmental problems sound like whispers compared to the other economic and social shouting on our plates. And, truthfully, without our basic needs – physical and psychological – taken care of, the earth probably won't have too many champions. Essentially, there is no "one size fits all" solution – and we will need butchers, bakers, candlestick makers and eco-jedi all in symphony to craft a liveable future.

Economic Responses

The society around us is still pretty much all-in behind the belief that the economy can grow forever based on sheer human demand, detaching itself from any need for increasing energy and materials. (Our expert economists say these things, so they must be true). For that reason, the stock market – which measures aggregate perceptions – is still acting healthy, along with the property market, financial markets, and wide belief in continuing globalization. We believe that our money, and our debt, and thus our growing societal wealth is backed by that permanently-growing prosperity. It's a set of beliefs which has been true for what seems like a very long time, so we tend to think of it as a "first principle" law of reality.

But as you know or at least suspect, it isn't one. Our large blind spot has hidden an army of invisible fossil-energy slaves which have created essentially all the extra prosperity, convenience, biomass, and wealth markers. And they're going away soon, because the *real* "first principles" of physics and thermodynamics require that they

must. Their departure won't be obvious at first: we measure our world in dollars, not in net energy. Yet as the net energy available to our species crests the depletion curve and takes a shark-fin dive back toward sustainable solar flows, our fiscal systems will become ever-shakier. There's currently massive debt overhang – debts which there will not be sufficient energy to ever repay. That debt has been incurred to keep the party going awhile longer. But there's a funny thing about ponzi schemes: anything that can't go on forever, won't. Thus, in your lifetime there will be impressive monetary gyrations leading to discontinuities, and such fiscal convulsions will be how humanity initially experiences the reality of diminishing net energy.

This will probably be interesting to live through: there's no telling what mix of good and bad ideas may be adopted by a society which doesn't really understand what's happening. Certainly the underlying gene agenda which has our species in thrall will cause a number of emergent phenomena which have been seen before: the sorts of things which fill our history books. It would be good to also see a robust Sapiens response, but if so, it will have to play out in situations where many people are angry, afraid, resentful, and somewhat desperate to retain what they feel they should have.

This is one of several ways in which this course could help you and your loved ones: if you know to expect this, you can prepare for it in terms of personal resilience, both psychological and practical.

Psychological Responses

In Reality101 we've done our best to present an honest first-principles synthesis of our evolved minds, and how they have so far interacted with the world and with the carbon pulse. It's not too extreme to say that the beliefs of our society are crazy by physical-world standards, thought they seem normal to most of the people we (and you) know. We've gotten away with such a disconnect due to the nearly unlimited "do overs" enabled by our fossil slaves. But as they go away, there will be a lot to deal with in addition to the demise of the dominant mythology of perpetual growth. A lot of things will change. (Remember the old Chinese curse: "may you live in interesting times"?) You do live in interesting times, and they're only going to get more "interesting" from here on out.) But you can prepare for that psychologically by expecting the changes, not setting yourself up to depend on business-as-usual, making your life decisions in an informed way, and deciding what sort of life would be most meaningful to you, since these are the times you were born to.

The human future will be significantly determined by the gene agenda, and past history shows where that leads in times of change. We are hopeful a Sapiens agenda

will also become a player. There will be a lot fewer of them, but they'll be playing chess while the others are playing checkers... badly.

Will we become less hooked on supernormal stimuli, or will society go ever deeper into designer drugs and electronic stimulation? Will we maintain high standards of medical care and long life expectancy, or will that be dialed back? Will families tend to stay closer together rather than fanning out across time zones? Will we embrace diversity, or will we default to blaming outgroups when social stresses arise? Will we move to even crazier belief systems in order to cope in stressful times?

Whatever the answers to those questions, bear in mind that even when humanity undergoes what are in retrospect momentous events and changes, they mostly seem pretty slow when they're happening. Most people who lived through the "depression" of the 30's and 40's had happy lives and didn't know they were part of the Great Depression until later. Just ask them – many are still around and the skills they used then might well be useful again sooner than we think. Events like world wars effect some people intensely, but to most people they are the backdrop to far more pressing events in their local sphere. The lesson to take from this is that even though the coming decades will be historic in many ways, you will live through them one day at a time. It's important to have the shape of reality in your head, but you don't need to confront it in its entirety every day. Rather, it should become a backdrop for planning, expectations, and defining your own success as a person. Immense transitions can be accompanied by a lot of laughter and good experiences, even if they're subsequently labeled as revolutionary by people in the future.

Ecological Responses

With regard to the human predicament, *nothing* makes sense except in light of the carbon pulse, a very temporary aberration from the normal rules of carrying capacity. This has disconnected the top of the trophic pyramid from energy and material flows and has generated environmental hockey sticks everywhere we look. This pulse is *inherently temporary*. Keeping it happening for a long time isn't even an option. So the things which might preserve a living world are the same things we will have to do anyway, just slightly sooner and less traumatically.

Being alive now at the inflection point in the carbon pulse - and therefore at the great energy/biomass collision and disconnect - is not like being alive in the fairly recent past or fairly near future. Your generation really is different, and not just because its nitrogen (proteins) was made in factories and you are literally eating transformed fossils. In the past we had very little knowledge about systems and very little about how our minds actually work. In the future there will be much less ability to steer

different courses due to receding horizons. But the coming 2-3 decades will be a time in which the course of earth events will be contested as though we were fighting for air. Due to social media, civic freedoms and the continued presence (and assistance) of billions of fossil co-workers, individual humans still have huge reaches and degrees of freedom in their ability to change the world. The far-seeing systems altruists – and perhaps there are one or three of you in this class - need to get very good at steering things. This is not something one would seek out, it's more like being on an airliner and hearing the stewardess come on the PA system and ask if there are any pilots onboard.

Let's be honestly aware that – current headlines to the contrary - the environmental movement has failed so far, in terms of being remotely adequate to the scope of planetary system loss. Its ideals have remained ideals, disconnected from the physical world. This doesn't mean it's impossible to change the course of events, just that it's difficult with the cultural baggage and beliefs we carry around with us. In other words, don't assume that the current failure of social movements to adequately deal with the human and planetary predicament exhausts all possibilities. We are evolved to pass information to other tribe members and to expect prudent decisions to result, but for many reasons that doesn't work well with huge diverse populations. Enlightenment per se isn't much of a useful tactic to change the course of events, despite that being the primary assumption of most activism. Finding out what doesn't work is productive, as long as we can admit it and learn from it.

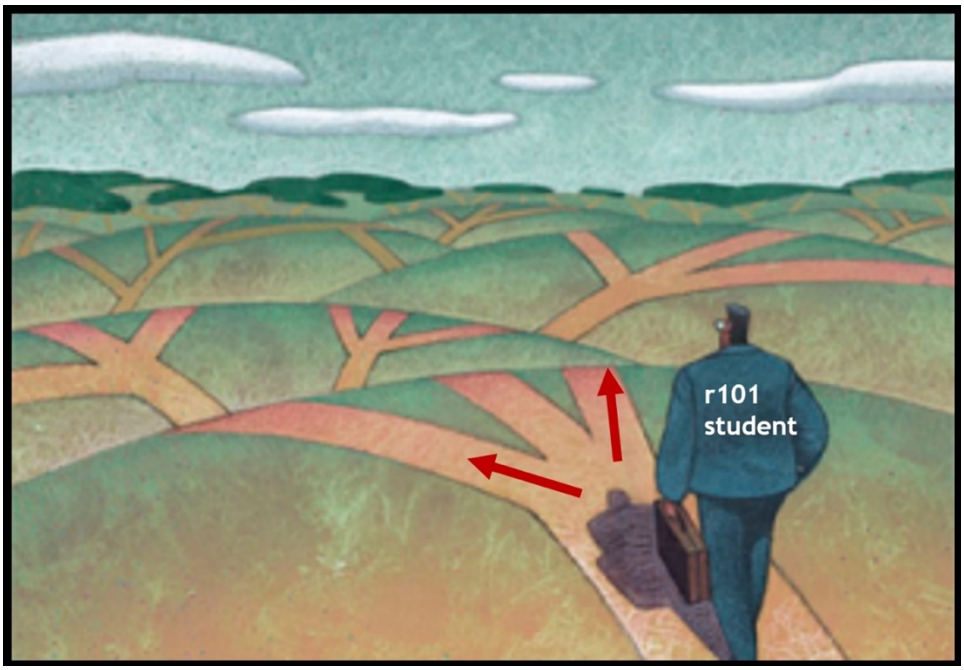
Nate and DJ do not have the answers, and this course isn't about supplying them. But we have some observations which can lead to rough suggestions to get you started.

First and foremost, know why you're doing what you're doing. Be mindful not just of society's blind spots but your own evolved tendency to rationalize and pick up conclusions and aspirations from those around you. **Once you decide what matters to you**, you should be able to analyze how your actions and decisions square with that. We live on a full planet ecologically speaking and are still adhering to small planet rules. From just being a better person and helping your community to being an Earth-life ambassador and everything in between, we invite you to participate in the future.

So, What to Do?

(A preliminary grab-bag of ideas)

Part 1 -An Introduction



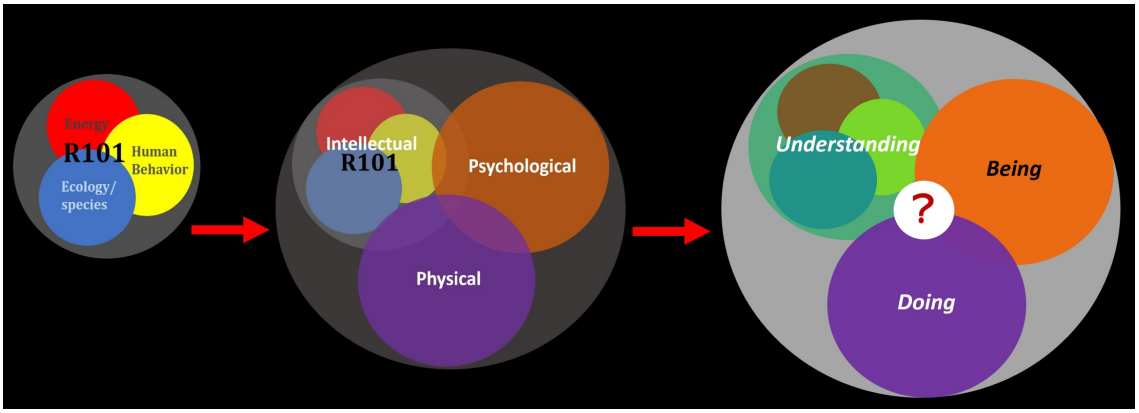
So. We've arrived at the end of the semester of our brief but packed survey of Reality. Here is where me and my friend DJ suggest '*what to do*' with all this information. Let's start with a question that some of you might be asking (though perhaps not): *what if we're wrong*?

I doubt any of you disbelieve much of the core aspects of what's been presented: that the evolutionary basis of our minds is relevant to our current global predicament, that energy and resources (not money and cleverness) are the foundations of the modern economy, that oceans and Earth's atmosphere are absorbing excess CO2 to their detriment, and that wild species and ecosystems are being severely impacted by human beings. The nuance and potential uncertainty in R101 lies within our secondary inferences: how much of our behavior is genes vs. culture and volition, how close are we to the end of growth due to energy remoteness and its repercussions, how

close are we to Heatlock tipping points and other environmental bottlenecks, and similar questions.

We don't know these answers - no human does - and as I've stated, given the absolute number of facts and assertions we've covered this semester it is virtually certain we will be wrong in retrospect about something. However, it's likely most of what we covered is reasonably accurate, and the puzzle we've assembled together will keep its general shape in coming years and decades. It's for you to decide – after more study, more observation, and more self-reflection - how our probability distribution of future trajectories, risks, and ethics matches – or differs – from your own predictions. The point is that you now have the tools and concepts to *make* such predictions, and to see the value in doing so.

Energy and economy, human evolved behavioral drives/ constraints, and the other species and ecosystems of Earth – these subjects comprise the Reality 101 synthesis. Now we're at the point of the semester where we figure out how to integrate these topics in a holistic way and come up with navigable paths, personally and for our world
So let's get into it.



First off, you were just exposed to an *intellectual* synthesis of the world situation - knowledge of the fundamental way things inter-relate. This is our global Reality, but your own reality - and how you engage with it - will likely be much more comprehensive than just *knowing* our situation. Equally (if not more) important will be your mental state, your psychological resilience, your daily behaviors, your skills, your emotional and physical health and your strategies, experience and abilities. Understanding Reality 101 concepts, as it turns out, is just one of the pieces of the wider circle that will be your personal reality – 'being' (how to live your life) and 'doing' (how and whether to try making an impact) will fill out the circle. What

follows below is a non-linear grab-bag of ideas that may lead you down some new, exciting and hopefully impactful paths on the '*being*' and the '*doing*' part of the future.

Surfing, Bobbing or Sinking

Acquiring a deeper knowledge of our human reality can seem like a bit of a mixed blessing. Once one digs a little deeper, to transcend the nonsense narratives of popular beliefs and expectations, one quickly begins to see a sharpening outline taking shape: the outline of fast-approaching *inevitable consequences* to a society based significantly *on* nonsense narratives. This clearer view isn't, seemingly, for the faint-hearted. The challenges and discontinuities facing our future can seem intractable and overwhelming, and speaking about them can put us in an awkward social limbo due to their dissonance with consensus beliefs.

So what to do? It's clear that humans don't automatically retreat from challenges. People have been making up thin excuses to climb tall, dangerous mountains for thousands of years at least. The mountains' mere existence simply challenges some of us. Yet even so, the sudden appearance of *unexpected* mountains in our path - metaphoric or otherwise - can be daunting. Their "unexpectedness", in turn, emerges as a direct consequence of our evolved modes of thinking: optimism bias, the Christmas pony effect, and a list of biases and fallacies as long as your arm.

So what hope is there? Quite a bit. We call ourselves *homo sapiens*, and sapience is definitely something we can aspire to. Part of this is learning how our own brains work, and why. As we start down that path, it quickly becomes clear that the

"feelings" which evolution built into our core brains in the deep past are a mismatch with the human existence which confronts us today. And that includes "feelings" about scary futures, which are anchored on very subjective standards.

If magically transported above the arctic circle to a landscape of ice, snow, wind and sea, a person from industrial society might assume they had been given a death sentence and simply sit there waiting to freeze, while an Inuit placed in the same situation might consider it a beautiful day filled with promise.

Alternately, finding oneself a quarter-mile offshore in huge breaking ocean waves would strike many people as a hellishly hopeless situation; but a body-surfer might consider it one of the best days of her life, and the best place in the world to be on that day.

That is, there are far more situations which *seem hopeless* to us than there are situations which are actually hopeless. This has much more to do with the way we think, and the extent to which we understand the situation we find ourselves in. The thing which makes us feel hopeless is not having mental tools for dealing with situations that seem novel and threatening.

There's no particular physical difference between an Inuit, a surfer, and an office worker; they simply have worked on very different skillsets and are confident in very different situations.

The rest of this century will be a lot like what a surfer experiences: constant change will increasingly BECOME the landscape, but in ways which can largely be anticipated, and which obey physical law and deep drivers of human behavior. This will tend to throw existing advocacy, activism and accomplishments into turmoil, because those are largely predicated on continuation of the social, physical, governmental, and monetary infrastructures we have become accustomed to and consider stable. However, it could also – in principle – provide huge leverage for those who learn to surf those waves of change.

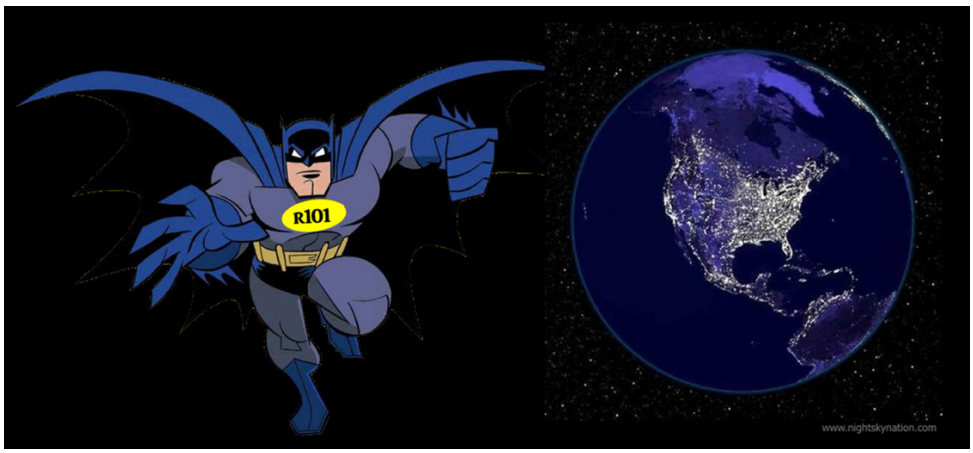
Big step back. *Why am I teaching this class?* The initial DECISION to teach it was because I (and DJ) feel strongly that the synthesis story is vitally important to the way things may turn out, and hope to be able to communicate it effectively. If we can do that, then a few out of each group of 20 students may run with this stuff in their own ways – ways that could makes significant change on our environmental and social issues. That was the goal. But once I put my "teacher" hat on, that is no longer the (sole) objective. From the first day of class until the final lecture my role is to better equip you all as human beings for the cultural transition(s) ahead of us. That is no

small feat - as my voice is but one of many in a cacophony of chaos in a busy college life, and a voice that is saying things which are not always easy to hear, and not immediately obvious how to implement.

The coming Great Simplification and its peripheral events will be like nothing we've experienced in many generations - if ever. Some people will be shocked and overwhelmed by news and events into frozen inaction. But others will navigate the ups and downs with aplomb, while moving events along the way. It's my hope that going through this class will at least give you adequate 'treading water' capabilities, and perhaps for some it may be like providing a metaphorical surfboard.

So, if you follow the surfing metaphor, the following pages are something akin to a "Surfers Guide to the 21st Century".

The *Superheroes* of the 21st Century



One of the things I (NJ) will never forget from traveling is that in the poorest countries, most stricken by disease and hardship, where you would expect children to be sad and miserable, I encountered the happiest, most genuine kids I've ever seen anywhere. In Zambia, in cities where there was 50%+ HIV/Aids and incomes were less than $100 per month, the children beamed at me with ear to ear bright smiles. In poor forest villages of central Ecuador, the children worked hard, but then also played hard, about 50 of them sharing one soccer ball, kicking it around the village and encountering various chickens and obstacles to laugh and remark about. What did these young humans have in common? And what did they have different than most American children (and young adults)? *They had an understanding of their reality and the reality matched their understanding*. And so they found time for joy and play and work and discovery.

A few of you might now be asking yourself: '*how can Nate be so mean and teach me all this sad and scary stuff*"? As I warned the first day of class you might be simultaneously thanking and cursing me well into the future for opening your eyes to view the modern human enterprise with Reality lenses. But it doesn't really have to be scary or depressing or ominous – the scary part is the DELTA between what you (thought you) knew and what you now understand. If all Americans were taught about reality the way a Zambian or Ecuadorian child was, then what we are experiencing right now would just be another challenge to navigate, with zeal and passion, as opposed to a near paralyzing mountain of dissonance from what our cultural beliefs are. It's not that Reality is so bad – it's that it differs dramatically from the cultural stories we're being told, and have been told since we were born.

It's probably pretty clear by now that the gene-agenda "business as usual" scenario, unmodified, could result in simply awful outcomes. Continuing as we have, extracting and burning flammable fossils and pursuing relative wealth, will wreck the oceans and climate right about the time we run out of most physical wealth and start engaging in the energy "poverty wars" which may quickly turn nuclear; with the aggregate potential of ending the experiment of human civilization, and with it perhaps the "age of mammals" as we have known it; all within the lifetimes of a child born today. So with that as the "Plan A" perhaps it would be worth facing a bit of angst for a better "Plan B."

Modern environmental efforts are flailing because both the story and the 'ask' don't go deep enough. Scientific articles about OA or climate or biodiversity-loss spend 98% of the article/movie painting a picture of how bad things could soon get and then 2% in the conclusion saying 'the time for bold action is upon us'! The bold actions implied are usually run-of-the-mill capuchin-pleasing social dynamics – that resolve dissonance but accomplish little. Your authors think the time for bold action was many decades ago; now is the time for desperate, sincere and creative action, undertaken with discipline, focus, and seriousness.

If there were to be such a class as Reality **201**, it might be a course designed to assist Reality 101 graduates to become real-world catalysts who can put all the stuff they just learned into useful practice. One doesn't win a chess tournament playing with checkers rules, and today's universities are churning out no shortage of very-bright graduates who have very little idea about the realities which will shape their future and that of their country (and planet). The world doesn't really need more of those types of college graduates but does need more superheroes and catalysts - persons with qualitatively-greater ability to affect events on all scales than most people do.

Perhaps the biggest focus of R101 is the nature of human blind spots and systematic errors about how the world actually works, how and why the things around us actually happen. Not all R101 graduates will choose to personally engage with the "great challenges" of human futures, but even those whose life-course is largely unaffected may still find themselves just a bit more "super" in terms of their level of awareness and planning, and this may help shape their expectations and their future prospects, that of their families, and of their communities. Just as humanity is no longer surprised by hurricanes due to geosynchronous weather satellites, incorporating a top-down integrated view of reality can prevent unpleasant surprises in many ways. Now that we're used to weather satellites, few are depressed by the ability to predict, monitor and chart hurricanes. It's a good thing, not a depressing thing, even if it does cause us to "think about" hurricanes more often than we otherwise would.

In the below pages are some of our current thoughts on how the integration of Reality101 principles – especially with insight and effort into your brain's workings and potentials - can improve your own lives and contribute to Good in our modern societies and natural world. For all we've learned about human behavior, it should be clear we - as a species can't 'change' our basic natures. But it is now possible to use our knowledge of whence we came and how we tick, to steer events – in our neighborhood, in our city, and perhaps in the forests of our region, and just maybe in the azure bays in an ocean halfway around the world a thousand years hence. Minnesota, the United States, the World, and the Future could all use some Superheroes about now…

Part 2 -Getting Used to your new 'Reality Lenses'

In the movie 'They Live', Roddy Piper puts on some magic glasses and suddenly sees the hidden messages that were all around him, but when he takes the glasses off the "cultural spell" returns. In a similar way, you now possess the '*magic lenses*' to see the world through new energy, environment and human behavior/cognitive bias filters. Though it will be intense and scary at times to see reality this way, it is akin to looking 2-3 cars ahead in a snowstorm when conditions are dangerous – such

foresight will not always prevent an accident or predict events with 100% certainty, but by using these 3 lenses you're much more likely to properly assess what's going on.

Your now each have several pairs of new lenses which can help you view our world with different insights and different focal lengths. The ecological lens obviously has the longest timeline. The energy/economy lens is more intermediate in the distance it sees. And the evolutionary psychology/human behavior lens is for "up close" daily interactions with other human beings – and with yourself. What follows are some suggestions on how using your new prescription might lead you to different routines and decisions than a 'monetary' or 'what they say on TV' lens.

The Consensus Trance Lenses

Wearing the same lenses as everyone else can be problematic when it comes to understanding the way the physical world works, because – (wait for it) - *most people don't.* So instead of having a scientific worldview, we believe what conforms to what our ingroup believes. Take two kids: one lives in rural Iran and one lives in rural Alabama. Just by knowing this one fact, we have high statistical odds of knowing what they believe about the fine points of the universe's history and future.

Modern economic theory believes humans are independent arbiters of fact. If so, it's a freaking amazing coincidence that everyone believes what their friends believe. And it's not just their friends who influence them.

Our minds are biologically and culturally pre-programmed to conform. This leads to some enormous blind spots which we grow up entirely unconscious of, constantly reinforced by the cross-checking validation we do with those around us, through body language, imitation, verbal inflection, and frequent communication. If you happen to find yourself in a room full of fools, it will be your strong inborn tendency to conform with them. *(combine this with the capuchin-like "fairness imperative" from the Gene Agenda and you have a recipe for democracies which do dumb stuff).*

These tendencies made for kick-ass aboriginal tribes which functioned as an effective superorganism. But now that we're living in groups of thousands, millions, and billions they tend to "damp out" creativity and novel thinking while enforcing conformity with existing consensus belief systems and the "status quo". In fact, the reason which many of the problems we face "feel impossible" is that they would require individuals to violate consensus norms and "be different" in some ways in order to accomplish them.

In effect, our evolved default lenses are "unicorns and rainbows", which is to say magic and optimism. That's really fun to believe as kids, and while we stop believing in literal unicorns as adults, most humans cling to our figurative unicorns; the myths around which our social consensus is constructed. There's nothing wrong with looking through such lenses, but there's a time and a place to change them...

…With the Simplest Changes

For some of you, winter break couldn't have come any sooner. The content in this class was a sledgehammer and you are going to be happy to get far away from it and back in the warm cocoon of Christmas and conventional societal distractions. And. That. Is. OK. Normal even. (For us too).

You can still hold a positive view of the future, get a good job, stay in mainstream society, and ensconce yourself in the excitement and fun that 20-somethings usually do. But while still wearing the happy pink tinted lenses, you can remain 'woke' to the issues raised in this class. You can't help but know about energy, behavior and global ecosystems at a deeper level than most of those around you. You have a huge advantage in life because you understand these things, but that doesn't mean you have to think about them 24/7.
History tends to roll ahead slowly in our subjective experience. People who were kids during the "great depression" mostly don't remember any great depression, because everything was normal to *them*, and life was dealt with a day at a time. It will for the most part be that way going forward, with the "Great Simplification" still invisible to most people, though you'll see it as the mover behind events.

When you find people who are open to discussing and learning about these issues, engage with them, befriend them. When, one day in the not too distant (but perhaps plenty distant-feeling to a 19 year old) future, the Great Simplification begins to more obviously unfold, perhaps you'll have had time to process the content in this class, and in this essay, at a more personal level and will have thought about productively engaging with it in some way. Perhaps at that time you can emerge as a 'sleeper' and contribute at a time when the world needs your knowledge.

In the meantime, you might consider being a closet ambassador for sanity on some of the core issues raised in class. You now know the drivers and constraints that your modern stone-age mind possesses. Me vs Us, Us vs Them, belief, habituation, focus on the present, empathy, creativity, knowledge-of-what-has-come-before, etc. As Paul Ehrlich mentioned in class, human culture and reaction to events has and WILL change very fast in future – how it changes and where it settles is an emergent property of the people dancing at the time when the music is temporarily halted. Do dance moves that accentuate the brighter side of our natures. The world has changed with less. In an effort to be human, ***BE REALLY HUMAN*** in the best sense. Then dance to the various tunes that life will present.

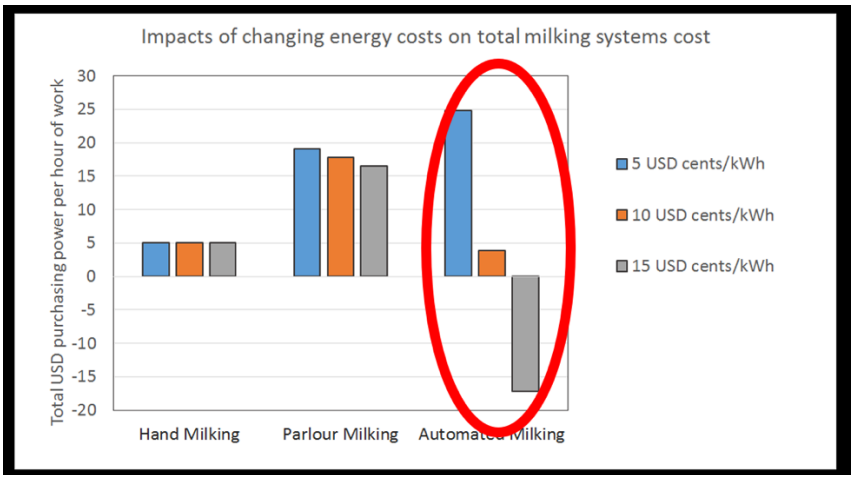
Seeing the World through the Energy/Economy lens:

But there are many other tints of glasses (other than pink) that were handed out in this class. Here's an overview of how you might view your future and the human economy with your new 'energy' lenses.

Recognize the Surplus around you.

Whether you think in terms of EROEI (or prefer TaaL's term 'Derr'), seeing aspects of our world as products of energy surplus can help inform decisions about what may prove viable in your own life, your community, or your country and world. (As well as what might *not* be viable). We are living during a period of enormous energy surplus. As we allocate a greater percentage of our economy towards energy procurement, this implies smaller surplus available for marginal pursuits. Allocating energy (and time) towards its best use will be important.

***Use energy foresight* –** As we recall from the milk/technology example, higher energy costs don't adversely impact low- and intermediate-power situations all that much. But processes that have high energy intensity (fully automated milking in above graphic) are extremely sensitive to higher energy costs. In a similar way, your personal universe will be sensitive to higher energy costs in coming decades based largely upon how energy-dependent your lifestyle is. Large homes or vehicles, long commutes, long-distance relationships (unless you embrace intermittent embraces), and complex energy-intensive gadgets and infrastructure will all require more energy (and in turn, more money) than simpler, more flexible arrangements. Avoid highly energy-intensive lifestyles and behaviors and you will tend to avoid energy-related consequences.



***Notice and invest in Real Capital* -** The first thing that Reality glasses will highlight is that money is just a marker for many of the things you really care about. The financialization of the human experience in the last 70-80 years or so has obscured this fact so it's not always visible. On your journey to redefine what

'wealth' and 'success' mean to you, think about creating stronger tethers to natural, built, social and human capital. And invest time and resources accordingly.

****Recognize and minimize meaningless consumption*** – Once you internalize that the "wanting is a more intense sensation than the having", this gives you great power (in theory) over your purchases and consumption profile.

****Towards TRUE FREEDOM***: If you have the discipline, try a goal-oriented voluntary simplicity, with a far lower consumptive footprint. The benefit of this ISN'T that you consume less, that's an aesthetic consideration which ultimately makes little difference while our current economic system remains the same. Thus, in and of itself, it's just a lifestyle choice. The real potential benefit is that you can – in principle - use the money you save thereby to fund your own ongoing primary career as a self-directed steerer of events, or do anything else that has meaning to you. Most people live near the limit of their means because that's the social signal they get from those around them, and a way to signal status and inclusion. *Yet there's really no reason to do so.* Most people, by the time they're 30, are well-enmeshed in a hierarchy of financial and time commitments which preclude much freedom of action. This means they need to worry about keeping a job they may not like, doing right by their 2.5 kids, waking before the sun rises to commute in traffic, and be constantly afraid of losing what they have. Such folks will have little personal flexibility as the economy begins its 200-year process of simplification, and few moments to spare for thinking of issues outside their own crisis management. However, for those who learn to live and be happy on absolute wealth, those times needn't mean a decline in lifestyle. This course of action is available to pretty much anyone in America; you don't need to be born rich, have connections, or be brilliant. You don't need to wait for some windfall or lucky break. You just need to teach yourself a bit of discipline and not allow your hedonic ratchet to by hijacked by social imperatives which aren't imperative at all... they only "feel that way" due to your evolved programming.

****Don't just stand there – be useful***. In the future you will have a choice to be active or passive with events. If you choose to, your knowledge of systems and synthesis can make you invaluable to those around you. You can help them learn to prepare for the long energy downturn and its accompanying fiscal storm clouds. You can learn skills which will have pragmatic value to your family, neighborhood, and town. And you will likely understand what's going on better than those around you. A "Reality MacGyver". Pick some skills you already have and refine them – whether its cooking or "small engine repair" or music or computer programming or being a good listener. The point is to actively be useful, as opposed to not.

****Localize and regionalize supply chains*** – the future will be a lot more local, as globalization driven by essentially-free energy progressively slows down. As the

world becomes a much larger place again, national and regional economies will increasingly disengage with far-flung trade. If this is planned for, it needn't be a problem. If it isn't, there will some very rough adjustments. Having shorter (and lower-carbon) horizontal and vertical supply chains will be the needed trend.

****Help create cross-generational technology – not stimulating gadgets*** – We're near the all-time peak of net energy use – meaning that we still have great ability to make the energy downslope less traumatic for your generation and those to come. We can invest energy to terrace fields for non-mechanized farming over the coming thousand years, can make dwellings which don't have to be rebuilt every 60 years and which passively retain heat in the winter and coolness in the summer. We can rebuild canals, build out low-energy electrified railroad networks. We can build the low-energy infrastructure we'll need. But our societies currently aren't doing that, because those societies are effectively delusional about energy and most other things, and expect our current wealth and "growth" trajectory to continue increasing indefinitely. We need to shed the fantasy of the "future rich" and realize that the people of the future – including our older selves and family members – will not have the many invisible energy slaves we now take for granted, or for that matter the human wage slaves on the other side of the world who are now making most of our stuff, delivered to us by nearly free energy. The decisions made, and actions taken, during your productive lives will make a huge difference in what future generations experience.

****Become more flexible and adaptable*** –In a world of declining surplus and uncertainty, reducing the complexity in your own life probably makes you more adaptable to change. This goes beyond energy and monetary changes – and crosses over into the psychological aspects – consider a NTROPI *(neutrotransmitter return on Personal investment).* Simpler, for many reasons, is probably better.

Get to know an "energy slave"

As we've discussed, energy is mysterious thing, more a quality that stuff has rather than being "stuff" itself. The essentially invisible nature of energy has made it an easy fit for one of humanity's ubiquitous blind spots, which is why energy illiteracy is the norm even among high-status highly-educated people. If you think about it, the inability to comprehend energy and its ramifications is behind *most* human confusion about what the future holds.

For instance: **baseload power**. That's the current societal distribution system, supplying essentially unlimited amounts of electricity to any individual at any time, on whim. The main reason that things like "solar PV panels" can't fully power today's civilization is that they produce power when the sun shines, and with a high degree of

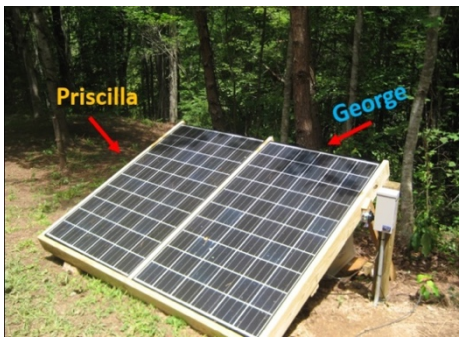
intermittence. They may produce a lot of power on Tuesday, but only a fourth as much on a cloudy Thursday two days later. This would seem to imply that humans will always need to burn fossils, or to build humongous energy-storing batteries somehow, because how else can baseload be maintained?

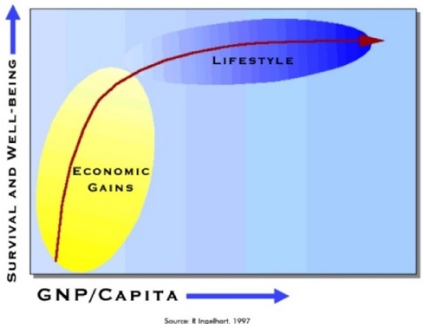
Well of course there's a basic fallacy in play there. While some things, like industrial production of solar panels, do need uninterrupted power for some parts of the process, we really don't need huge baseload to exist as humans. Heck, we don't inherently need exosomatic energy at all. Once we have well-designed houses and clothing and blankets and stuff, our actual needs for wattage are pretty minimal. High energy draws are in many cases a "supernormal" stimulus we've gotten used to, like watching it snow from a steaming back-yard hot tub in the dead of winter. That's a fun thing to do, but it's hardly an absolute constraint we should design our energy systems around.

Have you ever spent a month camping, with only basic food? What you find is that a healthy human can maintain a high quality of life without baseload power, without luxury food, without the internet, and without any real-time fossil slave magic needed. Indeed, many people who spend a month that way later consider it to be some of the best time of their lives. Intermittent access to food, water, electricity, communications and commerce is what we're evolved for. Moreover, having re-set one's hedonic ratchet with a month in nature, one can then deeply appreciate simple luxuries like clean flowing tap water, a shower, a good rocking chair, a cherry pie, or a party with friends. The fact that we don't need the stuff we currently demand, in order to be happy and healthy is the best news there is. It means that while the net energy our societies have will be dropping for the rest of your lives and long after, this doesn't mean that quality of life can't improve at the same time.

So how best to come to some sort of reasonable balance with the lowered number of energy slaves in your future? We recommend that you start by getting to know one up close and personal.

Conjuring up a personal energy slave





Here's the deal: you get the most benefits of electricity from your first hundred watts. After that, it's all rapidly-declining returns. The difference between "no electricity" and 100 watts is huge: potentially communications, lighting, cooking, refrigeration, and much else. The difference between 10,000w and 10,100w is essentially negligible in terms of an individual's life-quality.

The nature of energy use in today's society is that we can use 10,000 watts of electricity without seeing or otherwise experiencing the heat and combustion products necessary to supply it to us, which might be 30,000w or more in combustion energy from burning fossils. Yet our "hedonic ratchets" are set by having high energy consumption for marginal increases in subjective convenience. Our cultural obtuseness about energy means that we don't even think about the fact that – since it's finite - we're depriving future people of their basic 100 watts, as well as the climate and ecosystem which they would have been able to depend on.

Here's our recommendation: build yourself a small solar energy slave system and get to know its personality, what it can and can't do, what it costs, and how it works. If everyone did this, we would take a large step forward in energy literacy. Moreover, it could provide not only skills but a useful degree of resilience which could come in handy going forward. And it's fun, really.

You can do it with a single solar panel, say 100 to 200 watts, mounted in your yard, on your roof, on your doghouse, or anywhere the sun will hit it directly. You won't need permits because it won't be wired into the grid. To that you'll add a cheap charge controller and a 12v battery, and a small inverter to make that into AC power. The budget will be a few hundred dollars. The result will be a nice little energy slave which, when the sun in shining, can kick out as much energy as the legs of a human athlete, without getting tired.

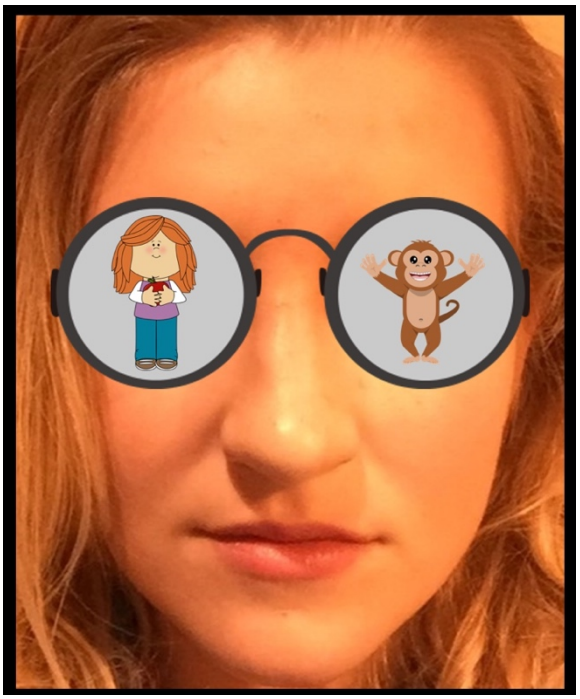
With such a system you can charge your electronics, run a stereo system, cook (within reason, no turkeys) with a microwave oven, run a small refrigerator, pump water, power a fan to cool you on a hot day, or do anything else with modest energy requirements which comes to mind – just not all at once. And if the grid goes down, your system will still work, unlike all those houses you see covered with grid-tied solar panels, which go down when the grid does. Those people will be coming to YOUR house to recharge their phones!

A system like this can be a good primer in thinking about energy flows, because you probably can't run the microwave and the freezer at the same time. Then again, a freezer has thermal inertia, and will stay cool just fine when powered intermittently, even overnight if it is well-insulated. LED lighting doesn't use much power, and won't drain your battery too far at night. Modern computers don't have to use much power... this essay is being created with offgrid power from a very similar system (only with a few more panels) running a mac mini computer on a large low-wattage display, with no energy storage between the surface of the sun and the written word. However, you do have to be conscious of whether the sun is shining, the state of charge of your battery, and what things are "on" at any given time. It's less automatic. Whether that makes it a pain in the butt, or more fun, is an individual choice. But clearly, it's possible. Baseload is not an inherent human need.

Once one has picked up a few tips on lower-energy lifestyles – and has gotten to know a small energy slave's *personality* – intermittent "renewables" can be seen for what they are; a miraculously cool thing, and what they're not: a way to keep baseload happening indefinitely.

To our ancestors, 100 watts of power would have been like a genie in a lamp, granting many wishes every day. If we have fewer energy slaves going forward, and our kids and grandkids have fewer still, that doesn't mean they'll be doing badly. It may just mean less energy wasted. And they may appreciate it if we start practicing energy moderation before then, because you *can't* run an air conditioner on 100 watts, even if you need one.

Your Pleistocene Lenses – Turning Brain Bugs Into Features



We evolved. And just like our eyes, muscles and feet are products of evolution, so are our thought processes, mental modules and prepared social learning. *If you understand only this about yourself and others, you have more insight into human-human interactions than the majority of our species.* But can you use this to your advantage?

In the past, humans have had little to work with but the subjective experience of existence: our brains came without user manuals, and what it "feels like" is going on is often nothing *like* what's really going on inside them. It feels like our virtual worlds are a seamless representation of the world we perceive around us: in fact, our brains assemble an imaginary "user interface" for the physical universe out of whole cloth, with no more absolute correspondence to physical reality than the icons on a computer screen have the billions of microscopic transistors, electron flows and magnetic fields we are interacting with when we use a computer. These virtual worlds have humongous "blind spots" which evolved to be a good fit for "savannah-salience", the things which worked best for a tribal primate in Africa, and which defaults we still inherit.

It's only in very recent years that we have understood the way modular mind has evolved to function in humans. Every human mind consists of more recent layers added over ancient layers, and all these contain specialized modules running constantly and without subjective effort in the service of special functions and purposes. The deep/stupid layers like the limbic system are the root of all our most powerful feelings, and of behavioral rewards and punishments for hewing to or departing from the genes' agenda, while the more recent layers are involved with socialization and the manipulation of abstraction.

What we each seem to experience is something like being a small conscious "pilot" riding somewhere behind our eyes, making the executive decisions for the body and person. That's not what happens, though. There is no such unitary executive 'self';

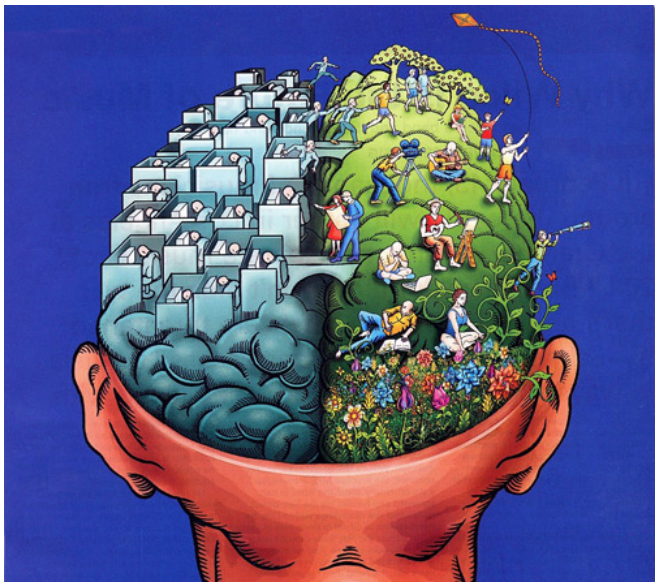
rather, that's part of the (relatively) seamless illusion. In fact, there are thousands of voices clamoring in any given head, but only a few systems which can interact with the outside world. Ancient modules may no longer have positive survival value, but they retain their deep connections to motivation and feelings which the conscious mind inherently lacks. The left cerebral hemisphere is the only one which can talk, but without the input of the separate individual in the right hemisphere, many of its perceptions would be altered.

We evolved a self-regarding module, and a related "public relations" module, which give us the ability to think of ourselves as though "seen from outside" and compete more effectively as social beings. As it normally functions, this system creates and continually updates a "personal storyline" of ad hoc confabulation to explain our decisions and actions. It's "ad hoc confabulation" because the "conscious" module has *no access* to understand why the other brain modules – some of them a lot more powerful, others more deeply connected – made a given decision.

Yet our experience is of unitary consciousness and a seamless perception of world. This illusion is so robust that one *doesn't even notice* if the link between cerebral hemispheres is surgically severed, much like the blind spots in our fields of vision where the optic nerve connects to the optic disk. Do you see blind spots in your field of vision? They're there, but the illusion is that they aren't. Indeed, your eye only sees a tiny part of the scene in front of you, the rest is assembled in memory from tracking samples. In such a way, our entire experience of conscious existence is separated from the physical world by huge blind spots which made no difference to a tribal hunter, but could matter hugely to a world-controlling species. We need to learn, in the words of a prominent brain researcher, to take our perceptions of the world *seriously* but not *literally.*

Evolution got us to where we now are. It's an irony of reality that our evolved minds must now learn to detach in some ways from their evolved default feelings if we are to continue the experiment of human civilization and science. Indeed, it's our evolved defaults which have put us into a series of nested predicaments which require extraordinarily fast cultural evolution to not destroy our environment, our cohort species, and ourselves.

Getting to know your Modular Mind, and Strategies to make the best use of it



"Intra-skull *realpolitik*" refers to the development and learning of new sorts of self-awareness, methods, and techniques to take the evolved brain you were born with and bend it into the service of rationality, ethics, and logic as consciously decided by the formerly-subservient "self-aware" social modules; while retaining the deeply-meaningful non-rational aspects which make human lives worth living. This is necessary because "**following our feelings" is what got us into various messes. In our current situation, it's a recipe to be overweight, overpopulated, over-stimulated, overmedicated, and passive in the face of dire situations which don't directly trigger the strong motivating emotions of the limbic system.**

It feels good to do what feels good. That's a truism as well as a tautology, but it has sufficed as a core philosophy for many people. It would seem the corollary to that is that departing from "feel good" brain rewards will make us feel bad, but that's only true in the short term, because we can learn to change the things we get brain rewards from, bringing our other modules and the deep stupid powerful systems of our core brains in line with our conscious preference. Your authors will be speaking here mostly from personal experience, but we expect this subject with a funny name to have a bright future, if humans are to have much of a future at all.

Social points or environmental stability?

Earlier in the semester we learned about how our brains are products of conserved 'circuitry' which contributed to our historical survival. Modern brains now have a 'neo-cortex' which can process facts, create science and intuit abstractions about our future. But these thoughts and feelings – arising as they do from a relatively new part of the brain - are not as intense as the routines of resource acquisition, social rank, and short term focus whose time-worn ruts were present from the beginning.

A case in point. Everyone in this class is worried about the long-term effects of CO2 and pollution on the oceans and our ecosystems. As new information comes to light we are eager to share it with our friends, families and colleagues – 'Look at this! Something isn't right about polar temperatures this month! We need to change our behavior!' *(expecting of course that OTHERS will be the ones to change).* When it turns out to be a false alarm, and that our environmental situation – at least for the day – gets a reprieve, those who have shared the scary information widely feel shame and embarrassment for having called attention to something extreme that didn't occur. This is a perfect example of modular minds in action. Our social status module gives us a much more intense reaction than 'the polar ice cap is melting while we are alive' module. To any other of the 7.5 billion humans alive and any number of billions that will live in the future, one person's social status alteration from being right or wrong is completely irrelevant next to the monumental changes underway in our natural world – but to the one individual in question, it doesn't 'feel' that way. Different parts of the brain – *wanting to be right – and caring for the environment* – both active simultaneously (*a majority of French citizens currently support both reducing CO2 emissions and the Diesel riot protests).* Odd combinations like this, that make us 'root' in different directions, occur every day.

What's going on here?

Embrace your modular mind

So as long as we're stuck with having triune brains with evolved modularity, we might as well make the best of it. Get to know them and coexist peacefully, figure out which systems should never get their hands on the metaphorical car keys, and deal with the uncomfortable fact that our stupidest and most primitive modules – those we share with reptiles - have the greatest influence on our emotions and motivations, while our more rational impulses have no direct line to emotions or motivations. To realize that the brain's "behavioral rewards and punishments" such as neurotransmitters are doled out to reward a brain for doing things which may no longer, in the 21st century, make any sense. To recognize that a helluva lot of physical reality, and its very nature, is invisible and counterintuitive to us but will determine the fate of humanity's future.

Realpolitik: A term to describe or prescribe politics based on strictly practical rather than idealistic notions, and practiced without any sentimental illusions

We refer to this process of coming to an accord with our internal entities as "*realpolitik*" because we are unable to overrule the brain's defaults by sheer force of will. The conscious/rational subsystems of the mind will lose that contest in the short term every time. Rather, one can engage in a gradual process to bring them into line with one's ethics and scientific/rational awareness, which is more like congressional lobbying or wild-animal training than it is like using "will power". The result can be worthwhile: it's possible to train your brain to "feel good" about things it didn't originally "feel good" about, and "be averse to" things it formerly had no interest in. One can also enlist the connections to the deep mind for motivation, bravery, and dedication to your chosen goals, while continuing to enjoy the emotions which have little to do with logic and science - like pride, love, meaning, self-respect, feelings of reverence and spirituality, and joy - *without* having them conflict with your rational agenda. Since this is an unnatural thing to do as far as a brain is concerned – like learning to play a harpsichord – it's gradual and subject to continuing improvement throughout a lifetime. But knowing the way your brain actually works is an advantage people never had in the past, and should help with insights.

"Go down into the crater of Sneffels which the shadow of Scartaris touched before July. Then you'll reach the centre of the Earth. I have done this. - Arne Saknussemm."
'Journey to the Center of the Earth' by **Jules Verne**

Making oneself useful to the future – your own or the world's - involves becoming at least quasi-sapient, and this requires self-awareness far beyond the simple test of mirror self-recognition which today tests for that basic benchmark. One needs to be

self-aware of the way their mind works, and learn to experience those modular parts working in different ways. **That is, to see oneself not as others see us, but as others can never see us.**

There are deep parts of the brain which are powerful, simple, and stupid. These can give you great power of will or take it away from you. They exist on their own terms and follow their own skewed logic, wild animals you can never domesticate, but which you can come to an accord with, the way you might if you had to share a cave with a grizzly bear, several wolverines, and several dozen screaming monkeys, all deranged in such a way to be unaware of one another's existence - only of yours - yet still crowding one another. You need to throw raw meat to some, learn to scratch the others in the way they want scratched, learn the soothing things to calm the monkey screams, so as the weakest being in the cave you eventually emerge the dominant arbiter of the cave's dynamic, leveraging the strengths of each off the others. This is possible because none of the others actually have goals to do so, they just want what they want and are not even minimally self-aware. But their imprinting about "what they want" is terribly powerful, and almost impossible to directly resist. This means being a bit Machiavellian with them, teaching them gradually to eat and lust after different things which you provide, a semblance of their original desires packaged in a different way.

Without them in your corner, you may blog a good game but you won't do much else. It's not easy, but like climbing a mountain it's hardest before you're sure it can be done. Once you realize others have done it, it's like booking a sherpa to help climb a mountain with known trails. Of course, the standard human condition - in this metaphor - doesn't even see the mountain, much less the trails. At the very least, this process takes a lot of time alone, isolated from other humans, and a great and steady desire to tease apart the inner personalities and what they need. It's an ongoing process, and your entire life you're still working with a cave full of beasts which are in no sense tame, but which gradually learn that following the rationale agenda is the only way they are allowed to eat. Maybe not eat what they would prefer, but eat.

Avoiding Denihilism

Once one realizes that "this isn't really happening" and "there's nothing which can be done" are dissonance-quashing and effort-avoidance routines built into a human brain, and are not rational conclusions or products of logic, one can avoid them by just refusing to indulge in them (and "*indulge*" is the proper term), but there's a lot of self-reflection which goes into the ability to "just say no" to such basic routines. Of course denial and hopelessness seem like opposites but they really aren't: they're peas in a pod, both serving exactly the same end of rationalizing inaction. That's why one of the best ways not to fall victim to them – and many other such pre-programmed routines – is to spend some time owning "who you are", and to be always aware that you are a brain (and body) doing something different than what it evolved to do. The measure of your individuality is the extent to which you can take what you were born with and do something extraordinary with it.

It's hard to avoid dissonance-reducing rationalizations without being aware of what they are and how they function in one's mind. Thus, there exist a number of quite intelligent science-based people who find pleasure and social status/fulfillment in blogging about the futility of trying to alter future planetary outcomes. This means that not only are *they* not trying to do anything useful to steer future outcomes, but they're actively evangelizing the very monkey trap they've fallen into, becoming a part of the problem and making things worse. Of course, they are able to rationalize to themselves that since the situation can't GET any worse, they are doing no harm. Once you go down that path, it's like eating the mythical lotus. One can grab an illusion of moral high ground and get social stimulation and status without doing anything difficult or uncomfortable, functionally equivalent to those who deny the same problems exist at all. Ironically, many such folks profess abhorrence of the situation they are helping "lock in", but they have abandoned rational attempts to direct their minds; their urges predominate and they learn to enjoy their tapeworm-like social niche.

If one sees denial and hopelessness/nihilism as two sides of the same coin - two faces of the same dissonance-reducing heuristic - they can be avoided along with the other

"gotcha" biases and fallacies which can make an otherwise rational mind worse than useless. But those who fall into this trap become an "attractive hazard" which can pull in others.

Creative Personal Abhorrence and Delight

In the previous section, we mention the term "creative abhorrence", which – as you might expect – is another term we've created as a part of the new language which becomes necessary to deal with hacking a caveman brain to be effective in a changed world. It's a minor tactic in the scheme of such things, but is one which is fairly easy to describe. So let's unpack it just a bit more here:

It can be a struggle to contend with the gene agenda successfully, and consciously do something important for the future, whatever that may be. Our gene agenda isn't made for the future, for other people, or for other species. It was designed by actions taken in past "nows", which just happened to increase reproductive odds in the contexts when then prevailed.

Still, that doesn't mean it's impossible to do, or even all that difficult. The problem arises when you repeatedly conduct an arduous decision-making process, weighing the pro's and con's over and over again. If you repeatedly roll the dice of "*persevere*" versus "*give up*", it becomes inevitable that you'll eventually decide to give up. Las Vegas skyscrapers and successful insurance companies have been built because of that entirely predictable "aggregate probability" outcome.

This is a familiar experience to dieters. If there is a carton of Haagen-Dazs in the refrigerator, then every time that door is opened, there's a decision tree on whether to "just have one spoon" or not. Even the strongest-willed person is going to have a

moment in which they're feeling sorry for themselves, low blood sugar, weak willed…. and that ice cream disappears in a frenzy of ecstasy and quick regret.

The easy fix, of course, is simply not to have the ice cream available, so those "Chunky Monkey" or "No Chunky Monkey" dice don't get rolled so often. (That's a good reason never to grocery shop while hungry.)

A person may agonize for years over whether to eat meat or to be a vegetarian, however, once that decision is made, future decision trees are greatly simplified. A person who self-identifies as a vegetarian does not re-engage the tortuous decision process each time they go to a restaurant or a supermarket. Rather, they have chosen to limit their spectrum of choices through the effective use of negative associations, which constitutes sort of a "learned invisibility" regarding those things, a self-made perceptual blind spot. When this is done ahead of time, with a plan and strategy in mind, your authors refer to it as "creative abhorrence".

If you ask a vegetarian if they want a bite of steak, they will generally show a look of distaste on their face, because the easiest way of converting to vegetarianism is to train yourself to be disgusted by the thought of eating flesh.

And you've experienced it too. What do you think about cannibalism? Nothing predatory, just eating some person who died accidentally, and whose wallet donor card instructs that his body not go to waste. Presumably, just now you didn't go through a long checklist of pro's and cons of whether to chow down on this hypothetical guy's mortal remains. You immediately thought YUCK, and that was it. In fact, human flesh is reputed to be quite tasty, but there's a general cultural agreement that it's disgusting to eat "long pig", and this disgust (which you're probably feeling right now) is so effective that in most parts of the world there are no laws against cannibalism. They're not needed, because abhorrence is such a reliable inhibitor to human behavior. A negative feedback speedbump thrown into the positive feedback human dynamic of consumption. Such speed bumps – and catalysts - of human behavior can be useful when negotiating reality with a primitive, modular mind.

"Creative abhorrence" is one useful way of exercising "free won't" in reprogramming ones own behavior to fall in line with the agenda of who you choose to be, rather than the generally more despicable and moronic default agenda of the gene. The rationale is the removal of the constant "roll of the dice" on many daily behavioral decisions which cause most people to take an easy, boring, self-indulgent and ultimately self-imprisoning path through life.

Lest this sort of tactic sound “abhorrent” to you in and of itself, we’ll note that any “abhorrence” quickly becomes entirely subliminal. You don’t actually visualize yourself eating some other human when you think of cannibalism; you just don’t “go there” in your mind and can rely on the “deep associations” of your non-rational core brain to enforce such a rule without your thinking about it, so there’s no stress and no temptation. This is the case for many vegetarians as well.

In addition, one can also establish “delight” associations and train them in much the same way, such as the delight at saving a wild creature’s life, the delight at preventing waste, the delight of scientific accomplishment, and many other things your brain is not programmed by default to feel good about. Your brain has evolved defaults, but is somewhat plastic: you can shape its future decisions, even its future *snap* decisions, by consciously laying the groundwork.

As noted, the first thing we recommend after integrating Reality (and maybe taking some time off to recover from Finals) is deciding Who You Are. Not defined by those around you, but defined by yourself, based on YOUR choice of ethics, the things YOU have chosen to treat as sacred, and the life which, if lived, will in old age cause you to look back and justly admire the life you have lived. This can be, and perhaps should be, a secret you never share, or seldom share. A self-designed “this is who I am” is a precious gift of self-aware mind, and yours for the taking. Moreover, once you decide who you are, what that person would ignore and what he/she would engage, what to stand for and stand against, you will find that few difficult decisions will arise in life, because the “who am I” answers them for you; being true to your own principles will steer you on the path you’ve decided upon, even if the exact path is by its nature not yet clear.

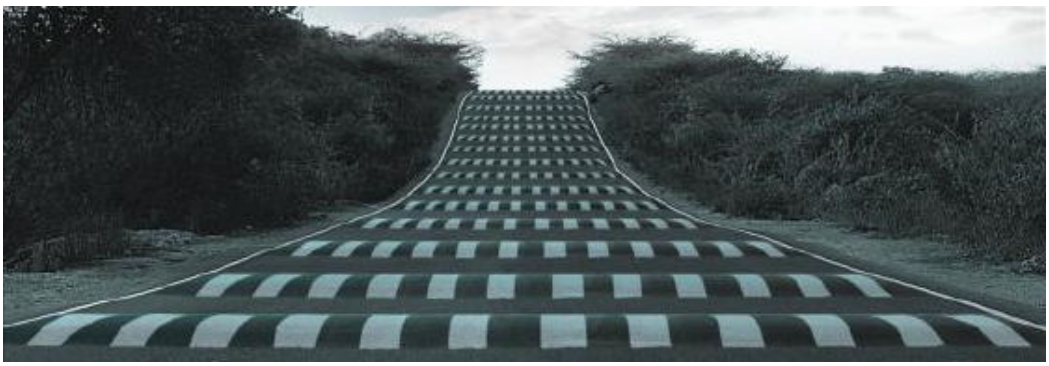
And beyond....

After that, there are many strategies for training your mind in intra-cranial realpolitik to come into line with this “who am I”, and those ways would fill a book. They include learning to recognize your own mind-modularity and the multiple personalities represented by those modules; getting to know the “invisible” parts of your mind by the suggestions they deliver; deconstructing your “PR” module’s confabulated and rationalized storyline, throwing raw meat to the limbic system to bring its deep psychological power in line with your consciously-set goals, and much else. But the creative use of abhorrence is one useful general strategy, and what we’re discussing at the moment.

As a counter-example, if you decided that you personally wanted to conserve energy as an example to others - even knowing that global Jevons effects would likely moot

most actual energy savings - you could fill yourself with guilt and angst over everything you didn't do perfectly… and face it, there would be a lot of things you didn't do in an ideal way. Add a few more socially-conscious angst-sources like "buying american" "not using the F word", etc. and you could wind up walking around all day in a continuing state of low-level free-floating guilt and angst for not being more perfect in following your own principles. This, in turn, can lead to lowered self-esteem and a decision to just quit trying. The problem here is that such a person is "rolling the dice" within the context of a dissonant decision matrix every time it comes up, rather than restricting future actions with the creative use of positive and negative associations, which your brain is designed to do quite readily. Have you ever eaten a food while feeling nauseated? You will be unlikely to intentionally eat that food again. Conversely, if you eat a new food while you're famished, you're likely to seek it out in the future. Such associations are made constantly in the human brain, and it's up to us whether that reality is going to be a "bug or a feature" in terms of your quest for sapience.

If, for instance, you simply trained yourself to associate any unnecessary energy use with the smell of car exhaust, the image of polluting coal chimneys, the pollution of formerly-pristine waterways, etc. then there is a mild distaste which can be attached to any wasteful use of energy. Not a raging guilt, but a slight counterbalancing negative to go along with the positive stimulus which comes from the energy use. This would cause you to experience relief when replacing an incandescent bulb with a low-wattage one, or just to remember to turn out the lights when leaving a room. Such creative abhorrence, planned for ahead of time, can be applied to any number of situations, habits and aspirations, and it can paradoxically make your life more pleasant because it offloads "cognitive load" issues into the unconscious and effortless "association circuits" within your brain.



A side example from DJ:

Because I decided to include similar associations in my "who am I", I ultimately found it to be rewarding to arrange my driving so I only go to town once per week, and to modify other activities in similar ways. This doesn't engender angst but some private satisfaction, because it turns out that by doing so I miss out on nothing but traffic and save a ton of time. It means I drive less than 1000 miles per year, giving my old Honda accord better effective energy-efficiency than a moped: gasoline price rises don't directly affect me. By replacing "impulsive trips to town" with a pre-planned schedule, everything still gets done and I have more time to do productive stuff.

In a similar way, my "trained abhorrence of waste" also led to an enjoyable hobby in which I do most exosomatic-energy-using tasks when the sun shines and I can use energy via generation of non-stored PV electricity matching my usage with the natural cycle of solar energy rather than expecting the grid or batteries to wastefully compensate. With many people, this would be done for social reasons, I suppose. In my case, very few people know about it and I'm writing about it here for the first time on request; because it isn't about impressing anyone, it's about the "who am I". It's aesthetically pleasing to me to use less energy, to pollute somewhat less, and do a number of other things differently than those around me, not because it saves much energy on a societal level - which is debatable - but because it simply feels better to me. That sort of mental redesign has real staying power, and utterly avoids guilt, indecision, and stress which might otherwise be associated with what could "feel like" a sacrifice. There is no "cognitive load" addition the way there is, for instance, when going on a temporary diet. Because being true to who you've decided you are isn't stressful, it's stress-relieving.

Modular Transtheism

If there's an electrified "third rail" in discussions of human mind and future, it's religion. Since this is a science-synthesis course, we've mentioned it in its correct context - a class of unifying belief systems which provide some societal and personal benefits entirely divorced from the truth or plausibility of the central stories themselves. This always loses some readers, because religion has long co-evolved with human mind. Just as our genomes consist partially of bacterial and viral sequences which inserted itself into our DNA long ago, our minds have evolved in parallel with shared mythological belief systems which are still the dominant force in human culture, and the prime conscious rationale (and rationalization) for following and channeling the "feelings" generated by the core brain.

There are clearly some downsides to this; a person who believes that the physical world is explained by the premise that the creator of the universe wrote an infallible

book, and “here it is”, is pretty well armored against a scientific viewpoint if he or she cares to be. For instance, the bible says that God promises the earth will never flood again, so that means CO2 cannot make the seas rise. End of story. This utterly negates the fact that geology shows that there never was a global flood, and that the basic science of CO2 and ice has been understood since the 1800’s. This sort of “shrugging off” of science is not practiced by all religious people, but by many you know of (and that we know of).

It might be surprising, therefore, to realize that the authors of these materials are not “down on religion” per se. Religion – or more specifically –‘religiosity’ *(the numerous aspects of religious activity, dedication to ideas, and beliefs)* is one of the most powerful forces which has ever existed to motivate humans, in large part *because* it transcends logic and speaks to the deep feelings of the powerful ancient brain-layers. If you had a religion which imparted deep feelings, motivation, kindness, and sane environmental stewardship without the outright-crazy bits like talking snakes, arks, living inside whales and similar erroneous physical-world stuff, you’d really be onto something.

And in fact, many people are using “modular mind” for religion without actually copping to it or even knowing it exists. All of us know people who both believe in a large standardized religion with some crazy stuff in it, but who also function as moral and rational people with a decent understanding of science. Modular mind is what makes this possible: they don’t just believe one or the other, *they believe both*, selected by the context they find themselves in at a given time. While such picking and choosing is inconsistent, such inconsistent standards are built in to human minds, and seldom reconciled. Such terms as “self deception” and “in denial” predate the modern understanding of modular mind, by erroneously assuming there’s only a single “real” mind “in there” which holds one belief or another. When in truth, one module may be a Baptist, another a scientific rationalist, and still another a Zen Buddhist, all happily living in the same skull because only one gains ascendance at any given time during the day.

There are many cultures in which Christianity coexists with voodoo, with paganism, with science, and presumably other beliefs like leprechauns or Menehune’s. Nobody makes that big a deal about this… that, for instance, in the Philippines a large portion of the Catholics also believe in black magic and curses. These “contradictory beliefs simultaneously held” are exactly how mind modularity works. A reason that atheists are hated is that they insist on reconciling the modules logically, which is exactly the sort of dissonance that human minds hate. Conversely, a person of Religion B is still a “person of faith” and not disliked even if a person from Religion A thinks they are as wrong about their beliefs as an atheist is. The biggest accusation that believers make

against atheists is that they're "untrustworthy", which probably derives from an atheist's lack of belief in the inevitability of divine punishment for sins. This breaks the "belief in belief" pact which allows people to coexist with large numbers of strangers they don't know. You don't care so much that the other person believes in your exact sect, but you do care that they believe in a version in which they get eternal punishment in some nasty place if they do terrible things to you. The point is, modular religion already exists and is widespread, it's just not acknowledged as "a thing" yet, and so exists in limbo.

So is "modular religion" sacrilege? Not necessarily. No less an authority than Jesus is said to have opined on the question of metaphysical versus physical issues. Physical coins for paying taxes are a physical world reality, and one should "render unto Caesar what is Caesar's, render unto God what is God's". That is, deal with physical realities like Roman tax collectors pragmatically without expecting miraculous intervention, and deal with spiritual things in a spiritual way. That Jesus (reportedly) didn't see this as a conflict with what he was saying is a good example of functional modularity, the pragmatic schism between virtual and physical worlds. Thus, in addition to atheist-Christians, we could have some powerful mind combinations: activist-Buddhists, ExxonMobil-climate activists and so on. Once we embrace our modular minds, lots of pathways that are currently closed to use because they cause dissonance and angst, open up. Homo sapiens could use such tools.

So what does this imply, going forward?

Humans evolved to believe multiple mutually-contradictory things at once. If we decide to "own" that and admit it to others and ourselves, it could be liberating, a next step in self-awareness. Indeed, it may be high time to define self-awareness as a continuum rather than a single threshold.

So let's say we, as authors of these projects, were to endorse religion, even while saying that we don't subscribe to any particular religion and that we recommend using only science and life-ethics for making physical-world decisions. Those ethics, in turn, would derive non-mythologically from simple statements about what is preferable in 4D time to conscious living beings within ecologies.

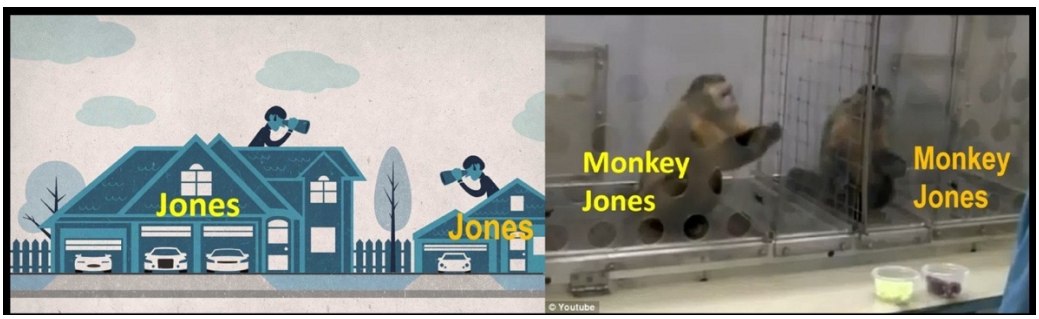
Prayer would be for personal strength and comfort, not the expectation of altering physical-world probability or outcomes. We would urge personal repudiation of the gene agenda. That would have a number of aspects, but one of them would be to choose a religion and keep it in the virtual world of magic and emotions. The pragmatic reasons for having a religion are similar to the reasons for uploading a "patch" to a glitchy computer operating system: to help it work better within the

current class of situations. The subjective reasons are that religion has evolved to fit hand-in-glove with the stable function of human mind, and provide a workable framing for nearly all of our deep feelings. In a way, a religion is a stock user interface for a human brain, to keep it from doing things which will get it in trouble or cause it to not function well.

What are the good aspects of religion? There are many: Tying together community, reducing existential angst, stoking the ego, throwing raw meat to various primate-needs for relative status, relative fairness in distribution, deferred reward, assuring punishment of outgroups, providing a free-floating rationale for ingroup altruism and lack of outgroup altruism, breaking dissonance loops on personal mortality, reducing feelings of personal responsibility and obligation, conveying feelings of tribe/family. It provides a context for ritual, for sacred values and feelings. It obviates "why" questions by replacing with "because X wants it". Without this stuff some of us would be pretty messed-up chimps.

The "holy grail" as it were, would seem to be finding a way to achieve these benefits in a way which was not ecologically suicidal to a race of billions of corporeal beings using exosomatic energy; *a situation which was far from reality when the religions initially came into being*. Religions helped make us very effective primates; too effective for our own good, as it turns out. If we can figure a way to take the best things from religion and apply them to a virtual world, and the best things about science and follow them when dealing with the physical world, Amen.

Absolute versus Relative Consumption



Another tip related to avoiding the consensus monkey trap is is to train yourself to appreciate the absolute, rather than the relative. Did your neighbor get a grape while you got a cucumber slice for the same task? Did he get a sports car while you still drive an old Honda? You could scream, you could attack him, you could resent him,

or you could make yourself unhappy about your relative privation and lower social status.

But really, why? Those are all deep-brain defaults which evolved to ensure your survival within a tribe existing at subsistence level on the plains of Africa, in which situation unfair distribution might actually endanger your existence. Those tribes no longer exist, and driving around in a Honda – even if it no longer has "new car smell" - pushed at high speeds in the snow, uphill by uncomplaining fossil slaves is enormous luxury, far more opulent than what was available to royalty during most of human history (and probably most of the human future). So how can you be happy for your neighbor's good fortune, and happy with your own situation, without becoming a rampaging consumer?

Again, this runs afoul of the "gene agenda" defaults, so it doesn't "feel right" initially, but it really can work. You just need to train yourself to stop worrying about what other people around you have, while training yourself to appreciate what you do have. Instead, try comparing yourself to the average human existence of the roughly 100 billion human lives which have ever been lived, in which your teeth would have been cracked, you'd have carried a fair parasite load, you'd have been at constant risk of attack from predators human and nonhuman, and your prized possession might have been a feather necklace or a flint hand-axe, and a wrap of stinky animal fur to keep you from shivering at night. You're currently something like 1000x as wealthy as "the historic Joneses", so it logically follows that being 50x as wealthy probably wouldn't suck. And 250X-500X wealthy would be quite something indeed.

Once one does this, it's child's play to do something like living on half a normal american salary; because if your internal neural comparison is not with the consuming apes around you, but with the barefoot shivering apes of most history, it's easy to do so while vastly appreciating your wealth, even if others might consider you living beneath your means. This doesn't mean a live of asceticism; one can live a life which is outwardly pretty identical to that of others, just a little bit off the cutting edge. Learn to do your own repair; buy used stuff; learn to cook well and healthily using bulk staples. You'll be better off, because you're operating in the range of reward your brain evolved for (well, a fair bit above it, but within reason), which means you're less likely to need antidepressants or self-medication to feel relatively sane. Yes, it's a mental trick, but can be done and offers immense benefits with practice. Actively choose who you compare yourself to. And who you don't. And in addition to neurally, you'll also be fiscally operating in the steeply ascending part of the reward/cost graph, getting 90% of the pleasure and utility from 20% of the investment. That's a formula for personal freedom.

What? Personal freedom?

Well sure. Because if you can live on half a normal salary, it means you need no longer be defined by what "job" brings in that salary: you have twice as much money as you need, which means you are NOT dependent upon a rich uncle dying, an itinerant billionaire to take a shine to you, or some granting network to pull your name out of a hat: you can immediately begin a parallel career doing whatever it is that means the most to *you*. (*If this sounds theoretical, it isn't: it's exactly the path walked by author DJ.)* Moreover, this is *scalable*: millions of people could, in principle, do it immediately by simply deciding to. It circumvents the Jevons effect which neutralizes individual "lower impact" consumptive decisions, because you're still spending the money... you're just spending it on constructive stuff rather than in compulsively feeding your "gene agenda" urges. It's damn near all upside, just from learning not to care passionately about what those around you are receiving and consuming, and therefore what you're expected to do to fit in.

It really is just that simple.

Make the normal, Super.

We humans live in a ridiculously amazing world right now. Not only are we for the most part not starving, diseased, and exposed to the elements, but we're surfing the absolute all-time peak waves of cheap exosomatic energy as applied to a virgin planet. This is not such good news for the virgin planet itself, but for humans it means Whole Foods cornucopian shopping, jet air travel anywhere in the world, the internet in your pocket, the ability to have video calls with someone in Mongolia, to have tarantulas, macaws, and border collies as pets. In other words, we can stimulate our brains to transcendental levels. We can jump out of airplanes for fun multiple times per day, breathe a hundred feet underwater while being felt up by a giant octopus and taking selfies, dine on thousand-dollar-a plate sushi from endangered Bluefin tuna, take designer party drugs, and just generally indulge in pleasures beyond traditional dreams of mortal avarice.

Yet chasing supernormal levels of stimulation has a number of downsides. One is, of course, that we're wrecking the planet and its ecosystems and have kicked off only the 6th major planetary extinction event since complex life began over a half-billion years ago, by exchanging gigatons of burning fossils for microliters of transient brain-chemicals. But even getting beyond the "environmental externality" of perhaps ending human civilization and most large animals in the not-too-distant future, there are downsides for our minds themselves.

A key downside is that we quickly habituate to any level of stimulation. That's one reason drug addiction is a bad thing: your neural system quickly habituates, and requires an ever-higher dose to get the same feelings. Once you reach toxic levels, you can die or go insane, so that's not good. And pretty much the same mechanism controls all the other supernormal stuff we seek. Our brains *evolved to habituate*. That's why millionaires jumped out of windows when the 1929 stock market crashed. It wasn't a bad day, and they still had their health and a lot of other stuff; but the brain feelings they got from abstract wealth markers (and attendant social status, whim fulfillment, etc) had gone away, so life was suddenly *relatively* intolerable.

This is a salient thing to note as we giddily forge into the 21st century, because as we've seen, our exponential grown in the use of energy and materials carries with it the inevitability of that growth ending, and starting a multi-century roller-coaster ride back to sustainable solar and resource flows. Just as "more energy and stuff every year" has characterized the last century, "less energy and stuff every year" will be the theme of most of this one and all of the next one, so it would probably be good to figure out a way for that not to be a massive bummer.

Inasmuch as we will still be enormously wealthier than the historic human average for your entire life, that should be do-able. We evolved to be capable of happiness, fulfillment, love, accomplishment, meaning, and all that good stuff just from having enough to eat, shelter, and good company. Most of the best times you'll ever have will be about exactly those things. So how can we manage our brains to "stay civilized" when some of the things to which we feel entitled start slipping away? And might we do this *before* they slip away, proactively, so we avoid that stress and empower ourselves to make decisions which lead to better futures?

Resetting Your Hedonic Ratchet

They say the first step is admitting you have a problem.

Hyperstimulus traps abound in our modern world: junk food, porn, computer games, compulsive tweeting, shopping, status pursuit, etc. When indulged in, they overfeed a powerful inner moron, turning it into an addict with hands on your main controls, amping up its power to shout louder than your rational will and eventually squelching it entirely. Over time, this 'ghost of dopamine past' becomes stronger, craftier and shows up so many times during each day he begins to function as your scheduling secretary. So, before one sets out to make changes in the world, it's good to exert a bit of control in one's inner house. *(Your personal hedonic ratchet is a very small subset of the 'cave of the mind' wrestling match, but one accessible even to those who don't plan to fully train what's in the cave).*

The key to the ratchet is that your inner imbeciles are made temporarily whole, and feel rewarded, not by absolutes but by relatives. Some humans have gotten to the point where they are simultaneously shooting heroine and snorting cocaine, having marathon sex with multiple partners, while being adored by the masses and binging on the finest food. It breaks them, because after all this, they have nowhere further to go to feel better than their "new normal", and either inevitably become damaged and then slowly heal, or pursue a level of stimulation which physically kills them. However, if you understand the nature of your hedonic ratchet and want it to serve you - or at least not hinder you much - it's best to set a low baseline level of stimulation to leave yourself plenty of dynamic range without straying too far into the hyperstimulus smorgasbord currently feeding the humans around you.

For this, nothing can beat approximating the situation we evolved for… alone in a wilderness with nearly nothing, learning to appreciate the world and then re-introducing, one at a time, things to be immensely grateful for, like shoes, warmth, a little bit of light, basic food, add a friend or two, etc. So that by the time one gets back to a humble roof and bed, there's a feeling of enormous wealth, and an entirely valid one. Do this enough times and it's easier to see the supernormal stuff for what it is, a hijacking and an addiction, and to avoid it all in exactly the same way one avoids shooting heroin, by realizing it's a preposterous high to pursue, even if others are doing it. We advocate this 'resetting of one's ratchet' periodically, both as an aesthetic and to give one larger flexibility once various societal intermittencies become more common. It's a bit challenging but very rewarding.

We recommend appreciating things, small things, to keep your human brain well-calibrated. There's wonder all around. Take some time to get to know about a species of bug, the lizard which watches you when you come out of the house, learn to see the fossils and other signs of deep time around you when you take a walk… and be delighted by them. Know the names of the stars and planets that are above you in the sky at night, and let your mind take you to them based on what we now know. Find out the shoe size of that homeless person and bring her a better pair next time you see her. Make such little things important and they will be, and will keep your sense of wonder well-calibrated for the unexpected.

Once having done so, such resets may cause you to feel you're surrounded by addicts, which is but a small piece of the truth. Learning to achieve, and never lose, the feeling of subjective wealth at having the simple things one really needs is powerful, and opens many doors. And it's not illusory: a human with food, shelter, shoes, water, warmth, a few friends or family and something worth caring about is as wealthy as a human can ever be. The supernormal is a distraction, a drug. It requires a flow of money, which for most people requires that they pursue money rather than direct their own lives. Remember that the Ghost of Dopamine Past - for most of us – will

constantly be by our sides pointing out something that is higher-level stimulation than these slow but wondrous parts of our lives.

Feed the tortoise, starve the hare. You'll see more of the countryside of life. And be moving slow enough to do some things.

Go on electricity, technology, food, alcohol, social media, etc. holidays

"*If you are caught unprepared by a sudden rainstorm, you should not run foolishly down the road or hide under the eves of houses. You are going to get soaked either way. Accept that from the beginning and go on your way. This way you will not be distressed by a little rain. Apply this lesson to everything." Hagakure*

If your brain had come with a "user manual", it might well have given this advice: *do without* from time to time. It's counterintuitive but it's a good thing to try, for a number of reasons.
For one thing, you evolved under conditions of hiatus and intermittence. Your entire body and neural system is tuned for that. By creating cultural conditions in which emotional, physical and psychological discomfort is now almost constantly avoided, we've created populations which are heavily medicated by antidepressant drugs and self-medicated by alcohol, overeating, and other things which dull their senses when any 'departure from comfort' occurs.

It's amazing how food tastes when you're really hungry, and have not had high-salt-high-fat-high-sugar "junk" food for a while. It's nice how you feel after being "off the internet" for a week, and it can be fairly amazing to see the world around you re-emerging once you have been off that quick-stimulus-and-response treadmill for a while, ignoring social-status "likes."

If you'd like to be a bit more extreme, try going without electricity or other exosomatic energy for a while. There is an important point to doing so: you'll get a bit better handle on what you need, how you feel, and the utility of energy. And become more mentally resilient in the process.

In addition to a 'vision quest' and a periodic resetting of your hedonic ratchet, we recommend using your knowledge of your brain's inner workings to overcome some of its drawbacks. One of the core insights of Reality 101 was that our modern skulls house stone-age minds, and as long as we know what this means, in many ways it's a good thing! Our brains look and act very similar to those of our ancestors of 50,000-

100,000 years ago, but our culture and the technology and available activities are what have progressed exponentially.

When we feel overwhelmed, or in a rut, it can make sense to 'purge' - not food or drink per se, but the overly intense stimuli in our lives that most in our culture take for granted as normal and healthy. In addition to lowering the daily 'unexpected reward' from higher and higher levels of neural habituation, the practices of email, social media, internet and even electricity holidays may be useful practice for future years/decades.

It can also be good for the "now," if you're one of the few that decides to walk your own path.

And, in addition to improving your health and well-being today, it may pay significant benefits down the road. In the universe of possibilities this century, some – even many – will involve intermittent or no access to electrical services. Teaching your mind that this is no big deal because you've experienced it in your younger years could be a large (mental) asset.

Environment/ecology lenses:

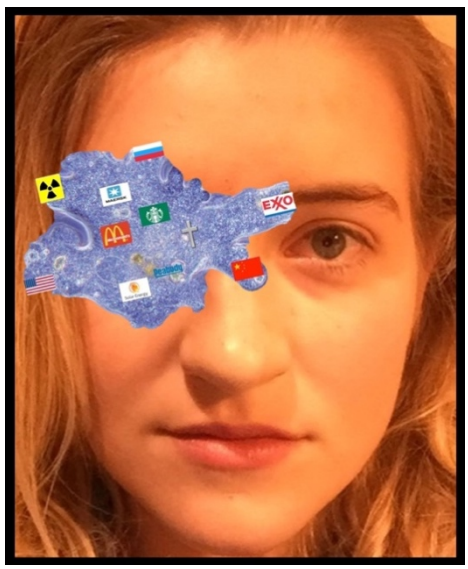
Much of the rest of this 'what to do' essay outlines ecological initiatives or ways of thinking that align with pro-future ecology, so when you view the world with any lenses, first remember this:

****There is an environment,*** and our economy is part of it, not beyond it.

Thorstein Veblen famously critiqued the American economy as being comprised of '*business*' (financiers, speculators, investors, etc.) and '*industry*' (factories, supply chains, basic goods, etc.). His critique - that in good times the 'business' overwhelms the 'industry' and becomes the focus of the human economy - is even more apt circa 2018. But the criticism still employs narrow-boundary lenses. There is a part of the economy – the factoring in of

our natural capital source/sinks - that does not add immediate surplus to our bottom lines, but that lays the foundation for future surplus. Full-world economies need industry, and a much smaller 'business' (in the Veblen sense) but also during your lifetimes a third component: *future/ecology*. And our current culture has lots of industry/business people and lots of environmentalists but very few who understand and can articulate the intersection of both worlds. Join that awareness, and transition. In a small way, or bigly.

The Amoeba Lens:
"I'm part of the Superorganism, and I am NOT."



On first blush, it can seem a bit of an existential dilemma to realize that one is part of a superorganism. And - at that - not a brilliant and godlike superorganism, but one which is none-too-bright, crawling around like a ginormous BTU-seeking amoeba and screwing up a previously productive planetary ecosystem in the process, with no more guiding ethic or introspection than shown by a frog's kidney. Any brilliant insights associated with our species' history have been largely the product of single minds, and exist without that brainless collective acting, or significantly able to act, upon them.

Thus, the natural reaction of a prosocial, pro-future individual discovering this is to seek disengagement or escape from one's destiny as simply one cell in that superorganism. But that's easier said than done. It's particularly difficult to disassociate from the metabolic aspects of the human heat engine…. even if one buys a cabin in the boonies and becomes a vegan alpaca-herder, the best one can do is to subjectively "feel like" a somewhat less-destructive part of the amoeba while still being conjoined to it in a thousand ways, from toilet paper to prescription alpaca medicines and emergency services. So such a path means knowingly turning one's back on the ongoing planetary damage one knows is occurring while pursuing individually higher karma on some imaginary status ledger of respective blame.

The thing is, IF one is aware enough to grok the situation that well, now is the time to *maximize* ones individual impact on the future, not minimize it. A very small part of earth's biomass has developed brains capable of understanding the things which affect the livability of the planet. -Very few of them have had the opportunity to be educated enough to understand it. And only a tiny portion of THOSE few will be able to navigate past inborn cognitive biases and systematic errors to think realistically about what might actually be done to achieve less-bad futures. What a waste it would be for the few minds which make it through all those filters to decide not to try.

Big group and Small aspirations should perhaps be avoided…

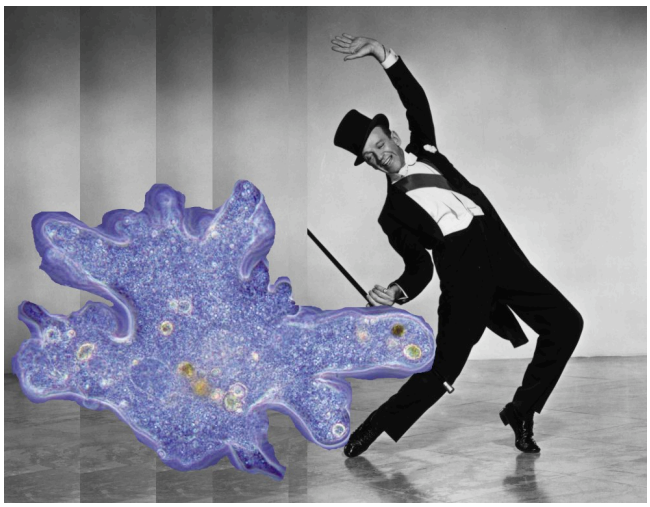
There are a number of bumper-sticker, t-shirt and motivational-poster slogans out there which might be construed as encouraging one to only engage issues on a small scale: two of those are "be the change you want to see", attributed to Gandhi, and "think globally, act locally" which generally isn't but could equally well be, since Gandhi never said either of them. So if you envision a world of vegan Alpaca farms, it would follow that you should simply do that and wait for the teeming masses to follow your example, (which they won't). The latter exhortation strongly implies that the best way of engaging with world problems is locally, which ranges in effectiveness from inadequate to outright silly. If, for instance, you are worried about south american rainforests being plowed under, it makes little sense to spend time focused on the suburb you live in. If you worry about a possible extinction of orangutans and bonobos, there's not much you can do in your town to deal with it. In this day and age of passports, internet, and peak energy, one can directly engage with nearly anything in the world: "think globally, act globally". If you can affect a local change which impacts the world in a positive way, by all means do so, but it's better to aim at affecting a scale far larger than the scale on which you personally live, because that's the only way your own life will be a "net good" to the future rather than an ecological "lesser evil" by simply minimizing your own impact.

Another Gandhi misquote, about large-group organizing, also comes to mind: "*First they ignore you, then they laugh at you, then they fight you, then you win.”* This plays to the myth that organizing in large groups may seem futile at first, but inevitably leads to victory. In fact, it feels futile at first because it generally IS futile, and seldom leads to any kind of victory unless *within* that large group you have a fairly sophisticated stepwise plan coordinated by an individual or small group of prime movers, as Gandhi did.

But what right do I have to steer and influence what other people do?

To maximize the number of human lives lived in deep time, maximize the total happiness and number of childhoods, and minimize bad experiences, the human amoeba (and its child) will need to be steered; and it can only be steered to specific target outcomes by groups small enough to understand the complexities of the world. This runs up against a social-ethics dilemma: what right do I have to steer other people? The laws of reality, in combination with our aggregate actions for the last couple hundred years, now have a good chance of taking us into realities we would not wish to visit, during your lifetime and beyond. By having a top-down view of what may unfold, you also have – at least in principle – the ability to steer things towards realities which are more humane, fair, and worth living in. But this runs up against a social-ethics dilemma...

Well it’s not a right, an honor, or an ego trip: it’s a responsibility, and the alternative is negligence. The person who isn’t drunk *has a responsibility* to grab the car keys from those who are. The great majority of humans are non-rational, *happily* non-rational, and wouldn’t want to be any other way. They will be steered as they always have been steered, by reacting in the way their limbic systems urge them to, because they really don’t want to face any difficult decisions. There never has been any real question of whether they’d be motivated by intelligent metacognitive self-analysis, because they would no sooner engage in that than eat worms. It doesn’t feel good to their brains, while reacting quickly and passionately to inane stuff does. The only question is what or who



their stone-age limbic systems will be steered by: random events, political propaganda, consumer marketing… or just perhaps, someone with an ethical, rational long term agenda who is not so wrapped up in his or her own pursuit and display of self-purity that they actually take the wheel and try to do so.

Look around you. There are mere decades in which to make crucial, major changes in the way we exist on earth on all scales. The world will not, on that time scale, be saved by the sudden consensus agreement of a voting majority of erudite philosopher-citizens arriving on-scene in the nick of time.

That being the case, it is incumbent upon the 1% who are "woke" to reality to step up. It may seem like 1% is an underestimate, since you know a lot of people who vote as you do. But if anything it's currently a large overestimate, because most people - even those who seem to agree with you - adopt opinions and positions about things based on social consensus and tribalism rather than an actual process of science synthesis calibrated against physical reality. As we have noted before, even rational goals pursued in a democracy can only succeed via primarily non-rational support.

Organizing large social groups to affect the future is primarily about trying to affect the consensus in a democracy - a mechanism which often won't get the job done, but at least in principle might. Yet we tend to try organizing on large scale for all classes of problems, and many of them are spectacularly ill-suited to being addressed by large organizations or movements. When these large organizations or movements don't make any real progress, we become dejected, because it seems as though they constituted the last hope for real change. This can lead to depression and disengagement.

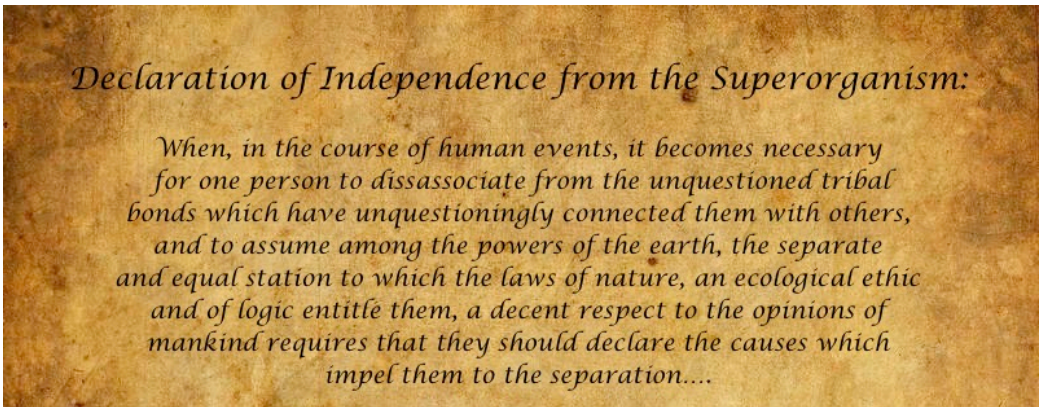
It's useful, then, to realize that large social movements are really not all that useful in a lot of cases; because, as noted, very little of the actual steering of the human species is done by conscious consensus or even agreement. To a large degree, there's no rational steering whatsoever, just the emergent results of billions of individual actors pursuing what 'feels right" to their inborn brain-reward mechanisms. Such steering as is done by conscious volition is generally done by those who are good at it to pursue relative advantage rather than achieve any optimized future on earth.

Some of the points to be made in this essay will seem extremely counterintuitive; so let me note from whence they spring. The author of this section (DJ) had the instructive experience of attempting to affect the exact same medium-scale global issues as (a) the international program director of one of the world's largest and most famous conservation advocacy organizations, and then (b) as the director of an unknown organization without any funds. The only extraordinary thing about such a

sequence of events is that the success of the small, poor, unknown organization with only a few members turned out to be fantastically higher than that of the large, wealthy, famous one with millions of members, on not just one issue but *all* of them, which was unexpected. How could that be?

Well, the long answer would fill several books that may well never be written, but the short answer is simply that - as stated above - large social movements and organizations are simply not very effective at getting things changed in the real world *(even if it feels like they should)*, while individuals and small groups can be really good at it, even on the largest scales.

Opting out of the behavioral aspects of the Superorganism



We've noted that it's nigh-on impossible to truly detach from the metabolic aspects of the questing heat engine which undergirds our collective existence. However, it's quite possible to detach *behaviorally* from the "human amoeba" and become a self-directed actor who wrangles what the amoeba will and will not do. And it's probably not overstating things to say that such individuals constitute the main hope of things turning out OK.

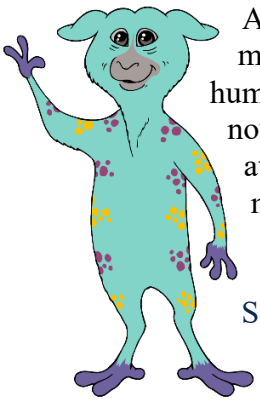
Just realizing that the superorganism/amoeba/heat engine exists in the way it really does is a huge perspective shift which very few attain. It is quite reasonable, from that vantage point, to decide to repudiate the amoeba, to be self-aware of our evolved deep-brain defaults and when necessary to override them.

This might seem counter-productive to personal happiness, if it amounted to ignoring all that "felt good or right" and doing only stuff that felt uncomfortable. But that doesn't necessarily follow. In fact, it's possible to be quite depressed and unproductive

even if following every urge your brain gives you. People who do generally end up with addictions and other consequences. Your "gene agenda" doesn't seek your happiness, it seeks slavish response. But we're at our best when we're about more than just pleasure-seeking after dopamine and other limbic-system behavioral rewards. There are things like pride, self-respect, a sense of purpose, place, and mission; triumph over challenge, loyalty to the people and things one loves, satisfaction at accomplishment, and much more. These things may actually be far *easier* to find in a consciously-directed life. Moreover, just because society in general may think such a person is a bit of an oddball doesn't mean one can't find or assemble a tribe with shared values and goals which can provide the sort of mutual support and camaraderie a savannah-designed mind works well within.

That is, it's possible and even practical to repudiate the Gene Agenda, and your authors recommend doing so. You owe it no loyalty or responsibility, because there is really no "it" to be loyal or responsible to. It's simply part of the web of unconscious happenstance - luck - which caused your brain to assemble in a way which created your mind and its independent universe. Other than some atavistic limbic-system compulsions and rewards, it offers nothing. Resigning the "gene agenda" means resigning from your part in emergent amoebic tropisms, and potentially steering some aspects of the amoeba intelligently. When doing so, you'll still be tied to the energy footprint of the collective, but you'll be using that energy creatively, for rational and altruistic ends which may alter the very nature of that huge footprint.

Be A Little Alien



Any way in which one intentionally disobeys the gene agenda makes them just a bit alien. And that's a good thing. Boilerplate humans hewing to the Gene Agenda have had a good run, but are now running toward a brick wall they don't see. Being 5% alien, at this point in time, is probably more useful than being 50% more intelligent, because even very intelligent people spend their lives within the consensus trance.

So hey! In the spirit of our advice to be 5% alien: Join AAA: be an "altruist alien anthropologist". Pose as human, and enjoy life as human, but be able to switch in and out of alien-perception mode by wearing Reality glasses and your alter-ego thinking cap. Beneficent aliens are needed now, but none have shown up. Become them. The human race badly needs loving gamekeepers who can operate from a detached perspective at least part of the time.

And the indirect effects...

The "consensus imperative" may also have something to do with the tendency of humans, when wanting to solve a problem, to search for (or create) a large group of people – the larger the better, presumably – with which to address that problem. However, this tendency contains the seeds of its own problem, because the larger a "consensus seeking" group of humans gets, the dumber, slower, and less effective it gets, for many reasons. Thus, you can wind up with a "problem solving" group which is spectacularly ill-suited to solving most sorts of problems.

However, even after the demonstrable failure of such structures and strategies, it still "feels like" the thing to do, so we "double down" on it, with the "big groups" getting bigger and the "small groups" fading away, even if the small groups are far more effective (which they generally will be).

Creativity and abstract planning have enormous potential to deal with problems and predicaments, and we have plenty of those starting to show themselves. If you wish to use that potential, you'd be well-advised to *not* seek validation from large groups or those who happen to be around you, but to get your validation from first-principles analysis, a synthesis worldview, and logic. This works best for individuals and very small groups of people who come together because their creativity is reaching similar conclusions. This can be the start of a more useful sort of mini-tribe, and aligning with humans it is less inhibiting to seek consensus with.

I (DJ) am often contacted by college grads asking how to get a position in a large prestigious conservation organization, to help change the world for the better. My advice to them is generally "don't". If you want to make money, go into some other line of work; and if you want to change the world, just do it. Don't chain yourself at the ankles to a group which is already far along the downslope path of diminishing returns (on resource investment in complexity). It "feels like" joining a large group is the right thing to do, but that's just the subverting effect of some atavistic tendencies we'd arguably be better off without.

Choose your tribe...

Now it's all well and good to point out where the "gene agenda" leads us into being ineffective and to make poor decisions. But we *are* stuck with the brains we have, and we won't get much done if we're depressed or unhappy. So to some degree we have to give our deep core-brains the things they need to not be despondent, depressed, bored, or un-stimulated. Fortunately, this can be done in ways which don't compromise rational life-plans.

Since we "feel best" when we're "fitting in" with a tribe, it makes good sense to choose your tribe to be in alignment with who you want to be and what you want to accomplish. If your ideals and plans are ridiculed or disapproved by those around you, perhaps it's time to seek out people who are more supportive, and whose ideas strike sparks with your own in good ways. Within such a tribe, you may well find collaborators to work on projects and plans, and your background stress will be low.

Obviously, it's *still* good to be wary of too much consensus, and to stay 5% alien when possible, but you can find or assemble a tribe in which this is considered cool. A group of friends who experience life to the fullest and are on the same wavelength on most issues is one of the most stimulating situations a brain can experience.

With all the Lenses removed – *Who Am I?*

When learning about the interacting economic, energy, and environmental risks which face our species and world this century, it's natural to feel a bit of panic along the lines of "what the heck do I DO about this stuff?". Do you buy solar panels? Lobby for a carbon tax? Move to Iceland or New Zealand? Buy an electric car? Buy a ton of canned beans and spam and move to a cabin in the woods with a short-wave radio, or live in a shack and grow a vegetable garden? Buy guns & gold and hunker down as a survivalist? Have a dozen kids and train them to care for you? Become a preacher? Or just "go with the flow" of society and see what happens?

It's probably good that there are still a lot of potential choices available, and the choices mentioned are ones we've seen people making! But the big changes we can see taking rough shape in the future are still moving in slow-motion relative to the pace of individual human lives, and it makes sense to take the time to really think it through, lest you wind up spending your perfectly good life in a way which is less enjoyable or useful than it might otherwise be. The main point is that whatever answer you come up with should be *your own* answer, with a good fit for who you are and truly wish to be.

That's the reason a central part of a "what to do" section begins with "**who am I**?" It's because this will be a momentous century. We can know, beforehand, the rules which will constrain the future's possibilities, but not which twists and turns reality may take within those constraints - our complex existence will iterate into the future a day at a time. That means the "what to do" responses may change, and change significantly, based on these changing contexts. The things which make sense to do this week may be supplanted by a different set of goals five, ten, and twenty years from now, as we each observe and react to the systems we live within and alongside. Moreover, since this *will* be a momentous century, it will have stresses: not just those now apparent, but new and different ones. There's no way to know exactly what they will be; just that they will present themselves as they did to past generations. Unless your decisions and actions are firmly anchored in *who you are*, it is likely they will eventually be abandoned. So here's another Reality insight: *what to do* really needs to flow directly from *who you are.* One person may have an entirely different set of *what to do's* than her best friend, who's a different person; and both of their *what to do's* will change as the things around them do.

It might seem strange for an honors course about "Reality" to ultimately urge you to discover *who you are*, but in your authors' experience, there's no substitute for it. Talking these weighty issues over with others is important and we encourage it. But the questions at the very core of your one existence are of a different class. The issue of 'who you are' is a private thing for you to come to terms with based on nobody's counsel but your own, perhaps in nature, perhaps in a place which has special significance to you; perhaps in a single marathon quest or perhaps in a series of sessions interviewing yourself over an extended period.

In a universe which doesn't care about you, humans, or even life, you have an opportunity to choose what sort of goals, ethics, standards, and principles make sense to you, and adopt them consciously for reasons that are your own. Which things do you care about, do you not care about; which of these things would you take a personal risk for? What will the guiding philosophy of your life be? Do you like and respect the person you have been so far? Why or why not? When you are 50 years older, what sort of life do you want to be able to look back on? What sort do you NOT wish to look back on? What sort of small (or medium) things can you "let slide" - What sort of big things shall you hold as personally sacred, and defend if necessary? Which "gene agenda" urges are you better off re-directing? What balance between the inner world of feelings and the physical world of matter and energy do you wish to have? Will you cede power to your urges or give it to your principles (or some combination)? What is your answer to "why am I alive?" There are no right or wrong answers to these questions in general, but there will be right and wrong answers for

you.

This might seem to be a bit of a woo-woo thing to do, but it cuts to the core of "what to do" about our various predicaments, because you should do the things that make rational sense to the person *you actually are*, to achieve things you will value by your own standards and ethics in the context of an extraordinary period of history. Moreover, to the extent you are following the logic and emotion of the person you have chosen to be, it will be far easier to make life decisions going forward because you'll know who you are and won't have to work it out from scratch every time the world throws you a curveball. *This may wind up being the most important thing you take from this course*. Only something with the depth of a "I am ___x__and I stand for __y___" answer will be resilient against the bottleneck tribulations. To persevere, your sense of core identity needs to be stronger than the hate, fear, resentment and uncertainty your brain evolved to generate during stressful times.

So while some people will go into politics, others will decide to raise a family; still others will chain themselves to a bulldozer or press for a carbon tax, or provide food for the poor, others may advocate for solar panels or endangered marine species, and still others may try setting in motion humane and sapient responses to get their communities through the coming physical bottlenecks. No one person can do everything, or should try. It's best to first figure out who you are, who you want to be, and then follow that where it may lead using all the skill, motivation, and bravery you can bring to bear in a life worth living. That's what your authors are attempting, and for that reason. So when you answer the question "who am I?" It should ideally be the person you have *decided* to be with your one life, a person who you respect based on your own standards, who your older self in the future will be proud to have been.

In times when many things are going away, it could be very sad to be alive to see them go. But knowing that you have saved a thing which otherwise would have been lost, is one place hope and meaning may be found. It could be a species that no one knows about, one that everyone knows about, or even an idea, an ethic, an infrastructure, a way of thinking, a limited natural resource, a skill, a culture, a language, special knowledge. A species of bird, mammal, reptile or insect. You could make that your creative reproductive contribution. Only in very special and very strange times can one reproduce other species (see below). These are just such times. Compared to all of our ancestors (and probably most/all of our descendants), we now do have the potential to prevent some major things from being predictably, irretrievably lost to the future; to make things significantly better than they would otherwise be. This is an amazingly creative life-choice to be able to make.

So that's the core of it. To think of yourself as a unique individual with a conscious

mind which intends to significantly direct its own destiny. This is a rarity: many people never consider this, and just do the "gene agenda" thing of subconsciously managing PR with other humans to achieve advantage and hope others somehow fix things. The gateway beyond this is the realization that there is a "you" apart from the way other people define you. This is one reason being by oneself in nature (or anywhere) is a good idea, separated from the consensus signals of constant social posturing and reaction. Without doing something like this, it's (very) hard to get out of the genes' clutches and become self-aware by more than capuchin criteria.

Once you learn to care about who you are, and who you could be, that opens all the other doors, including the one to *deserved* self-respect. It's possible to easily go through life without facing up to whether one likes themselves or respects themselves, not because of self-aggrandizing narratives and ego but simply because they know the truth about themselves and they'd respect and like any such person. It really does come down to your urges versus your principles. If a person always chooses the former, it's probably reasonable to conclude that he doesn't actually have principles. But this is for nobody else to judge, and certainly not your authors. Rather, it's something that a person should conclude for themselves, and hold as a personal core truth. It's not for social shaming or social anything, it's for self-respect.

Once you figure out the "who am I now, and who do I wish to be" answers, you'll tend to find your own way by steering in the general direction of your goals via thousands of tiny decisions and a few large ones which will add up. You'll probably find that there are *many* things to do which have meaning and align with who you are. Remember, 'what to do' makes very little sense except in light of the bottlenecks, which make no sense except in light of the carbon pulse, which makes no sense except in the light of evolutionary psychology and physics. And finally, anything you do makes little sense except in the context of who you are.

A Bottleneck Vision Quest

One suggestion we might suggest is perhaps a bit analogous to a "vision quest", a practice among some native American tribes in which they spent time in solitude, often accompanied by fasting or the self-infliction of pain, seeking a spirit guide to follow. We say "analogous" because we don't recommend adding pain, (and any spirits you may dream would be part of your personal virtual world). Likewise, the fasting is entirely optional unless it works for you or you'd like to lose a couple pounds. The important part is to unplug from the social net, and that doesn't just mean the internet, but the constant high-bandwidth back & forth with other members of your species, all of which is very soothing to the gene agenda but not helpful in terms of getting in touch with the core "you". The location should be one in which are

inclined to feel inspired: a pretty vista, a spot overlooking the ocean, a starry sky, a journey in the woods that "feels right" to you, or just a place which has personal significance in your life. Then start dissecting the way you feel, the way you think, the things you fear, the things you truly love and care about; the things you regret and the things you're proud of. The degree to which you're living your life to impress others specifically and generally. The degree to which your working definition of "success" has relied on society and the expectations of others, rather than what would constitute "success" in your own terms. What are your ethics? Where do they spring from? Do they agree entirely with those of others around you, or do they diverge in some ways? Can you recognize the modular nature of your own mind, examine examples of retroactive confabulation your mind has engaged in to place you in the best light in your own eyes and those of others? Can you feel the fact that your left and right hemispheres are different individuals, and that your mind is composed of many voices wishing to be heard? Can you find cases in which you truly believe utterly irreconcilable things in different modules? And can you accept what you are and take responsibility for who you will be? What would it take for you to become one of your own heroes?

Don't expect to come up with these answers immediately. Some of them may elude you, and you may find others which aren't mentioned here. But see if the process doesn't help you know yourself, as the first step to whatever you decide to do. We recommend that – whatever answers you come up with – you keep them to yourself. They are not for purposes of sharing outside your mind, and should not require any external validation or reconciliation. If they do, then do it again, with that as an insight/input.

We realize that the unique time you have been born into is a powerful and compelling context in which to seek these answers. There will be immense things occurring during the time you will be alive. To some extent, those few people who have been exposed to synthesis science, such as this intro to R101, are a bit like time-travelers from the future who have been granted the wish to be transported back in time before

many changes to the earth and to humanity were irrevocable, to make changes for the better. That's because this way of looking at the world may well be obvious in retrospect, hundreds of years hence, but during your life it will not be. You are living in the future's past. This is cutting edge, heretical stuff by the standards of the day, like the revelations of Copernicus.. The pieces of the puzzle you have fit together in your mind are not apparent to most of your species, and likely will not be for a very long time, if ever.

On Reproducing - (other species, ideas, ethics, and maybe babies)

Given what you've learned in this class about the Reality of the coming century, the decision whether to have children becomes a non-trivial one. It "feels like" giving birth is an optimistic pro-future thing. It's the strongest "gene agenda" drive we have, for good evolutionary reasons. Yet reproducing in the current circumstances might be counterproductive. Having children is about instinct, pheromones, social pressure, and that whole package, and in the current context it precludes doing much for the future, because of the physical, monetary and time resources required to be a good parent. Also, new parents aware of Reality could be knowingly sending kids into a very chancy period in history without much regard for their prospects. Anyone who's reasonably aware of the world today and decides to reproduce may be doing it for any number of rationales (or no rationale), but it likely *isn't* for the kids.

So are we about to make some sort of environmental case for you not to have kids? No. The standard environmental view is that having children in a developed country is far and away the most harm you can do to the environment, no matter how ecolate, kind-hearted or brilliant your child may grow up to be. By driving a hybrid car, being a vegan, and using clean power, you would save 488 metric tons of carbon dioxide

during an 80-year lifetime. By having one fewer child, you would save 9,441 or almost 20 times more. This is certainly worth thinking about.

But this rationale - to not have kids because of world overpopulation and resource consumption - may not always be as true as it sounds, because lower birthrates - occurring for any reason – are unlikely to be the major control on population going forward. Moreover, the "Jevons"-like effects of consumption will, within a market society, largely absorb small sacrifices and redistribute any conserved resources to others, rather than sending signals - overt or otherwise - to "slow down" the corporations which extract coal, oil, iron and phosphorus from the earth. In the same way that the CO2 emission savings from 'greater efficiency' and 'adding solar panels' only apply to an individual not an entire system, the energy saved from having one less child will likely be used elsewhere in our system of growth. Thus, our argument for seriously considering whether or not to have children is not this one, but more nuanced.

Our reasons for taking the decision to procreate *extremely seriously*: we love human kids, but there's no shortage of them. Indeed, ecologically, humans are in plague-population mode and are heading for bottleneck events in which the human population will be reduced, possibly drastically, during this century. If so, that's a terrible thing to knowingly send a kid into.

In addition, raising a child requires and deserves a full effort. But morally, full effort is currently required *by someone* to try ameliorating the future travails of the kids already born, of kids others will surely have without a second thought, and of other species which may or may not survive the bottlenecks without help. Not having kids – *or at least delaying the decision* - frees up time, emotional load and physical resources for one to engage in events of meaning during once-in-a-species events. A baby in your 20s precludes a great many choices of action – and impacts – effectively taking you out of the game and pulling you fully back into the Amoeba.

As another consideration, the same bottlenecks which will eventually reduce human numbers mean that thousands to millions of other species will have trouble surviving this century. Most such species have not a single dedicated human caring whether they do or not, to the extent of trying to actively help them survive. And probably never will. Think about that. It means that there's a choice to make: a human can, in effect, choose to reproduce other species than human, by devoting the care and resources which would have been given to human children to one or more other species that person has "adopted". There are no adoption fees or papers, *a simple personal decision is enough to seal it*. Ergo, we are not advocating abstaining from reproduction because there are already too many people – we are advocating thinking seriously about the decision, because without kids, you'll be more flexible, more

effective and more involved in the challenges that need your efforts and skills and passions.

The essence of our recommendation is this: don't be pressured by others, or by society, to have kids. Do it because you've really thought it through with their well-being and interests paramount, and have chosen to spend your life bringing them into this world at this time, and adequately preparing them for what they can expect to encounter.

On Reproducing Other Species – (A note from someone who's done it -DJ White)

Here are some personal thoughts on my and my wife's decision not to have kids of our own, not because we'd expect you to necessarily make a similar decision, but because it's at the deep core of the brain's "gene agenda", as well as those of the culture and our guiding mythologies. Evolution being what it is, it could not produce anything else. Over-reproduction is the *single standard and* strategy of the gene agenda; everything else is details. Our myths and cultures need to fit with what "feels right" to do, and the ones which encourage reproduction acquire a numerical edge over those which don't. The mechanism of evolution is a life-and-death competition for energy and other resources, which is why nature - including human history - is red in tooth and claw.

These days humans are essentially genetically identical. The other human species are long gone. Evolution's de facto "death cage match" battle for allele survival is a terrible idea in the context of a self-aware species, and is pure heartless unproductive gene agenda unworthy of any ethical code worth the name. Someone else's kids already carry all our genes forward, times a billion. It's not like sexual reproduction clones us anyhow, at best our kids are a random mashup of their parents' genes… so what's imperative about that? Is it the entertainment value of having kids to bond with? The social points we get with family and society for having them? The oxytocin rush of baby smell? A safety net, hoping they'll care for us someday? None of those are remotely morally persuasive, particularly when one reflects that knowingly inserting kids into a population that may undergo rapid traumatic shrinking could be tantamount to premeditated child abuse.

The things we should "want to survive" about ourselves aren't our hair and eye color, our ability to digest lactose, or our immunity to sickle-cell anemia. Rather, it's the unique things about us, which are (almost) all products of our minds, and can be culturally passed on to kids. But those don't have to be *our* genetic kids. We have done our best to pass our values, our new ideas and aspirations, our re-framings and

priorities, our sense of the sacred, to thousands of people in person and far more by proxy. These are the things that are "us" and that we want to see continue within the human species.

Is it, somehow, our eugenic duty to the future to clone our 'superior brains' and prevent "idiocracy" scenarios, lest the dim rabble outbreed us? Well, I couldn't sell that to myself either. What constitutes a superior brain? Were we actually smarter than the Neanderthals, or are we *their* Idiocracy scenario? At a small scale we can contemplate deep mysteries, but on the large scale that translates to amoebas with H-bombs, and the heat engine goes on. Moreover, who's to say that a person who is kinder, more empathic and wiser but lacks 20 IQ points might not be a better human than her friends in Mensa? But beyond that, speaking as a person who has spent years in comparative cognition research, I'll note that, broad brush, there just isn't much variation in mental capacity among humans these days. Most of the functional variation is cultural. We've long since killed off significant genetic variation in the "final exams" of evolution, determined by who kills, rapes, out-cooperates and out-competes who. And of course, the world's largest brains, which aren't human, are being rapidly pushed into oblivion by the sheer biomass of the carbon-pulsed gene agenda of the third chimpanzee.

Here's the thing: I'm not speaking against having kids. I'm speaking *on behalf of* the kids, yours and others. Reproducing is, to me, the biggest moral decision one can make, as well as being in many ways the decision which constrains all subsequent decisions. My wife and I were physically capable of having kids; we both love family dynamics, having come from fun families. But had we done so, we probably couldn't have done the other stuff we did, like facing some seemingly impossible quests together. We faced the gene agenda versus a sapiens agenda bigtime, and it wasn't easy; but then neither is parenthood. Again, I'm not pushing this - and have never done so to anyone - just laying out what we decided. But I do recommend that your major life decisions be made subject to clear thinking about who you have chosen to be, in this one life that has been given to you. It's hard to make any sort of logical case that there "aren't enough humans" at this point. By putting our effort and energy into other species instead of having our own kids, my wife and I reproduced very successfully in an unusual way: instead of adding to human biomass, our physical progeny are sea creatures.

Our efforts of the last 40 years have, evidently, saved on the rough order of a million dolphins, countless whales, seals and seabirds, and a huge biomass of sea turtles, sharks, and other marine creatures which would have otherwise been taken by destructive fleets we succeeded in having banned from the high seas, from drive-kills we have permanently stopped, from illegal commerce in endangered species we have

curtailed. Those critters will never hug us, and we don't require it. We like knowing they're out there. Their future, we don't know, but we know their species have a better chance at what's coming than they would have had. To us, that's a worthwhile thing. I won't say it has been easy, but I'll say I recommend it. And there are a boatload of humans kids we've affected as well. Our intellectual progeny are those who have been moved by our rationales, arguments, and actions.

We missed the standard joys and pains of bringing more humans into the world, but having some notion of what those kids and their kids might face, we realized that what was unique about ourselves that we wanted to pass on wasn't my red hair or my wife's brown eyes. It was our thoughts and values, and any species which we might be able to save from going away. There was no shortage of red-haired, brown-eyed human kids. Every human kid these days already has nearly our exact genomes in the ways that matter. Is modern human existence really still some sort of desperate competition for "allele survival supremacy over the kids of others" that we're supposed to buy into? And if so, isn't that ultimately a fairly half-assed idea to cleave to? I care about the kids of others, and near as I can tell they're just as suited to represent my species genetically as mine would have been, even without the red hair. Why the heck should I be motivated by some sort of allegiance to red hair? Desperation to consciously adopt the gene agenda really makes little sense, and popping out kids for social-conformity reasons or for our own pleasure ultimately didn't make the cut for us.

Personally, I've disowned and repudiated the gene agenda, and have done my best to substitute love, responsibility, and understanding. I realize how corny that sounds, but there it is. I don't claim to be any sort of sapiens, though I am "sapiens curious". While I live, I will fight for the existence of the trillion human childhoods which should be lived rather than being discarded as an irrelevant future, and for a living world in which they too might know a dolphin as a friend. There is no motivation but those for my having participated with you in offering materials for this course. I sure as heck don't get paid for it.

Don't be pressured to have kids. It's not your responsibility to do it. If you do have kids, be a great parent. Do it, if you do it, because you've decided it's right for them (the kids you'll have), and is how you choose to spend your one life. Because adequately preparing them for experiencing the second half of this century, as things start contracting in earnest, will be a challenge.

Part 3 - Hitchhiking in the Sapient Direction

Sapience: *the ability to think and act using knowledge, experience, understanding, common sense, and insight.[1] Wisdom has been regarded as one of four cardinal virtues; and as a virtue, it is a habit or disposition to perform the action with the highest degree of adequacy under any given circumstance with the limitation of error in any given action. This implies a possession of knowledge, or the seeking of knowledge to apply to the given circumstance. This involves an understanding of people, objects, events, situations, and the willingness as well as the ability to apply perception, judgement, and action in keeping with the understanding of what is the optimal course of action. It often requires control of one's emotional reactions (the "passions") so that the universal principle of reason prevails to determine one's action. In short, wisdom is a disposition to find the truth coupled with an optimum judgement as to what actions should be taken. – Wikipedia*

Your authors have strongly recommended “Homo sapiens” as a good idea for a species which hasn’t quite arrived yet. We *call* ourselves “Homo sapiens”, but that’s largely because we invented taxonomy and didn’t care for the notion that we properly belong in the great ape family. We have been very clever, but historically we have generally whiffed on the “wisdom” part of that vanity nameplate. Recently science has given us incredible new insights into the nature of mind, evolution, and the physical world, which makes “sapience” more attainable and useful in principle *than it has ever been*, as the conscious outcome of pursuing a synthesis worldview based on an ecological ethic. Such self-awareness opens the door, at least potentially, to a long and exciting human future on a healthy planet.

However, our cleverness in finding ways to please our stone-age brain-reward systems has resulted in some less-than-wise outcomes, and this was thrown into overdrive when we added hundreds of millions of years’ worth of flammable fossils to the equation. That allowed us to get ourselves into a number of pickles which simply would not have been possible otherwise; pickles which will now *require* sapience to extricate ourselves and our world in reasonable shape. And it has lit a short fuse: had

all those fossil carbon compounds not been accessible, we'd have had tens, maybe hundreds of thousands of years to pursue sapience. With the "carbon pulse" engaged, that time shrinks to decades: a make-or-break cage match between the backward-looking Gene Agenda and the nascent 'Homo sapiens.'

Yet you should now be aware it isn't really possible to just "decide to be sapient" and *voila*, have it happen. Unlike the "gene agenda" which you're born with, absolute sapience is a destination at which we can't ever expect to truly arrive. A behavioral and ethical asymptote. At best, we can identify it as a direction and goal: to be more sapient than we have been, and to continue that pursuit. The Reality101 course has been about prepping for a more sapient future in which we can see the entire chessboard and make our personal moves accordingly. We are all (acutely) aware of the accelerating threats in "metabolic space" to oceans and the ecosphere. And we see daily examples in mischief space of the things our species does with surplus energy-both to the environment and to ourselves and our culture. To meet these challenges, we advocate first starting personally, in 'sapience space.'

So *the decision* to pursue sapience is the first step towards Homo sapiens and away from adherence to the behavioral rewards and punishments of the Gene Agenda, to challenge our urges with our principles and win. Below you'll find some scattershot ideas regarding "hitch-hiking in the sapient direction", which is what your authors are pursuing and recommend.

Wise Guys: Homo Sapiens Doesn't Exist Yet

The human race, *homo Sapiens sapiens* (which means "wise man"), is the most advanced and intelligent creature on earth *(***at least by its own standards)*. For the last 20 thousand years, we have increasingly uncovered previously unseen emergent effects by combining fire, flammable fossils, technology, cheap raw materials, extra-somatic information storage, grasping appendages, cultural rather than biological niche adaptation, and the stored solar energy of a hundred million years.

There are a lot of adjectives which could be used to describe this species, but "wise" is not yet one of them. So far we are "clever man", using mind and technology as a tool to satisfy the urges and goals of the gene agenda. A snapshot at this moment might look very successful, but the existing trends - accelerating toward immutable physical limits - throw the intermediate-term thriving and surviving of this species into question.

Wisdom is worth cultivating. It is about long-term good judgement based on a useful synthesis of knowledge of mind and nature, stripped of the evolved bias, fears, lusts

and illusions which fight against it. Until we begin actively seeking *homo sapiens*, we won't find them. *Homo sapiens* is still something to aspire to, and soon.

Don't try to be perfect. Try to be effective.

There's simply no way to deal usefully with everything an inquiring, conscious and conscientious mind will come to care about, and trying to do so can paralyze anyone by imposing cognitive load, scattered focus and ultimately depression and burnout. That's one reason that "social shaming" or "social capital" is an iffy mechanism for changing the world; attempting to "do everything right" and project that image to the world. This can very quickly overwhelm a person.

Moreover, pursuing personal "karma" doesn't actually accomplish much. If one decides to go live in a cabin off-grid and only eat self-grown vegetables, boycotting most aspects of industrialization, that may give him or her peace of mind, but it doesn't fix any problems. Jevons-like effects reallocate resources to others and minimize any positive impacts their partial withdrawal from the big Heat Engine might have. *At this point in time, sapient individuals need to maximize their effects on the world, not minimize them*. Withdrawing from society to ignore what's going on in the world is in that sense a bit of a cop-out, an abrogation of responsibility, which is a victory for the Gene Agenda and its array of dissonance-resolving heuristics.

A more realistic and useful standard to aim at is to choose one or a few things you really care about and be disproportionately effective in changing them for the better, on a scale larger than your own existence. For all the additional issues you're aware of, have some reasonable balance and just try not to be a hypocrite. Do your best without subjecting yourself to a crippling load of mental stress. Can't eat organic? OK. Don't want to be a vegetarian? Well, come up with something that you can live with. Can't donate to all the good causes? That's OK, they probably can't donate to yours either. You don't have to do everything. You don't have to even try to be perfect. Just do the stuff which makes you feel you are who you'd wish to be. (not the stuff you think others expect you to do).

Your authors certainly aren't perfect. We don't live in remote communes gumming radishes, we have cars and occasionally fly on airplanes. At any given time, there will be a primary project we're working on, and we'll be thinking about several others, but we try to be kind to ourselves... because it's people who find a balance who can get good at changing things. Do we always nail that balance? Nah, we're not perfect about that either, and nobody will be. You'll find that there are things you can do which conform to your "who am I" answers, and do NOT add to your cognitive load, like consolidating car trips, using energy intelligently, not eating endangered species,

etc. These sorts of things actually wind up freeing up your time to do more thinks like hike, spending time in nature or with friends, and resetting your hedonic ratchet.

You won't see obvious progress toward your big goals everyday, but you can live in a way which allows you to respect yourself, and the "big goal" progress will become evident on the scale of years.

Don't quit your day job at Exxon: use it to follow your own principles

So here's some advice which is about 180 degrees out-of-phase with that of current social activism: consider NOT dropping out, but creatively staying in, this society. This too goes to our advice to keep track of your own principles rather than hewing to social notions of **"personal karma" or "purity".**

DJ used to work in the oil industry, and NJ was formerly a Wall Street executive. We've both long since quit those jobs, but are perhaps better at what we currently do for having had that experience. Plus, if one has a conscience and quits a job on principle, that job is filled by someone else who likely does not share the same principles, and you wind up one more person trying to do good from a position of relative poverty, feeling pure but perhaps not getting much done.

The human heat-engine amoeba will not be steered by people quitting their day jobs to go start organic-carrot farms. There's nothing wrong with such lifestyle choices, but they don't change any of the macro trajectories. Jevons effects will reallocate the stuff they don't consume and the money they don't spend to others, as long as the economy is organized the way it now is, so buying a bicycle is good for your health, but has the effect of making gasoline cheaper for people driving Humvees in the bike lane, which may be less good for your health. (Rebound effects abound).

So here's a notion: if you work within the amoeba – as pretty much everyone does – there's a way to get around the Jevons effects, and the "mischief space" effects, and ameliorate some of the problems caused by the Amoeba, while giving yourself a high degree of freedom to pursue your own goals. It's simple in concept, eminently do-able, and so scalable that tens of millions of people could do it – if they cared to – tomorrow, transforming the very nature of society, activism, and creative engagement with the future.

The crux of it is a path explored by author DJ: just make the decisions that only half (or some other set portion) of your income from that job is "for you". Define the other portion as "for your second-career projects". That's it, all it takes. It means ratcheting

down the conspicuous consumption from maybe 200x what you need to 100x what you need to survive. That, in turn, just means prudent budgeting rather than taking your cues on expenditures from a social peer group, be it friends, family, or work contacts.

Are there happy people living on a small fraction of what you're paid? Yup, and you can be one of them, *while still earning that full paycheck*. The extra money makes you an instant activist, inventor, philanthropist, or whatever you desire to be; it becomes the YOU while your day job is just what pays the bills.

The way it circumvents Jevons is that you're still spending all the money you bring in... you're just not spending it on yourself, as a consumer. Rather, you're spending it creatively on some issue in human or environmental mischief space which is subject to being changed for the better, which means Jevons effects can't reallocate it to someone else's consumption.

It's also a bit of a revolutionary model: these days, if a person wants to change the future, they wind up looking for some way of supporting themselves and discover that paid activist positions are not only scarce as hens' teeth, but most of them are really fundraising positions in disguise; and if they aren't fundraising they're administration. In contrast, a self-directed-self-funded pro-future person is far ahead of the game, personally financially secure and able to – half the time – pursue being who they want to be.

This is what author DJ did: while working a job in oil exploration, he set aside half his salary to save whales, and became a high donor to one of the first efforts, in 1974, to shut down whaling; becoming a chimerical creature: a doodlebugger/whale philanthropist. Ultimately he decided to leave and pursue the conservation part of his interests full time, but without spending time getting to know the issues and think about them by being a half-time whale philanthropist, he might not have been able or confident enough to. And by living on about ¼ of the actual funds he was making, he also had a bit of financial pad to make that jump once he decided to.

So this can work. Whether it'll become a broad movement is an open question. It first requires stepping outside the gene agenda to *consider* the fact that even with no money at all, a person in a rich nation today has better health, security, and nutrition available than the kings and queens of old, with a longer life expectancy. A person on food stamps eats better than medieval royalty, if they're halfway competent at cooking. That means that living on a third, a half, two-thirds etc of pretty much ANY salary will provide for a respectable and **comfortable life plus a budget to fund the freedom of a primary "sacred" purpose outside oneself.** It does take a bit of impulse control not to immediately spend all one's money, but really no more than

one should have learned by third grade. It means being secure enough not to need to spend what one's friends spend on consumer items to "prove" anything about social status. Really, it could be something a lot of people would do IF it was presented as a respectable sort of life option. There are many plusses to it; one lives more creatively, practices good fiscal hygiene, becomes more personally financially resilient against uncertain times, and much else.

But the big plus is that the *who you are* dimension falls far more within your own control. It's no longer just theory, you can live it and steer it. Of course, this means getting a cheaper apartment, using a year-old smart phone with a lesser phone plan, driving a less-shiny car, etc, but those are really incredibly minor things in comparison with having a life which is more than a cycle of paychecks and consuming. It's possible that if it became known that this was being done by a fair number of people, a ton of others would follow. It just isn't "done" yet, and people don't like to feel odd.

It's a shame to shame.

*"You drive THAT car? We bought a new Prius. Electric, low emission you know". 'Did you know that raising beef is one of the biggest impacts on climate? -I buy organic tofu and love it!". "I can't meet you for a movie, I am biking all of our cardboard and bottles to the recycling center".....*Any of this sound familiar?

The reason to differentiate this sort of self-funded parallel life from the sniping and shaming of standard social activism is that - for one thing - social activism doesn't work very well. It creates tribes of people who "feel like" they are superior to others, with or without reasonable justification, but it doesn't accomplish much. Using that polarizing template, a person at Exxon is automatically on the Dark Side. If such a person were to quit their job to become an activist, Exxon would hire someone else immediately with no impulse to help the future, while the erstwhile activist would find very few paid opportunities available to do anything useful. But if that same person mentally splits her life between the means of obtaining money for living, and the mission which is deep, sacred, and meaningful to HER, it can be transformative, of that person and of the issue. It adds a far deeper dimension to life, an additional way to "keep score" of personal success.

We need a movement that doesn't shame people into tithing 2 or 5% per year, but instead welcomes them to be a full-fledged wonderful human being for having this extra dimension. We simply don't need all the money (and what it can buy) that modern first-world jobs pay, which is why there is so much overpriced junk being

consumed by most consumers and quickly making it into the landfills. We do what those around us do, because it's easy not to think much. But thinking has its rewards.

Looking into the future, there *will be* a time in which the "limits to growth" mean that people *will* need to live more frugally. What better prep for those times than engaging now with a dual purpose, so that one's lifestyle need not take a painful "hit", when the standard obligations and debt of a "normal life" suddenly become a trap. Looked at in that way, this sort of choice provides the additional benefit of a personal buffer against hard times, and the acquiring of skills and disciplines you're likely to need during your lifetime anyway.

The only way to make this a movement that welcomes such people is to drop the "gene agenda" trappings of social activism: shaming and judging. Nate and DJ have worked in the oil industry, the financial industry and the charity world, and y'know, there are about as many good people, and selfish jerks, in all of them. We'd like to see a movement in which people weren't chided for not measuring up to the purity judgements of others. That's pretty much the standard for capuchin-monkey troop dynamics, and we can do better.

Warriors & Mystics

As noted above, in the current situation, reducing your impact just makes you a lesser evil. You're still part of the problem. Moreover, since perhaps only one in a hundred people seriously tries to do so, any effect is overwhelmed by others using what they don't through Jevons-like effects reallocated by the capitalist system of wealth and resource distribution. "Living correctly" is a social response, often to signal to others that you are better than they are, and it's generally socially policed with shaming,

status markers, and a hierarchy of displayed karmic purity which gives good 'monkey vibes' but which does little to solve any actual problems.

The only way to be a "net good" for the planet and the future is to have more of a positive impact than the negative effect you have on the world. Aesthetically, it's good to live lightly as a matter of principle, but that doesn't come close to making one a part of any solution. To do that, one needs to engage at a larger scale than themselves, to make up for not only their own impact but also the hundred or thousand who aren't doing anything future-altruistic. This means thinking big, acting big, and succeeding. This is quite do-able, but not do-able by trivial effort. It means focus, discipline, intelligence, and perseverance, with the tenacity and fierceness of a warrior combined with a sense of the sacred.

We've referred to these roles as "Warriors and Mystics": not "warriors" in a violent sense, but in the sense of being deeply committed to a principle or something one has decided to hold sacred, like a piece of land, a tradition, a wild species, or the wild oceans. Many times in human history, humans have been called upon to be warriors, but never for such stakes as now exist: not just for our own species survival but for the shape of the living systems in which we evolved. The "Mystic" aspect refers to finding a way to motivate ourselves to rational action by harnessing the power of the deep, powerful illogic of our ancient brain structures. This means committing to sacred stories which are by and for our virtual worlds and have personal meaning to us; while staying conscious of the distinction between the virtual and physical worlds. There's magic in our minds, and there's physics for the physical world. Without the element of stories which motivate our spirits, we won't engage; and without a synthesis understanding of the physical world's rules, we won't succeed.

How does one get started making a difference without going crazy?

Here's the big secret: don't feel like you have to prove yourself to anyone but yourself, but make your own standards high. Do what you reasonably can in your life, and don't engage in social posturing regarding it; don't brag or compare yourself to others, keep it to yourself. But beyond that, specialize: choose one big thing that you are going to stand for and affect, over the years of your life, and let that largely define you as you define it.

If you worry about "living as though you were poor", who are you trying to impress? Is your status as a consumer really more important than accomplishing something

original and self-motivated with your one and only life? Don't answer: that's a question for your own musing under the stars.

In fact, the things which others do to posture may not make as much difference as they think. For instance, buying an electric car has huge environmental impacts from the car's construction energy footprint. In many parts of the nation, the grid power is from coal, even if there are solar panels on the roof. So that's not really helping much. However if you owned a cheaper gas car and simply consolidated your impulse trips to one day a week, you'd consume far less primary energy, pollute less, waste less time, take less traffic risk and offer less to others, not need to make high car payments on a fancy new electric, yet still have the benefits of a car. Of course, setting up your work life so you don't need to commute a long way to a job everyday can help make that possible… and surprise, if you learn to do such stuff, you might not NEED to commute to that far-away job. Modern jobs are often a hamster wheel which you need because of the things you need to keep the job.

One can, and should, do logical "first principles" analysis on the life they are living and want to live. To what extent are they just reacting to what they think they are 'supposed' to do socially, rather than piloting their own flight path?

Ultimately, once your life has been lived, it's not about your relative karma or purity, it's about results. *What was the net result of your having lived on earth?*

Be kind to yourself

Here's another radical notion: *be kind to yourself*. Living at this special time with few delusions is a stressful thing, particularly if you've pushed back against the "imposed feelings" of your brain's reward system and are trying to be a decent, sapient person. This doesn't mean "be self-indulgent", which is pure gene agenda. It doesn't mean to be smug and self-superior, which is ditto. It means to cut yourself reasonable slack and know your limits. It doesn't help the future if you burn out, and *most* people who start as idealistically hoping to change the future *do* wind up burned out, long before they get good at it. This happens when one doesn't pace him or herself, but throws him or herself entirely into an adrenaline-fueled push for quick world change. Since system-steering takes time and a coherent plan, it's generally a poor match for adrenaline.
If you realize from the getgo that "burnout" is the primary failure mode for those wishing to affect the future, it becomes only pragmatic to prevent it, and one of the best ways is – with the context of your high personal standards – to give yourself some license to enjoy life. Spend time with friends, take days off to recharge your soul

in nature, go be with a dog or a horse or wildlife. Try standup comedy, write songs, build a treehouse. Pace yourself, for steering the future is a marathon, not a sprint. How to know the difference between "being kind to oneself" and shirking? You'll know.

So what about society?

You'll note that what we have given here are mostly individual recommendations, and not recommendations for society. There are reasons for that.

Chief among them is that society doesn't innovate, it moves in very simple ways, and it has no mind. Society is changed by individuals who become astute in steering it; an art something like training a bear to ride a unicycle. This requires learning realpolitik – what works rather than what we wish would work – but it's not inherently cynical. It can be pursued successfully to achieve altruistic, pro-future and pro-ecology goals.

Clearly, society should quickly wean itself off fossil slaves and stop wrecking the planet's ecosystems. Just as clearly, it's not doing that. Despite all the blogging and conferences and slogans, it's behaving as a relentless, growing heat engine. This growth will be eventually be curtailed by natural limits, but not in time to save the climate, preserve productive seas, or slow the 6th mass extinction.

It's our hope that society will increasingly be influenced by those with a "sapiens" agenda towards future humanity and other life on earth. Since relatively few human minds will ever pierce through the veil of gene-agenda delusion, this means that those who do will have a vital role to play: they must attempt to have a disproportionately large effect on the world. Understanding reality, and their own minds, gives them exactly that option.

Society's goals and methods need to change if the human story is to end well. The way that will happen – if it happens – is through individual minds deciding to curb their fears and unreasonable desires, and make it happen. There are many such minds in existence as you read this sentence, but most of them are yet unaware of what they can accomplish.
Bear in mind that although your authors have some ideas and are coming up with new ones each week, we do NOT represent that we know the best things to do, or even that such things are specifically knowable yet. However, we think that logic, ethics, and a look at the science indicates that some courses of action are probably better and more likely to be meaningful than others.

Also bear in mind that there are three relevant stages to come: (1) the remaining peak of energy/wealth/mischief and illusion of permanent growth. (2) the period when bottlenecks become obvious and then become severe, with less energy and physical wealth, high stress, biomass drawdown, and various helter-skelter human reactions. (3) the dawn of the first day after the bottlenecks pass their narrowest, and the millions of years thereafter. Different strategies and ideas will be effective during each, though degrees of freedom are now at their highest, obviously.

In many ways, a hundred thousand years of cultural evolution will occur in this century. Exciting times, dire times, but also perhaps times of greatness, when our species either rises above the agenda of the gene or goes down with it.

Some final summary suggestions from your instructor(s) preliminary grab bag:

*****The future exists as a probability distribution – expand your capacity for uncertainty, change, and hope.*** There's no way to know exactly what's going to happen. We can know a lot about what *won't* and *can't* happen, but far less about exactly what will, because its future state will be contingent on billions of decisions and actions. You can't know exactly what you'll need to deal with, but you will likely see it taking shape before others will. Learn to use your mind creatively, to think on your feet, and to be centered with a sense of who and what you are which isn't anchored to the aspects of society which may find themselves on shifting sands. Viewing the future as a distribution with shifting probabilities resolves dissonance and allows you to engage, much like treating weather forecasts as a probability distribution has been adopted as the most sensible way of presenting them.

*****Avoid blaming as much as possible – take ownership and responsibility*** Blaming is a gene-agenda default, which is a pretty good way of predicting in advance that it won't make much sense. The problems you will encounter aren't necessarily anyone's fault. Bear in mind that you're far wealthier than the next generation will be, and so on. Appreciate your luck, and let it help you feel humble. You have a lot.

Embrace life. Play, laugh and live every day. No explanation necessary. Balance is key and having fun and keeping a sense of humor is vital in these times. In any times. *Appreciate how amazing life now is.* In addition to embracing life, take time to realize that we are flying, communicating, eating, experiencing life in ways that just a century ago would seem like magic. Don't lose this appreciation of what we have nor take it for granted.

Try to narrow the gap between virtual and physical worlds (but keep a vibrant, healthy, fun, sane virtual world intact) Know your delusions... and celebrate them. The magic, love, and stories of our virtual worlds are what make us human, and make living meaningful and fun to us. But be aware of physical-world reality and make decisions concerning it with your anti-delusion goggles on.

Grieve, when appropriate. We are culturally trained to think displays of grief and sadness are forms of weakness. I disagree (NJ). When my golden retriever died I felt so lost and sad I wouldn't have wished that feeling on my worst enemy. I cried, at 37 years old, for a solid hour. And felt amazingly better. *(Edit: happened again this semester w my next Golden who was too old to bring to class. Same result).* These are not normal times – recognizing the 6th mass extinction and some of our social stresses is beyond the worries we evolved to regularly encounter. Grieving is not only acceptable, its appropriate and probably at times required. And talking these things through with a close friend, even if the talk is sad and doesn't come up with answers, is itself a beneficial healing response. Be kind to yourself and don't bottle up what are completely normal feelings.

Lean into your fear – There is very little to fear, personally, other than the loss of expectation of things we never needed in the first place. Fear is a big part of the gene agenda, and it got us here, but at a high cost. Living a life free of fear is worth attempting. We all feel it, but we don't have to be guided by it or motivated by it. We'll all die someday, and until then we'll live. It's the same deal humans – indeed every animal – has always gotten.

Know your inner reptile - Your limbic system is powerful and reptilian. In effect, you're riding an Orinoco crocodile which has deep ability to influence how you feel and what you do. But those deep-brain regions can only give you feelings and urges and tendencies, they don't really "think", and aren't conscious. As suggested earlier, learn to live with your deep brain, to throw meat to the modules which need it, but don't let them steer or define you. Become a lifelong student of metacognition, and gradually bring those deep parts of the brain into line with your desired self.

Practice "Free won't" - Build neural structures for when tomorrow becomes today (basically, use your knowledge of time bias and Reality 101 to re-shape the relative probabilities of your future responses) It is difficult to make sapient decisions quickly. However, you can alter the odds of how you'll react to future quick-decision situations by pre-restricting some future choices. We call this "free won't" to playfully contrast it with the term "free will". Many of the decisions we make "feel like" they're free, but they are highly constrained – and often made entirely – by illogical and even unsavory subroutines burned into the structure of our minds since long before humans existed. However, we can consciously steer this by training ourselves to "not do" certain things, and to be mentally rewarded when we do things we have decided to value. This raises the odds that future quick decisions will be more "sapiens" and less "gene agenda."

Protect your Mind -Make sure to give yourself balance - and engage with these topics and the future - part-time, because full-time will tend to burn you out. *(It's up to you to define what 'part time' means)* Find a personal retreat from the craziness of the day. This can be a real place, preferably with green things and quiet, but can also be an imaginary place in your mind if you practice – and eventually master the art of meditation, whatever sort "meditation" might work well for you. Nate's mental 'favorite place' looks something like the below:

Allow 1-2 mental parking spaces at all (or most) times. Cognitive load (the tendency to max out at 7 chunks of information in your brain at the same time) is a real thing. People who worry about money and are addicted to various electronics show much higher levels of stress and do poorer on aptitude tests – not because they are less intelligent but because they have limited cognitive bandwidth left. If your

neural RAM is all filled up with trivia and fluff, there is no space left for the real, beautiful and meaningful.

Educate and inspire others to change our collective cultural definitions of success -Don't stand by passively while events and people 'do wrong'. This happened in 1930s Germany and many other places in history. You already know what you care for and mostly what you stand for. Don't be imprudent about when and where you take your stands, but don't be silent either. Humans aren't 'evil', but for the last 12,000 years or so we have been following a novel cultural pursuit (surplus). It doesn't have to always be this way (and probably won't be). We – each of us - can write a bit of the *Towards Homo sapiens* movie script.

~ ***Avoid the error of seeking to blend with a very large tribe if it doesn't reflect your core values***. Communicate clearly with others when that's a part of your life mission, but don't slide into the mediocrity of large groups when you have a choice. This probably also means that it's best not to seek your direction within a large established organization, even one whose mission seems aligned with your principles, for that will likely prove discouraging.

~***Pick a species or issue and commit to it as a sacred purpose***, as though it were a child of your own, a core goal of the "who am I". Never quit. Learn from each failure, learn to understand systems and what steers them. Think in 4D. Be outside the mainstream, unthreatening, implacable. Visit your comfort zone to recharge, but exist mostly outside it.

~***If you can't do that, tithe to a friend to can***. Learn to economize as an ethic, and work a regular job and give half to them to direct, working in collaboration. Don't send it to a big-name group to do administration with; take a role in seeing where it is spent. Make their success your own, while living what is otherwise a normal American life based on a somewhat lower income. The way out of Jevons' paradox is to redirect a portion of your spending to alter the nature of mischief space. This is original, creative, scalable, and at this point in time far more useful than becoming low-consumptive and passive.

~***Take it upon yourself to eradicate some destructive activity*** which is negatively affecting the odds of a decent future outcome for humans or the world in general. It may be small in scale or large, very localized or international. Accept the consequences of doing this, and make your best attempt.

~***Continue to learn how reality works and teach others***, to increase the number of reality-based tribes. At the moment, there are effectively very few.

~***In the spirit of our advice to be 5% alien: Join AAA: be an "altruist alien anthropologist***". Pose as human, and enjoy life as human, but be able to switch in and out of alien-perception mode by wearing Reality glasses and your alter-ego thinking cap. Beneficent aliens are needed but we don't have any. Become them. The human race badly needs loving gamekeepers who can operate from a detached perspective at least part of the time.

~***Be a pro-future, pro-biosphere 'sleeper'*** who springs into action when something happens. Decide which things should not be allowed to go unchallenged in your reality, and react appropriately based on your own values.

~***Bend the systems around you*** to reach a different state than they would otherwise reach. This can be done in thousands of ways. It can be done to save armadillos or burrowing owls, but also pothole repair or Cub Scout funding in your community. The important thing is that you can affect these systems with your mind, make them respond.

~***Inspire others by your example***, not your ego. Blaze a trail so others will follow.

~Don't be daunted by a problem's scale, only by it's structure. If you can't tell the difference, study until you can. Engage as necessary.

~***Become relatively ego-free*** something like a monk, but don't sink into navel contemplation. Instead, take a step into engagement with the 6th extinction and/or the future of those people and things you love.

~***Fight hopelessness***. At best it's a counterproductive "gene agenda" heuristic to resolve dissonance. At worst, it's a mental illness.

~***Reclaim the sacred***, the special things that define you… that you can feel about with possessive intensity as a part of yourself, no more to be abandoned than a loved one. It becomes your task to see that special thing through an intense storm which can come only once in the planet's life.

~***Don't try to be perfect on all issues***. Be mindful of your impact, managing abhorrence, but focus on your sacred passions, uncompromising.

~***Get out of situations in which those around you disagree with what you feel is sacred***. Find your clan, or create one. No solution works unless it can get through the coming bottlenecks. The existential malaise and powerlessness you may now feel *is*

significantly due to the opinions of those around you. Try being surrounded by people you can encourage to try great things, and who wind up doing the same for you.

~***Your focus might be a species, a population, a resource for the future***, a forest, a special place, a special knowledge, a prevention of burning or destruction. helium. oxygen. A human culture. wombats. hummingbirds. redwoods. amphibians. butterflies. you don't have to do it all, but you can do one or two things very well, with passion and competence. Get one nuclear warhead dismantled, one fuel rod sequestered, etc. The power will lie in thousands, then tens of thousands, each doing his or her sacred task to make the future probabilities somewhat better.

~***In engaging with reality, be a student in the art of what works***. Not what you might WISH would work, but what actually works. Learn the nature of human thinking in groups, and how pivotal humans steer groups. It is not immoral to use these dynamics, and it may well be immoral not to.

And we come to this: knowing what you know now, you're the most powerful sort of being ever to have existed: a self-aware mind, in a society which leaves you free to move and innovate with the resources of a culture at the peak of industrialization and energy use. The limits on what you can do are more defined by the consensus trance of social conformity than by physical reality. It took this world billions of years to produce you, and now here you are, against all odds, living a too-brief life at an amazing and perilous time. You can own your aspirations, and decide what your ethical standards should be. There are countless adventures for the highest stakes hiding in plain sight, in our collective blind spots. Learning roughly where the blind spots are is the first step toward self-awareness and away from the gene's mindless and self-destructive agenda. And once you learn that, you're free.

I do not live happily or comfortably
With the cleverness of our times.
The talk is all about computers,
The news is all about bombs and blood.
This morning, in the fresh field,
I came upon a hidden nest.
It held four warm, speckled eggs.
I touched them.
Then went away softly,
Having felt something more wonderful
Than all the electricity of New York City.

~Mary Oliver

You were born into a time in which you can make a difference…

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Appendix – A Look Ahead

Vital projects hiding in our blind spots

That forehead-slapping moment...

In Reality101, the experimental course we've created and taught, the participants start out with a welcome skepticism, and are then exposed to not one or two but *dozens* of ways in which humans have evolved to get stuff wrong. This leads to a fair bit of dissonance: how can the society they grew up in, and even the teachers of their *other college courses* be mistaken about some basic aspects of human reality? But ultimately there's a forehead-slapping moment when the sheer weight of converging evidence shows that it's probably true, and that it has important predictive and explanatory value.

That predictive and explanatory value is used in the examples which follow, which spring from one small but important subset of Reality101: our misunderstanding of energy.

A few examples of unaddressed issues springing from a misunderstood energy reality:

Our society misunderstands energy. This misunderstanding has simple explanations, but massive implications for the human future. What follows is a brief overview about the ramifications of some aspects of these misunderstandings. The upshot is that we need to entirely re-prioritize most of what we're doing.

We would all like to see humans continue to thrive for a long time, in significant numbers and with a high quality of life. However, many of our current individual and collective actions are at odds with these general goals. Humans are to a very large extent working on the wrong things in the wrong ways. We're doing this because we see the future through a distorted lens of unrealistic expectations, based on shared stories about what *seem to be trends* based on a very special period we have just lived through.

If these misunderstandings were easy to see past, there wouldn't be much of a problem. However, they've been incorporated into our cultural stories for so many years that they now seem self-evidently true. The science which could clarify things exists as islands of specialization in a sea of biased storytelling which *feels good to believe* for quite understandable evolutionary reasons. Moreover, we are evolved to

focus nearly entirely on the near-term, while the real-world limits we're up against will make themselves felt over many decades in seeming slow motion, and often indirectly.

Over the last few years, we (Hagens & White) have created and taught a course on remedial reality - R101 - which points out these systemic errors and constructs the bones of a synthesis worldview with known biases accounted for. This is being well-received, but as a college course it stops short of connecting the obvious dots to what is indicated about the future. This short overview will look at ONLY a few of the most glaring of the implications; yet even those are sufficient to make the point that we're currently prioritizing the wrong stuff. And it'll be capped off by a short list of things which we really need to be on top of... and aren't. This list will seem surreally eclectic, yet all the subjects derive from the same simple physical truths we have collectively overlooked.

This is important because we're facing an imminent new beginning, in which the systems around us will soon begin behaving in very different ways from what we have grown used to and have planned around. This could be an exciting and upbeat time, the beginning of a true "age of sentience" for mankind. It could be humanity's finest hour... or it could go in other ways. The stakes couldn't be higher.

A few terms from the R101 course which are important to this quick peek are **energy primacy,** the **carbon pulse, the biomass bubble, sustainable carrying capacity, net primary productivity, energetic remoteness, and money as a claim on future net energy**. Fortunately for this essay, these are all straightforward concepts. These will lead us to other important concepts, such as **the great simplification** and **receding horizons.**

By **energy primacy**, we simply refer to the fact that all life, all commerce, indeed any movement against gravity or inertia, or any generation of order, is an energetic process and is enabled or delimited by available net energy. Humans and their activity don't fall outside this reality, despite many fanciful stories to the contrary. Energy sets our physical limits.

Having understood this basic, it can be shown that nothing about the world we live in today makes sense except in light of **the carbon pulse**, a very temporary infusion of energy magic and abundant resources made available by the one-time confluence of cheap fossil energy and a virgin planet. Being individually short-lived, we have assumed that the way things have been for the last ten generations *(more energy and resources to go around every year)* defined permanent new trends. Without understanding what drove and enabled these trends, this has seemed reasonable, even

if it flies in the face of what we know about science. It's called a "pulse" because of the relative brevity of its roughly 300-year (+/-) duration, set against a human history (and future?) of hundreds of thousands of years.

The carbon pulse has in turn caused or enabled many unusual things. Among these, and something you've almost certainly never heard of, is **the biomass bubble**; a concept so obscure in human parlance that your authors had to *invent* this term to describe it, yet in many ways it's a vital aspect of current human reality with a large bearing on how this century will play out, quite relevant to many people currently alive.

To wit: the terrestrial (land-living) vertebrate biomass of earth is now considerably larger than its historic size, and most of that is the flesh of humans and our livestock. Put another way, that means not only that the sum total of wild terrestrial vertebrates is now an insignificant rounding error to the total, but that the mass of humans and livestock is higher than the total historic mass of all terrestrial vertebrates since before man existed. The age of mastodons and giant sloths and bison as far as the eye could see, bird flocks blotting out the sun. The abundance of walking, flying wildlife - before mankind existed - amounted to a fraction of our current weight. The key enabler: tapping huge amounts of ancient solar productivity, via fossil energy effectively *turned into food* via industry, rather than relying on solar energy and natural flows to produce food as the earth has through history.

The biomass bubble – which includes our own bodies – is thus a part of the carbon pulse. Its exact extent is open to debate: some scientists have suggested that the terrestrial vertebrate biomass is now 5-7 times historic levels. Yet even if it were only 120% of historic levels, that fact would have enormous ramifications for the human story.

The term for the ability of the planet to support animal life is defined by the "net primary productivity" via photosynthesis and is referred to as **carrying capacity**. The natural carrying capacity of earth for terrestrial vertebrates was smaller in the past than the artificially-boosted carrying capacity we have recently created.

The increase in the total amount of edible plants made possible during the last century is generally referred to as the **green revolution**, but it is popularly attributed solely to technology while ignoring the fact that the technology is highly energy-intensive, essentially converting oil and natural gas into delivered edible calories at a large (10:1) energy cost (growing, harvesting, processing, delivering, cooking). (It uses photosynthesis as an intermediate step which adds near-negligible energy – about 9% - to the total). This highlights a vitally important *basic error*, because while

technology can in principle be permanent, unlimited cheap chemical energy is definitely not.

This would be little more than entertaining trivia except for the fact that the carbon pulse IS a brief pulse in human history, with a down side to the curve corresponding to the up side, and it will soon enough be ending. This will, in turn, pop the biomass bubble as the earth reverts back towards a carrying capacity determined by the net primary productivity from natural flows. Inasmuch as this biomass bubble currently consists of humans and their livestock, the imminence and inevitability of its decline has ramifications for every aspect of civilization, society, and human life in general.

Moreover, the sustainable carrying capacity isn't ONLY about energy, but about all other relevant limits which affect it, such as fresh water, soil quality, stable climate, insect life, soil fauna, and much else. This is worth mentioning because all of these aspects of carrying capacity have been, and are being, degraded relative to the way they existed prior to the carbon pulse, so *the sustainable carrying capacity we will be reverting to post-pulse will at least initially be a diminished one*. Just *how* diminished will be subject to our actions.

The second to last of the handful of concepts we'll consider in this overview is **energetic remoteness**. Put simply, we use energy to get stuff and do things. Much of the stuff we get and do things with is non-renewable on the timescale of human existence. Things like metal ores, for instance. Such resources, locked in rocks, exist in a broad range of purity and availability. Being pragmatic, we use the purest and easiest-to-acquire stuff first, and always have. This means that ALL such resources automatically become more *energetically remote* as time goes by: it takes more energy to acquire and refine a given amount of finished material - copper, steel, phosphorus, tin, niobium, name it - than it used to. And *it always will*. This very much ALSO applies to things like oil, natural gas and coal, the source materials for fossil energy, and this all has important ramifications our current culture is still blind to.

We've been blind to it because it was rendered invisible by - what else? - the upside curve of the carbon pulse. Finite resources have been getting more energetically remote for at least 200 years, yet the annual rate of net energy increase from the increased pace of global fossil energy extraction made the trend SEEM to be in the opposite direction.

If that's the case, you might well ask, why does an invisible trend matter? Well, again, it matters because the carbon pulse curve *also* has a downside, in which there will be LESS net energy available to human societies every year for a very long time, and we're likely very near the inflection point now. *(The institutions we currently rely*

upon to report such an inflection point – the UN, IPCC, IEA, etc - have not done so since they're incorporating economic assumptions which ironically fail to include energy primacy). Oil extraction increased at 6.6% annually from 1880-1974 – since then it has increased at about 1% a year. (Smil, EIA) There remain significant stores of fossil carbon, but most of the coal and oil remaining has much higher costs in money, energy and environmental terms, providing significantly less benefits to society, and in turn, making many of our activities and plans in coming decades more 'energetically remote'.

The last of the R101 concepts we'll review in this essay is **money as a claim on future net energy**. We all know money is important, we all want some, but we don't really know where it comes from or what it actually is. The odds are good you've never heard either of these clearly laid out, even if you've googled it. (Or majored in economics or business in college).

What money IS, in principle, is *an abstract claim on future goods and services*, based on faith and trust, which boils down to a claim on future net energy. Those claims are the "money" we use to keep the economy going. When we create more of it, we spend it and doing so stimulate our economies to consume faster, which amounts to burning (mostly fossil) energy faster. So it's a bit like a person taking a stimulant drug. In society we currently refer to this entire process as "growth".

Where most money comes from, these days, is banks making loans. No kidding. Under current banking rules, when a bank makes a loan of a million bucks, that money pops into existence without being deducted from an account anywhere else, other than being added as an IOU on the bank's balance sheet. This can seem to be a great way of doing things, because there's a general societal myth that we have thousands - if not millions - of years of increasing net energy and "stuff" available. We don't.

If a person, a nation, or a civilization misses the fact that future net energy is the basis of money, and creates more money than there ever will be future net energy to redeem it, then there can be a helluva lot more claims created on future net energy than *can ever be redeemed*. This sets the stage for a bunch of dramatic "oops" moments when this overhang eventually corrects itself, as it must do.

This essay includes only a small fraction of the concepts from R101, which take months to learn but are necessary backdrop for this essay. Please refer to the R101 course materials – soon to be available online ion the Bottleneck Foundation website – for a more complete description of the "rules of reality" which underpin these summary descriptions. Those materials also offer a synthesis human behavior

overview which explains how and why we and our designated experts have so many durable consensus “blind spots” about reality, even in a technological society. All we’ll presented here are some very basic conclusions, and show how even those basics turn our current priorities on their heads.

In short, despite the fine details of the future being unpredictable, certain major things we expect are definitely not gonna happen, and certain major things we don’t expect definitely will. The reasons our societies believe otherwise are rooted deep in our evolution, in the very way we think. We need to plan around actual reality. For the most part we aren’t doing that yet.

So where does this leave us?

So let’s review:

* Energy underlies life, biomass, and economies. Thus, the “carbon pulse” has solely and directly enabled a terrestrial vertebrate “biomass bubble” by diverting millions of years of stored fossil energy into a bolus of food creation and acquisition. This biomass currently consists almost entirely of human and livestock biomass.

• As an obvious but seldom-remarked corollary, the carbon pulse has also enabled wealthy human economies, with the greatest wealth going to those which have used the most fossil energy. We have pretty much ignored, denied, and obfuscated the fact that this wealth has been an absolute consequence of cheap net energy, while accelerating the pace of burning by creating ever-more money.

* As a finite depleting resource, the carriers of fossil energy are problematic over the intermediate term. Not only do they disrupt the climate and acidify the seas, but the liquid fuels on which our societies are largely based are quite finite and will begin inexorable - and fairly steep - declines in total availability within decades, followed by similar declines in the other types of fossil energy source materials.

* For the last ~200 years, we have been on the upslope of the carbon pulse, with the overall trend being more net energy recruited continuously year-over-year. We are now using far more oil than we are finding, and drawing down reserves in the process. For roughly the next ~200 years the trend will be less net energy recruited each succeeding year. The inflection point for that change is around now, give or take a few decades.

* As available net energy to humanity declines, it will no longer obscure the

increasing energy remoteness of all finite non-replenishing resources. These two effects together will mean a new trend of decreasing physical wealth for centuries.

* Our societies are largely oblivious to these points due to evolved idiosyncracies and bias in how humans think about the world, and in particular (don't) think about energy.

These are not wild observations. They are direct consequences of the nature of reality, of thermodynamics, and of basic physics; and of tribal minds which evolved to optimize for the Pleistocene. We entirely understand that this leads to conclusions at odds with prevailing narratives, and we understand why: our societies are primarily social and political, with islands of specialized science floating in a sea of popular stories. The essential difference of the paradigm behind R101 is looking at all aspects of reality simultaneously rather than in isolation. Thus it's not surprising that it leads to conclusions which are disconnected from myth, which will necessarily be different than those which aren't. *(By all means dig more deeply into the R101 materials, or get in touch with us, for a fuller story).*

The emergent consequences of these points include:

* There will be a "**great simplification**" in human affairs as the net energy of the carbon pulse winds down. We call it that because the net effects of increasing energetic remoteness and the end of monetary credit additions will be human systems becoming more simple, less complex, and smaller. That doesn't mean *easier*, because much of the complexity we've invested in is for convenience. This will affect, in profound ways, the ways we are able to live, as individuals, as communities and as nations. *(We use the term 'great' because the disconnect with todays economy/GDP will be significant – almost certainly a bigger drop than the 15% global decline in the prior 'great' event – the global depression in the 1930s).*

* There will be **receding horizons** in terms of the feasibility of energy intensive activities. We define "receding horizons" as the experienced effect of two synergistic trends described above: *increasing energy remoteness* of most physical things humans use or desire, and *decreasing net energy availability*. Our societal narratives have generally assumed that everything will be easier in the future, and that people will be wealthier. That will generally *not* be the case, which is why we call it "receding horizons": the practicality of all energy-intensive goals will recede, becoming effectively farther away. Diminishing net energy availability will mean that everything with a physical energy footprint is less energetically affordable, and thus there will be less to go around. Things which require a lot of net energy, and are not necessary for our survival, will be the first to go. *(for instance, no air conditioning for*

the poor... and a lot more poor.)

* The **biomass bubble** will deflate. The amount of available food for humanity will track the amount of available net energy, because the excess biomass is created or recruited by that net energy. This means that the population of humans and livestock will decline from a high peak somewhere near midcentury, and that decline will probably seem precipitous, declining by many billions by the end of this century. The actual shape and severity of the human decline will be affected by the types of new technologies, by whether most humans become vegetarians or continue to eat livestock, by the stability of climate and rainfall in growing regions, by the availability of such resources as minable phosphate, by the survival or collapse of world fisheries, by wars and many other factors, but the terrestrial biomass must eventually revert to at or below its historic levels. And as noted, the carrying capacity will at least initially be diminished/damaged relative to where it was historically.

* These things will cause all sorts of disruption to human systems. It's likely that the first way most of us will experience "**receding horizons**" is when there are **abrupt discontinuities in our fiscal systems**. The huge debts represented by money and other abstract claims – currently over 300% of GDP in the developed world - can for the most part never be redeemed, and this will play out in some disruptive fashion along the lines which have been seen in the past, and likely in new ways as well. Price volatility, cascading fiscal industry failures, national currency failures, market crashes, recession, depression, devaluation, revaluation, debt jubilees, and whatever else results from national leaders try to get things back on track. An inevitable energy reality will be perceived as an unforeseen money problem.

* Humans don't generally understand the deep energy-rooted effects which will be causing fiscal chaos, lessening relative wealth, and lessening food supplies in most of their lifetimes. Our human default is to blame such problems on designated "outgroups" of other humans and to politically organize and seek redress from them. **Historically, such pressures have led to unstable nations, regime overthrow, the victimization of minorities and the weak, and wars**. Though the magnitude of past events – even world wars - has been tiny by comparison with what's baked into the cake this century. It would be enormously valuable for humans to understand the inevitability of these processes, and that the effects are nobody's fault in a malign sense.

* The predictable fiscal chaos, the destabilization of nations, and the preconditions for wars of all sizes, will mean that the current assumptions underlying **globalization, treaties, and all other existing webs of commerce and political/diplomatic agreement will become untenable**. There will thus be periods of hiatus after which

new arrangements may or may not be negotiated.

All these effects emanate from a simple misunderstanding of energy. This is a very simplified listing of inevitable and nearly-inevitable high-level effects. But even this shortlist can illustrate why there are some projects we really should undertake, and others which will have been a waste of time and resources,

*(**it's not insignificant to note that even if the science pointing to these effects were mistaken - which it manifestly is not - that it would be necessary to curtail fossil energy use voluntarily on much the same time scale, and with the same effects, to prevent cooking the planet and turning the seas to toxic slime, which might spell the actual end of humanity and much else. The reason the effects will be much the same is, once again, that energy is misunderstood, leading to an erroneous narrative that "renewables" will allow us to maintain current civilization and "growth" without fossil energy. They won't. For details, see R101 section of 'Rebuildables'.*

So what should we be doing differently? Nearly everything.

Even a basic list of necessary re-prioritizations would start with a "top hundred" and "top thousand" projects. Essentially *none* of these is now getting attention based on a realistic energy understanding.

So what does the Bottleneck Foundation suggest in this essay as examples of societal projects which acquire huge importance through the lenses of energy, ecology, and human behavior as it actually exists? What follow are just 10 examples out of thousands which should get immediate attention.

- Our Education system is becoming irrelevant for the future we are facing.
Primary and secondary education are a product of energy surplus. Paradoxically, they also are one of the few investments that can contribute to 'future surplus'. In the near straight line up economic growth over the past 3 generations, there was no societal cost for large numbers of students learning esoteric subjects. In a world of energetic limits and overall declines in economic growth, the curriculums in our schools are going to have to change to be more relevant to a source and sink constrained world. We'll need children and young adults emerging with an understanding of the actual world they will face as opposed to what it was the past 2 generations. We'll need more focus on science synthesis, understanding our own minds, on ecological principles, and on the skills which will be increasingly needed in a lower-energy-throughput society. We'll need to transition back to a situation in which a large percentage of people are directly involved in growing and preserving food, and in keeping a desirable society running without the option of wasting of energy and materials. Ideally it'd be good to have grades 1-9 or so be redesigned to teach this stuff, followed

by trade schools which teach specific skillsets. The capitalist basis for going into extreme debt to become highly specialized will likely become irrelevant, though it's hard to say whether that transition will happen in 5 years or 40. From such an education system, many of the additional 'projects' listed below will make sense to a greater number of people

- **Foundation and large funder priorities are out of whack**. The initial funding available to make the future a better place lies largely in the hands of private and public foundations, in networks of philanthropists, and in NGO's, which are traditionally the innovative "first responders". Yet currently those demographics don't understand energy realities, and their directors and boards subscribe to prevailing narrative versions of the "growth" mythologies of neoclassical economics, under which the corpus of their endowments is expected to grow annually forever. *(This is simply incorrect; reliable "earned interest" is an emergent result of more net energy available every year, and that will soon reverse itself on the downside of the carbon pulse)*. Future fiscal dislocations will make the 1's and 0's in bank hard drives diminish and ultimately become meaningless, and any unspent charitable funds will have been wasted when they could have done much good. Of course, by planning for a future far different than that which will exist, much of what they have spent to date will also have been wasted.

The bad news: Networked philanthropy is not a sector which is characterized by the ability to easily adjust to new facts, being heavily influenced by network consensus inertia, risk avoidance, highly-specialized advisors, perceived sunk costs in the status quo, the tacit assumption of systemic and fiscal stability, and presumed career stability. This synthesis – elementary as it is – is an almost "perfect storm" combination of concepts these players reject out of hand.

The good news: In principle, the smarter, braver, less-networked players could take the lead and eventually catalyze a large portion of the rest. They could start with ideas and pilots base some of the remaining examples:

- Avoiding giga-starvation this century. As noted, terrestrial biomass is now inflated over historic or sustainable levels by leveraging off fossil energy, principally oil and natural gas. As liquid and later gas fuels become more energetically remote and fiscally expensive, crop biomass and thus animal biomass (human and livestock) will track net energy down. This could lead to the most terrible famines in history, or be managed in a humane way by diverting energy from other uses and by phasing out industrial livestock operations while having extant humans eat the plant calories themselves. If this is to be done, the logistics and prep work should be planned and started well in advance, because **it will be the largest humanitarian challenge, for**

the largest stakes, in all history - past or future. *(Since human populations will never peak as high again for energy reasons)*.

The bad news - if we don't understand that this is inevitable, we will fail to plan for it. Major organizations like the UN still view the future with money and technology lenses instead of a biophysical accounting. There may be be little empathy for those who starve in foreign lands while there is a perception of diminished wealth at home *relative* to the recent past. It will be our human default to deal with this through wars and isolationism. The wealthy will not wish to stop eating corn-fed meat as often as they like. We are wired not to believe depressing things even if they are entirely simple and logical. Even now your brain modules are working to disbelieve this. Furthermore, the **carrying capacity** of the planet – the number of food calories it can create simply from sun and soil - has taken a big hit while we've depended on "green revolution" techniques which are ultimately unsustainable.

The good news: The huge amounts of energy currently wasted on unnecessary consumer stuff, and the huge amount of food now fed to livestock, could in principle be a buffer which prevents such starvations IF this is handled as a legitimate world crisis with no one ultimately at fault. There are probably a couple decades to politically and logistically prepare for the really deep declines, and for young people to prepare for the humanitarian challenge of the age, saving billions of men, women, and children from the awful fates nature traditionally provides for population overshoot. We are still near the peak of all-time net energy availability, and can direct more of it to preventing foreseeable problems if we choose to.

Even if "gigafamine prevention" was the ONLY project to be undertaken, its ramifications would be daunting, because the knock-on effects of billions of starving people boggle the mind.

Gigafamines can be largely averted by planning decades in advance for the inevitable. This project – in many ways the largest and most important in human history – has yet to be begun.

- Maximizing human life quality this century. In addition to the looming energy-shortage famines of the latter 21st century, there will be a related problem: maintaining human life quality in a vastly changed world. There are many aspects to this, but high on the list would be the problem of global heating and climate change, which takes on somewhat different attributes through non-delusional energy and behavioral lenses. For one thing, the water supplies for traditional farming areas will be directly threatened by CC, from monsoons becoming unreliable to glacial melt diminishing rivers, just as deep aquifers become too energetically remote to rely upon

at recent scales. This is already realized by climate campaigners, except that they don't realize it will occur against a backdrop of destabilized commerce and fiscal dislocations, if not outright resource wars. Another thing not widely recognized is that the coming generations will not adjust to elevated heat and humidity the way nations now do at the all-time peak of cheap energy availability. We must expect that just as wet-bulb temperature limits make areas near the equator increasingly uninhabitable, the energy grids which now allow people to take refuge will become less stable, less robust, and more expensive. Our progeny will not be using ubiquitous air conditioning in 100 years, they will be migrating away from areas too hot and dry to live in, abandoning what have in the past been some of the most sustainable ecosystems and farming areas on earth and attempting to resettle in vast numbers where other people already live, and to large degree without the benefit of the high-energy lifestyles and infrastructure we have today. Our myths currently have us believing that in the future people will be wealthier and more capable. This is simply false. It's within our power to make their lives far easier than they'd otherwise be.

- **Social Stability** - The glue which undergirds our physical societies is *"more net energy every year than the year before"*, which general trend has been true for over 200 years. As this trend ends and then reverses, there is no aspect of society which will not be profoundly affected: fiscal instability and hiatus, rationing and unavailability of staples, the "rolling warehouse" model of asphalt highways and diesel trucks to ship supplies, a loss of faith in the political system, the opportunism of demagogues, the polarization of segments of the populace against other segments, the migration of population within nations and between them. Even those who are luckier than others will "feel like" they have less than they formerly did, and historically this precedes unrest and revolution. Preparing people for the new reality in advance is a priceless advantage to have, but only if it's acted upon.

- **CO2 Campaigns**. These campaigns are vital, to allow ongoing human habitation of the planet at some level of life quality, and to prevent the seas from undergoing irreversible food web collapse to jellies and bacterial slimes. However, such campaigns must be recast if they aren't to run up against realities they aren't expecting. On one hand, the highest levels of IPCC CO2-release scenarios won't be realized because global economies will be contracting as liquid fuels become far more expensive, somewhat throttling down energy use in parallel with fiscal dislocations. The IPCC bases its scenarios not upon energy availability but upon human demand, in accordance with spurious econometric assumptions which have no biophysical basis. On another hand, though, the entirely fictitious "CO2-sucking machines" predicted by the IPCC as integral to their mitigation strategies are, thermodynamically, simply fantasy constructs and must be treated as such. At the risk of running out of hands, there's also the fact that the green narrative of 100% or even 70% 'renewable' energy

at anything near current throughput levels is not physically achievable with anything like current physical throughput and economic structures. Not only are they intermittent, but the mechanisms involved are in no way renewable; like an automobile they need to be periodically rebuilt from scratch with fossil energy, and at present mostly liquid fuels. Yet a far greater problem is a different blind spot: very few now realize to what extent *the wealth of our economies relies directly upon the enormously cheap net energy provided by burning fossil carbon compounds*. Even if one sets aside the fact that there has never been a solar panel, wind turbine, hydroelectric dam, or nuclear plant built with anything but fossil energy, and that it is far from clear that they COULD be, the fact is that most actual value created in industrial economies now comes from leveraging off cheap fossil energy *(as opposed to human labor)*. As we remove barrels of oil from our economy, we will remove the underpinnings of physical wealth and need to deal with that. Alternatives can power a good civilization, but not THIS civilization. Lowering CO2 is the existential ecological challenge of humanity's existence, threatening not just the coming century but tens of thousands of years into the future, so we'd better get our facts straight. Currently, we're very confused. It will be harder than we think it will be, yet we still need to do it. If we represent it as easy, we'll crash into the reality that it won't be

- **The 6th Mass Extinction**. Ecologically, mankind has set into motion what looks set to become only the sixth planetary mass extinction in the last half-billion years (and 9th overall). Our success or failure to limit its effects will determine the nature of life on earth forever, and some of us are aware of this. However, very few have integrated the inevitabilities of energy decline and fiscal dislocations into the picture, which changes the way we should plan. In particular, environmental campaigners and species advocacy is now done by entities which, like others, share the prevailing societal assumptions of neoclassical economics and capitalism, which predict indefinitely increasing wealth in all nations, stable governments, increasingly enlightened and noble populations, increasing globalization, and stable geopolitics, nations, and treaties. *This is simply not what is in store.* Rather, based on a reality analysis, we should be planning based on pretty much the opposite of those assumptions. Saving species "on paper" via treaties will not survive the fiscal, political, and resource-shortage crises which will characterize the latter two-thirds of this century. "Protected" species near to human population concentrations will be quickly poached and eaten or sold during the first of many inevitable hiatus events. Energetically remote species will tend to get a break as they become too expensive to go after on an industrial basis. In the latter half of the century, pretty much anything living near dense human populations - from trees to birds - will be consumed. Species which are endangered by this reality - even if now extant in significant numbers - will need to be relocated or be lost, even though that will probably be at odds with current laws and treaty rules. The high seas will become more of a conflict zone as fishing

fleets act in a more piratical manner, accompanied with gunboats and using slash-and-burn type technologies. If we would protect biodiversity, we need to plan for this with the advantage of foreknowledge. The tragedy of the ocean commons, and the race to take accessible wildlife, will be a free-for-all if not prepared for well in advance.

- Fuel Rods in Swimming Pools. In the USA and in many parts of the world, nuclear reactors exist to create baseload electric power. With a few notable exceptions, they have operated without serious mishap. However, adjacent to the reactors, in what are effectively swimming pools, are huge numbers of irradiated fuel rods which were previously used. Euphemistically termed "spent fuel", they are far more toxic, radioactive, and dangerous than the fuel rods were when new. In the US, Japan, and some other nations there is nowhere to send them, so they just stack up there, waiting. The number of curies of radiation in the irradiated fuel rods is far greater than that which is inside the operating nuclear plants. Few people have a problem with that, because our societal narratives believe that the future will invariably be one of greater wealth, higher technology, and more energy. If that's true, then surely those advanced-technology, money-rich, resource-rich, and energy-rich future people will find something to do with them and we needn't worry.

Yet as we have seen, looking at reality based on peaking and declining net energy, big projects will soon start getting harder - not easier - and they will be increasingly hard every year for a very long time. As this happens, there will also be a predictable attrition in terms of how much of our total energy (and thus money) budget we will choose to spend on emergency response teams and infrastructure maintenance in general.

This is salient because constant active cooling is the only thing which keeps those swimming pools from evaporating and turning into radioactive volcanoes venting a witch's brew of waste. The thing which keeps them from evaporating is more cool water being pumped in, continuously. This, in turn, is accomplished by grid power and backup generators. *(What happened at Fukushima was not an earthquake causing reactor failure; it was simply a failure of grid power followed by the backup generators running out of fuel.)*

If we "kick the can down the road" indefinitely on the "spent fuel" pools, we risk entering a time of failing grids and infrastructure; a time in which plant workers will run away and evacuate their families rather than running towards a potential radiation disaster. There are current efforts to secure better power backup for these sites, but crucially the*se efforts still operated under the assumption of rising prosperity in the future and leave the irradiated fuel rods where they are*. Getting the fuel rods out of the swimming pools and into a remote repository is something best done when energy

is cheap, and civilization is well-funded. If we wait too long, we'll pass the point when experts run towards a potential meltdown of irradiated fuel, and instead run away from it. Every year which passes makes the ability to relocate these time-bombs more energetically remote and unaffordable.

- **Diesel Trucks go away**. If we believe current societal narratives, there will be no shortages of energy or materials with which to continue cheap transportation of anything and everything. Asphalt roads may be rebuilt indefinitely and diesel trucks will continue to carry nearly everything to everyone. However, if we look at things through an energy lens, we see that we've already burned through roughly half of the available oil, and are burning through it at faster rates every year. By mid-century oil will be high-priced, less available, and in permanent decline affecting the affordability and availability of shipping. The recently-touted "electric semi-trucks" powered by lithium batteries are infeasible even in principle as the batteries would constitute the bulk of the load carried. In addition, many current roads will not be practical to maintain, and this will be cut back every year.

This is an important consideration, inasmuch as diesel trucks and containers are also the way ocean shipping is done, and the way our fractal network of stores and homes is serviced.

The good news is that there is a workable, proven alternative which can be powered by electricity or alternate fuels: railroads. Not super-fast passenger liners, but robust, regular-speed, easy-to-maintain energy-efficient regular railroads. The problem is that the network of rails which used to connect every city in the nation has largely been pulled up or allowed to rust away. It will need to be rebuilt if distribution of goods is not to someday grind to a halt, and this will take acting significantly in advance of the need, while energy is still relatively cheap and materials are easily available. This will also, to some extent, mean rebuilding the way we inhabit the land, as rail is somewhat different than trucks. This should be a high priority. It isn't even on our radar yet. The ability to distribute supplies within a nation is utterly basic to that nation's survival. Traditional steel-on-steel railroads are likely the only feasible way forward for the USA, and will need to be ready when needed. This is a multi-decade project which should have been started years ago. It hasn't been due to our huge blind spots about energy and the nature of reality.

- **Drain America First**. Deluded by our belief in ever-more energy if we only drill more, we are expanding the rate of oil extraction within the USA, and many people are excitedly talking about exporting it to other nations at whatever the going rate happens to be *($60/bbl at this writing)*. Seen through a declining-energy lens with a focus on the imminent decline of liquid fuels, this is nearly suicidal to a nation in the

medium term. Exporting oil is about the dumbest thing which a nation can do. Even back in the 1950's Shell chief geologist M King Hubbert noted that if we were wise, we would save a lot of it for the future when it would be scarcer. Nations which have sold off their oil at $10-20/bbl will in the future have to buy it back on the open market at $200-300/bbl… if it is even available. Oil is the current basis for the wealth of nations, and this has been true for some time. Moreover, when wars come - and wars always do - the nations with the most oil win. In many ways, WWII was a war for control of oil, and victory did go to those who had the most of it. Those who fancy themselves patriotic should be opposed to the export of domestic oil, yet the myths of permanently increasing wealth are strong in our minds. The last nations with oil will geopolitically be the dominant nations in nearly every way. A campaign to highlight this has been roughed out by Bottleneck Foundation. On one level it could teach lessons of the value of energy and basic societal responsibility. On a more aggressive level it could catalyze resource nationalism globally and ratchet down CO2 emissions while allowing human societies to deal with energy realities on less of a crisis basis. There will ultimately be a realization that a nation selling off its oil is counterproductive, and the international spot market for it will increasingly go away, with it being treated as a strategic resource. When and how that happens will be important.

- **Fix it Now.** It is well known that the basic infrastructure of the nation is in pretty poor shape and getting worse. This is agreed, in a general sense, to be a problem even by those who think we will have more energy and resources to use every year. But of course, due to that belief it seems reasonable to put such construction off as long as possible, so those higher-tech, richer people of the future can deal with it.

However, looking at energy realities, we have a far greater ability to fix infrastructure now than we will in the future - for a LONG TIME in the future - so we really should fix in in such a way that it lasts a good long time, the way the Romans attempted to do. Our bridges will at some point fall if not replaced; and while the roads leading to many of them will not be maintained for diesel and gas vehicles, the railroad bridges will be needed. Moreover, the networks of pipes for water and sewage, the treatment plants, the trillions of dollars in coastal facilities, all are rusting away and most were built in an era of far cheaper energy and resources than today's. Our biggest buildings are concrete and rebar, which will fail within 100 years due to water seepage and rust. For a very many repairs, it's now, soon, or never.

We cling to the belief that it's cleverness rather than energy availability which enables infrastructure projects, so have always assumed we can indefinitely re-make things better every couple of generations. That turns out to simply not be the case. We need to think about our future from the perspective of having more energy to spend in the

next couple decades than we ever will again. Simply galvanizing the rebar in our concrete could make buildings last 3x as long. We don't do it because we live by stories in which we expect to be able to replace everything with bigger and better versions indefinitely. Since that isn't actually the case, we are now in a position to do a big favor to succeeding generations.

- **Cross-Generational Projects and Technology** – Terracing fields. It is nearly inevitable that future generations will be working the land by hand, by animal power, and with small indefinitely-repairable machines. There are many favors we could do for those people – our descendants – to save them the labor of prepping fields for manual labor the way the pioneers did. These days, diesel-powered tractors and graders can do this at warp speed, leaving a friendly environment for those who – in the intermediate future – will be feeding everyone through traditional hard work.

200-year solar panels – This is a seemingly-silly concept which has never been pursued, offered as a case in point. Current PV panels are wondrous things which can turn sunlight into work with no moving parts. They're currently made to last about 20 years, because our current society is based on the tacit assumption of more liquid fuels available every year, permanently. Based on that error, PV panels are called "renewable" even though, of course, they aren't. If a 200-year solar panel were available now, its "net present value" would be considered little more than a 20-year panel. Nobody would buy them, even if they cost only 20% more. Yet if one takes onboard a few inevitabilities of physical reality, it could well be that a PV panel which lasted generations would become one of a community's – or a family's - most valuable possessions, after the demise of globalization and cheap energy. Is a 200-year solar panel possible? That's the point... due to our societal beliefs, nobody is even asking such questions. We should be.

Preservation of knowledge – this essay is being written on a cheap computer attached to three inexpensive 8tb hard drives; spinning aluminum disks magnetizing excruciatingly tiny shingles using mechanisms of ridiculous precision, via proprietary controller cards and algorithms that not one person in a million understands, and which vary from brand to brand. Going forward under the assumption that each year will be richer and higher-tech than the last, this doesn't seem a problem; but as we head into a future of lower wealth and more expensive tech, there is a high risk of much of our knowledge and records being lost. If that is not to occur, the problem must be anticipated and taken seriously.

- **Low-Energy Technology** – Another very-worthwhile thing to do, at the peak of all-time net energy and resource availability, is to focus research on developing methods that technology can be maintained at a far lower energy throughput, with rarer

elements and complex synthesis chains unavailable. Such research is far easier done now than later. Is it possible to make solar panels from rocks using only electricity? We should figure that out. Are there ways of building good batteries and wind turbines using common materials rather than rare elements? Are there ways to prevent disease and confer immunity without the high-energy megafactories which currently produce vaccines? How, in principle, can future humans be healthy in a world without cheap disposable plastics, supercooled medical scanners, and a constant influx of new antibiotics to keep pace with superbugs?

Once we drop the mythological narratives about wealthy sci-fi futures, it becomes clear that we have a large responsibility to use our cheap energy, and the brief time remaining while we have it in copious amounts, to prepare humanity to thrive and survive for the coming thousands of years. By far the easiest time to experiment with low-energy, common-materials technology is before that's all there is left.

- **the end of globalization** – globalization has made a lot of things cheaper. The traditional explanation for this is that it provides for global arbitrage, allowing everyone to do what they do most effectively. When applied alongside cornucopian narratives, the implication is that poorer nations are just lagging a bit, and will someday have the wealth now enjoyed by richer nations. From an energetic and entropic lens, however, it becomes immediately clear that the actual basis for globalization has been nearly-free transportation of goods and services, which has been almost exclusively due to cheap petroleum.

That same energetic perspective shows that it is not "being developed" per se which separates the wealthy from the poor nations, it's which ones have benefitted from the work stored in this petroleum. As this peaks and declines in coming decades, the poorer nations will be affected first and most severely. One aspect of this will be that the "globalized" jobs which now allow many to eke out an existence will become less tenable. Preparing for this, domestically and internationally, is a big deal.

The world will become a much larger place, with its parts more isolated, than has recently been the case. Localization will mean less total wealth to go around, which will compound the fiscal and energetic problems. It will also contribute to trade wars, and perhaps general wars. Insofar as this is foreseeable, we should plan to mitigate its negative effects.

- **Gorillas, Elephants, and Rhinos, etc** – species which are now "protected" rely on an incredibly fragile tissue of treaties and laws. Although even now the trends are not encouraging, one might at least hope that in a future of greater wealth and stability, such conservation measures might ultimately keep them alive in the wild. Yet this

future world of greater wealth is illusory; as noted, we'll be heading for a world with far higher populations which must suddenly deal with food shortage, resource wars, and unprecedented human migrations. This will predictably lead to change and infrastructural deterioration, and it will only take days or weeks of such hiatus to see extant populations of mountain gorillas, chimps, bonobos, rhinos, elephants and other easy-to-find megafauna to be eradicated by the surrounding well-armed human populations. This is baked into the cake at this point, and what such species will actually need to survive is to be evacuated to some livable habitats removed from desperate humans, in which they can survive the 21st-century bottlenecks and spasms of overshot human populations. Such a proposition would be *at odds with* pretty much all current conservation laws and narratives, which incorporate the "permanent growth" assumptions of neoclassical economics. This is an error big enough to swallow many species. There will be a more realistic paradigm required if we are to end the century with such species still existing. Most wild megafauna will be lost to spasms of armed lawlessness in coming decades unless something disruptive is done to change the status quo. They're currently in the jaws of a trap most of us can't or won't see.

- **Helium** – is generated deep within the earth, one atom at a time, by immensely slow radioactive decay. The only helium which will ever be available to the human species is being vented into outer space because we believe the narratives of economists. Specifically, the narrative that human demand will always cause a resource, or an equally-valuable substitute, to become available. Though oft-repeated, this is simply supernatural mythology. What might future humans – in the coming years on a relatively depleted planet – use helium for? We don't exactly know, and that's the point. Currently, it's vital for medical scans and superconductivity, deep diving and welding. But there's no plan to save any, due to the same energy errors which underlie these other problems: IF we assume that energy will be ever-more-available year-on-year, then in principle we can pursue small pockets of trapped helium even at huge energy cost. However, in a real world of declining net energy, helium (and many other elements) will rapidly become unavailable. It would be trivial to save some, just by "not digging up and flaring off" helium-rich gas deposits. But that sounds daft by prevailing cultural beliefs. The cost to save some helium-rich natural-gas deposits would be trivial, but we choose not to, again because of nonsensical cultural narratives and a powerful optimism bias. Is there a single human now working on conserving helium for the human future?

- **Nuclear Disarmament** – This is a well-known issue, even though it is can seem like something of an old-fashioned concern. Although studies show the odds were probably against our avoiding global thermonuclear war from the 50's through the 90's, we did avoid it, and it is generally not on the "top ten worries" of today's

societies. A large part of that is, once again, the cultural "blind spot" about energy, material, and financial disruptions this century: it seems to us that rising prosperity for all nations should yet lead to world peace. The problem, of course, is that in the intermediate term prosperity will be actually begin falling precipitously, and for a very long time to come. If we proceed into that negative-growth future still "blaming outgroups" and with high inventories of nuclear weapons, we *will* see them used. Even the exchange of a *hundred* or so of the 15,000-odd warheads now targeted could lead to an ad*ditional and immediate* global gigafamine starving 2 billion due to multi-year "nuclear winter" effects on crops, to say nothing of the global biological effects of ubiquitous radioactive fallout. If we go forward blaming problems on enemy outsiders rather than fundamental realities, we will have major wars; and if those wars are fought with nuclear weapons, the toll on humans and the earth will be frightful. We now have the scientific and informational tools to show this is the case, and could in principle reprise past arms-control agreements and improve upon them before nationalistic resource wars of attrition commence in earnest. However, the time to do so is short.

- Slavery, minority safety, and women's rights – A lower-energy, lower-materials world of failing currencies, in which globalization becomes progressively impossible, will tend to drift toward historic human attractors unless these are actively avoided. As food becomes scarcer, angry fundamentalism ascendant, refugees more common, and governments both weaker and more authoritarian, there will be a propensity for the weak to be unprotected by civil law and cultural practice. Among the things to avoid in the latter half of this century is losing the progress made by women in many societies, losing the protection of minorities, and the re-imposition of institutionalized slavery in many forms. What can be done now, by we the wealthy, to actively prevent the worst aspects of history repeating themselves on far larger scales? <u>And is not this more important than a lot of the other stuff we're spending time and energy on now?</u>

- Geoengineering Debacles – Techno-optimists are now proposing a number of "tweaks" to mother earth to "fix" aspects of the planet being compromised by the side-effects of industry. Central to all of these is the same assumption which blinds us to these other issues: the anti-scientific cultural belief that human "demand" and cleverness is more fundamental than energy. Seen through even a rudimentary energy lens, all proposed geoengineering solutions are inevitably temporary, things which might be done for a time but which would ultimately have to be ended for lack of money, energy, and materials, leaving humanity and the planet in worse shape than it would have otherwise been. Like everything else which requires making things, geoengineering is a way to *use excess net energy*. Excess net energy is exactly what will be going away. Money, as an imperfect marker for future net energy, will probably go haywire first. Most geoengineering is a bad idea on several levels, but

once one factors in the energy, materials, and fiscal limits of the 21st century, pretty much all of it becomes clearly a bad idea.

- **Peak Phosphorus** – Just one more representative example of a problem which arises due to energetic remoteness. One which is entirely predictable, scary, largely ignored at the present, and a lot less subtle than helium.

Point: we need phosphorus to grow food in any thing like the quantities we're now used to. It isn't replaceable. It's getting scarcer and more expensive because it's getting progressively more energetically remote. This hasn't caused any existential hand-wringing because we've compensated by throwing more net energy at the problem every year: as the minable phosphate ore becomes scarcer and worse, we simply dig up far more of the lower-grade phosphorus ore. As long as we have lots more energy every year forever, as many economists would have us believe will be the case, it might be possible to stay ahead of the trend. Except that we will soon, and for a very long time, have LESS net energy available year-on-year. So in addition to the other gigafamine aspects, there's another: to get through the century in good shape – much less the following centuries – we should be radically altering the amount of phosphorus we need to grow food, which would also help curtail ocean "dead zones", lake and river eutrophication, and several other problems. Our inability to take "peak phosphate" seriously is one more aspect of our basic energy blind spots. It doesn't matter how much phosphorus may be in the earth's crust or oceans if we don't have the energy to obtain it. Again, this is a subject which could be worked on now, and probably with a lot of success. Yet it's likely an issue you've never much thought about, due to our societal myths.

- **Peak Airplanes** – We currently live in societies in which – for the equivalent of a couple weeks' wages, nearly anyone can jump a jet to the far ends of the earth. Groceries are air-flown so we can have fresh salads in the wintertime. This is amazing, and transient: our physical future will not be about ubiquitous air travel since it's inherently chemical-energy intensive. Our grandchildren will still occasionally see jet contrails, but these increasingly will be military and corporate flights, and far fewer than exist today. In a real way, jet travel for the masses is a "canary in the coal mine" of diminishing Cenergy, already flirting with nonviability. Remote locations will increasingly get more remote as declining numbers of planes make maintenance of airports hard to justify. Popular stories about battery-powered planes won't materialize due to the inherently-lower energy storage (and inherently-higher cost) of batteries compared with kerosene. This societal transition can be anticipated and adapted to in a non-disruptive way, or we can assume crash positions and come in for a wheels-up landing.

- **Expensive energy initiatives** – Our current societies are based on cheap chemical energy, so it's not surprising that conventional wisdom holds that the cheaper energy is, the better for society. But this conventional wisdom is blinkered by our short "future attention span" and a basic physical-world innumeracy, melded with a pervasive optimism bias. *(Our governmental agencies charged with keeping track of this stuff base future chemical-energy availability solely on projected demand. Really*). Our physical future – whether we like it or not - is one of increasingly-scarce chemical energy; we can either realize this and plan around it, or pursue cheap energy until that societal model abruptly breaks. Already the liquid-fueled chemical energy carrier, oil, is beginning to yo-yo between "too expensive to sustain the economy" and "too cheap to be worth extracting", as a highly manipulated fiscal system based on debt sends the wrong signals.
Counterintuitively, we need chemical energy to get expensive as soon as possible and stay expensive, to favor investing it in ways which will not inevitably crash (and not incidentally take steps to prevent catastrophic climate disruption). Campaigning for expensive energy is a tough sell, but *most* worthwhile adaptations to the physical world will be tough sell for a society which has long been able to coast on pleasant delusions. Demonstrating the practicality of planning for expensive energy is a campaign whose time should come.

- No baseload: one way forward – We face a future of increasingly-expensive energy. One of the biggest disconnects in our current stories about energy is that "renewable energy" will allow the continuation of our current "growth" society with few changes. While that makes a good story and slogan, it's simply not the case, and some significant time in R101 is spent on just why that is.

However, "fossil energy extender" mechanisms like solar panels and wind turbines can power a perfectly good civilization for quite some time, just not *this* one. There is a large qualitative difference between chemical potential energy – upon which our societies are now built – and kinetic energy flows which must either be used instantly or converted to dispatchable potential energy. Fortunately, humans are superbly adapted to intermittent resource availability. Currently our society operates under a "baseload power" system in which anyone, at any time, may decide to use tens of thousands of watts. That's convenient, but comes at a very high cost in infrastructure, and requires that a significant portion of the energy supply must always be from chemical potential energy. A perfectly good society could, alternatively, use power from kinetic energy when it's flowing; doing higher-energy tasks when the wind blows and the sun shines, and designing to obviate the need for baseload while maintaining the low-power basics for convenience. "**No Baseload**" communities are a slogan and a challenge whose time is coming, and it's a technological goal and a lifestyle ripe for innovation and demonstration. Baseload will, one way or another, be

going away; we ultimately have no choice about that. We still have some level of choice about whether it's abrupt and disruptive, or planned and pleasant.

- **A challenge worthy of our young people** – A large portion of our population is currently on antidepressant medication, including those still in school, and many more are caught up in depressive feelings without medication, simply due to being enmeshed within the human superorganism as limits to growth begin to become obvious. One of the things we've found in offering R101 is that even though the synthesis framing is new to the students, it is not a surprise, because many have already intuited that the descriptions of reality offered by their society are increasingly dissonant with the reality they see. Surprisingly for us – since R101 lays bare some difficult-to-process facts about reality and the human story – an increasing number have welcomed a way of seeing the world which finally "makes sense" of what they've experienced, and suggests ways in which individuals can – should they so choose – engage with this reality to help write a better chapter in the ongoing human story. In a society in which participation is often made intentionally simple, it is interesting to see that a difficult, complex commitment to future goals can be inspiring to the young; a challenge worthy of their intelligence, ideals, and energy. Many of them also find it liberating to realize that standard social organizing & mass activism is only one of many possible avenues for steering events in more positive directions. For better or worse, today's students will be alive through what will in many ways be the most dramatic century of human existence**. The power of learning about their own evolutionary and cultural blind spots can in principle free them to make game moves in the biggest game of all, as individual actors as opposed to being tiny cogs in a social movement.** There are cultural treasures to save, technology to develop, entirely predictable human tragedies to avert, species which need not become extinct, oceans which need not become stagnant and anoxic: high-stakes challenges for a motivated population of creative campaigners, mankind in its finest hour. It's arguably past time to stop being depressed and learn to inspire ourselves again, by undertaking really difficult things because we must. This is what we gain when losing our blind spots, and one path implied by R101.

- **A new language and movement to describe the Future** – The science synthesis demonstrated in R101 illuminates physical and probabilistic inevitabilities which derive from the nature of physical reality. This can *seem* to be at odds with popular science stories because the exact timing of such inevitabilities is contingent on many factors, and our current societies find "what cool stuff could happen soon" to be far more interesting than "what must happen eventually". Thus, we watch an abstract competitive "stock market" which is a confidence index rather than paying attention to actual physical resource stocks.
Our dysfunctional relationship with our physical future has a lot to do with the way

we think – and don't think – about it. Indeed, "the future" has different meanings in different minds. There's not even a consensus symbol representing the physical future.

We suggest using $\mathbf{t}$, a lowercase "t" with a right-pointing arrow on the crossbar, as a shorthand for the physical future, literally representing "time forward", and referring to a probabilistic array of possible outcomes. This stands in contrast to physically *impossible* outcomes, which now comprise the bulk of our society's "future" stories. For demarking the boundary between "possible" and "impossible" outcomes must be the starting place for any transition to sapient planning.

The hockey sticks of exponential growth which are now apparent in all aspects of human habitation of earth are mostly cautionary trends, but these trends have also brought us crucial knowledge about who we are and what our story has been. We're the first generation to really know where we came from, what we want and need, what we are doing and what science informs us about the human predicament and the human itself. Yet other than some vague visions and sci-fi movies most people don't feel attached to the future -other than to ignore it or to fear it. Uniting all the above projects would be a new social movement where people – especially young people – feel connected to something larger than themselves.

Unconventional Activism

So, with your new lenses of Reality you've a rough idea of future trends: larger (and poorer) populations, increasing social stresses, periods of fiscal (and political) chaos accompanying the end of growth, and - on the current default trajectory - more pollution and encroachment on an already diminished natural world. So for those who want to strive for good and improve the odds of 'nice futures,' what do we DO on this chessboard called Reality (above image) during the coming century? Well, as we'll show in the next chapter, perhaps the first thing to DO, is to each consider who we ARE in this context, enabling our decisions and behaviors to then come from an internal place of confidence and strength. But before that, does an understanding of R101 convey an understanding of how best to engage with it all? Because while learning about reality, one subtle observation which occurred to you must have been: with all the well-intended and smart people becoming aware of these circumstances, why have most efforts to combat them so far failed?

We've now explored the way the individual "gene agendas" of millions of people create an emergent "superorganism" which 1) physically functions as a resource-seeking heat engine, and 2) displays behavioral repertoires somewhat analogous to the mindless tropisms of very simple organisms. The more people involved, the more the overall group "takes on" each of these attributes *(note: this generally describes our current human culture; there may well be possible cultural structures and modes in*

which humans would not display these effects - if so we haven't found or implemented them on large scales. We can hope to diverge from ultrasociality+large energy surplus=Amoeba type behavior. Indeed, that's probably the ultimate 'sapient' goal).

We've discovered that it's possible for individual humans to understand a high degree of complexity, and - with some effort - to steer their own actions toward different probabilities and outcomes than the default of those around them. We've seen that not only is it a difficult process to "resist" the powerful deep-brain feelings of the gene agenda, but that until now it really hasn't even been recognized that there IS a "gene agenda" *per se* underlying the way we feel, the way we believe, and the way we create and adjust our personal realities in an ad-hoc process of confabulation *(that is, we make stuff up to fit the social situation and continually revise our own self-beliefs – see 'Interpreter Module).* Humans are capable of planning things that will work in the real world, but this doesn't come easily, which is why "rocket science" is considered a benchmark for human brilliance even though it obeys quite simple rules. Rocket science is "all physical reality, all the time," and the universe cuts no slack when it comes to landing a probe on Mars.

The universe also cuts no slack when it comes to physical realities here on earth: drastic reductions in insect, mammal and fish populations, acidifying oceans, rising CO_2 levels, plastics and other pollution, resource depletion, and general impacts from the modern turbocharged human commerce. And yet, despite wide agreement among scientists for at least the last 50 years, little has changed to ameliorate our environmental (and social) problems during this time other than at local scales. The essay below outlines our take on a few of the reasons why this is the case, parses our environmental challenges into two distinct classes of problems, and explains why certain of our modern assumptions about successful activism are incorrect: in part because they are organized to 'feel good' or 'feel right' rather than be effective.

Enlightenment, Cargo Cult Style

We all inherited the "feeling" that sharing information immediately, honestly, clearly, and with everyone is the way toward the best decisions and outcomes. We have that feeling baked into our inborn defaults because it *worked* when we were roaming as hunter-gatherer tribes during most of human existence, and only very recently (in evolutionary and cultural terms) ceased to, when we became part of huge, wealthy populations without a tribal structure. In setting up societies, which at this point mostly exist to distribute the largesse of fossil energy, we have moved away from "*quick reactions to events" and "satisfactory outcomes" towards "limiting individual authority while maximizing perceived distributive fairness."* Representative governments mostly function to prevent significant changes from occurring by structurally favoring the status quo, and being able to continually tweak that status quo back towards the collective feelings of the gene agenda as necessary: more wealth, more demonization of outgroups, and more 'fairness' for those who feel unfairly treated even if they already have more than most.

So, much like the Melanesian natives went through rituals of building runways *(and even fake airplanes, to function like decoy ducks)* to bring down cargo from the skies we have created "cargo cult" economic systems. But in parallel to this we have also extended aspects of this "cargo cult" mindset to environmental and social activism. Today we look to educating everyone to the point of enlightenment, as though doing so will automatically bring about a revolution in better decision-making. Except that this almost never works, and often backfires, so we then start feeling as though everything which might work to improve the situation has *already been tried*, even though nearly *nothing* has actually been tried other than doing what "feels right" to do. It does not surprise anyone reading this essay that building fake planes out of coconut trees did not cause boxes of cargo to appear in Melanesia, because we understand why the planes went there during the war, why they stopped, and where cargo really comes from *(from the invisible hand, obviously!)*. By the same token, it should be just as unsurprising that petitions, demonstrations, and blogs haven't altered the pace of coal-mining or the nature of consumerism, because why would they? If there are ways to steer the future of our species towards better futures, there's no reason to think that they will turn out to be simple, immediately apparent, or be pre-programmed to "feel good" to our evolutionary brain defaults.

Yet essentially everyone who does get interested in engaging with the future adopts a number of unexamined assumptions, and boilerplate "social activism" is pursued despite having not worked for most classes of problems. Indeed, how many times have we see a minority opinion vociferously challenging a status quo, and thereby *(via very basic realities of human brain function)* hardening opinions on both sides in their pre-existing proportions via default "motivated reasoning," which result disadvantages that minority opinion? How often have we seen an uneven match between a

sophisticated new activist message with no visceral appeal versus a really stupid message with enormous visceral appeal, ignoring the way human brains make decisions? And can we blame those who take the stupid side of an argument if our own efforts are based on what "feels good" to us but makes little tactical sense?

In the early '70's, there was a whale-saving movement run by visionary conservationist Joan McIntyre, who hoped to educate the world to how wonderful whales were, and managed to carve out a niche. When Greenpeace started blocking harpoons on the high seas - which was a very different sort of symbolism - she opposed it, because "I want to save the whales, but not *that way."* That is, enlightenment or bust. In fact, it took imagery, the creation of new legends, a bit of education, and frankly a whole lot of Machiavellian planning and realpolitik over a number of years - actual work, drudgery and risk, politics, lobbying, threats and cajolery, plots within plots - to get commercial whaling largely shut down. The retroactive story that everyone hears is that the people of the world came together to care about whales. The reason that story is necessary is that it places a stamp of retroactive mythological indelibility into the zeitgeist, obscuring the gritty details of achieving conservation goals and making it seem like a pure revolution based on enlightenment. And amazingly, that kind of works once the heavy lifting is over. But there's mostly no such thing as pure enlightenment revolutions, so each narrative of an enlightenment victory only sets the stage for the next phase of cargo-cult activism, and the resulting despondency when that doesn't work.

The thing is, we really haven't tried yet as a species. And we really should. Because approaching our challenges a bit more like rocket science and a bit less like cargo cult mysticism might work really well. When nobody is steering the bus, even a novice grabbing the wheel can be a huge improvement.

An Important Distinction: Mischief space vs Metabolic Space

Had humans never dug up and burned fossils, there would have been an inherent limit to how much ecological trouble we could get into. Limited by the amount of exosomatic energy we could get out of burning wood and falling water, we would not have created the big experimental "rube goldberg" machine-with-no-real-purpose we now exist within. This human use of fossil energy has two qualitatively-different aspects, which we'll introduce here as ***metabolic space*** and ***mischief space***. The first refers to the inevitable outcome of burning fossil carbon and hydrocarbons: heat and combustion products and their downstream effects. The second refers to *what humans do* with the net energy they tap by that burning. Thus, in this formulation, CO_2

emission is a ramification of metabolic space while plastic 6-pack rings and tiger penis medical supplements are ramifications of mischief space.

Why bother to make this distinction? Primarily to note that problems and solutions can be analyzed and characterized in many ways we haven't previously had the vocabulary for. As just one example of this, these two classes of problem are quite distinct in the nature of their impacts, and represent qualitatively different levels of difficulty when it comes to strategizing, affecting and managing the systemic outcomes.

There are near-infinite "game moves" possible in mischief space, because pretty much anything within this sphere of human impact could be done in a different way, or not done at all, without affecting the general course and functioning of society. For instance, there was no absolute reason that world fisheries need to use destructive "pelagic driftnets". This meant that it would be feasible in principle to achieve an alternate "stable state" in which those nets were banned and replaced with less-destructive technology for catching target fish. In general, nothing in mischief space is inevitable, and some of it doesn't even make much sense. It's just stuff humans have decided to do out of convenience with a lot of spare net energy, and therefore somewhat malleable in terms of our ability to steer events toward alternatives. Many of the problems we face can be dealt with quite well by understanding the rules of "mischief space", in conjunction with *the way things actually happen in the human world.*

In contrast, there are relatively few moves possible on the "metabolic space" game board, because when it comes to fossil energy there's pretty much a binary choice: use it to provide brain services for humans (meaning burn it), or don't. That makes the metabolic aspects of the problem a lot harder to deal with.

Basic metabolic effects on Earths natural systems are, as noted, inevitable from burning flammable fossils. Thus, short of simply "not burning them," there is no way to prevent their coming into existence. Inasmuch as CO_2 excess currently poses the greatest danger to the biosphere, that's a problem, because there may well be no way of "sucking out" the CO_2 from the air which does not require more energy than is originally gained by burning it *(IPCC scenarios currently assume that this will be done on a massive scale, based on no good reason in particular other than needing a miracle and therefore projecting one)*. Work-arounds like pumping CO_2 underground forever are examples of projects which may not be impossible (in some places), but which won't be done much, or for long, due to geological realities and human behavior as stressed societies demand more power and experience tougher times. The intractability of this situation - figuring out how to get a population of energy-hungry

fire-apes to use less stuff - is daunting, though not impossible. But on first blush it might seem impossible, because all the standard advocacy tools have thus far failed at making a dent.

In contrast, the things humans do in "mischief space" are things which, strictly stated, don't need to be done at all. They are anything but inevitable, yet to date they have been the most environmentally destructive effects of the carbon pulse, and will continue to be until heatlock and acidification really do kick in in coming decades (as they are currently projected to do). The effects in mischief space are things humans *decide to do* rather than need to do, and the effects - foreseen or unforeseen - of doing them. It has been mischief-space stuff which has kicked off the 6th mass extinction. And unlike metabolic effects, mischief-space effects are subject to being entirely changed through the intervention of individuals or small groups who actually know what they're doing.

Negotiating with Fire

In contrast with fighting elephant poachers or fishing quota violators, when dealing with "metabolic" level problems such as fossil-energy addiction, we're up against amoebic tropisms on a vast scale, a situation in which individual human decisions tend to make little difference. The superorganism has been likened to an "amoeba" since it acts *in aggregate* with the behavioral simplicity of a mindless organism. The rational decisions of scattered individuals within the amoeba don't propagate to steering its gross behavior.
It's odd to think of an organism whose cells are each far more intelligent and wise than the overall organism, since what we experience is the opposite: our kidney, elbow, and toe cells don't possess any sort of individual sentience or sapience. But we evolved to function that way over millions of generations, since before kidneys, elbows and toes even existed, with our cells gradually becoming specialized to make simple decisions while our minds reacted to more complex situations at the organism level. The human superorganism of billions we see today did not. It simply emerged as our populations grew, and now contains complexity and consciousness without understanding (or using) them.

Convincing the amoeba to change its ways is akin to arguing with a forest fire.

New tools, tactics, and strategies needed...

Of course, nobody ever said you can't control a forest fire. It's done all the time, but not by appealing to the better angels of the fire's nature or seeking to convince it.

Rather, forest fires obey a deep emergent behaviorism which makes their propagation predictable, and makes strategies to interdict them feasible in many cases. One can also learn to anticipate when forest fires are more likely, understand the things which restrain and propagate them, and make intelligent game moves which a fire cannot counter.

We've been talking in generalities about social activism, enlightenment, and their general ineffectiveness against a backdrop of human mischief and metabolic space. This course has been about understanding Reality, not training you to be eco-jedi. But to understand WHY many people perceive aspects of the worlds problems and are working on them but few are meeting with success is ALSO a part of understanding Reality, albeit a bit more nuanced and advanced one.

The current rough model of activism seems to be a belief that humans cause change through outstanding purity of motive, steadfastness, and costly signals of social commitment, which - if done right - cause issues to resolve in a righteous way due to the resulting rise in their social capital and corresponding enlightenment of humanity..... despite the fact that this is almost never what actually causes system change. Current activism at the macro scale seems largely about *being seen by others to strive mightily while enduring privation until maybe something happens*.

Without casting stones at those who mean well, it's simply the case that the movements, organizations, and infrastructure we now have are not all that useful in dealing with the classes of problems we're up against. What follows is in draft form only, deserving of far more work in the future and offered to students in this class as a peek into future writings, but it may help illustrate that "economists" are not the only humans who are stuck in paradigms of somewhat-mythical and counterproductive assumptions.

Modern models of 'Enlightenment' are not Working

Education is a great thing, no doubt about it. Yet as we've noted, there's a pervasive fallacy which attributes all bad decisions to "not having enough information" to make good ones, and that's just not the case. There are *many* reasons the human mind makes bad decisions, or fails to make good ones, even in possession of ample information to do better.

This fallacy causes most social activism to focus on correcting the "information deficit," because – the logic goes – having access to the best information means making the best decisions. Yet in these days of the internet, pretty much everyone has at least potential access to all the information and chooses what to ignore or believe to

a degree which is nearly arbitrary. Life at the peak of fossil-fueled civilization is so protected that there are generally no immediate consequences for believing anything at all, even absurdities, and it "feels right" to believe what those in our ingroup believe. We don't turn our back on that ingroup based on abstract facts. Abstract facts bounce around in the cerebral cortex; it's the deep *associations* which move us, often unconsciously.

Yet those hoping to steer the future in a better direction have for the most part doubled down on reciting facts, assuming that if they just say them loudly enough, the beliefs of others will change. This seldom happens. We tend to have a very idealized notion of how successful activism has changed things in the past, one which doesn't take into account those who failed. So we careen toward the future doing our best to inform and educate one another, and it keeps not working.

It's seemingly not appreciated by many people that those who accomplished a lot in the past were either very lucky, or were active tacticians and strategists playing something like a 4-dimensional chess game in the real world. Gandhi and Hitler had this in common: pragmatism, and stepwise plans to move the world in a desired direction *using human nature as it actually existed, working with the "gene agenda" and the beliefs already in the heads of the populace*. Those who successfully steer the earth's future, for good or ill, will almost certainly be Machiavellian in this sense. Unfortunately, most future-oriented altruists don't "feel right" being this pragmatic, and largely abandon such effective tactics to those with no such scruples. And thus lose. *Over and over and over again.*

Why the Environmental Movement has (so far) largely Failed.

On top of using information-deficit models and social sorting mechanisms, many well-intentioned organizations fail because they are both too big and too few. Large problems "feel like" they require a large number of people to impact them, so we set about collecting large numbers of people together. While this was probably a good tribal response to repel opposing tribes throwing spears, it's simply not all that useful in many situations these days unless you can create a large minority (5-10% or so of the population) which adheres very strongly to a simple notion, which can then be intelligently leveraged into dragging the other 90% some distance toward your position *unless* the required behavior would cause them significant perceived loss of some kind (which it often will).

However, a problem arises: if the notion you hope to advance is somewhat complex, it will need to be made simple to be widely repeated and agreed with, and a lot can be

lost in that translation. *So one price we pay for "large groups of people" is the oversimplification of issues.* And not just oversimplification, because in order to be well-received by large groups, the message must also "feel good" to believe *and* not be identified as a belief similar to one held by an outgroup the target audience doesn't like. This can certainly be done, but it results in a large group with very simplistic shared notions which - in order to be liked and accepted - have edited out any negative aspects to the proposition in question. This grows the support base, but at the cost of making it fairly brittle if any real-world results ever contradict the simplified narrative which the large group is organized around. To the extent it isn't resilient against real-world perturbations, it becomes an illusory – and temporary -tribe. Many such examples exist – and it wouldn't take you to long to imagine a current one.

And that's just the beginning, because "larger groups of humans" become progressively more 'amoeba-like' and over time become drawn to a plethora of attractor-states which rapidly diminish their effectiveness. These attractors are legion, far beyond what can be described here, but they include the "mainstreaming" of the founding propositions to make them uncontroversial, replacement of the original visionaries with administrators, and a phase-shift from the interests of the original proposition to the re-defined interests of the group itself, under the rubric of "increased fairness". There is also a strong tendency, based on "procedural fairness," for governing bodies to swell from tight management by passionate campaigners to large boards staffed by non-experts, drastically lowering the response speed, willingness to take risk, and level of complexity which can be parsed by the movement. At the same time, this all causes annual budgets to grow without effectiveness growing along with it.

It doesn't end there. That group then "networks" with other groups which have been similarly constituted, further watering down its core message in order to more effectively form temporary coalitions for information-sharing, and identification of points of perceived overlap. Most advocacy organizations spend increasing amounts of their time doing exactly this. And they need to, because the bulk of funders tend to do the same. Very similar dynamics create networks of funders who, lacking any sort of synthesis knowledge of the core issues, use social sorting mechanisms (the consensus of other funding entities they know) to allocate funds to those who have best networked and thus have the highest recognition, somewhat analogous to "likes" on Facebook.

So what builds the initial social capital which enables this progression to start? **High-profile, extended failure**. A group makes its name by declaring its support or opposition to a principle or proposition, and is then *seen to be striving mightily* toward that goal by others *while valiantly failing to achieve it*. It is during this "deadlocked"

period - which may last years or decades - that it builds mailing lists of supporters, does networking, recruits funding, becomes secure in its "niche," and adds layers of administration. If a group - alternatively - experiences quick and complete success, it skips this step and quickly vanishes in terms of recognition, social capital, networking, and the possibility of mainstream funding. Nobody donates to a problem which is already fixed before it becomes infamous, after all. To the extent such groups form, they exist in a consensual social "blind spot" and are quickly extinguished by a process analogous to natural selection, self-regulating the overall movement away from effective intervention.

Of course, even basic human psychology long ago established that strongly advocating a position hardens existing opinions in their current proportions, so this is largely ineffective at actually accomplishing the ostensible objective of a group – and is often antithetical to it! - but it is *vital* to recruiting funding and networked ties.

One would assume, based upon the fact that they are so ubiquitous, that funding networks, coalitions and mass movements, are the gold standard of effectiveness in dealing with real-world problems. Yet if so, one would be wrong. Aside from vacuuming up a large portion of available funding, highly-networked groups with large governing boards actually get very little done for the amount of resources expended. It just "feels like" they should since it "feels fair" and large numbers of well-meaning articulate people seem to always be busy doing something *(note: this commentary is coming from a past co-founder of one of the world's largest and highest-profile organizations, who wasted no few years learning these lessons).*

However, these groups run into a paradox. The proximate goal of saving the environment or XYZ goal, is subverted to the ultimate goal of social status, funding, and the continued viability of the organization. Over time, the stuff they are busy doing is, per the nature of large groups, largely administrative, based on servicing in-group complexity growth, and also increasingly reductionist and specialized "administrivia" as more humans are added. It's the nature of, and an attractor for, large groups of cooperating humans. *Mini-amoebas trying to wrangle the Amoeba using the same tactics and unspoken assumptions they are confronting*.

This means that to the extent such groups actually do engage with real-world issues, they tend to specialize in one isolated aspect of a problem. That becomes their focus, and what started as a high-priority fast-track make-or-break crusade often becomes someone's day job with a retirement plan. Thus, one group specializing in research might point out a problem, another group specialized in PR might (eventually) come up with a slogan to popularize the problem, still another specializing in some aspect of social activism might (eventually) come up with a tactic to try dealing with the

problem, while several others ultimately create mutually-incompatible strategies on what to do next, with each step potentially taking years – during which time any opportunities for actual change have long since slipped away. This might feel *fair*, but it's not a productive way to actually achieve new stable system states in the real world.

There is no inherent mechanism within networked social movements to hand off the issue based on competence or to sort from among the multiple competing strategies which evolve, and generally no consensus on what would even constitute success, even among networked groups, much less what should be put in place beforehand if some sort of success were to be suddenly achieved. The pace is glacial since the large governing bodies take a long time to make decisions, and they cannot react in real time to any short-term opportunities which present themselves.

Due to intra- and inter-group social shaming and status pressures, the "purity of process" at all levels tends to be prioritized over the attainment of satisfactory results. Since most members of networked organizations believe in some version of "enlightenment," most broadcast all their information as soon as they hear it, making impossible much in the way of strategy. Thus, the networked aggregate of "social activism" groups becomes in many ways its own type of amoeba, with an uncomfortable degree of resemblance to the bigger one.

As part of this process and central to it, the designated opponent outgroups and individuals are identified and to some extent publicly vilified, because that "feels right" to do, adds members to the group, becomes "news," and attracts funding. This adversarial polarization largely precludes negotiations which might actually solve many identified problems quickly and creatively.

What Price 'Fairness'?

So just look at all the things which are sacrificed in order to have large social-activist movements as they now largely take shape:
- small, efficient governing bodies
- the ability to make decisions rapidly and take advantage of opportunities
- the ability to keep budgets modest and so not spend most time fundraising
- the ability to avoid "mediocrity attractors" like growing levels of administration
- the ability to stay focused on the original reason for the group's creation
- the ability to deal competently with a complex proposition or situation
- a willingness to take risk
- a focus on the reason for the group's existence rather than intra-group social-status jockeying

- the luxury of being able to create tactics and strategies using timing and realpolitik
- the ability to have a fairly sophisticated plan whose tactics are not pre-telegraphed to the world
- the ability to win by eschewing social capital and making the bad guys look good
- the ability to enter a negotiating situation without "wearing your agenda on your sleeve"
- the ability to stay focused, rather than modifying the goals to conform to peer and funder networking
- the ability to avoid fame and stay in the background, if that serves the main goal
- the ability to prioritize effectiveness over perceived procedural "fairness" as a parallel goal
- the ability to move an issue multiple steps to a stable state quickly rather than shooting for incremental progress and hoping someone else will take the next step
- the luxury of NOT having a legion of "allies" who are cooking up conflicting strategies and leaking crucial information at inopportune times (tragedy of the social-activism commons)
- the ability to network *only after the goal has been achieved*, to share the credit and create a narrative of enlightenment once it's too late for others to mess up a series of intelligent game moves with cluelessness, opportunism and monkeyshines
- the option of sacrificing ongoing funding and personal status to efficiently achieve the desired outcome
- etc, etc, etc

This is just a *sample* of the reasons why we should not be surprised that social (and environmental) activism, as now comprised, seldom accomplishes much. This sample is meant to give heart to those who think everything possible has been tried, and has failed, insofar as solving the "big problems" of human existence and ecosystems. The fact is that while time is indeed terribly short, we're still mostly doing what "feels like" it should work rather than what actually does, while those working against pro-future goals generally have no such self-hobbling compunctions.

Part of integrating Reality into our strategies is an ongoing struggle with the very notion of "how things happen" in the human world. In addition to understanding the central role of our evolved "feelings" in making decisions, we need to understand that these "feelings" also lead to belief in unexamined assumptions which continue to create ineffective movements and advocacy strategies. If we're to deal effectively with these problems, we need to actually do what works rather than what feels like it should work.

You may surmise from this quick discussion the shape of some of the recommendations we will offer, which might have higher odds of working: looking

beyond the ‘feelings’ of a strategy, keeping the numbers on the team small, maintaining tight control of information, and recognizing that the process requires as a complex learned skillset, applied with self-control and discipline.

“As the name implies, “process politics” emphasizes the adequacy and fairness of the rules governing the process of politics. If the process is fair, then, as in a trial conducted according to due process, the outcome is assumed to be just—or at least the best the system can achieve. By contrast, “systems politics” is concerned primarily with desired outcomes; means are subordinated to predetermined ends.”—
William Ophuls,

From: **ECOLOGY AND THE POLITICS OF SCARCITY REVISITED**, 1992

Note from Nate: *Much of the above is really beyond the level of Reality 101 for undergraduates and more for ‘Steering Reality 501’ for PhD students (of life), but let’s continue on with one real-life story of success in ‘mischief space’, shared by DJ upon my urging.*

Post Script by DJ: R201 – Adventures in Mischief Space

The subject matter of this postscript is a bit out of place for this course, more properly an essay subject for the yet-nonexistent Reality201, but is being briefly introduced here to provide some perspective, and hopefully some 'hope.' Reality201? Yes, that's a hypothetical course designed to begin the process of making some subset of R101 students – at their request - into superheroes *(for lack of a better term)* who can deal usefully on large scales with all the stuff they learned in Reality101.

It may at times seem that R101 is simply a course designed to psychologically depress the best and brightest of today's college students with near-toxic levels of reality: not so. There would be no purpose served thereby. R101 is a remedial primer, a re-introduction to the obvious which "hides in plain sight" within our cultural blind-spots. It's meant to help anyone pursue "sophisticated generalist" status with a synthesis worldview, and as a prerequisite for a self-selected portion of those students to mindfully design useful action, for of what use are clueless proto-superheroes?

We covered a lot of ground at a dead run in this course, but the main focus of R101 is the nature of human blind spots and the reasons for systematic errors in human thinking about how the world actually works, and how and why the things around us actually happen. Not all R101 graduates will choose to personally engage with the

"big challenges" of human existence, but even those whose life-course is largely unaffected may still find themselves just a bit more "super" in terms of their level of awareness and planning, and this may help shape their expectations and their future prospects, along with those of their families and their communities. Just as humanity is no longer surprised by hurricanes due to geosynchronous weather satellites, incorporating a top-down integrated view of reality can prevent unpleasant surprises in many ways. It replaces the former "anything can happen" ignorance about such storms with a probabilistic and deterministic concept of hurricanes and their behavior, at a modest cognitive cost of now having to additionally be aware of hurricanes which might miss. Now that we're used to weather satellites, few are depressed by the ability to predict, monitor and chart hurricanes. It's a good thing, not a depressing thing, even if it does cause us to "think about" hurricanes more often than we otherwise would and occasionally board up our windows before a near-miss.

As will be the case more often than not in R201 - should it even ever exist by that name - the terminology will be new, novel, or re-tasked, which is why you can't yet google "mischief space" and find any of this. Of course, not everyone taking R101 is destined to be a superhero, or would even wish to be; but a more complete insight into the worlds around them - both physical and virtual - and the most-likely prospects for the future, should help inform whatever path they decide to take. And it makes "superhero" a possible career choice in a world which needs a lot of them.

Superheroes?

Wait, what? Superheroes? COME on...
Well, as just warned, we're re-tasking a term, because we think it's a useful one. By

"superhero" we mean a person who has a qualitatively-greater ability to affect events on all scales than most people do. We've also occasionally used the term eco-jedi for deep-time system-steerers. Maybe, going forward, we'll settle on a better term. But "superhero" is not that far afield, because *relative to the norm,* individuals can develop disciplines and skillsets which enable them to confidently take on situations which to others seem impossible, and can often succeed in changing the course of events. I've seen it happen many times, and can attest that we're still novices, just scratching the surface so far in terms of what's possible.

When is a firestorm like a fishing fleet?

As a peek into illustrating both the *general structural similarity* of some seemingly-disparate "mischief space" issues, and the paradoxical nature of "metabolic space" issues, I'll give a very brief account of one past campaign which has elements of both. In 1991, Iraq leader Saddam Hussein had his retreating troops blow up and set fire to around 700 producing oil wells, as well as laying pipes to dump oil into the sea and setting minefields around them. This produced a petrochemical hell of smoke, flame, and unburned gushing oil, but the images of it were kept from the world. The remediation of the situation was put "on hold" until British and US firms could shut down all the fires themselves and thus reap the presumably high profits of so doing. Which would have perhaps been a reasonable plan IF the US and Britain actually had the *capacity* to do so in a reasonable period of time, which they did not; Britain didn't have a single firm which did such work. The fires were thus projected to burn for many years. The group EarthTrust, half a world away in Hawaii, decided to see whether the techniques which had been used to shut down destructive fisheries and cetacean kills might not work equally well at breaking this deadlock. Not because we had experience in the middle east (we mostly didn't), had funding (we didn't), or had dealt with oilfield fires (nope), but because it was clear that nobody else was doing anything useful, and it just seemed like a shame to let it burn and pollute. If that seems like an odd decision, I'll just note that it was a reflection of a fairly tight team which had learned that "impossible missions" often weren't. We had some experience and insights on how intractable real-world problems could sometimes be solved – and little else.

To make a very intense epic of a story very short, it worked. ET was relatively quickly able to get through into the burning zones (which were in theory unreachable and blockaded) and escort essentially all international media – who previously had been in a holding pattern in Bahrain - into the flaming hellscape to show the world what was going on. But also - behind the scenes – the team had by that time already done private video documentation and presented it to top Kuwaiti officials (who were at the time far from Kuwait), resulting in a reversal of the "hold" and opening remediation to

crews from around the world. The fires were snuffed in just a few months, saving an estimated 2+ billion barrels of oil from uncontrolled burning. There was, of course, no small amount of heroism as ET field members shut down oil pipes pumping into the sea, braved minefields and drove into walls of fire to deploy oil barriers, worked to save wildlife, provided advocacy for the families of poor foreign oilworkers whose children were coughing up black carcinogenic goo in the streets due to being made to work alongside the flames, and just generally did what needed to be done in the best traditions of human heroism, which in my experience humans want to rise to when given the chance. This story has never been widely told, as there's no place in our current culture for such stories yet. Perhaps someday it will be dramatized with your favorite movie stars – who knows? - but at the time it was tactically necessary to have credit go to the people causing the deadlock, not those working to fix it.

There are certainly lessons to be found in this story; for instance, why was it a small group from Hawaii, largely unfunded and seemingly specialized only in marine-conservation issues, which engaged and quickly succeeded while the rest of the world stood by? The answer to that goes far beyond this essay, but it came down to a different way of seeing the world and analyzing world events, and a different toolkit for leveraging and steering alternate system outcomes in mischief space. One part of this toolkit is the willing abandonment of the increased social capital, financial capital and personal status rewards which are generally pursued by default in standard intervention and advocacy (as described in main essay above). Creating a palatable scenario which gives social benefits to those causing the problem in the first place is a tactical force-multiplier, but its downside is that changes so achieved don't wind up encouraging others to employ such a strategy, because they may never hear about it. There are many other analytic and tactical principles which could be illustrated using this "Hell on Earth" campaign example, among them real-world granularity, effective invisibility, critical states in social systems, timing, rapid progress during the suspension of system accommodation, compartmentalized information flow, illusory obstacles, intentional obscurity, and the design and effective deployment of memetic icons, but again, we're getting ahead of ourselves. This brief essay is just about the much greater potential effectiveness of small groups and individuals, and the difference between metabolic and mischief space. And a hint that there may be ways of getting things done which you haven't yet heard about.

And the big difference is that steering systems to different outcomes in "mischief space" is a matter of skill, engagement, and flexibility. Some system destinations are easier to reach than others, but many things which seem impossibly intractable have very straightforward solutions. We humans tend to be daunted by the physical scale of a problem when the structure of the problem is what actually determines whether it's amenable to change. And we tend to deal with the obstacles we imagine to exist rather

than the ones which actually do. Mischief space is a complex mix of individual human idiosyncrasy on the small scale and reliable behavioral regularities on larger scales. These may be engaged successfully simply by having a better mental model of what's actually going on than others involved do. So for instance, speeding up the snuffing of the Kuwait oilwell fires was simply a matter of taking charge of some parts of the information flow and presenting the right information to the right minds in the right context, playing the 4D chess game. Both the decision to restrict the firefighting and to de-restrict it fell within the realm of single-mind idiosyncrasy, and were thus reasonably accessible to quickly leverage into a modified narrative.

Everything's impossible until someone does it.

As noted in the main essay, classic "social activism" simply doesn't work for most situations, and would never have for this one. The entirety of the earth's social activism movement was seeing the same situation we were, and had no game moves to offer while the situation was still pliable. "Enlightenment" was just a small part of the necessary strategy, nearly a side-consideration, and only certain information was released.

Speaking as someone who did a lot of "enlightenment" type activism in my early career, I'd say that's fine as a communication strategy in special situations, but it doesn't work all that well in terms of actually steering reality, which requires time, skill, nuance, discipline and a certain amount of time and failure to master. Am I down on large groups? Not at all: there are some classes of problems they're uniquely suited to deal with. The problem is that they are quite inefficient, nearly ubiquitous, and ill-suited to *most* classes of problems. The reason they seem productive is that they're often spending enormous amounts of money, despite the rapidly-diminishing returns inherent in their structure *(I've addressed the* exact same issues *as the person in charge of the international campaigns of a large famous global advocacy group and then directing a small group with few resources, and the difference in effectiveness was night and day... it was easier with the smaller, poorer organization which wasn't restricted to "social activism" game moves).*

And it's *not* always the case that having a larger group of followers or allies will make achieving a goal easier. Sometimes that's the worst possible tactic, because putting your information out prematurely to huge numbers of people eliminates most possibilities of strategy, timing, negotiation, and success. Being the only small group working on a huge issue can be an enormous advantage, as crazy as that sounds. It initially seemed crazy to me, but it has repeatedly been proven true, a corollary to the "scale versus structure" fallacy. But again I'm straying into R201 territory.

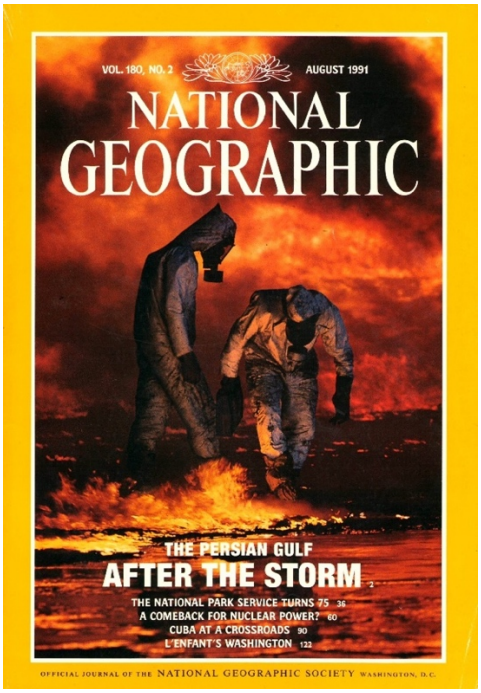
It has been said, truthfully, that nobody yet knows what to do to solve the biggest problems facing humanity and our world. *That does not imply the narrative converse*: *that therefore any approach by anyone is equally likely to succeed*. Metabolic-space issues are simply inherently more difficult, and so will require more exacting plans by people who deeply understand the systems needing intervention. By way of analogy, nobody had ever tried to land a jumbo jet with zero hydraulic pressure, a situation occurred due to a catastrophic engine failure at altitude in 1989. The books say it was impossible, and all aboard should have died. But the plane had an experienced captain and happened to also have a DC-10 expert onboard; between them they managed to steer the plane to an airport landing using only the throttle controls for the remaining two engines, saving most of the people onboard. Understanding the system you're trying to affect - what can and can't happen - is essential, and the fact that nobody has yet laid out a workable plan doesn't make any plan equally qualified to succeed.

Or to offer another metaphor; if a heart transplant has never been done before, it doesn't mean all persons are equally likely to succeed at doing one. Rather, you probably want a surgeon who has done a whole lot of other successful heart surgeries. In a similar way, I'd say that learning to be effective in affecting the "mischief space" issues we describe is probably the best preparation for the analysis and implementation of workable campaigns in the daunting simplicity of metabolic space – the challenge of our time (species?).

That's why we're hoping to make additional tools available to the generation which is - like it or not - stuck with being the last generation with a reasonable chance of steering to far better earth-futures and more humane transitions back to sustainable flows. This makes your generation the necessary source for 'superheroes' who study systems with the diligence and focus normally reserved for professional music, medical research, or space sciences, taking the time necessary to get good at it rather than becoming frustrated and "burning out."

A few have pointedly asked: by bandying this term in discussion, do I mean to imply myself a superhero? I'll answer with a fairly self-aware NO. I'm a failed prototype at best, ruefully conscious of the huge gap between my aspirations and actual successes to date. But I don't think it's unrealistic to for a person to aspire – as a personal goal - to being a sort of superhero compared with what now passes for normal within our species, because - face it - that's a pretty low bar to clear. Indeed, a person can easily spend an entire life inside mental boxes which are culturally- and self-imposed, and never realize they could do extraordinary things due to simply never trying anything extraordinary. Certainly, I feel better about my path now than I would have if, say, I had stayed an oil geologist in 1974, taking a fat paycheck instead of striking out where there was no path to follow, but how I "feel" isn't the point either. The point and sole

criterion, I think, must be the results. The fact is that I took a different path and because of that, the world now is slightly different than it would otherwise have been, in ways that I intended. I recommend that. My hope is that the current generation gets far better at this than my own, if for no other reason than it will have to.



Both “mischief” and “metabolic” effects threaten our planetary future, and both need to be tackled. The metabolic effects are a lot harder to deal with, so it’s my recommendation that any prospective “event steerers” hone your skills on mischief-space issues before tackling the more difficult challenges of metabolic space. Nobody expects you to quickly figure out a way for the human superorganism to stop doing what it’s doing, but - as we’ll describe in the next essay - you can pick an issue and engage in something that matters to you, unlearning the mental limits, incorrect assumptions, short attention spans, addictive behaviors, and blind spots which society has drummed into your really quite remarkable brain, while realizing that the metabolic issues are still “out there” once you’ve learned to successfully navigate the white-water of events and systems.

*It’s hard to find a news photo of the disaster showing humans without Earthtrust field staff in it, including the ET team members with oil fires in the above National Geographic photo (*EarthTrust.org)

Aftermath: musing on metabolism & mischief

So, getting back to the difference between metabolic and mischief problems, here's a question: quite apart from whether it succeeded, was that campaign intervention in Kuwait a *good idea*? It certainly felt worth doing at the time, but what was the net effect? The roughly 2+ billion barrels of oil which were saved from immediate burning have - in the 25 years since then - long been pumped and refined for input to human society, and burned anyway, emitting fully as much CO_2 and heat as they would have if left to burn wildly in the desert. That is, the metabolic effects were substantially unchanged. However, the "mischief space" effects, which for "burning oilfields" is essentially zero, were instead significant. That 2 billion barrels of Kuwaiti oil powered the equivalent of the entire global human superorganism for something on the order of 3 weeks, creating pleasing brain stimulation in human minds around the world, but also supporting ongoing overfishing, toxic waste creation, the pumping of depleting aquifers, the mining of coal, and a good portion of everything else humans did during that time. Inasmuch as the "stimulation" effects are far in the past, and the cars and electronics made then are now in the landfills, all that remains are the residual toxics, a huge amount of CO_2, more-depleted mines and soils, and 3 weeks' worth of extinctions and habitat loss. Should I feel good about creating and deploying a team likely to have saved a couple billion barrels of oil from burning in the early 90's, or instead feel responsibility for the additional mischief which would arguably have been avoided had it kept burning? A strange situation we find ourselves in, that such questions may be reasonably posed and not so easily answered.

Certainly it felt emotionally clear that letting the fires burn was *wrong.* It's hard to be philosophical about hell on earth, and both I and the team took it personally. Yet without a plan or way to prevent that oil from being burned anyway, it cannot be said to have been a successful campaign in metabolic space. It saved some birds and some sea animals, and probably some people, made some Kuwaiti Royalty a bit richer for a bit longer, and gave me another tall story to share (but only now, on Nates suggestion). Perhaps, at best, we bought the world an extra 3 weeks of time-buffer before the easy oil runs out. If so, what a mixed bag that is, and what a short span for such a volume of oil. But perhaps it's 3 weeks our'91 Kuwait campaign team can offer to your generation, going forward. The clock keeps ticking. Use it well.

Postscript 12/5/2017*: This last section, discussing the Kuwait campaign, was presented to last year's students, and several of them suggested an expansion, such as: "*How does one study and learn about effective systems steering?" *Here's the thing: there is, as yet, no pre-digested formula for doing what is described here, no place you can yet go to soak this up from observing those around you. Rather, one learns to do this by significantly disconnecting from the consensus and learning to see*

into one's own blind spots and those of others. By learning to ignore what feels true in favor of what actually works. By making guesses about what the systems which interest you will do in response to various stimuli, and then calibrating your guesses against what you actually observe them to do. By being patient enough to learn more than others know about the systems you want to change, and the systems they rest on, whether locally, nationally, or globally. And then by constructing a stepwise strategy which is invisible during most of its stages, and which can quickly move your target system to a new stable state like falling dominoes once you give them a push. By being audacious enough to "go for it" once you realize that point has been reached. And by realizing that these are just words which will mean little to you until after you've tried and failed a few times.

Doing stuff which doesn't particularly "feel good" to our minds simply has a higher degree of difficulty than the stuff most people do, and not everyone can maintain a core desire to be effective (as opposed to being socially admirable). There's a reason this is not a well-trodden path (yet). To some degree it suffers from the same problem as any new path: nobody knows anybody who has taken it. That makes it seem hard, but it's the easiest way for you to really affect the world.

It may well be that your authors will indeed develop one or more such paths in the future to recommend; by all means stay in touch if you like. But the main, the crucial, thing is to make a decision that your life WILL have a large effect on the future because it's personally unacceptable TO YOU that it not. This leads to a personal prioritization of actual effectiveness over lifestyle, and a level of 'freedom of action' which might be hard to find otherwise.

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