Preparing for the 21st Century Existential Risks

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The current rapid changes seem to be accelerating while unmatched by social responses, leading many to question our capacity to survive. Big History can offer a (perhaps sobering) perspective since this situation seems to be part of a much longer process, which must face a limit and change, for example, a major inflection while transitions occur in energy, environment, population, economies. These global scale issues are critical, requiring unified cooperation, with potentially irreversible consequences.

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The rapid change in technology (genomics, robotics, artificial intelligence, nanotechnology) seems to be accelerating while the social response to its potential benefits and unintended consequences seem to be lagging. This has caused many thinkers, for example Martin Rees (2003), to question whether humans are capable of surviving this. Big History can offer a (perhaps sobering) perspective (Korotayev and LePoire 2020). The rate of change seems to be part of a much longer trend observed in the rate of major events on Earth. However, this trend cannot physically continue but must face a limit and change. One interpretation of our current period is one of a major inflection while many systems undergo transitions in energy, environment, population, economies. These issues often concern a global scale, requiring a global consensus on resolution; whereas previous transitions occurred over longer times among many regions. This transition is critical in that it occurs over a short time, requiring unified cooperation, with irreversible consequences. However, if we do manage to cross this transition, further transitions might not be as critical as the rate of change slows down and reduces stress.

The current challenges in the transition to sustainability are unique with very rapid changing technology, requiring international collaboration, and with potential irreversible consequences (LePoire 2010). The aspects cover a wide range of fields including the environment, science and technology, international collaboration, government involvement, and economics. The scientific issues concern the environment such as climate change, water availability, sustainable agriculture, sustainable biodiversity, disease control that are being handled with a variety of technologies including the GRAIN (genomics, robotics, artificial intelligence, and nanotechnology) technologies. Various scholars have identified this as one of the most vulnerable periods in human history with many possible paths to existential risks. The risks not only occur from the powerful technologies in the hands of individuals with harmful intentions, but also occur through unintended consequences (Torres 2017). These incidental consequences can arise from either faulty decisions made with polluted information or surprising behaviors of complex systems. Examples of these are recent financial collapse, amplification of natural hazards, near catastrophes when performing safety studies of technological systems, potential pandemics, and potential cyber disruptions. The consequences of not addressing these risks correctly may lead to collapse, a technologically stuck society, or a suboptimal advanced technological society.

Much has been learned in the process of denying access to nuclear and cyber knowledge and materials that might cause harm. Rapid technology changes might require a more proactive strategy. One way to estimate the existential risks is to identify and extrapolate the scaling behavior of lower risk events, as has been applied to earthquakes and by the author to malicious use of radioisotopes. This technique could be applied to help build scenarios based on the trends that lead to possible, probable, and preferred outcomes. Possible leading indicators could be determined and monitored to help make decisions concerning criteria, characteristics, and options (similar to bioethics).

The work would need to be done with international collaboration with various futures groups such as IIASA, UN technology Development, Resilience and existential groups to develop this existential risk center along with international collaboration to facilitate risk mitigation while enhancing benefits of the technology it discovers. While the planetary boundaries and resilience studies could provide significant information, the focus of this project would be wider.

As mentioned in the *Anticipatory Governance: Practical Upgrades*,

> Other countries have developed systems in their governments that enable them to plan and execute long-range policy, but the U.S. Government continues to operate using institutions designed for an era gone by. The consequences are visible in terms of an increasing number of collisions with "unforeseeable events" and the terms of economic opportunities lost to rivals who are consistently pursuing their strategies (Fuerth and Faber 2012).

There have been many historical transitions in Big History (LePoire 2019). Some of the human transitions include the transitions to agriculture, civilization, and industrialization. These transitions occurred over a relatively long period with different innovations being diffused over somewhat independent regions. The analysis of the timing of these transitions shows an accelerating pattern over increasing spatial scales. This leads to the current challenges in the transition to sustainability which are unique with very rapid changing technology, requiring international collaboration, and with potential irreversible consequences. That is, there might only be one chance for a globally integrated transition. These challenges can only be met with consideration of a wide range of fields including science and technology, international collaboration, government involvement, and economics.

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Trends Envelopes

There are many disparate energy scenarios roughly categorized as business as usual or progressive. There are many factors that might determine which path is taken including technological advances, political will, and global development rates. While all of these are quite uncertain, there are trends that might help reduce some of the uncertainty, leaving better clarity to the remaining factors. These trends include the convergence of the gap in global inequality as more people realize better lifestyles (Korotayev, Goldstone, and Zinkina 2015). This gap has been correlated with the population growth rate. There is also the advance of technology and development in finding more efficient and cost-effective means to deliver substitutes such as renewable energies. These learning curves show the factor in cost reduction for a doubling of production, as have been seen in both solar and wind energy development (Elshurafa *et al.* 2018).

However, this innovative path may put pressure on certain segments. If the world were to equalize its energy use to the level of the U.S., then it would take about four times as much energy. The current phase seems to be investments in conservation, but this is nearing the peak and seems to be replaced with the renewable energies of wind and solar. At the same time, economic growth seems to be somewhat decoupled from increased energy use in the developed countries. A final trend is the decarbonization of primary energy fuel, showing a logistic transition. These trends are combined to help build an envelope of potential scenarios. This is compared to the business as usual and the progressive scenarios of others.

Scenarios

The International Institute for Applied Systems Analysis (IIASA) constructed a set of possible scenarios (Grübler *et al.* 2002). The assumptions that would lead to a prediction of renewables/nuclear are similar to the IIASA Scenario C: 1) The relative use of coal and oil/natural gas will remain quite constant (prediction from the logistic analysis), and 2) renewables/nuclear will substitute for them with strong growth after 2020. However, some of IIASA's other scenarios could result when starting with slightly different assumptions, for example development of nontraditional fossil fuels, such as tar sands, oil shale, or methane hydrates. Various predictions about the reemergence of nuclear power have been suggested, but even the most aggressive of these scenarios would not generate the historical logistic growth rates seen in previous substitutions (Devezas *et al.* 2008).

However, recent trends (*i.e.*, since the 1970s) suggest that economic factors are leading to a more efficient use of energy, although there are many other opportunities for further conservation (Ausubel 2003; Lovins 2011). There are many other global issues besides energy accessibility, but energy may be the key for addressing other issues concerning water, pollution, and illness (Smalley 2003). Leaders might over commit to an existing energy source and therefore find it more difficult to make a transition using new technologies and sources. Ausubel (2003) looked at a series of technology transitions and found that the early adopters tend to over commit, while later adopters can learn to use the technologies more efficiently.

If the system of human development through energy use and technology development follows the patterns of adaptive complex systems, then future development might continue towards the accelerating rates towards more chaotic states as suggested by Kurzweil (2012), or reverse the bifurcations in an overarching logistic framework suggested by Modis (2002). Bifurcation reverse has been studied in ecological complex systems (Stone 1993). A speculative possible interpretation is that the transitions from commerce, industrial, and knowledge-based societies are superimposed on the development of a system undergoing bifurcations as an ordering parameter, such as energy use per capita, increases. A reversal would coincide with a slowing down of technological change. Much change would still occur, although not at an ever accelerating pace. This might be similar to a transition to a sustainable society, where growth is not the highest priority.

Tools

It is unclear whether current tools and techniques along with many others being developed or yet to come will be sufficient to mitigate potential environmental problems. At a larger level, the question of nature's sustainability has been recently debated with seemingly opposite hypotheses – the Gaia Theory (named after the Greek Earth Goddess) advocated by James Lovelock (Volk 2003) since the 1970s, and the more recent Medea (the Greek mythological figure who killed all her children) Hypothesis by Peter Ward (2009).

The Gaia Hypothesis suggests that the Earth's systems of geology, biology, and climate act together in a self-regulating system that has been able to maintain temperature, atmospheric composition, and salinity of the oceans suitable to the evolution of life on Earth, despite outside changes like the intensity of solar irradiation. The computer simulation Daisyworld was developed by Lovelock in the early 1980s to demonstrate the principle that plant growth could alter albedo as a feedback mechanism to stabilize temperature.

Lovelock's most recent extension includes how this Earth system might be strained to a tipping point from the environmental impacts of humans and our technology, specifically energy use. He takes the perspective of a physician, making an analogy with the diagnosis that Gaia is becoming sick and fighting it with a fever, that is Gaia is fighting against the human-caused impacts to maintain the Earth system survivability. He advocates the use of nuclear energy, at least in the near term, to circumvent major environmental impacts from climate change. This would give time for renewable energy sources to develop to an economic and efficiency level to support a sustainable society.

The question is, then, what is the role of humans? In the Gaia Theory we are part of nature and the system should try to stabilize in various ways including human intervention or natural reduction of human impact. The alternative Medea Hypothesis suggests that that the environment is always under stress by the current biosphere. Then it is up to us to intervene or have a pathway to adaptation to a new system. These two might be compatible if evolution is viewed as a sequence of systems that respond to the environment, overshoot, collapse, and regenerate as a new system – similarly to the Panarchy model (Gunderson and Holling 2002). In this way the system maintains life through a series of collapses of unstable systems, similarly to the punctuated equilibrium model of evolution.

Metaphor

Metaphors are an important way to facilitate understanding of new processes. This metaphor is constructed based on the transition fueled with a limited supply of fossil fuels from sustainable pre-industrial society to another more advanced sustainable society (LePoire 2018). However, to realize this potential, society must transition to a sustainable energy supply since fossil fuels are dwindling. A major question is whether this global transition can be completed at the same time that global development continues to improve lifestyles and economic opportunities. To help understand some of the complex relationships and challenges in this transition, a metaphor of evolving technological society as a rocket is developed, which once launched needs to reach a critical velocity and altitude before obtaining a sustainable orbit. The basis for the metaphor is that there are two stationary locations for the rocket – the ground (pre-Industrial society) and a stable orbit (advanced technological society). The rocket transitions between the two with technology to utilize a finite amount of fuel to overcome gravity and atmospheric friction to attain a speed, altitude, and orientation for a stable orbit.

Technological civilization depends on large energy flows but its current major energy sources from fossil fuels are dwindling. Much economic progress was made in the twentieth century with the energy generated from burning fossil fuels improve the quality of life for many people. However, to continue on a successful path, civilization must transit to a sustainable energy supply. This transition involves a balance of increasing energy demand (from both increasing population and lifestyles) with the new energy sources and improved efficiency. However, the higher quality of living often results in a decreased (or negative) population growth rate. A major question is whether this global demographic transition can be completed simultaneously with the world's energy transition from fossil fuel to renewables. If energy resources dwindle before the demographic transition is complete, economic foundations may crack.

An evolving technological society as a rocket is a metaphor. A rocket, once launched, needs to reach a critical velocity and altitude before obtaining a sustainable orbit. Once a stable orbit is attained, there are many further beneficial options such as space observations or facilitating further space exploration. As we already pointed, the basis for the metaphor is that there are two stationary states for the rocket – the ground and a stable orbit. The ground is analogous to the historical situation of a society based on traditional solar energy for crop growth, warmth, wind, and water. The stable orbit is analogous to an improved situation of an advanced society with more freedom, comforts and fulfillment, which is also stable through technologically capturing a larger fraction of the solar energy (or supplementing it with nuclear fission or fusion). Also, it is not clear if society's transition to energy sustainability (the metaphorical stable orbit) will be completed successfully. For example, fuel could run out or a fundamental flaw could disrupt the process.

We are in the process of determining whether this energy transition can be done. Learning curves for wind and solar technologies show that the cost of production reduces by a factor for every doubling of production. This cost reduction is driven by improvements (learning) in the production process. The variability of many renewable sources due to night, clouds, calm weather necessitates an ability to temporarily store energy when it is produced.

The main metaphor is that just like a rocket, the society that advances with fossil fuel is initially on an unsustainable path. After launching from the safety of the ground (leaving early agricultural sustainability), there is another sustainable situation – the orbit for the rocket and the use of technologically enhanced renewable energy for society. Both systems – rocket and civilization – have to reach the second stable situation before their limited amount of fuel runs out. There are also many similar issues such as achieving stability, transitioning to new stages (phases), and passing through the atmospheric friction (GHG release). First, the situation of a successful launch into orbit includes aspects of preparation, launching, achieving stability, surviving atmospheric friction, flight planning, and obtaining orbit will be discussed.

To have a successful launch into orbit, many engineers, controllers, and astronauts work together to design and then monitor progress so that changes can be made to correct problems. Currently we do not have a set of equivalent monitors or controls. In many cases we really do not know the characteristics of the systems, for example the amount of fossil fuel, the CO_2 level that causes irreversible harm, the number of people that need the energy, the level of energy efficiency that is attainable, the economic viability of renewable energy sources. The transition to sustainable energy seems to have started (lifted off) with some self-correcting systems like market economy. It has also undergone a few changes in technologies (stage separations), for example, dramatically increase energy efficiency. But only now do the possible criteria for reaching sustainability such as total energy demands and technologies (stable orbit parameters such as altitude and speed).

In conclusion, this current period seems to offer difficult and unique challenges as we move towards global sustainability. In this case, all available information helps in developing scenarios based on previous trends, monitoring the transitions with key indicators, and adapting to the emerging situations with scenario revisions to help guide networked collaborative decision makers.

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