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Profiling 'Threshold 9': Using Big History as a Framework for Thinking about the Contours of the Coming Global Future

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Abstract

Big History provides a very powerful framework for understanding the broad contours of the past, from the beginning of the Universe at the Big Bang to our present globe-spanning information-based technological civilization. But to what degree can this framework also be used to draw potential insights into the contours of the possible future of humanity, as it emerges from the complex dynamics of the present?

In this paper, we make use of the '8-threshold' formulation of Big History due to David Christian and examine some of the conceptual possibilities that arise when we consciously and systematically take a 'Big History perspective' on the future of humanity at the global scale. Specifically, we consider the question of what the next major threshold in Big History – what we might therefore call 'Threshold 9' – may look like in broad outline.

We find that, of the four main 'generic' categories of possible futures, the most probable global future currently in prospect – barring a major catastrophic shock, technological energy breakthrough, or similar low-probability 'wildcard' event – is a slowly-unfolding collapse or 'descent' over a time-scale of decades-to-centuries towards a human society characterized by ever-declining access to sources of fossil-fuel-based energy. Such a future trajectory clearly has major implications for the level of human societal complexity possible. This suggests undertaking an anticipatory program of continuing research and exploration into both the underlying nature and the emergent characteristics of the coming transition to 'Threshold 9'.

Keywords: *Big History thresholds, energy systems, energy transitions, post-fossil-fuel civilization, alternative futures, world futures.*

Introduction. Contemplating 'Epoch 8', Profiling 'Threshold 9'

The modern scientifically-based understanding of how humankind came to be here – called, among other things, Cosmic Evolution, the Epic of Evolution,

Universal History, or Big History – is an intellectually exciting and very powerful conceptual model for making sense of the entire past, leading from the Big Bang nearly 14 billion years ago to our present planet-wide information-based technological civilization (*e.g.*, Brown C. S. 2008; Chaisson 2001, 2007, 2008; Christian 2004, 2008; Delsemme 1998; Jantsch 1980; Spier 1996, 2010). It represents a remarkable synthesis of diverse knowledge domains and scholarly disciplines brought together into a unified account of many different dynamical processes arising since the beginning of the Universe. It also allows us to identify some of the major forces and drivers of change in human history operating over a number of different spatial and temporal scales, providing insights into how the globalized world we know today has come to be the way it is.

While there have been many examples of earlier attempts to synthesize knowledge in this way (see Spier 2010: ch. 1), Erich Jantsch (1980) wrote perhaps the first account of Cosmic Evolution / Big History based on the modern understanding of non-equilibrium thermodynamics, drawing strongly upon the work of, amongst many others, Nobel Laureate Ilya Prigogine, to whom he dedicated his book. Nazaretyan (2005) noted that surprisingly it had not received very much attention in the West, and considered some possible reasons for this. Nonetheless, it has managed to stand the test of time well and, even after three decades, it still remains a stunning work of synthetic scholarship and insight. Two of the key concepts in this approach and the approaches of Eric Chaisson (2001, 2004a, 2004b), Fred Spier (1996, 2005, 2011), David Christian (2004; 2008), and Frank Niele (2005), are those of *energy* (or more precisely, energy *flow*), and *complexity*. Our attention here will be primarily focused upon the issue of energy availability and the social complexity it supports, and how these may be viewed within the context of the 'thresholds' approach to Big History (described below) applied to thinking about the *future*.

In Eric Chaisson's approach, he considers seven major 'epochs' of increasing material-energetic complexity in the unfolding scenario of the evolution of the cosmos: particulate, galactic, stellar, planetary, chemical, biological, and cultural (Chaisson 2007). An interactive web site based on his body of work over decades also adds the eighth epoch, 'future evolution', where 'the cosmic-evolutionary scenario is extended in time' (*Idem* 2008).

In David Christian's approach, he considers eight major 'thresholds' of this increasing complexity: the origin of the Universe, the first stars and galaxies, the formation of chemical elements, the formation of the Earth and solar system, the arising of life, the arising of humanity, the transition to agriculture, and the modern revolution (Christian 2004, 2008). Clearly, these eight thresholds can be seen to fit within the seven epochs described above, albeit with an obvious emphasis on the *cultural* (*i.e.* human) epoch, as his account is told from the perspective of an historian rather than a physical scientist. The matter of the future is also considered in Christian's work (2004: ch. 15), and, indeed, in the work

of others as well (*e.g.*, Brown C. S. 2008: ch. 13; Niele 2005: ch. 7; Spier 2010: ch. 8).

As a physicist-turned-futurist, I am interested in using scale-appropriate frameworks of understanding to generate ideas for further exploration into the dynamics that are shaping our present world and which are likely to be involved in shaping the future (Voros 2003, 2005). By choosing frameworks of appropriate scope, we may look for insights about potential futures at a 'deeper' level than merely extrapolating 'surface' trends, and thereby undertake profoundly 'deeper' futures thinking than that engendered by merely 'reading' these trends (Voros 2006, n.d.). The grandest model currently available for use in this way would seem to be the all-encompassing scenario of Cosmic Evolution itself, which can be viewed as a broader process that includes the specific case of how that evolution has played out in this corner of the Universe here on the planet Earth, namely, Big History. One can readily imagine that there could also be other civilizations, or at least inhabited worlds, which may also have their own unique versions of Big History.

If our interest in the coming future is at the global scale, then our contemplations of 'Epoch 8' naturally find expression in the activity of attempting to characterise the unfolding of global dynamics over the next few decades and centuries.[1] Given that our present civilization has arisen over the last few centuries following the emergence of 'Threshold 8' – based upon the ever-increasing use of non-renewable fossil fuel energy – as a futurist I naturally find myself thinking about what the *next* threshold of Big History might be, when these fuels are either much less, or perhaps even no longer, easily available for our use, or if they are in the process of being replaced by other primary sources of energy. This will no doubt be a major energy transition, one of only a few in the world history (Niele 2005; Smil 1994). Vaclav Smil has observed that such energy transitions are 'inherently protracted', and 'usually … take decades to accomplish' (Smil 2010b: viii). This will surely have profound implications for our present civilization, so it would seem wise to undertake some serious fore-

[1] Terms frequently used for foresight work include: prediction, projection, forecasting, prognostication, prophecy, conjecture, prognosis, inference, speculation, and a wide variety of other terms. None of these is entirely satisfactory; they all carry certain connotations which may not be helpful, such as the connotation of certainty that the word 'prediction' carries, or the connotation of ungrounded guesswork that the word 'speculation' has. What is needed is a neutral term that is as free of connotations as possible so as to be merely indicative of the activity of thinking about the future. For over a decade I have used the term 'prospection' to denote this. As described in, for example, Voros (2003), this is formed from: 'pro' = 'forward', 'spect' = 'look', and '-tion' = the noun form of the action. Thus, the word 'pro*spec*tion', where the stress falls on the second syllable, has the meaning 'the activity of purposefully thinking about the future to create "forward views" and ideas about, or "images" of, the future'. In the present context, I will instead use the somewhat more familiar term 'profiling', following Clarke (2000), as it carries the appropriate sense of trying to discern broad contours in the complex dynamics of our world (Voros 2009); we will not undertake the entirely futile task of attempting to pin-point specifics.

sight thinking in order to begin to prepare for the consequences of such a change in the global energy system.

This, then, is the key logical starting point of our current futures exploration: to recognize that there *will be* a time in the future when a *new* Big History threshold has been crossed, one where fossil fuels are no longer the primary source of energy powering human societies – what we might therefore call 'Threshold 9'. One wonders then what forms human society might take, and what effect will be on social complexity that is based on different sources of energy than these. Will it continue to increase in new and emergent ways owing to the discovery of newer more energy-dense sources of energy? Or will social complexity perhaps be reduced to relatively simpler lifeways due to the availability of only less-dense energy sources? One cannot know the future for certain, of course – and no one knows this better than a futurist – but it is usually very instructive to systematically contemplate many possibilities that may await us there. Moreover, it is prudent to consider deeply what may happen to human civilization when access to these finite sources of energy inevitably begins to tighten in the not-too-distant future. Thus, in our present contemplations of Epoch 8, we find ourselves focussing upon and 'profiling' Threshold 9.

In what follows, in order to set the context, the main 'human' thresholds – 6, 7 and 8 – are very briefly considered from the perspective of energy use. Since post-Threshold 8 modern industrial civilization is so overwhelmingly based on easy access to cheap abundant fossil fuel-based energy, confronting the uncomfortable question of what comes *after* such easy access would be aided considerably by some sort of organizing framework to guide our thinking. To this end, four 'generic' classes of futures are examined to see how they can be used to 'contour' our thinking about the implications for the longer-term human future which arise from considering this far-reaching question. We then briefly examine past dynamics in an earlier threshold to look, by analogy, for potential insights into the upcoming transition period, and end by reflecting on how we may need to prepare as a species for the coming transition to a post-fossil fuel-based civilization.

The discussion here should be regarded as merely an initial and very preliminary exploration of a few of many possible ideas, being done as much to show the process of undertaking such foresight-focussed exploratory work as much as for any insights that might be generated by it. I hope that it can contribute in some way to a wide-ranging continuing conversation among big historians, sociologists, futurists, and any other similarly interested scholars, around this important aspect of our common global future.

Reviewing the 'Human' Thresholds

In David Christian's 'thresholds' conception of Big History, the three thresholds which pertain to humanity and so are of the most direct interest to us here are:

Threshold 6, some 200–300 millennia ago when our species *Homo sapiens* emerged as distinct from other closely-related hominines; Threshold 7, some 10–11 millennia ago when humans began changing their main approach to making a living from foraging to farming; and Threshold 8, some 2–3 centuries ago when humans began to utilize more extensively the energy stored in highly energy-dense fossil fuels, in their many social, economic and other activities.

At Threshold 6, it appears that gaining access to the (chemical) energy stored in foodstuffs is simply a 'given' as the primary goal of biological survival. In this sense, from the point of view of energy use, it would seem to differ little from Threshold 5, the emergence of life on Earth.[2]

Following the human migrations that ultimately extended to all major land masses except Antarctica, human freedom to range widely into hitherto unutilized territory eventually began to become more constrained, leading to an increasing intensification of the use of existing lands rather than simply extending presence into newer lands ('extensification'). This transition of techno-economic base from foraging to agriculture – Threshold 7 – seems to have been a fairly gradual and possibly initially unwelcome process (Brown 2008: ch. 5; Christian 2004: ch. 8). Here the utilization of environmental resources and energy also intensified, as humans domesticated plants and animals and subsequently began to harness wind and water energy.

By Threshold 8, human energy usage had begun to unlock the stored solar energy encapsulated in long-dead fossilized organisms – the 'fossil fuels' made up of peats, coals, crude oils, and some natural gases. The much higher energy densities (energy per unit mass) of these fuels compared to previously-utilized biomass fuels and dispersed forms of renewable energy made them very attractive, as did their relative abundance (Smil 1994: 153, 219), and their relative ease of accumulation or extraction. Efficiencies of energy use have also improved markedly over the last several centuries, from less than 5 % in open wood fires to 94–97 % for modern gas-fired space heaters (Smil 2010b: 7–8). Today almost every aspect of the modern industrialized world has become utterly dependent upon fossil fuels. Smil (1994) has called this dependence 'fos-

[2] It is possible to argue that perhaps *the defining aspect* of Threshold 6 is the emergence with physiologically modern humans of what appears to be a greatly-expanded ability to *utilize information*, brought about through increases in brain size and perhaps also through changes in the brain's structural organization, as well as other physical changes, such as the development of more refined vocal capabilities. This ability to process (through cognition), store (via memory) and transmit information (via speech and/or symbols), from individual to individual, would seem to be the major disjunction that marks this as a Threshold. Christian has argued at length in many places that it is the capacity for *collective learning* that is the defining characteristic of our species. That capacity is very likely founded upon this *intensification of the capacity for information processing*, and manifests in the interaction of the individual and social domains of human groups as an enhanced ability for symbolic informational exchange, which Christian has identified as the capacity for collective learning.

sil-fuelled civilization'; while Niele (2005) has even characterized modern fossil-fuel-using and fuel-dependent human beings as a distinct subspecies: *Homo sapiens carbonius*.

What Comes *After* 'Fossil-Fuelled Civilization'?

But these luxuriantly energy-dense non-renewable fossil fuels obviously cannot last forever.[3] At some stage, access to fossil fuel energy will inevitably face a severe bottleneck of availability and then a decline. The energy infrastructure that powers contemporary industrial civilization, and which is hugely interdependent with and upon the social systems and institutions that are themselves powered by it, will then undergo a crisis of stability which will have a flow-on effect to industrial civilization itself.

A large number of contemporary writers have examined this emerging civilizational crisis, generally framed around climate change, energy decline, or economic instability (Ahmed 2010; Brown 2008; Brown 2011; Greer 2008; Heinberg 2010; Heinberg and Lerch 2010; Holmgren 2009; Kunstler 2005; Lynas 2008; Roberts 2005; Slaughter 2010). The investigation undertaken by Nafeez Ahmed (2010) is particularly notable for its attempt to look beyond disciplinary boundaries and specializations to examine the many mutually-reinforcing interactions between the various crises that different experts focus upon, as well as the identification of 11 'structural' issues that will need to be urgently addressed if we are to transition smoothly to what has been called a 'post-carbon civilization' (Ahmed 2010; Heinberg and Lerch 2010). There are many recent and contemporary commentators around the 'peak oil' (Hall and Klitgaard 2012: ch. 15), 'peak energy', or even 'peak everything' (Heinberg 2010) debate, with many arguing positions both pro and con; far too many to list here. In sketch, though, the 'con' position usually tends to counter to the 'pro' position, which argues that easy access to energy is rapidly running out, by claiming that there are vast reserves still left in the ground which will last many decades or centuries yet, or that some new technological innovation in the future will surely occur to mitigate the problem.

But, on a Big History timescale, the next few decades or centuries are only a momentary 'blip' in the overall trajectory of the human species and planet Earth. On this scale, the availability of highly-concentrated energy-dense fossil fuels is but a 'brief anomaly'[4] in the long history of the Earth, so a properly diachronic view of human and Earth history needs to look well beyond the pre-

[3] Of course, on the timescale of Big History, strictly speaking these fuels *are* renewable, but only on time frames beyond any practical utility for humans, these being on the order of tens to hundreds of millions of years. Thus, for all *practical* human purposes, they are *effectively* non-renewable.

[4] J. Floyd. Beyond This Brief Anomaly: An Inquiry into Energy and Society [weblog]. URL: http://beyondthisbriefanomaly.org. Date accessed: March 21, 2012.

sent 'peak' debates to the longer term when fossil fuels are no longer so readily available. Thus, the question of what effect the running-down of fossil-fuelled energy systems will have on the structure and complexity of human civilization is a genuinely serious one which deserves somewhat better than to be wilfully ignored, deferred to future generations, or wished-away through reliance upon a hoped for miraculous technological salvation.

That is why the futures-thinking approach taken here is to imagine a time in the future when fossil fuels have either effectively run out or, at the very least, that our fossil-fuelled civilization has run out of easy access to these fuels, and is increasingly based on other primary sources of energy. It is this that I am calling 'Threshold 9'– a time in the future when the predominant sources of energy powering human societies are no longer fossil fuels. This is a way to bypass the sometimes rather heated and often unproductive current argumentation about energy scarcity and to simply acknowledge that fossil fuels *are* indeed finite – something which no one could seriously argue against – and use *that incontestable fact* as our foundational starting point. This has the important effect of enabling us to avoid getting 'stuck' in the present debates about the imminent coming, or not, of 'peak oil' or 'peak energy' and to instead simply take up a stance in the farther future when these debates will be over because they are moot. This is an example of a 'discontinuous' method of thinking about the future: we 'escape' from the tyranny of the present, and of limited-imagination extrapolations based on our constrained view of the present, by purposefully 'jumping' to a point in the future (Voros 2006). From such a *future* perspective, we are then able to 'look back with different eyes' (as it were) to see in a different way what sort of future-history trajectories might emerge from our current situation.

Four Generic 'Images' of the Future

So, where to from here? How can we begin to seriously examine alternative futures for our present civilization on a Big History timescale? Futurist James Dator has studied the ways that different cultural groups and societies think about the future. According to him, all ideas about – or what in the terminology of Futures Studies are called 'images' of – the future can be grouped into four broad generic classes, as follows (Dator 1998, 2002):[5]

[5] These are sometimes called 'scenarios', although it would be more correct to refer to them as 'generic classes of futures', or even, for simplicity, 'generic scenarios'. They each, to use the language of Futures Studies, define certain 'logics' which are the overarching structural dynamics of the worlds depicted, and act as a sort of 'envelope' surrounding and bounding the processes taking place within these worlds. The four generic classes of future can be considered a more nuanced expression of a simpler two-class approach, comprising (i) extrapolative evolution, where the system dynamics are assumed to continue relatively smoothly; and (ii) disjunctive revolution, where the dynamics are assumed to deviate sharply from smooth continuity.

- *Continuation* – the current historical trajectory continues, most usually conceived of as continued economic growth;
- *Collapse* – a breakdown of the social order due to one or more of a number of possible causes, such as economic instability, environmental overload, resource depletion, moral degeneration, military conflict such as an external attack or internal civil war, meteor/comet impact, *etc.*;
- *Disciplined Society* – a society organized around some set of overarching values, whether ancient, traditional, ideological, natural, environmental, God-given, *etc.*;
- *Transformational Society* – which sees the end of current forms of behaviour, beliefs, norms, or organization, and the emergence of new forms (rather than a return to older or traditional ones, as above), possibly even including intelligent life-forms. The two main subvariants are 'high-tech' (technological) and 'high-spirit' (spiritual) transformation.

Scoping Future Dynamics

These four 'generic scenarios' can provide a useful structure for thinking about the future in general. But let us now choose 'energy availability' as the organizing principle or focus of examination through this framework to see what potential insights we might be able to extract from this particular analysis about the future dynamics of the world system.

Continuation

Much of what is known as the 'technoliberal' optimist literature (Wagar 1991) assumes that things in general will simply continue improving as they have been for the last two centuries or so, guided by the further spread of democratic ideals, unfettered free enterprise, and unbounded technological progress (*e.g.*, Diamandis and Kotler 2012; Schwartz *et al.* 2000). And it makes perfect sense from a straight-forward (if somewhat naïvely unsophisticated) application of 'extrapolative evolution' (Voros 2006) of the world system's dynamics and technological changes over the past few centuries. The *Continuation* generic scenario characterizes precisely this viewpoint. It takes as its baseline the historical trajectory of industrial civilization since it emerged, and simply extends this trend line into the future. Therefore, in this view, we can expect ever more economic growth, and ever-more numbers of humanity to be lifted out of poverty as 'progress' continues to improve the lot of humankind.

This admittedly quite attractive view of the future of human history is fairly prevalent – and not without some basis (Millennium Project 2012) – not only in the OECD countries, that stand to remain in their present comfortable lifestyles, but also in many industrializing nations, that sense that there is much to be gained as they seek to approach the living conditions and lifestyles of the richer industrialized countries. Unfortunately, such an uncritical extrapolation

of past trends into the future is based upon the (usually unchallenged) assumption that the deeper underlying system dynamics which have made this possible will also continue into the future. These system dynamics have to a very large extent been based upon the energy sources fuelling industrial civilization – dynamics which, as we have noted above, are quite literally running out of fuel.

Thus, regrettably, the *Continuation* scenario for economic growth and well-being is almost certainly a phantom based on the (most likely) delusional assumption that easy access to cheap, abundant energy will certainly continue without abatement. Barring a technological breakthrough which puts us into the high-tech transformation subclass of the *Transformational Society* scenario, to be described below such an anodyne view of the future is not sustained by the currently-available evidence. Indeed, as mentioned above already, the preponderance of emerging evidence seems to point to the inevitable decline of easy access to abundant, concentrated sources of energy (Niele 2005; Smil 1994, 2010a, 2010b; and many other contemporary works, including those cited earlier), with the result that *Continuation* cannot be sustained beyond a fairly short time into the future – if at all – and certainly not on the Big History timescale we are utilizing as our baseline.

My point here is not to argue nor necessarily to disagree with the optimists who assume that we will find a positive way forward, but simply to note that this *cannot be assumed* as a natural or inevitable continuation of the past. Rather, it *will* require some kind of innovation or breakthrough for this to occur – and *that* is the point that needs to be borne in mind. It is akin to basing a retirement plan on the assumption that one will simply win the lottery when it becomes necessary. It would of course be quite nice and very welcome! But it is by no means certain, and is probably not the wisest strategy to pursue for one's long-term future. Perhaps, it is for the best to have at least a credible back-up plan.

Collapse

In contrast to the endless-growth mindset, there exists a considerable literature dealing with what may happen when energy sources, usually conceived of primarily as 'oil', begin to run dry (*e.g.*, Brown L. R. 2008; Kunstler 2005; Roberts 2005) or when the biosphere can no longer tolerate and absorb the stresses that human civilization is placing upon it by burning them (Brown 2011; Diamond 2005; Farnish 2009; Lynas 2008; Meadows *et al.* 2004). This is precisely the *Collapse* generic scenario, although variants of the other subclasses of this class also exist, such as asteroid impact (Chapman 2004; Collins *et al.* 2005; Schweickart *et al*. 2008). Of course, from the perspective of Big History, this latter possibility is not as farfetched and improbable a 'wildcard' (Petersen 1997, 1999) as many people may think, not only since we owe the ascent of mammals over large reptiles in significant part to just such an event (Alvarez 1997), but

also because there has actually been an impact in the very recent past that could have had devastating effects had it hit densely populated areas – the Tunguska Impact of 1908 (Di Martino *et al.* 1998; Gasperini *et al*. 2007). Had this occurred during the Cold War, one wonders what the consequences might have been, or indeed might still be if any similar future impact blast is mistaken for a nuclear detonation (Sagan 1980: 76).

The *Collapse* generic scenario came to wide popular attention with the publication of Jared Diamond's (2005) eponymous best-seller, which continues a tradition of scholarly study of the complex societies' collapse in history that includes the important earlier work of Joseph Tainter (1990). However, the concept of 'collapse' itself is a somewhat imprecise one, and carries a certain connotation of rapidity that may not be entirely useful for our current purposes. As some scholars have noted, from the present we tend to see the historical 'collapses' of the distant past through a greatly-foreshortened perspective, which can make even very drawn-out processes seem somewhat abrupt from this vantage point. For example, the 'collapse' of the Roman Empire is generally thought to have taken some three centuries or so to occur (Tainter 1990). To those living through it, however, it would hardly have been noticeable over a lifetime, let alone experienced as the kind of rapid decline which the term 'collapse' connotes.

From the perspective of the longer-term human future on a Big History timescale, the end of fossil-fuelled industrial civilization may well be viewed similarly as a 'collapse', due to the same foreshortening of timescales that we ourselves experience when looking to the past. But on our *own* timeframe – the timeframe of our individual lives and those of our immediate descendants and subsequent generations – we will almost certainly not experience this as a rapid 'collapse' in the sense that the term is commonly used.[6] Rather, there will almost certainly be a kind of 'envelope' of declining fossil-fuel energy availability, which will shape the contours of the degree of complexity that is possible for human society. Thus, while this might eventually be considered a 'collapse' by historians from the farther future, it will almost certainly not take place on the same timeframe as other more rapid events which might more fittingly merit the term 'collapse', such as nuclear war or asteroid impact.

For this reason, some commentators conceive of the end of fossil-fuelled industrial civilization due to energy scarcity not in the 'rapid' terms of a 'collapse', but more along the lines of a drawn-out 'decline' or 'descent' to an eventual new form of societal organization with a techno-economic base founded upon renewable forms of energy – notable examples being John Michael Greer

[6] The question of how to meaningfully and rigorously use such 'collapses', 'shocks', 'wild cards' or similar 'discontinuities' in futures thinking is and remains a difficult one (Hiltunen 2006; van Notten *et al*. 2005).

(2008, 2009), David Holmgren (2009) and Richard Heinberg (Heinberg and Lerch 2010). Of course, other forms of rapid societal collapse may also occur – acute environmental disasters, sudden economic recessions or depressions, unexpected social upheavals and unrest – and they should of course also be borne in mind. But our present futures assessment is based around a focus on energy availability, and the implications for social complexity that it allows. This therefore suggests not a sudden rapid 'apocalyptic'-type end to fossil fuel energy sources, but rather a more gradual decline contoured by a narrowing energy-availability 'envelope' as we inevitably move down the descending side of the empirically-derived bell-shaped Hubbert Curve which was initially developed to describe oil production (Hall and Klitgaard 2012). There are some commentators who, perhaps wryly, even look upon the coming decline as an opportunity (Homer-Dixon 2006; Orlov 2008).

Disciplined society

The notion of constraints on what human society can do being forced upon it by relative energy scarcity can also be considered a variant of the *Disciplined Society* generic scenario. In essence, human society is in this case constrained not by the social values held by the majority of the populace (that is, by an 'internal' constraint), which is the more usual form of this scenario, but by the fact that cheap abundant energy is no longer easily available for use *by* the society – an *external* constraint. The fact that most forms of this generic scenario have generally been of the 'internal values' kind may be indicative of how pervasive the assumptions of abundant energy, continued progress, and lack of constraints on human society and ambition have been. The negative reactions to the observations made by the authors of *The Limits to Growth* (Meadows *et al.* 1972) or *The Population Bomb* (Ehrlich 1971), to name only two such 'constraints'-type works, is a telling case in point.[7]

Greer outlines a series of stages through which he believes our civilization will likely pass from our current 'abundance economy' based on still-freely available high-density fossil-fuel energy to a 'scarcity industrialism' wherein the constraints on society are becoming increasingly prevalent to the age of 'salvage' where earlier infrastructure is dismantled and reused due to an increasing difficulty of manufacturing new materials; and ultimately the move to a new 'ecotechnic' age, some one-three centuries or so hence, based on sustainable

[7] On a related note, we might observe that there has been a stabilization of the 'Malthusian' population collapse cycles which occurred prior to the modern revolution (Christian 2004), as these appear to have been driven primarily by inabilities for productivity to meet the consumption needs of human societies. This has not been so large a problem since Threshold 8, pandemic disease events and warfare notwithstanding, although with energy and resource constraints again looming in the future, it may be that such Malthusian cycles might once again make an unwelcome return to the long view of human history.

forms of techno-economy and organic agriculture (Greer 2008, 2009). In all these stages there is a high likelihood of considerable economic and human turmoil. Beyond doubt, this is no 'sweetness-and-light' transition to a Utopian paradise of blissful co-existence with Nature (what is sometimes known in the Futures Studies literature as 'ecotopia'), nor is it a return to Marshall Sahlins' somewhat idealized 'original affluent society' (1972). Rather, it is a process of *de*-industrialization, with all of the consequences that winding back many of the accomplishments of the last few centuries implies. This trajectory of what Greer calls 'catabolic collapse' is compared with similar cases from history, most especially the Mayan collapse, and his analysis is fully aware of a Big History perspective, even if he does not name it as such.

These types of energy-constrained societies are a very important class of futures to be aware of, as I suspect they will become increasingly important in guiding our collective thinking about the decline of readily-available dense-energy sources over the next decades and centuries. Greer is one of very few authors I am aware of writing about the next stages in human history which are expected to emerge on a timeframe of generations as opposed to the more common timeframe of a few decades as well as dealing with a disciplined society. Another is Warren Wagar (1991, 1999), whose future society is admittedly disciplined mainly by socialist values and by the physical aftermath of a global nuclear war (*i.e.* a prior abrupt 'collapse'), and is itself merely a transitional stage on the way to the eventual 'transformational' world civilization (see below). With respect to the coming 'energy discipline', Smil's work provides an important 'envelope function' of realistic energy system possibilities over the longer term which could be used to help guide our collective thinking (and, hopefully, collective *learning*) about the next transition in the configuration of our global energy system (Smil 2010a, 2010b). And finally, drawing on Big History itself, perhaps we can make use of our understanding of what we might call the 'anabolic' *rise* of modern industrial civilization over the past few centuries as a framework to generate some ideas and potential insights into the prospective 'unwinding' processes of decline that may well lie ahead.

Transformational society

Of course, there could always be some breakthrough or transformation that radically changes the nature and form of human society. Dator suggests that these, are usually conceived of as being either technological or spiritual in nature. The case of the singularity (Broderick 1997; Kurzweil 1999, 2006; Smart 2003) could be considered a 'hybrid' form of these idealised types. Let us consider technology first.

It is certainly true that technology has in the past radically altered humans' relationship with nature, especially our ability to utilize environmental energy. Thus, in this view, it will simply be another such technological advance that

will mitigate the energy problems we currently face in prospect. There are several very well-known possibilities frequently mentioned in contemporary commentaries, so it will suffice here to simply mention a few of them briefly.

Almost all renewable forms of energy such as photovoltaic, wind, running water, and wind-generated wave energy are ultimately based on the energy output of the Sun (Smil 2010a, 2010b), which we must therefore fervently hope will continue to have a stable lifetime on the main sequence for a good while yet! The other main forms of renewable energy not derived wholly from the Sun are geothermal, to be discussed later, and tidal. The trouble with these otherwise attractive sources is that they are nowhere near as energy-dense as fossil fuels. Electricity can be generated from a variety of sources, including renewable and, while therefore an attractive form of potentially cleaner energy, it is not necessarily suitable for all tasks – aircraft transport is a case in point.

Hydrogen which is often mentioned in discussions of energy transitions is only useful as a *means* for transporting energy, not as a *source*, although one can envisage, for example, a solar-powered conversion plant producing hydrogen gas from electrolysing seawater, with a view to its application as a potential transport fuel. It has the distinct advantage of producing only gaseous water (*i.e*. steam) as a by-product of combustion – a greenhouse gas, certainly, but much less troublesome than carbon dioxide or methane, two of the main offenders. A transition to a hydrogen-based transport fuel system would require considerable recreation of existing fuel infrastructures, and were it to be feasible there does not as yet appear to be the political will to undertake this.

Fusion energy is also often assumed to be a potential clean energy goldmine, but it has not consistently made the progress that was being hoped for it in the latter part of the 20th century CE. Yet, despite this, it persists in the public consciousness, and, if we are being fair-minded, it just *might* turn out to be more substantial on the longer timeframe we are considering. So if we are to remain alert to the existence of 'wildcard' breakthroughs (Petersen 1997), we need to keep it somewhere in mind. There is, of course, also some hope held out for more attractive forms of nuclear *fission* energy, which, if the promise of thorium is fulfilled as opposed to the increasingly-unpalatable uranium and its by-products, might be a more socially and politically acceptable way to act as a bridge to the fully-renewable system we will probably need to eventually create. The reader is referred to Smil (2010a, 2010b) for a comprehensive analysis of many of the conventional forms of energy noted here.

Then there are the possibilities of some astonishing technological breakthroughs about which we are at present wholly ignorant and unable to even speculate. An ability to concentrate the more-diffuse renewable forms of energy into higher densities might be just such a development. Or perhaps some entirely new 'miraculous' source of energy is found, such as tapping the quantum

vacuum energy of space-time, to give but one extreme example (Clarke 1999). I have suggested elsewhere that there is merit in entertaining 'preposterous' futures ideas (Voros 2012), so perhaps 'cold fusion' can also be mentioned here, since Clarke dedicated his short story, albeit perhaps with tongue-in-cheek, to the two scientists who first announced it, but for which there has as yet not been any widely-accepted experimental confirmation.

The other major variant of the *Transformational Society* is one of consciousness or spiritual transformation – some new form or aspect of human consciousness emerges and redefines our value systems, such that we become focussed on 'higher' goals that we currently pursue. A number of futurists have considered this from the point of view of either a contemporary transition to a new 'expanded' worldview (Harman 1998) or from a sequence of changes over the next few centuries, which is precisely the time-frame we are using for considering Threshold 9. Thus, Wagar (1991, 1999), mentioned above, considers 'three futures', which pass through the four major classes we have been discussing here, culminating in a more spiritually-informed consciousness-based planetary civilization, while Duane Elgin also sees a transition to planetary civilization over the ensuing centuries, based upon an expanded awareness of our place in the Universe (Elgin 2001, 2009).[8]

It may be that it is just such a new sense of ourselves and our place in the Cosmos that gives rise to the mindset required to live within our energy means, and might indeed be the main prerequisite for us to successfully make the transition to what Elgin (1994) has called 'initial maturity' as a 'sustainable species-civilization'. Thus, it might be argued that Cosmic Evolution, Big History and other related frameworks may themselves provide a foundation for a new more integrated worldview, onto which an almost spiritual dimension could be read. There are several authors who are, to varying degrees, pursuing something like this line of thought (Abrams and Primack 2011; Christopher 2013; Genet *et al*. 2009; Primack and Abrams 2006; Swimme and Tucker 2011). However, Carl Sagan, who could rightly be considered one of the early pioneers of the modern scientifically-based worldview we now know as Cosmic Evolution or Big History (Sagan 1973, 1980), maintained that *any* meaning or significance to our existence was to be found within *us*: 'The significance of our lives and our fragile planet is then determined only by our wisdom and courage. *We* are the custodians of life's meaning. … If we crave some cosmic purpose, then let us find ourselves a worthy goal' (Sagan 1995: 57).

Finally, it is perhaps fitting to end this discussion of a more cosmically-aware integrative worldview by returning full circle to cosmic-evolutionary pioneer Erich Jantsch, whose decades-old work is still able to strengthen and

[8] The question of the future of human consciousness itself is also an interesting focus of study, although much of this work is still emerging (see, *e.g.*, Ghose 2003; Wilber 1999–2000, 2007).

deepen our understanding of the many processes in cosmic evolution and Big History (Jantsch 1980). His thoughts on what he called 'the evolutionary vision', which can help us not only understand our past history and present place in the Universe, but also to confront our coming future, were published posthumously after his untimely death, as literally his last words in print:

> The evolutionary vision is itself a manifestation of evolution. The reward for its elaboration will not only be a new (or partly revived) natural philosophy or an improved academic understanding of how we are interconnected with evolutionary dynamics at all levels, but also an immensely practical philosophy to guide us in a time of creative instability and major restructuration of the human world … With such an orientation, science will also become more realistic and meaningful for the concerns of human life. It will be not merely an end product of human creativity, but a key to its further unfolding in all domains (Jantsch 1981: 213).

Lessons from Earlier Thresholds

Another approach to thinking about the future arises from using as an interpretive framework an adapted form of 'macrohistory', the study of how social systems change over time in search of patterns, or even 'laws' of social change (Galtung and Inayatullah 1997; Inayatullah 1998). In this approach, one looks for regularities in the key dynamics of historical change and uses these as a way to seek insights into the situation being studied. In the context of our use here of the 'thresholds' view of Big History, this would imply utilizing earlier thresholds to try to generate insights about the next one. I call this use of earlier dynamics as a trigger for seeking insights 'reiterative analogy'. There is naturally no assumption that the dynamics *will* repeat; we merely make use of some aspect or aspects of those dynamics as a cognitive trigger to try to generate new ideas and potential insights. Of course, the most recent threshold, Threshold 8, which was the transition *to* wide-scale use of fossil fuels, was clearly the initial stimulus for thinking about the next threshold, Threshold 9, which I have thereby defined as a corresponding time-symmetric transition *away* from fossil fuels. Let us now, by way of further exploration, go back one further threshold to Threshold 7, and seek to draw some insights from that one.

Threshold 7 was characterized, in essence, by the transition from a techno-economic base of foraging to one of farming. This was a way to obtain food more reliably and predictably than relying upon simply finding it in the environment, although Palaeolithic food-gathering does seem likely to have been undertaken fairly methodically from existing knowledge of growth and seasonal cycles (Christian 2004), rather than being as haphazard as this brief characterization might suggest. Clearly, there is an analogy being suggested by this between 'food' and 'energy'.

If we consider our approach to energy today, we can see that for several centuries we have been, effectively, 'foraging' for fossil fuel energy by searching the environment to see where it may be located. We have then 'gathered' it by mining or other forms of extraction and then moved on to look for newer deposits when the ready supply has become exhausted or no longer able to yield commercially-useful quantities. In this way, one can see a clear resonant parallel between the extensification of human foraging range during the Palaeolithic era and the increasingly extensive exploration of the Earth's surface for energy reserves during the Modern era. In the late Palaeolithic, we eventually ran out of new ranges to enter extensification 'ran down', as it were and we were forced to settle down and intensify the production and harvesting of *in situ* food-energy sources in order to continue to make a living. This was probably not, as noted earlier, an easy or even welcome process, and not necessarily everyone automatically took to it enthusiastically. Similarly, in the late Modern era we again find ourselves running out of readily-exploitable energy reserves *i.e.* our energy-foraging extensification is starting to 'run down' and so we now once again find ourselves beginning to be forced to seek ways to intensify production and harvesting, this time of *in situ* environmental energy. We are being forced to become, as it were, 'energy farmers'; and, as before, this does not appear to be an easy, or indeed welcome, development!

There are clearly further ideas that can be drawn out from this analogy. One intriguing thought is that, as certain geographical areas were found to be conducive to farming and agriculture with the result that human populations were increasingly drawn to those areas in the transition to Threshold 7, so perhaps there might be certain new and different areas which are found to be conducive to farming energy in the transition to Threshold 9, so that human populations may increasingly be drawn to those regions. In effect, a demographic-geographic shift might take place to new centres of energy farming and the economic activities supported by it, analogously to the shift which took place in the early Agrarian era for food farming. This will be an interesting potential dynamic to watch for.

One final idea to briefly consider here is whether there might be any potential analogy between conventional fossil fuel energy, given how it revolutionized human civilization and gave rise to Threshold 8, and any other form of energy that may have been analogously 'fossilized' in some way. What comes quickly to mind, of course, is geothermal energy, which has, in an admittedly fairly loose sense of the term, been fossilized from the time of the formation of the Earth, and is due to a combination of the remnant heat of formation itself, as well as to the decay of radioactive elements present in the initial accretion disc that gave rise to the solar system. This 'fossil heat' is, in effect, driving the (so to speak) 'internal convection engine' which powers the tectonic movements that have had such an important role in Earth's history. This is an intriguing

resonance with the role that the internal combustion engine has had in the modern revolution.

In the context of this futures assessment, my interest is in whether this non-solar form of renewable energy could become an important source of power not only in the energetic sense, but also in the geopolitical sense, given that it is not subject to the problems of intermittency that other renewables have, like solar or wind.[9] Thus, in the same way that some countries have had considerable advantages conferred upon them from the geographical distribution of fossil fuel reserves – one thinks of OPEC, for example, the Organization of Petroleum Exporting Countries – it is interesting to wonder about whether, in an energy-constrained future, relatively easier access to the non-intermittent renewable energy from geothermal sources might also become a source of advantage for another group of countries. One might imagine a geothermal analogue to OPEC; perhaps an 'OGAC', an Organization of Geothermal-Accessing Countries, who use this geographical good fortune to their economic advantage. If this access to geothermal energy were used to generate hydrogen, for example, then there could emerge a system of fuel distribution based on hydrogen which is analogous to the present system of oil trading and distribution. This will also be an interesting potential dynamic to watch for.

Concluding Remarks

These have been some preliminary exploratory ideas based upon the awareness that, as the fossil fuel-based energy sources which have powered industrial civilization since Threshold 8 begin to become scarcer, there is an increasingly urgent need to confront and make sense of the wider implications this fact has for our present civilization. This prospective new threshold in history – a time when fossil fuels are no longer the primary source of energy used to power human society – has been referred to here as 'Threshold 9'.

Why is this approach useful? It is often difficult to clearly see the present dynamics of the world system when we are so completely immersed within them. So, as a futures-thinking device to provide an entirely different perspective that is not, so to speak, 'lost in the present', we instead look to a future time when these confusingly complex dynamics have largely played themselves out, and use that position as our vantage point from which to seek some clarity. In the current exploration, we were interested in the longer-term Big History

[9] As before, strictly speaking, on the long view of Big History geothermal energy is of course a finite resource, as well as solar energy. But both can be expected to last for a *very* long time, with geothermal energy depletion only likely to become a problem on the same order of timescale as the post-main-sequence red-giant death of the Sun (*i.e.*, billions of years). One hopes humanity has found a way to move on before this becomes a pressing issue! In the meantime, we can treat both forms of energy as *effectively* indefinitely-renewable; or at least, to a *very* good approximation!

view of the global future engendered by considering what an imagined prospective 'Threshold 9' might look like. We then examined the shapes of resulting conjectured *possible* futures to see what insights they might give us into what some of the important aspects of the present are that we will need to consider carefully as we move into the *real* future. It is an oft-quoted aphorism that 'hindsight is always "20–20"'. In the approach taken here, we are, in essence, seeking to generate deeper insight into our present situation by taking a long-term foresight view based on a vantage point in the more distant future, and then, so to speak, 'looking back to the present' from that future-based perspective in order to generate, as it were, 'artificial hindsight'. This is obviously not a perfect process, but given the absence of practical time-travel and the logical impossibility of future-revealing technology, it is currently among the most powerful approaches we have. Conducting the same thought experiment using different analytical frameworks would of course generate different ideas, so that many different perspectives could thereby be tapped and integrated in this way.

The most probable global trajectory emerging in prospect – barring a major rapid *Collapse* episode such as nuclear war, asteroid impact or similar event, or a miraculous *Transformational Society* brought about by a stunning technological breakthrough – appears to be a slow-moving energy-system 'collapse'/decline over many human lifetimes to an eventual *Disciplined Society* scenario where the discipline is imposed by much more limited access to energy than we have enjoyed for the past few centuries. The main point here is that our civilization's current energy-intensive lifeways can only continue, it seems, by way of some technological breakthrough. Many people already know this, of course, and fully expect it to occur, given so many earlier technological innovations in recent history. However, the crucial difference here in our time is that, whereas the remarkable technological innovations of the past several centuries have relied upon easy access to sources of readily-available energy, this time it is *access to energy itself* which is the major bottleneck and which requires the breakthrough. And *that* cannot be regarded or treated in the same way as earlier technical innovations, nor can any technical circumvention of this issue be simply assumed or unquestioningly relied upon to occur. So it is as well for us to remember to be cautiously sceptical about technological optimisms.

While other possibilities remain open, and should of course always remain in consideration, a wise course of action would appear to be conducting detailed multi-perspectival multi-disciplinary anticipatory research into both the underlying nature and emergent characteristics of a Big History Threshold of this post-fossil fuel form. Indeed, the very concept of 'profiling Threshold 9' – to get a general sense of the broad longer-term future trajectory of our planetary civilization – could be considered a useful orienting direction for an entire research program in Big History scholarship, not only as an interesting academic

pursuit, but also as a prudent practical step towards *preparing* for Threshold 9. This program would involve re-imagining all facets of human social organization from the perspective of utilizing primary energy sources that, while they may by that time be renewable, are nonetheless almost certainly likely to be more diffuse and less energy-dense than those we currently have access to. These many facets would range from, among other things, agriculture, transport, domestic and industrial energy use (and probably, by then, *in situ* harvesting or production), climate adaptation, forms of work and organizational design, and so on, to the very nature of human relationships with the Earth itself, as well as potential new worldviews and forms of consciousness, founded upon a re-connection with the natural world and the Cosmos at large. It will be no small task to reconceptualize the entirety of human civilization in this way, as the example of the recent historical transition to modernity shows only too clearly.

Yet if we do face the future squarely and prepare ourselves properly, we might just be able to guide this transition with some relative agency and dignified freedom to act, rather than find ourselves being unwillingly dragged kicking and screaming into a future where we may be forced to abandon much of what we have accomplished. As the futurist Bertrand de Jouvenel observed long ago:

> The proof of improvidence lies in falling under the empire of necessity. The means of avoiding this lies in acquainting oneself with emerging situations while they can still be molded, before they have become imperatively compelling. In other words, without [foresight] there is effectively no freedom of decision (de Jouvenel 1967: 276).

Whether our species' transition to Threshold 9 is dignified or not, skilful or not, orderly or not, or commended or not, will depend very much on the seriousness of our preparations and the commitment of our actions. Let us hope that our eventual descendants, wherever they may be, will look favourably upon and approve of how we will ultimately choose to respond to the ever-looming crisis that our fossil-fuelled civilization is now facing. Let us ensure that they can.

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