

# Is the Innovation Society Sustainable?

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From the perspective of the archaeologist/historian and anthropologist we can compare the ups and downs of many civilizations and societies at different timescales, in different natural environments, both in the present and the past. Whether one looks at the Roman, Sassanian, Spanish, British, or American Empires, or at small-scale societies in Africa or Papua New Guinea such as the Huli, in each case a group of people constructs a way of living together, exploits it and grows in size and footprint to a full-scale society with many institutions, and ultimately disintegrates. Disintegration entails the dispersal of people, throwing them back on fending for themselves rather than depending on their group synergies for their survival. There may then follow a phase of reconstruction so that another society emerges, organized differently, with different means of subsistence and a different organization and institutions.

Of course, people have been aware of this for a very long time – Gibbon, Spencer and countless others have described the rise and fall of civilizations. But I am here concerned not with those descriptions, but with identifying drivers that may account for them in each and every case. Hence, I present the case here (in the very limited space allotted to me here) in a very abstract form.

First of all the above observations leads us to the conclusion that such dynamics are inherent in the societies themselves, rather than in the circumstances under which they emerge and flourish. Rather than see the disintegration as an externally triggered ‘crisis’ as we often tend to do, we must shift the focus toward the internal dynamics of the society, arguing that all such ‘crises’ are in effect due to the incapacity of the society itself to deal adequately with the dynamics in which it is involved.

What might be the cause of such a widespread phenomenon? There are two main approaches to it. The first (cf. Tainter 1988, Tainter and Patzek, 2011) looks at the energy flows that a society maintains to keep its members alive (which requires about 100 watts), but also to maintain its infrastructure (which currently absorbs 9900 watts per capita in the USA). In its early phases, a society’s expansion depends on using energy (and other material resources) that are easily accessible in the environment or have been accumulating through either natural or human processes. But as the society grows, it needs more and more energy. Ultimately, the rate of energy return on energy invested will go down as the resources on which the society is based become scarcer, have to come from further away, etc. In the extreme case, this throws the society back on the net energy productivity of the sun in the area it covers. This – in my opinion entirely correct – energy perspective on the rise and fall of civilizations is the perspective that is currently dominant, and as such drives our societies’ search for ever more and cheaper fossil fuel. There is no denying that our societies do indeed have an energy crisis looming, unless petroleum can be replaced by other sources of energy. And

they do have a greenhouse gas crisis looming unless those new resources emit much lower levels of CO<sub>2</sub> per unit of energy.

But I want here to draw particular attention to another dynamic that is inexorably pushing us towards a crisis in our mode of life. One that is much less frequently discussed, but no less dangerous to our societies. We also need to look at the information flows the society maintains (van der Leeuw 1981, 1997, 1998). This finds its roots in the growing awareness that all societies (and not only modern ones) are information societies because it is the information processing by their members that keeps these members together, sharing knowledge about resources, institutions, customs, language, etc., so that they can support each other in the life-ways that characterize the society. The two flows are related because the information processing enables the society to make choices about which forms of energy to use, how to process them, how to use them, and the energy flows enable the members of the society to survive and create the infrastructure (material and immaterial) that constitutes the society itself.

There are some interesting particularities of human information-processing that create their own limitations to the growth of societies. Whereas, ultimately, the limit to energy is external to society, the limit to information processing is internal to it. Individually, we are limited in the number of dimensions we can observe or manipulate (some argue that the limitation is of the order of  $7 \pm 2$ , inherent in the limitations of the Short-Term Working Memory of the human brain). Collectively, by dividing tasks and communicating and coordinating activities, clearly a society can handle more dimensions but it, too, is limited to a selection from among the infinite number of dimensions that constitute the complex system in which any society is embedded. Whether individually or collectively, therefore, any action that we humans undertake is based on a reduced perception of the challenges that action attempts to deal with. But the actions impact on the full set of dimensions of the complex system, inherently creating 'unanticipated consequences' that result from any actions we as human undertake. Now, suppose our knowledge and understanding expands linearly or even geometrically (as in the current phase of very rapid innovation in our societies), nevertheless, because of the difference in dimensionality between the complex system itself and the representation we have of it, the unintended consequences will increase exponentially. Hence, though we think we know more every day, proportionately we in fact know less and less about the socio-environmental system that we are continuously modifying.

On the one hand, this dynamic interaction provides an explanation for the fact that societies generally, when there are no energy limitations, grow larger and larger. That growth is due to the following feedback loop:

Problem solving structures knowledge → increases information processing capacity → allows the cognition of new (unanticipated) problems → creates new knowledge → more and more people involved in processing information → population and its aggregation increase → energy flow increases → etc.

But on the other hand, this feedback loop also explains why there is a 'natural' end to that process. Clearly, through time, any society will initially tackle the challenges that it encounters most frequently, i.e. the ones that involve rapid temporal rhythms. But as they tackle them, the human impact will transform the complex system in many different ways, involving many different temporal rhythms, including much slower ones. The cumulative effect of that process over the long term is a shift in the risk spectrum the society deals with, taking out known short-term risks and introducing unknown longer-term ones. Ultimately, that will lead to a 'risk barrier', a moment in time when, unexpectedly, many such hidden longer term risks emerge more or less simultaneously or at least in quick succession, and the society needs to face them. In fact, as we become ever more adept at solving short-term problems, we shift the risk to long-term problems---such as climate change---which do not match the skills we have developed and know how to reward. We are headed into a trap of our own devising. Or to put it differently, over time any society comes to a point when it is overwhelmed by the unintended consequences of its own actions. That is the 'tipping point' that we commonly call 'a crisis'.

What does the lead-up to that state actually look like, as far as we can learn from the study of ancient societies that have gone through the complete cycle of expansion and disintegration? It's all a question of value creation. Societies cannot exist without value systems and ideals their members share, or at least participate in, because they create similarities in expectations, and thus provide the society with behavioral norms, and with shared objectives to strive for. Values align underwrite the coherence of the society by aligning the behavior of its members.

All societies have developed value systems that are internal, valuing individuals' behavior, as well as their position in society, according to these internalized values. In isolation, societies can survive a very long time on such internalized values along. The Australian Aborigines, the Hopi of the US Southwest and the Amish are excellent examples. But when a society has grown so large that it can no longer provide the resources it needs locally, it starts to exchange and comes out of isolation. That sets a whole different dynamic in motion

Most of the larger civilizations (in terms of population) have ultimately focused on externalized values, creating monuments, material wealth, etc., in order to foster a bond between their members. One advantage of an externalized, artifact-based value system is that it can be cross-cultural, such as we currently see in the globalization of material culture, because sharing objects (and the love of them) can be integrated in very many different value systems. Such value systems therefore emerge when groups of people start trading across wide spaces in which populations with different cultures are living. Slowly but surely, this then shifts the value system in the (generally urban) core, increasingly involving values derived from trade, including ideas and objects obtained from elsewhere, to the detriment of values attached to local products such as primary resources, crops, etc.

As this allows more and more people to aggregate at the center, and spawn more urban centers because more value is available per capita, this also leads to more specialization, and increasing innovation at that center. Yet all these people need food, which generally comes from closer by, so the local environment is likely at some point to get exhausted. The specialization, if pushed too far, tends to increase dependency on communication and sharing the overall way of life, and have as a consequence that people cannot easily fall back on pre-specialization (pre-urban) modes of life. Ultimately, therefore, the urban centers are confronted with a shortage of reasonably easily available energy and other resources, and an incapacity of the population to go back to a different (pre-urban) mode of life. The society has driven itself into a trap as a result of the unintended consequences of the changes that have occurred. This seems to be the current state of our World System.

The last part of the trajectory up to that state of the system is characterized by an increasing focus of the society on short-term, tactical interventions rather than the strategic ones that characterized the early stages of the process of societal growth. We currently see this most clearly in the financial domain. There, long-term investment – enabled by long-term shareholders not required to report to the public – has been replaced by short-term reporting with an emphasis on transparency. In my opinion this reflects the collective awareness that unintended consequences may at any time overwhelm us.<sup>1</sup> But our current situation, characterized by a number of quasi-simultaneous ‘sectoral crises’ (environmental, resource, financial, economic, etc.) occurring at different speeds, increasingly shows the hallmarks of a system that has been driven close to a much more encompassing tipping point.

To explain how the Western world has come to that point, we need to consider the interaction between the energy and the information flow dynamics, and go back about two centuries in time. Until the Industrial Revolution began, c. AD 1800, innovation was essentially constrained by the availability of energy. To implement an invention, i.e. to spread it throughout society and as a result transform the structure and customs of that society to integrate the innovation, is costly in energy. Hence, up to the Industrial Revolution – bar very short periods in human history – innovation was essentially demand-driven. Inventions were only taken up widely if they responded to a particular, clearly identified, practical need that people were willing to spend the necessary energy to overcome.

But once the use of fossil energy freed our societies from that constraint, innovation became increasingly supply-driven. Nowadays, once an invention is available and recognized by a few, major investments are made to almost forcibly spread it around. This reflects the fact that our societies have become structurally and politically innovation-dependent. Over the last sixty years in particular, in order to maintain this acceleration in innovation, we needed (1) more and more energy and (2) more and

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<sup>1</sup> It is interesting to compare on the one hand the German, Japanese and Korean, and on the other the Anglo-Saxon economies from this perspective. The former, built after WW II, were until recently clearly able to maintain longer-term perspectives than the latter.

more innovative capacity. We have thus invested more and more human, financial and resource capital in finding energy and innovating (by investing in R+D). One result of this dynamic is the consumer society, in which the number of different artifacts increases geometrically, triggering an equal number of new, thus far unidentified, 'needs' and exponentially increasing the unintended (mostly hidden) consequences of this process.

We are now at the point that innovating within our existing problem- and possibility space is no longer sufficient to maintain the dynamic structure of our society. We continuously have to expand that possibility-space itself, through more and more rapid innovation, in order to maintain the growing GDP that is deemed the hallmark of societal success and a stable democratic society. This has led us to explore the innovative possibilities of completely new – and thus far invisible – domains, such as nuclear-, information-, communication-, bio- and nanotechnology. The inventions that emerge from these efforts are not in themselves needed by our societies, except in so far as they create new 'value domains' that allow this 'Ponzi scheme of innovation' to continue a little longer.

To get out of it, if we can, will require a battle with ourselves to wholly redefine our social structures and institutions to master the long term. The difficulty of that battle is that we do not have a fixed point outside our current societies' dynamic structure to provide the leverage necessary for that process. Hence the transition will necessarily be a chaotic one.

All of this makes us, of course, wonder what will happen in the next decennia, and whether the development as outlined here can be reoriented. In assessing that potential, we need to take a few things into account.

- **First** of all, we do not really know in what stage of the process we really are, and therefore we do not know how long the transition will take, how far we are into the process, and whether we have already reached or passed the tipping point.
- **Second**, the future may be full of imponderables, but that does not mean that nothing can be done. The last few paragraphs have indicated some things that may mitigate the impact of the process by preparing us for it. A renewed focus on thinking about the future, and emphasis on the precautionary principle are two of these.
- **Third**, from the perspective that is the archaeologist's, generally, humans have found solutions to their challenges in the nick of time. After all, as I have emphasized in the first paragraph of this essay, as a species we have gone through many 'crises' of this kind through the ages, and in one form or another, we have always been able to reconstruct a civilization.
- **Fourth**, we have to realize that the kind of 'crisis' referred to here, does not imply a 'mass extinction' of humans as a species, but merely a loss of the structure of our societies, and their restructuration.

- **Fifth**, and last but not least, there are examples of societies that have managed to overcome major 'crises' by fundamental restructuration. Our own western society did so around 1800. There are clear signs that it might have disintegrated at that time if fossil energy had not been introduced (cf. the French and American Revolutions, revolts in 1830 and 1848 in other European countries, and the Russian and German revolutions of 1917 – the difference in timing roughly relates to the degree of dependency of the societies involved on poorly paid labor). Similarly, Byzantine society did so in the Eastern Roman Empire when it, contrary to the Western Empire, decentralized and thus greatly reduced its bureaucratic and military overhead, surviving for another 800 years.

So, if we don't have to despair, at least right now, what are some of the stresses that we think might emerge in the transition, provided enough collective action can be brought together to make a serious start with such a transition?

One of these will, we think, be a stress between an attitude of 'building *on* the past' and one of 'building *for* the future', which will have major consequences for all aspects of our life. It is an interesting and worrying aspect of our environmental crisis, and of our more general position at this time, that we define our future by what we want to maintain, and what we feel we want to shed, of our current situation. In effect, we define our future with respect to the present (and to some extent the past), rather than think about it in terms of what we'd like to see as a result of lessons learned from how we have come to the point where we are. This is an inherent tendency for most people. They judge their own situation by comparing it to that of their parents or grandparents; even when they aspire for their children 'to do better', that 'better' is formulated in terms of current values and ideas.

It is characteristic of human perception that whereas the future is perceived in terms of uncertainties, risks, probabilities and possibilities, the past is perceived in terms of cause-and-effect, certainties and 'proof'. Too much reliance on the past therefore leads to what Kahnemann has called 'the planner's fallacy', the idea that one can plan the future, and that things will come out as planned. In reality, nothing is less true – the unintended consequences triggered by the execution of the plans will inevitably transform the result into something that was to a large extent unplanned.

The last few centuries, and in particular the last half century or so with its apparently so successful development of innovation in technology pushing the boundaries of our 'innovation space', were based on a conception of science that required 'proof' for any hypothesis, and therefore focused our minds on the relationship between the present and the past (as one cannot prove anything about the future). I would argue that that has helped our whole society fall into the 'planner's fallacy', an underestimation of risks and uncertainties, and a concomitant overestimation of our capability to determine our own course based on past achievements. As the transition towards a more sustainable society takes shape, it will inevitably need to take more of the imponderables of the

future into account.<sup>2</sup> That will inherently involve a wider use of the much-maligned precautionary principle.

A second stress we assume to grow in importance relates to the energy flows that also maintain society intact. Here, any shortage (in terms of a less favorable relationship between energy invested and energy gained) will entail a reduction of the coherence of our society, with more emphasis on smaller networks within society, less supra-nationalism, less bureaucracy, more self-dependency. Inevitably, that also means a reduction in the degree of functional specialization between individuals so that everyone will have to assume more roles than at present, satisfy more of their own needs by physical or other activity rather than by simply buying the products or services of others. The difficulty there will be that many of us have lost the capacity to efficiently carry out the activities that will be required for their survival (such as cultivating plants). Of course the severity of this tendency will depend on the extent to which (1) we can make many more processes energy-efficient, and (2) any new kinds of energy that may be tapped into by our societies.

The net effect of both tendencies together will be a temporary increase in the incidence of uncertainty, incomprehension and conflict, a reduction in the scope of collaboration and, in general, alignedness among people in the same society towards the same goals and values. Currently we are seeing what might be the first phases of that process both in Europe and the USA, whereas in the BRICS countries we see the reverse – an emergence of coherence and vision based on the model that is no longer the one of the West. But because of the differences between these two sets of countries with respect to the stage in which their energy and information flows find themselves, the latter countries are in the ascendancy. They are (for the moment) essentially seeing the advantages of the particular techno-economic development that the West has seen, but are not yet confronted with its unintended consequences.

Faced with these issues, it would be very tempting to continue on the path that our societies have been on for several centuries - i.e. try and find different sources of energy, save on resource use all around, find improved ways of information processing, and continue to be driven by external value generation. After all, the under-determination of our ideas by observations, and its corollary, their over-determination by past experience, make our societies highly path-dependent, and change hard to achieve. But in our opinion continuing on the current trajectory would simply be 'tinkering' with the underlying challenges and would, in the end, only make the challenges more difficult to manage. Ever more severe crises would emerge.

From our perspective, a long-term sustainable society would be one that derived its coherence from internal (abstract) values, rather than external (material) ones, values that would be shared across many cultures. If it were possible to achieve that, we might

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<sup>2</sup> A core element of the transition will therefore (have to) be that we systematically educate our children and ourselves to think in terms of alternatives, possibilities, multiple scenarios, and the risks and uncertainties attached to them.

end up avoiding the 'unintended consequences' trap for much longer, as we would be interfering less with our environment.

This, ultimately, is the change of mind that we need to bring about in our societies. We need to collectively move away from the narrow (mainly financial or money-related) set of dimensions and metrics by which we evaluate and identify ourselves and others. We need to (re)discover the many other dimensions in which one can value people. In the process, we will find that competition plays less and less of a role, because the number of dimensions in which people can manifest themselves and establish their identity will grow, engendering new sets of values that can keep us fruitfully interacting with each other, but in different ways. Equality will no longer have to mean equity.

As we engage in this process, increasing the number of dimensions we perceive and take into account about each phenomenon instead of reducing that number, and focusing on the non-material dimensions, the stresses will diminish and new techniques and social forms will emerge that make our communities more resilient, more able to deal with external stresses, and thus more sustainable. This process clearly has to be driven bottom-up but we can, and should, put better conditions in place for its success.