Global Systems Failures*

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Introduction

It is now obvious that there is a problem of possible massive failures of the various systems on which modern society, indeed all of civilisation, depends. Thanks to climate change and instability, we must reckon with the prospect of at the very least the disruption of our civilisation, quite possibly its serious damage or collapse, and indeed the real possibility of an extinction of species on a scale that takes us back to early in the history of life on the planet.

Should we escape from any of those fates, we still must reckon with the fragility of many other global systems. Those of national defence are threatened by the spread of weapons of mass destruction. Those of the management of wastes are already compromised by insidious pollutants. Our systems of maintaining health are seriously threatened by biological pathogens created by the conditions of modern technology— be they in mass over-medication, mass travel or mass food. Even the systems of communication are vulnerable to 'malware'—pathogens of information which, it now seems, can at best be kept at bay and never wiped out. And suddenly the world, particularly the Anglo-American part, perceives itself as threatened with a failure of systems of protection against 'terror'. This is considered by governments to be so serious as to justify the suspension of liberties that were won many hundreds of years ago. Everywhere we look there are threats of failures of systems, many on a global scale.

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There are many explanations for these threats of failure, which have intruded on popular consciousness so suddenly. In some cases, there are explanations for ecological damage in terms of our present dominant mode of production, distribution and consumption. Also there is now a widespread recognition of the contradiction within this style of work and life, namely that it cannot be extended much beyond the present 'golden billion' to include (say) all the people of China and India. This contradiction has both ethical and practical aspects. How can the rich nations now preach the virtues of poverty to the poor? And what does it tell us about our technology and the scientific style on which it is based—that it is now revealed to be a possession restricted to the global rich minority? The 17th-century vision of science, of man's conquest over a simplified, dehumanised natural world, must now be controversial. All these issues are worthy of full discussion in their own right. In this chapter, I have chosen to focus on the issues of failure of systems. For these systems—with their technical, societal and ideological aspects—are what sustain us and which might be our destruction.

It seems to me that we need an explanation of systems pathologies in their own terms to complement the very deep issues of ensuring the survivability of modern Western science and civilisation. For if we are to reverse the present trends, and so improve our chances of survival, it would be (I believe) very useful to understand how they have arisen, and also why it is so difficult to make the changes in consciousness that we need.

The 'systems' concept is very elastic; sometimes it appears to be infinitely so. Some treatments are on the model of mathematical physics, others are more like literature. In this chapter I will err more on that humanistic side, as I believe that until we have a rich understanding, any attempt to achieve accurate prediction or effective control would be misdirected. This choice is partly due to my focus on 'complex' or 'reflexive' systems, i.e. those that involve people and human institutions.

Previous theories of mega disasters

We know from history that all civilisations come to be and pass away. For those at the latter end of the cycle, this must feel like failure. To the best of our knowledge, the first historian to try to understand this process was the great 14th-century Muslim scholar Ibn Khaldun. His focus was on empires rather than civilisations. Integrating his personal and scholarly knowledge of all the aspects of social and political life, he constructed a cyclical process in which societies lose the pristine integrity of their 'group feelings' and become more varied, diffuse and eventually enfeebled. This was 'scientific' history in that it attempted to identify factors other than the personalities and morality of leaders to explain the process, which seemed to him to be inevitable.

The study by Gibbon on the Roman Empire (Gibbon 1776-1788) was more concerned with the process of the 'decline and fall'. Out of his vast narrative, he seems to have been content to blame it all on 'the triumph of Christianity and barbarism', the implication (for that Enlightenment scholar) being that the former is not much better than the latter.

In the last century, there were several visionary studies. Oswald Spengler warned of 'the decline of the West' in his speculative cyclical theory (1922), rather Germanic in style. He saw cycles of degeneration, typified by a 'high culture' (conceived in terms of leading art forms) becoming a 'civilisation' (characterised by a corrupt money-driven mass culture), which would then collapse. The professional historians denounced him, but his vision was very popular in Germany after its defeat in World War I. Equally ambitious in scope, but more Anglophone in its elaborated empiricism and modest theory, was the Study of History of Arnold Toynbee (1951). He studied some 23 civilisations, finding a religious challenge, and the response to such challenge as the reason for the robustness or decline of a civilisation. He described parallel cycles of growth, dissolution, a 'time of troubles,' a universal state and a final collapse leading to a new genesis. He was not at all deterministic in his vision. Although he enjoyed great popularity for a while, the criticisms of leading historians soon dimmed his lustre.

Attempts at a more 'scientific' approach to the large-scale problem were resumed by Joseph Tainter in The Collapse of Complex Societies (Tainter 1988). For him 'complexity' is the key. He imagines how civilisations introduce ever greater complexity to cope with their insoluble problems. This is gauged by the variety of differentiated social and economic roles, reliance on symbolic and abstract communication, and a large class of information producers and analysts not involved in primary resource production. In a manner reminiscent of Marx's theory of the falling rate of profit, there is a steadily decreasing benefit and an increasing cost of this added complexity. Eventually the whole system becomes unsustainable.

A further step in the scientific direction is the book by Peter Turchin, Historical Dynamics: Why States Rise and Fall (Turchin 2003). He produces a non-linear dynamical model, whose main variables are population numbers (in relation to the carrying capacity of the environment), the numbers of elites and the fiscal strength of the state. These can be estimated so as to produce quantities for a computer program. When appropriately tuned, the programs can simulate real historical processes, as tested by empirical data; among these are the cycles of population in China and three crises in the later Roman Empire.

The most popular recent work on societal collapse is Jared Diamond's Collapse: How Societies Choose to Fail or Succeed (Diamond 2005). Based on his scientific study of a goodly number of societies, he came to this verdict:

Despite these varying proximate causes of abandonments, all were ultimately due to the same fundamental challenge: people living in fragile and difficult environments, adopting solutions that were brilliantly successful and understandable in the short run, but that failed or else created fatal problems in the long run, when people became confronted with external environmental changes or human-caused environmental changes that cities without written histories and without archaeologists could not have anticipated.

For him it is a matter of foresight and wisdom, for he finds other societies that were equally challenged and yet managed to adapt and survive. He still holds out hope that ours will be in the latter class.

A simple but powerful model of 'catabolic collapse', a self-reinforcing cycle of contraction converting most capital to waste, has been produced by John Michael Greer (Greer 2005). His activity in the 'contemporary nature spirituality movement' in Oregon has not prevented him from producing a model in the best economic style. His key variables are resources, capital, waste and production; crisis occurs when production fails to meet maintenance requirements for existing capital. The continuing degradation of the infrastructure, particularly in the USA, provides evidence for his approach. He claims that he can account for key features of historical collapse, and suggests parallels between successional processes in non-human ecosystems and collapse phenomena in human societies.

Scientific work of a very different sort by the distinguished ecologist, 'Buzz' Holling, has produced a most insightful theory of cyclical change of systems (Gunderson and Holling 2002). He started by reflecting on the total failure of attempts over the decades to control the budworm moth that infests conifers in eastern Canada. This started him on a path of reflection on hosts and parasites as a single dynamical system. Eventually he produced a theory of ecosystems that was totally heretical in relation to the prevailing assumption that every system tends to a stable 'climax culture' of maximum throughput in its niche. His first version was of a figure-eight diagram of ecosystem dynamics. In this, the (temporary) climax culture comes in the upper-right loop, but its productivity is achieved at the price of vulnerability. Then comes the crash, after which the system loops back to the upper left with 'pioneer' species. Rather gently these are replaced as the environment stabilises (lower left) and then up towards the next temporary climax. With Lance Gunderson, he has generalised this to 'panarchy', where the prosperous socio-technical system requires ever more rigidity and greater attempts at control. The inevitable crash may be triggered by a 'tipping point', which is quite small in itself and takes the form of a 'flip-flop' to a totally new state. The collapse of fisheries is a good example of this pattern and is a warning that other systems, perhaps our symbioses with various meso- or micro-predators, might well be next.

Neil Harrison (2003) has studied society from a complex-systems perspective. His concern is to integrate social with ecological resilience, something that scholars had hitherto not attempted. He presents four criteria that are necessary for ‘resilience’, but his analysis can be quite easily adapted to our problem by observing that their absence is sufficient for failure. We start with ‘directed self-organisation’, characteristic of less complex societies, but absent where informal institutions are replaced by ‘authoritative governance structures’. In such societies, formal institutions must make an ‘adaptive contribution’. But how is this to be done in the face of the well-known rigidities of such institutions? This requires ‘openness’, where there is widespread diffusion of knowledge about their goals and behaviours. When this prevails, there is bound to be a tendency to ‘subsidiarity’, in which decision-making is done at the lowest level possible. Reading these in reverse, we might say that when decision-making is centralised as in a closed, hierarchical institutional structure, then an ‘adaptive contribution’ by government will be inhibited and ‘directed self-organisation’ will be suppressed even when it is attempted. This list of negatives amounts to a good analysis of what was wrong with state socialism on the Stalinist model. And since the ecological catastrophes perpetrated by those regimes (such as the Aral Sea) compares with anything caused by the profit motive, the unity of society and ecology is maintained.

There are two earlier classic studies of failures that are on a smaller canvas but which can easily be applied to societies as a whole. Both were stimulated by the experience of large-scale industrial accidents of the earlier post-war period. They provide very nicely complementary perspectives. Turner and Pidgeon (1997) look at the internal breakdown of the subsystems of communication within a bureaucracy, such that we can speak realistically of man-made disasters. They take two contrasting case studies. In one concerning a transport accident (a low-loading truck illegally enters a railway level-crossing despite clear posted instructions), it was the confusion of messages and instructions that made the disaster. In the complex system of safety at the interface of road and rail, there were just too many bureaucratic actors, each with their own perspectives, commitments and overloads.

Their other example, the hideous mud-slide at Aberfan in Wales where more than a hundred children were buried in their school, brings in the sociological aspect. For here was a patent hazard. It was a hazard that was clear to the local people and it was increasing in severity as water poured out of the base of an unstable tip of coal waste perched on the moors at the top of the steep valley. But the safety of the tips turned out to be no one's problem and so the complainants went round a circle of buck-passers that had come quite near to closure when the tip decided to slide. In both these cases, the assumption that somewhere there is someone who is in a position to know and to care turned out to be not merely idealistic but also catastrophically wrong. In these terms, we may speak of a 'hyper-complex' system as one where, against all protestations to the contrary, the subsystems go their own sweet ways while the centre flaps in the wind; no one really knows what's going on and there's nobody in control.

In Normal Accidents: Living with High-risk Technologies, Charles Perrow (1984) considers marine accidents, which are each taken quite seriously, frequently to the point of triggering an inquiry. In every case, causes are discovered and remedies proposed. But he shows that these well-intentioned efforts miss the real point—accidents in this area (as in so many others) are 'normal'. At the time of publication, no one would have missed the ironic parallel with Kuhn's idea of 'normal science' from which all considerations of philosophy, ethics or even criticism are 'externalised'. There is a logical paradox here, in that the total prevention of accidents would require a prior mastery (theoretical and practical) of an enormous, perhaps unbounded set of possible contingencies. So the criterion of 'reasonableness', imported from jurisprudence, comes to dominate policy about safety. Perrow's story cuts through such philosophical refinements; he shows that safety is not what it is about, but rather the maximising of profit within the rather loose constraints that may be enforced by insurers or regulators. In this sense, the breakdown of systems realised in the sinking of a ship amounts to an 'externalising' of the human and environmental costs of marine accidents; I apply the term ironically in view of its use in economic theory.

Concepts of systems applied to society and ecology

With these latter authors we find ourselves in 'systems' territory and so we can pass on to those who have addressed these issues in terms of an articulated systems theory. We should therefore first recall the person who created the concept and popularised it so effectively: Ludwig van Bertalanffy (1901–1972). Benefiting from a broad humanistic education, he had the great scientific-philosophical problem of creating a scientific alternative to reductionism. The subject of his PhD thesis, G.T. Fechner, had in the previous century tried to make a bridge between scientific psychology and mysticism with his discovery of the quantitative (logarithmic) law of perception. Van Bertalanffy produced a highly developed theory of self-organising biological systems, with the principles of:

1. The maintenance of the organism in a non-equilibrium state
2. The hierarchical organisation of a systemic structure This was later enriched with non-equilibrium thermodynamics.

However, his goal was a 'general systems theory' that applied to organisms, cybernetic machines and social systems alike. In all cases, the theory's focus is on the positive aspects of the behaviour of systems, particularly their resilience in the face of disruption.

Although van Bertalanffy believed that systems theory should be basically humanistic, with its laws expressed in language rather than in mathematical formalisms, when the 'systems' idea was adopted by scientists it became reductionist in language even if not necessarily so in aspiration. Insights about goal-directed behaviour of inanimate systems were achieved in the wartime Radiation Laboratory at Massachusetts Institute of Technology (MIT). Out of this came the 'cybernetics' of Norbert Wiener (another great humanist and visionary).

But soon the availability of unheard-of powers of computation convinced some scientists that mathematical models could simulate societal systems to an adequate degree for theTh purposes of prediction and control. They would even render social scientists redundant. First the RAND Corporation and then the Santa Fe Institute and the International Institute for Applied Systems Analysis became devoted to this essentially reductionist programme for the human sciences. The memory of van Bertalanffy became so dim that, when one independent thinker (G. Checkland) rebelled against the mathematical-reductionist paradigm, he had to name his approach as 'soft systems' rather than just 'systems'.

The humanistic heritage of van Bertalanffy remained strong in his adopted country, Canada. In several locations in Ontario, there are groups that develop systems theory along his lines and with enrichment from a social perspective. The late James Kay collaborated with Henry Regier and others to create a comprehensive theory of 'self organising holarchic systems'. This is partly based on practical ecology—the observation of how particular systems (notably lakes) can 'flip' between states when their homeostatic mechanisms are overwhelmed. But it also includes an epistemology (of uncertainty) and hence a research practice of participation and learning. The classic paper of this school is Kay et al. (1999). A somewhat complementary approach has been developed by their colleague, David Waltner-Toews, himself a poet and veterinarian as well as socio-ecological scientist. In a totally unified conception of the system, including humanity, he deals with the concept of ecosystem health (and disease) as an aspect and symptom of the whole (1996).

In a related contemporary strand, Mario Giampietro (in collaboration with Kozo Mayumi) has built on his practice of agricultural economics and his study of thermodynamics, to develop a highly articulated systems theory connected to ecological economics (Giampietro 2003). The main thrust of his theory is epistemological. Each level in any system has its unique properties (scales of space, time and change plus aggregation and internal structure). Hence attempts at a uniform measurement, description or even evaluation across all levels cannot succeed. Thus the death of the individual is necessary for the long-term health of the species. In this way the insights about 'emergent properties' in the theories of 'holism' of a century ago are given rigorous scientific foundations. Depending on the author and their location, all knowledge of such complex systems is therefore profoundly 'situated'. This is not a recipe for scepticism, but it is a warning against scientific hubris and myopia. It establishes the necessity for dialogue across and within subsystems when policy and, indeed, research are discussed. Thus democracy within policy-related science is as important for good governance as within the polity at large.

With Silvio Funtowicz, I have developed an insight about 'reflexive' complex systems (Funtowicz and Ravetz 1994). This relates to the theory of post-normal science, which is a common element in many of the approaches mentioned above. We understand a 'system' as an intended model of reality consisting of a set of elements with a branching ordering structure, which both contains subsystems and is itself a subsystem. The ordering relation can be (for example) of aggregation, of function (as organs in an organism) or of hierarchy. Given the branching structure, there will also be co-ordinate systems at every level, with their own mutual relations. Such a system is 'complex' when there is no single privileged viewpoint for its comprehension or control. Further, a system is 'reflexive' when some subsystems not only have 'functions' (goals defined services for super-ordinate systems) but also 'purposes' (goals that serve the well-being of that entity itself). Mario Giampietro expresses that difference well in his distinction between 'roles' and 'incumbents' in social systems. There is an essential tension between functions and purposes in such systems; later I will explain some of their characteristic pathologies in those terms.

Patterns of failure of systems

For some light relief, I offer some patterns of failure of systems. These will provide background examples for the more general systems properties that I discuss in the following section. I will start with the most familiar examples—those affecting computers such as a 'freeze'. What is a 'freeze'? Its manifestation is the absence of activity as seen on the computer's monitor and the failure to respond to instructions. It occurs when the commands in a software system cannot be carried out, or when they lead the system into a closed loop. In systems terms, this is the result of a radical incoherence among the subsystems. It is a common characteristic of software systems because, up to now, these have had no ability to improvise (unlike human systems) and thus to keep the show on the road somehow.

A 'crash', on the other hand, can occur both in software and human systems. This is when the system stops running altogether; in computer terms, it is either a shutdown or worse (the system falling into some sort of limbo where nothing but cutting the power supply can reach it). In software, its causes are similar to those of freezes, lying in the incoherence of instructions. The crash might be an automatic response to a freeze or it could be the result of an even more serious malfunction. Can social systems crash? This occurs when, for whatever reason, orders can simply not be carried out and those responsible for the entity recognise its non-existence. The phenomenon is most easily seen in wartime, when units become so battered by enemy action that they no longer exist as systems and their members save themselves as best as they can. Occasionally a whole political system crashes. This happened quite peacefully in the case of the German Democratic Republic, which one day announced that it was ceasing to exist.

A very common, and increasingly important, type of failure in information technology (IT) is the 'abort'. This occurs when those responsible for developing a system admit that it will be impossible to produce anything like the specified product within the accepted constraints of resources. Such failures are endemic in the public sector— and perhaps just as bad in the private sector, although these do not attract quite so much attention. Each abortion is a sign of gross incompetence and/or corruption. When they become the rule rather than the exception in a certain class of mega-projects, then they are a symptom of a very deep malaise in the whole system of procurement and production. With the honourable exception of the London

Congestion Charge, this now seems to be the rule in the UK government's ICT projects (Craig 2005).

Next we consider common modes of system failure in more traditional, mechanical systems. Here we find first, the phenomenon of a system 'seizing up'. This occurs in machines when typically a part overheats and expands, and thus cannot move within its constraints. In earlier times, automobiles could seize up quite dramatically, as when a drive shaft snapped while the vehicle was proceeding at high speed. This sort of failure usually resulted from the malfunctioning of an auxiliary system, that of lubrication. It could be that a very small and inexpensive part was responsible for the insufficiency of lubricant to reach a crucial bearing, resulting in the destruction of the whole assembly. This is a reminder of the non-linear behaviour of systems, most apparent when they are stressed.

The other traditional failure mode of mechanical systems is 'shaking itself to pieces'. This would occur when a part worked itself loose from its moorings and proceeded to bash itself against other parts. Here the cause would be in the defective system of fastenings. There are many cases where a small saving on nuts and bolts (perhaps using a cheaper metal that turned out to be less resistant to corrosion or fatigue) would eventually result in the failure of the constraint and then in the whole machine shaking itself to pieces. Such failures are prevented only by high-quality systems of quality assurance during design, manufacture and operation (note the recursion of 'quality' here). Otherwise small errors will always creep in with such impressive, even catastrophic, results.

Systems with a strong human element are normally protected from those sorts of failure because they have elements that spot dangers before they become lethal and do something about them even when the rules do not apply. When they do not, that is a sign of either a defective design or a pathological condition. The famous poem about 'For want of a nail the shoe was lost . . .' and on through horse, message, battle, war and empire, describes a brittle system—one with no resilience or redundancy built in. Such systems are doomed.

Finally, there is a type of systems failure that is known from politics, the ‘ancien régime syndrome’. Silvio Funtowicz and I introduced this in our initial study of complex systems (Funtowicz and Ravetz 1994). The name comes from France before the Revolution. In our terms, it occurs when powerful subsystems can defend their own interests so effectively that the system as a whole is prevented from solving its problems. Hence it eventually seizes up in a paralysis of government, and indeed starts to shake itself to pieces as different sections and institutions begin to go their own way. We described the final stage of such governmental systems as ‘autolysis’, where the institutions literally dissolve in chaos.

Properties of complex systems that create vulnerability to failure

We know that social systems are not as resilient as natural ecosystems. Indeed, as we have witnessed recently, they have a propensity to decline and collapse. And now we see that social systems that are relatively successful in their own terms are causing some critical ecosystems to degrade and collapse. It is therefore useful to consider vulnerability to failure from a more theoretical systems point of view.

Implicated systems and ramified connections

The systems we consider are not merely composed of static elements; they typically have operations or activities as well. And these aspects of systems introduce further complexities of a special sort. For an illustrative analogy, we might think of the Krebs cycle for metabolic processes; every process involves the transformation of inputs to produce outputs, which themselves become inputs for downstream processes. In human activity, each such transaction is rule-based, so that it involves criteria for taking an action, procedures for its implementation, and controls for maintaining quality. Each of those latter categories itself defines an activity within a system, and so on recursively. Hence in addition to the upwards and downwards connections of actions within systems, there are the implicated systems (we might lump them as ‘governance’) which themselves branch and implicate both vertically and horizontally. Even to map all the relevant implicated systems is a serious task. This feature of reflexive complex systems is familiar to all those who engage competently on legislation. The ramifications of any change in policy through these implicated systems (and others) must be explored with other agencies and with stakeholders. With questions such as 'what-if?' and 'what-about?', they will identify problems that are visible only from their special perspectives. The leaders who ignore such implications and ramifications will eventually need to engage in emergency remedial actions when reality catches up with them.

Recursion to informality at the top and the bottom: democracy and Murphy

A very important special case of the processes of implication and ramification is the upwards and downwards recursion of system activities. In the upwards case, this is best seen in connection with quality. The Latin proverb 'quis custodiet custodes ipsos?' [who guards the guardians themselves?] tells the whole story. For if guardians need guardians-of-guardians, or guardians-squared, in turn they need guardians-cubed, and so on. Where does it end? In the necessarily informal, vague and perhaps erratic arena of ultimate authority in modern societies—'the public'. We saw this recently in England when the school-leaving exam system was exposed as defective, a case of 'qualitysquared'. Then the scandal spread steadily upwards until finally the Minister (who had had no control whatever over the creation of the problem) had to resign. That ultimate level of governance, even beyond the formal sovereign, is always there in reserve. Even in tyrannies, there comes a moment when the soldiers refuse to shoot the demonstrators; and then the end of the regime is at hand.

In the downwards case, we have the impossibility of making a full specification of every task. For every unit task, however simple it may appear, is itself a little complex system, enmeshed in its own set of implications and ramifications, and is thereby incapable of complete specification. Any real organisation is kept working because the people on the job know how to bend the rules. And the propensity of things to go wrong is enshrined in all the instances of

Murphy's Law—that whatever can go wrong, will. There is great cultural and political significance in the social location and intellectual style of this 'Law'; it is not genuine knowledge as taught to scientists and experts, but is a 'shadow' knowledge of the less educated, expressed in jokes and collected on web-sites and amusing little books. But these are the people who really know how to keep complex systems working, to the extent that that is possible.

Functions versus purposes: principal–agent theory and its subversive variants

I have already mentioned the distinction between functions and purposes, or between roles and incumbents. This essential tension within reflexive complex systems is realised in the presence of dual systems of governance—one official, formal and public, and the other unofficial, informal and partly tacit and concealed. The concepts of 'principal–agent theory' have been developed in order to comprehend and ultimately to manage this contradiction. Simple models of the trade-offs help to bring awareness of its presence to those who might otherwise remain in a fantasy state about bureaucracies. But the complexity of the real systems should remind us that both principals and agents are individuals (or institutional systems) within other systems; hence the games that are played become highly complicated and deeply ambiguous (see Caswill 2003).

The fantasies of planners and managers are exposed when the defensive stratagems of operatives become public knowledge. The classic case is of the legendary nails factory in the Soviet Union, which produced spikes when quotas were in tonnage, and switched to tacks when quotas were changed to piece rate. Well-attested cases in UK bureaucracies abound; there is the practice of keeping arrivals at Accident and Emergency departments waiting in their ambulances until they are sure of being seen soon, so that they should not have too long a wait after 'admission' and thereby spoil the statistics and endanger the hospital's quality rating. I have never forgotten the aphorism of a tram driver in Atlantic City in 1952: 'Wherever there's a system, there's a racket to beat it' (Ravetz 1971). This should function as the beginning of wisdom for all those who devise or manage bureaucratic systems.

Degradation of systems

Another way of looking at the same phenomena is to articulate the principle that all systems degrade. This can affect even ordinary complex systems, to say nothing of the reflexive systems where rule-bending and corruption are 'natural'. Degradation can be a simple effect of change. For any working system will change both in its environment (when related systems change their specifications or their functions), and also internally as subsystems change or themselves degrade. Hence a supplementary maintenance and repair activity is essential for the continued operation and even existence of systems. This is itself a reflexive system that inevitably involves skill and judgement. Although the official manual for ordinary operations may superficially be comprehensive, there can never be a manual that covers all the ways that things can go wrong. It is significant that E.M. Forster described the decline of his automated dystopia in The Machine Stops (Forster 1909) as starting with losses of quality in the various service systems. At first people complained, but then they got used to it and eventually didn't even notice the reduced quality. The story is a fine parable of the degradation of systems, starting with acquiescence and denial, and finally going down to the point of self-destruction.

Systems levels, ethics and corruption

There is one well-known feature of social systems that deserves special attention: the difficulty of mobilising people to put the common good ahead of self-interest. In terms of the conventional individualistic theories of social action, particularly those presupposed in economics, the problem is insoluble. It can be understood in terms of systems levels; as one recent UK politician is notoriously said to have proclaimed: 'There's no such thing as society'.

For an example, suppose that I discover that I can cheat on the social system by regularly disabling my electricity meter so that it does not register part of the time. I have a real gain (£K), but each of the other N subscribers has a loss of only £(K/N). And that quantity may be quite negligible if the modest burden of my benefit is shared out among tens or hundreds of thousands of other customers. In terms of classical utility theory, there is a net gain and so the action is good! Mathematically we have, for utilities, $N*\pounds(K/N) \ll \pounds K$; there is an incommensurability of utilities between the system levels. I gain and no one loses. In the terms of this systems insight, the utility theory of classical economics can be interpreted as a cheats' charter. On the other hand, if I discover that a significant number of others are already onto this racket, then I am ethically obliged to join; otherwise I am contributing a real subsidy to their dishonesty. Thus corruption of this or any other sort is self-reinforcing in a reflexive complex system if the ruling ethics is pure utilitarianism. It should be observed that this type of corruption can operate on a simple market and does not even require the suborning of the institutions of quality assurance and fairness that is customary in real cases.

Incompetence

The most serious failing of social systems, frequently leading to near-collapse or worse, is the very ordinary phenomenon of incompetence. It might be thought that those who control the fates and fortunes of millions, either in corporations or in government, have some special talent whereby they exercise their responsibilities and, indeed, sometimes they do. But more commonly, incompetence is as banal as evil. There is a well known explanation in systems terms, known as 'The Peter Principle': people rise to the systems level beyond which they cannot plausibly be promoted and hence remain there, incompetently. This principle might be seen less as an axiom of organisational life than (paradoxically) as a defining criterion of a good organisation. In others, people float ever upwards, wafted on by glowing, meretricious references whose real meaning is well understood but quite irrelevant to the real issues of job placement. Thus incompetence is built into organisations, to the extent that the Peter Principle is correct.

There are other sources of incompetence, dependent on the relations between the various systems levels. It is well-known that leaders tend to surround themselves with 'yes' men, so as to reassure themselves of their own quality. But there is also a more systematic effect. No one wants to be proved wrong by subordinates for that would disrupt the power relationships between levels. Hence the subordinates, who normally know more about an issue than their superior, are kept away from the decisions lest they subsequently be proved to have been right in a disagreement.

At the time of writing, a prime cause of incompetence in organisations is the extensive use of outside experts, usually from one of the large consulting firms. These extract enormous fees, making huge profits. They normally provide advice that is useless at best, or contract for ICT systems that are generally disastrous. Although the general public has only recently learned of this peculiar sort of corruption, those in the corporate sector must have noticed that vast sums were being expended on these consultants for little positive return. In other words, we are dealing here with a widespread phenomenon of ingrained corruption at the top of corporate life (see Craig 2005). The success of this particular scam must be explained by some social pathology within the organisations, perhaps a combination of fear (the need to have someone else to blame for decisions) and indifference (to the waste).

Value flips

With this inelegant label I will attempt to deepen Mario Giampietro's analysis of the epistemic incommensurability between system levels. The same property also holds for values. We can appreciate this with a simple example of the brave soldier who is fighting for an evil cause. At the local level his actions are exemplary but, on the broader canvas, they can be judged wrong.

Many problems of ethical evaluation, and even of action, in the present moment and in the past, arise from this propensity of systems to 'flip' valuations between systems levels. This property of systems can also explain some of the complexity of ethical judgements in general, since every action is judged both in itself and as a representative of a class. Although philosophers may wish to establish one criterion as the essential one for quality assessment of actions, in the real world the complexity of actions and the associated inevitable conflicts of principle ensure that practical reason will never be subsumed under deductive thinking. In addition, this inevitable confusion of values and of moral judgements makes it all the more difficult for any system to identify and control corruption.

Ideology

The prevention or at least the containment of corruption is necessary for the health and ultimately the survival of a social system. For this, the social system must secure the support or at least the acquiescence of the vast majority in its ordinary operations, so that (in Giampietro's language) as incumbents of roles they subordinate their private purposes to their societal functions. As I have shown, this requires their active belief in some higher, general principle rather than simple utilitarianism. It may be a religious mandate, Kant's 'categorical imperative', or a culturally imposed sense of 'not done'. There must be something to stand in the way of the natural processes of ethical degradation and decline of such systems. Plato saw the problem and solved it with his 'noble lie' about the different species of people in society. In his case, the lie was intended to be truly noble for the elites were expected to jettison their children if they did not come up to standard. The common situation is that the principles and rules are bent and broken by those who make and enforce them on others. This contradiction is the source of tension and instability, sometimes quite profound and revolutionary in its consequences.

Denial and fantasy

Cultures vary enormously in the flexibility with which their members are trained to manage such contradictions. It might be said that few cultures are as sophisticated or 'enlightened' as they profess. But some deliberately inculcate very tight defensive belief systems. These can lead to very rigid patterns of perception and behaviour, either in individuals or in whole groups, as when the other is systematically deprived of value or reality. In contemporary mainstream economics, the exclusion is accomplished with a neat little pun: 'what you can't count, doesn't count'.

To the outsider these constricted belief systems may seem to be fantasy or 'denial', especially when they seem patently counterproductive. But so long as they perform their defensive function for the protection of entrenched power, and with it the personal integrity of its adherents and beneficiaries, they survive. However, when reality eventually breaks through the defences (as when a noble war is lost or a noble cause is admitted as corrupt), there is no limit to the severity of the damage to the cultural system or to its members.

A countervailing source of resilience: branching

The special properties of complex systems make them either quite resilient when they are in a healthy state or very brittle when not. The 'Ontario' systems theorists have observed how a lake can absorb change up to a point and then flip to a new state—perhaps one we call 'dead'. For all the reasons discussed above, complex social systems are even more vulnerable to such cumulative causes with sudden, non-linear effects. However, there is a source of resilience in complex systems as I have defined them: their branching. Every system contains a plurality of subsystems, and is also contained in a plurality or super-systems. Each of these super-systems imposes its own function on the given system, and so it has a plurality of functions.

An easy example of this phenomenon is the prison system. This functions variously (and confusedly) for deterrence, punishment, revenge, incarceration or reform; and each function reflects its own broader societal or ideological purpose. This variety of functions is reflected in the variety of names for prisons. The utilitarians' reform of prisons that Dickens found so grotesque (as in the case of Uriah Heep) is memorialised in the American names 'reformatory' and 'penitentiary' (abbreviated in traditional slang to 'pen'). Of course, out of this variety comes conflict; different functions are coherent with different ideologies and then with different sorts of purposes among those involved in the operations. But there is another outcome of this variety: survival in a changing environment. The institutional subsystem does not depend on a single supersystem of external patrons or supporters. Among its contradictory essences it can find the resources adapt to new realities. This is a 'systems' interpretation of Durkheim's insight about modern society, which he called 'organic solidarity' (1893). This is different from the 'mechanical solidarity' of a simpler society where everyone had fixed roles defined by their birth and situation.

Summary

We all know that social systems operate imperfectly by any criteria, many of them very imperfectly indeed. The previous headings provide some assistance in categorising the ways that things can go wrong, at the systems levels. It remains to be seen how there are also inherent sources of error at the individual level. These can also be illuminated in terms of the systems approach.

Causes of failure: a theory of human and societal error

Although criticisms of pretensions to perfectible human knowledge are as old as philosophy itself, they have been out of fashion for some centuries. The 'problem of knowledge' has indeed dominated Western philosophy since Descartes, but the task has been seen as one of establishing the credentials of genuine knowledge rather than exploring its pathologies. There may have been two roots to this exclusive focus. One is the debate between 'science' and 'theology', where the secular side needed to establish itself in competition with the other. The other is the general sense of the superiority of scientific knowledge over all other forms of knowing, as part of the triumphalist view of science. The task of philosophy (and in particular philosophy of science) was to demonstrate how scientists always got it right, while that of the history of science was to provide examples showing that this is so. Of course, scepticism about all aspects of science has been growing over the past half-century. This very brief sketch attempts to provide a conceptual basis for those generalised perceptions that things are different now.

Ignorance: ancient awareness and modern suppression

A distinguished 20th-century scholar once referred to the 'metaphysical barbarism' of the modern scientific world view (Burtt 1928). He mainly had in mind the impoverished cosmology brought in by Descartes and his colleagues. But the point could equally have referred to epistemology. With all the many studies in that field, one area of knowledge has been systematically neglected, one might even say nearly suppressed: ignorance. The traditional recognition of awareness of ignorance as the beginning of wisdom, extending from Socrates to Montaigne, was suddenly forgotten. To this day, there is hardly any systematic recognition of ignorance as an important philosophical category. One result is that we are ill-equipped to manage uncertainty; this is serious now that we increasingly find crucial decisions needing to be made in the absence of sufficient scientific knowledge. There is a need for an 'epistemic pathology'; the following sections will sketch in some ideas on that theme.

Reductionist natural science cannot provide a basis for that new epistemology. Indeed, that sort of knowing is inevitably mystified about itself. For a long time, it was plausible for those who deal with this special sort of knowledge to dwell in an illusion about its supposedly non-human character. Scientific results need not contain information about the systemic circumstances of their production, especially when they are transformed into general-purpose 'facts' for teaching or application. Hence it has been easy to foster the illusion that those circumstances are irrelevant to the understanding and use of science. The supposedly objective and value-free character of science, as proclaimed by the positivists in their battle against clerical reaction, are the latest and probably the last manifestation of that obsolete faith. We need a systemic philosophy of science, one that includes certainty and objectivity, along with value-loading, uncertainty, ignorance and error, all as complementary aspects of real knowledge.

The Scientific Revolution: the trivialisation of error

Each of the three great prophets of the Scientific Revolution had his own theory of error. For Galileo, it was not at all interesting; those who refused to accept the scientific truth as revealed and demonstrated by him were simply prejudiced or stupid. There is no trace of his respecting any argument against him, or any person who advanced it. For Descartes, error was nearly an obsession, but his solution was characteristically elegant. In his Discourse on Method, he first shows how he was disillusioned by his humanistic education, and then how the right 'Method' (modelled on his version of geometry) can rescue us and bring full knowledge of all the sciences and even theology. Bacon made the deepest study in his theory of the four 'idols' or sources of error: that of the 'cave' is our own inherent weaknesses of perception, that of the 'tribe' is our unquestioned common assumptions, that of the 'marketplace' is our ordinary ideas about the world, and that of the 'theatre' is the teachings of the learned. To conquer these idols he offers an unlikely combination: puritanical solemnity of purpose, together with childlike innocence. And that was the last word on the causes of ignorance and error among the great thinkers of the mainstream canon of Western European philosophy. Hegel stands out as an exception (see Kadvany 2001), but his philosophy is generally dismissed as too obscure for most intellects.

A memorial to the trivialisation of error among traditional apologist-historians of science is to be found in T.S. Kuhn's The Structure of Scientific Revolutions (1962). Kuhn was raised on histories of science that ascribed persistence in error, or even its commission, to some mental or moral defect. Thus the proponents of the caloric theory of heat, or the phlogiston theory of combustion, were derided for their rejection of plain facts. The most notorious traditional enemy of scientific good sense was Aristotle. His supposed beliefs about the behaviour of falling bodies, totally counterintuitive in themselves, were believed to be trivially refuted by a classic experiment of Galileo. When Kuhn found himself preparing lectures on this, he became uncomfortable at this casual dismissal of a great scientist; in his epiphany experience, he realised that Aristotle was solving a different problem from that of Galileo. When he later wrote his book, he savagely criticised his mentors saying:

History, if viewed as more than a repository for anecdote or chronology, could produce a decisive transformation in the image of science by which we are now possessed (Kuhn 1962: 1).

Systems: the interconnectedness of all things in reality and their separation in our minds

These problems of ignorance and error have become serious and urgent issues. According to the current consensus among leading scientists, we do not have much time at all in which to make the drastic changes in our industrial system that will require very drastic changes in our lifestyle and values. Why do so many people, including the great and the learned, continue to pretend that nothing is seriously wrong? How can they possibly be converted to a realistic assessment of our situation?

The systems perspective provides means for an explanation of how sensible, reasonable people can persist in such an error. To achieve the explanation, this perspective employs a paradox: through its various levels, connections, implications and ramifications, the systems approach provides a practical framework for comprehending how everything connects to everything. But at the same time, through its reminder of the incommensurability of various systems levels (and also from one subsystem to others), the systems approach explains how each part can seem totally alien to any other. This isolation is reinforced by what we know of the psychology of perception; we tend to see and accept only what is useful and familiar, and we tend to ignore or reject the rest. Hence a problematic feature intruding from somewhere else in the total system is very easily ignored, suppressed or denied.

The inertia of intellectual structures

The great insight of T.S. Kuhn's theory of scientific revolutions was that scientists, like everyone else, are generally not adventurous discoverers. Once they find a 'paradigm' in which they can solve their 'puzzles', they cling to it, even 'evading and suppressing' uncomfortable novelties. Only when they can't even solve puzzles, are they open to the possibility of a revolution—which then promptly introduces its own dogmatic paradigm! Popper's vision of the scientist as a bold self-refuter (1963) is strictly fantasy, taken from one dubious example about Einstein. The inertia of those structures that define and regulate our thoughts—be they called paradigms, frameworks or mental models—must be recognised by whoever would wish to change them. Indeed, we can speak of 'simplistic belief systems' in which complexity and ambiguity are denied, as the common standard for scientific and socio-political thought alike. They provide comfort, and will be defended fiercely against attacks. Those who raise awkward questions, like Socrates, can come to a bad end.

Existential aspects

To some extent the inertia discussed above can be ascribed to intellectual laziness, lack of commitment or the need to defend past investments. But it goes deeper. Especially in our culture, the unknown is menacing; we cling to our intellectual security, sometimes at all costs. To be proved wrong on a fundamental issue can threaten one's trust in one's own 'common sense'. Disillusion with a conceptual system to which one had given loyalty can induce disillusion with oneself, a very destructive condition. The faith of one's fathers might well be unsustainable; but who would lightly betray their father? Each of us has a personal investment in ourselves, whose loss threatens our existence. Such are the roots of denial (Cohen 2000). Of course, such reactions will be stronger in cultures where belief is codified, corresponding to a more formal definition of social roles and relationships. In those where it is a matter of tacit understandings and social networks, the patterns of conflict are otherwise. But for those who urgently desire change, it is well to remember that one's opponents, however harmful their views, are not necessarily stupid or malign, but may themselves be vulnerable people, trapped as much as their victims.

Summary on human error

The conclusion of this analysis can be that just as knowledge, ignorance and error are systemic things, so too is the correction of error. Correcting serious error involves reaching out to people's deepest thoughts and feelings, helping them to come to terms with their own suppressed fear and perhaps even guilt so that they can emerge into the dangerous world of new ideas and new realities. Although logic has its place and sometimes even non-violent coercion too, the task requires insights that resonate with something essential in the make-up of the person affected. This can come in paradoxical ways; thus the extravaganza of the space race produced the iconic picture of 'the lonely planet', all blue and shrouded in its delicate clouds. The environmental movement had found its irrefutable image—humankind the conqueror of nature, was dead and consciousness would never be the same again.

Conclusion

Although humankind has apparently been disrupting the natural environment for tens of millennia, now the situation is qualitatively different. Our impact threatens to be lethal; we face systems failures on a global scale. But, unlike in earlier epochs, we also understand what is happening. The task is first to convey that understanding to all those who can eventually contribute to a solution and, at the same time, to lay out the way towards a solution. In this brief sketch, I have worked on the first problem and considered the systematic obstacles to the achievement of the necessary broad understanding.

There are two kinds of lessons that I can draw at this early stage of my learning. The first is about strategy. When one is in opposition to a ruling paradigm, it is all too easy to accept the official version that its rule is monolithic and stable. But as we know from experience, and as I have attempted to show here, all systems—

including and perhaps particularly those of ideas—are in a constant process of coping with their inherent imperfections and of trying to prevent irreparable damage. Those who most stridently proclaim the necessity and perfection of their ideas may well be those with the most gnawing private doubts, although of course they may not! Systems change non-linearly, suddenly and sometimes self-destructively. Prediction is impossible; but as scientists know, chance favours the prepared mind.

The New York Times has always had a proud slogan on its front page: 'All the news that's fit to print'. But 'fitness' is a judgement, one involving politics as well as ethics. We might say that when a certain sort of news is deemed fit to print, the battle for consciousness is won in principle. For ignorance, and especially ignorance-of-ignorance, are among the most powerful weapons whereby an entrenched system controls minds. Giving the stamp of authority to unwelcome news is a sign that consciousness can no longer be controlled. As a personal example, I recall realising that the USA had lost the Vietnam War when the Times correspondent toured communist North Vietnam and reported an interview with the mayor of a town there who was a Roman Catholic woman, 40 years old and attractive. Such a humanising of the enemy was the most effective anti-war propaganda of all. We cannot know what it will take to convince people and politicians that things are genuinely different now. It may be worse climate instability, more collapsing fish stocks, or even a permanent price of US$2.50 for a gallon of gasoline. The strategic task is to be ready with insights and arguments when the terms of the debate, and its framing assumptions, really shift.

The other main lesson of this inquiry is about assumptions and behaviour. What made Nelson Mandela such a truly great man of his century was his quality of understanding and compassion. He sat down and collaborated with really evil men, for he knew that they had realised that their way was doomed. The way of true non-violence is not an abandonment of struggle, nor an easy excusing of past crimes on all sides. Rather it is an appreciation of another aspect of the old dichotomy between free will and necessity, totally insoluble in its own terms. We can interpret Bacon's four idols in systems terms. However free our will may be, our thoughts and hence our actions are constrained by the socio-cultural systems in which we are nurtured, socialised, educated and indoctrinated. Those systems are always imperfect; our ideals are always being betrayed and our personal investments are always being threatened. And not only ours, theirs are affected in the same way. We all struggle to defend our integrity and, in that struggle, we may well do stupid or cruel things. But we can all change, and some actually manage to do so. Along with decay, complex systems have the capacity for radical change and renewal. That is our ground of hope.

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