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Challenges More Difficult for Science than Going to Mars

or exploring the origins of the Universe or of Life on Earth

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Introduction

Society worldwide is faced with a multiplicity of challenges. It is therefore extraordinary to observe the resources deployed to reaching the Moon, Mars and other planets. And why not other solar systems? A particular focus is given to locating "habitable" Earth-like planets elsewhere -- and the possibility of extraterrestrial life. More extraordinary is the focus on the origins of the Universe, billions of years ago.

The manned mision to Mars is variously framed as being complex and challenging (Richard Cook, *Mars Science Lab: the challenge of complexity*, *NASA Ask Magazine*, August 2012; *NASA design challenge to simulate human exploration of Mar*s, *Phys.Org*, 2 December 2013; Tommaso Rivellini, *The Challenges of Landing on Mars*, National Academy of Engineering, 2004; Donald Rapp, *The Challenges of Manned Mars Exploration*, *The Space Reiew*, 17 April 2006) .

Science is however skilled in avoiding deployment of its creativity -- or justifying allocation of resources -- to challenges that are framed as "too complex" or simply "uninteresting". One relevant review is offered by Jason Pontin (*Why We Can't Solve Big Problems*, *MIT Technology Review*, 24 October 2012):

> Let's stipulate that venture-backed entrepreneurialism is essential to the development and commercialization of technological innovations. But it is not sufficient by itself to solve big problems, nor could its relative sickliness by itself undo our capacity for collective action through technology. The answer is that these things are complex, and that there is no one simple explanation....Sometimes we fail to solve big problems because our institutions have failed....Sometimes big problems that had seemed technological turn out not to be so, or could more plausibly be solved through other means.... Yet the hope that an entrenched problem with social costs should have a technological solution is very seductive -- so much so that disappointment with technology is inevitable.... Finally, sometimes big problems elude any solution because we don't really understand the problem.

Various industries, including the aerospace industry, have developed particular forms of complexity index (for example, *Complex Systems and the Darnall-Preston Complexity Index*). In discussing *Why is Mars so Hard?* (*The Space Review*), Jeff Foust notes that produced by The Aerospace Corporation (Bob Bitten, *Perspectives on NASA Mission Cost and Schedule Performance Trend*s, 12 August 2009). This identifies when a mission is too fast and when a mission is too cheap -- and concludes that missions that have the greatest complexity, are highest cost and longest development. The Index is framed according to hypotheses including:

- Complexity Index calculated based on performance, mass, power and technology choices for purposes of comparison
- Relationship between complexity and "failures" investigated compared with adequacy of cost and schedule resources
- Method to assess complexity at the system-level should allow more informed overall decisions to be made for new systems being conceived

Some use is made of such an approach with respect to non-technological initiatives, as with the Economic Complexity Index, a holistic

measure of the production characteristics of large economic systems. The concerrn here is the assessment of complexity by science in engaging with a down-to-Earth problem -- by comparison with projects like going to Mars, or promoting high-budget physics projects.

There is a sense in which the specificity of the extraterrestrial -- viewed through cognitive telescopes offering a form of tunnel vision -- is a form of conceptual displacement, readily to be interpreted as social irresponsibility. Efforts are made to correct this impression by suggesting that such exploration contributes to the "advancement of human knowledge". Little is said of how complicit such activity is with placement of satellites and military resources in space -- perhaps to be dubiously recognized as "dual-use methodology".

Perhaps most extraordinary is the recognition of some involved that humanity will need to leave Planet Earth -- shortly? -- in order to occupy the environments in which it can continue to replicate the complex patterns of problems that science has been unable to address on Earth (cf. Clara Moskowitz, *Stephen Hawking Says Humanity Won't Survive Without Leaving Earth*, *SPACE.com*, 10 August 2010; John M. Smart, *The Transcension Hypothesis: sufficiently advanced civilizations invariably leave our universe, and implications for METI and SETI*. *Acta Astronautica*, 78, September-October 2012). The imagination of the young is harnessed to such escapism. The widely-commented film *Avatar* (2009) offers many lessons in this regard.

The purpose here is explore a checklist of priorities and related considerations which science chooses to neglect in favour of associating its image with what is far away and long ago as being vital to the human enterprise. This could be caricatured as "cherry-picking", or a quest for "low hanging fruit", as being the most appropriate use of the intellectual resources of science. It could also be questioned as an indication of the subservience of science to vested interests able to influence through funding the direction of research (if not the results required). This neglect is also explored in terms of the renunciation by science of engagement with the so-called "wicked problems" variously explored with respect to planning and governance.

Part of the difficulty lies in an unhealthy interpretation of science by its advocates -- an approach increasingly defined as "scientism". This refers to belief in the universal applicability of the scientific method and approach, and the view that empirical science constitutes the most authoritative worldview, or the most valuable part of human learning -- to the exclusion of other viewpoints and approaches. Apologists for "science" have the greatest difficulty in distinguishing it from scientism -- and communicating that distinction. Hence the even greater ambiguity in the case of "scientist". This exploration follows from an earlier argument (*Knowledge Processes Neglected by Science: insights from the crisis of science and belief*, 2012).

Engaging with the disadvantaged proactively

The institutional environments in which science tends to operate avoid direct confrontation with the disadvantaged -- except on occasion for public relations purposes. Disadvantage is framed as a problem for society and more specifically as a political issue -- considered essentially meaningless from a "scientific" perspective.

Widely recognized examples of disadvantage are illustrated by:

- **Boat people,** namely the economic refugees traversing long distances and engaging in perilous journeys to reach a perceived haven. The process might be compared systemically with the flight of humanity to other habitable planets, as foreseen by science. As a systemic challenge, it is unfortunate that science has proved to be unable to address that of "boat people". What are the factors which would enable their situation to be defined as a legitimate "scientific problem". and the decision tree through which to engage with them most humanely?

- **Beggars**, namely the situation in which many disadvantaged are placed -- even in economic havens. The challenge here is how to engage with such people from a position of economic advantage. Many recognize the amount of game-playing involved in considering how to respond to a beggar, just as beggars are obliged to become skilled in maximizing their acquisition of vital resources through the process. Is there a case for a "science of begging" to improve the quality of the engagement and the decision-making involved? Understood more generally, the factors involved are consistent with those of other decision-making processes involving skillful management of priorities. Most ironic however is that many scientific initiatives -- whether individual or institutionalized -- are highly dependent on a process of "begging" for resources, perhaps partially framed for respectability as "fund-raising". Presumably beggars could also adopt consider themselves as "fund-raisers". Does science have insights to offer to empower that process with greater elegance?

- **Gender bias**, affecting a significant proportion of the population, most notably in developing countries and those with particular cultural framings of the role of women. A variant is evident in the case of alternative sexual orientations. Gender bias continues to be widely noted within institutionalized science. Other than contributing to statistical analysis of the situation, science has proven to have limited capacity to correct such bias within its own disciplines or to offer insights of relevance to wider society. Essentially it is considered as "not a problem of science". The implications may be extended in ways that could suggest the possibility of a much richer framing by science (*Transcending Simplistic Binary Contractual Relationships*, 2012; *Marrying an Other whatever the Form*, 2013)

- **Dementia**, as recently highlighted at the so-called G8 Dementia Summit (London, 2013), is a challenge of increasing concern. Science has actively sought resources to engage in research to solve the problem, as it has done with respect to cancer and other diseases -- for which cures are still in the pipeline, if such closure is really desired by researchers (*Cancer 'tidal wave' on horizon, warns WHO*, *BBC News*,4 February 2014). As with many issues, science has focused its engagement on acquiring funds to enable the "business-as-usual" of research and paper publication in support of career pathways and institutional renown -- however the quest is honourably framed for public relations purposes. Missing is the potential relevance of science to reframing the actual process of personal decline to which many scientists have every probability of being exposed, whether in their own case or in that

of close relatives. As discussed separately, science has a very primitive understanding of decline and death, despite the number of geniuses who choose to commit suicide (*Metaphors To Die By: correspondences between a collapsing civilization and a dying person*, 2013).

- **Ignorance** on the part of many, if not most, is naturally deplored by science in its cultivation of the advancement of human knowledge. Curiously every advance in knowledge achieved by science necessarily places others at a disadvantage -- effectively enhancing their relative ignorance, given the difficulty in disseminating and rendering comprehensible complex insights. This process might even be said to be institutionalized through publishing such knowledge behind paywalls, under copyright, subject to some form of secrecy, or in a language incomprehensible to most. Science devotes little attention to the manner in which many are obliged to live "in ignorance" (Nassim Nicholas Taleb, *The Black Swan: the impact of the highly improbable*, 2010). As with religion whose processes it seeks to displace, science contents itself with deploring the failure to achieve comprehension of the insights which it has to offer. As a systemic process of dissemination and comprehension, this might otherwise be assumed to invite creative insights of relevance both to those disadvantaged by their ignorance and those frustrated by the need to take their existence into account. Ironically the systemic problem is also evident within disciplines (given the lengthy learning process) and between disciplines (given the manner in which the "science" of other disciplines may be disparaged).

- **Illness** clearly remains a major preoccupation worldwide. There is no question that science has been extensively deployed to respond to its manifestations and to engender cures, many recognized as miraculous. The embarrassment for science is its engagement with illness whose symptoms are of a subtler nature, namely those primarily associated with the emotions and mental diseases. Historically science has been complicit in reinforcing disparagement of the reality of such illnesses and in engendering questionable cures, many of which are now considered barbaric (lobotomy, castration, etc). This has been associated with deprecation and condemnation of alternative approaches to both subtler symptoms and those more evident. The World Health Organization, influenced as it is by science, proved extremely tardy in its recognition of both subtler (mental, etc) illnesses and of the insights offered by alternative sources of medical knowledge.

- **Unemployment** is a major concern worldwide, especially for the young. The fact that the young are increasingly sensitive to the unavailatkinability of employment in any domain is irrelevant to science and does not constitute a scientific challenge of any interest -- unless exploitable as a source of public funding. How is it that "employment" does not lend itself to reframing beyond the skills of those "sciences" which the hard sciences consider to be questionable -- if not pseudosciences? (*12 Mindsets Ensuring Disappearance of Employment Opportunities: towards a systemic reframing of the job culture*, 2012).

Scientific resource management

The "information silos" within which science operates tend to preclude adequate focus on the challenges of distribution as highlighted by the following:

- **Food distribution**: Much is frequently made of the the millions who are malnourished or starving. Claims are widely made that "there is enough for all". The issue is that those at the end of the distribution pipeline do not benefit from that assumption. This is not perceived to be a challenge for science which prefers to focus its efforts narrowly on increasing food productivity, most notably through the questionable techniques of genetic engineering (and the patenting opportunities it offers). Little consideration is given to the "collateral damage" of such efforts -- evident in the case of environmental pollution from excessive use of fertilizer or the potential issues which may rise from the release of modified organisms into the environment. The so-called feminization of nature is already recognized as an issue, as with the collapse of bee populations. These are not framed as the consequence of science but rather of unforeseen applications of science. Science does not consider itself responsible for the unforeseen.

- **Overpopulation**: There are few resource problems which would not be mitigated by reduced levels of population, especially given its continuing growth and demand on those resources. The issue is highly controversial especially given the variety of positions taken by scientists in the debate. Most intriguing is that science has no capacity to address the debate as a system of discourse characterized by a variety of irreconcilable positions -- some of which are held to be "scientific" and others "irrational" or "misguided" from a variety of perspectives. As with the debate on climate change, science has proven to be incapable of bringing scientific method to the analysis of disparate positions in a debate. The claim is simply made that some perspectives are "scientific" and others are not. A more proactive alternation is offered from a public administration context (E. M. van Bueren, Dealing with Wicked Problems in Networks: analyzing an environmental debate from a network perspective, *Journal of Public Administration Research and Theory*, 2003). The expectation of emergent "consensus" is then framed with the greatest naivety. Anything more comprehensive is "too complex" to be worthy of consideration.

- **Energy**: Given the claimed importance of "energy", the disagreement within science with regard to appropriate approaches is of a pattern similar to that indicated with respect to overpopulation and climate change. Intense effort is devote to achieving "unlimited" energy, as with nuclear fusion. Remarkable science is devoted to more efficient extraction of energy and to development of renewable resources. The fact that many of these initiatives result in problematic "collateral damage" is framed as "not a problem for science". The emphasis is on the narrowly defined challenge. Curiously the issue is further distorted by the high level of dependence in times of catastrophe on other forms of energy to which science accords little significance (*Reframing Sustainable Sources of Energy for the Future: the vital role of psychosocial variants*, 2006).

- "**Big science**": Science is irresistibly seduced by mega-projects -- as exemplified by the construction of massive particle accelerators, telescope complexes, nuclear reactors, large dams, space exploration, and geoengineering. The seduction is

exacerbated by complicity in design and development of weaponry, most notably weapons of mass destruction. There is curiously no question of science envisaging its involvement in "weapons of mass construction" -- as might be suggested by enabling more appropriate organization of knowledge and society. Any framing of such possibilities is insensitive to proven vulnerabilities to problematic manipulation by technocrats -- which escape the framing of relevant simulations.

- **Creativity**: There is widespread acknowledgement of the importance of innovation and creativity -- even to "new thinking" and to the possibility of "paradigm shifts" (Edward de Bono, *New Thinking for the New Millennium*,(1999). Strangely science is typically reliant on the conventional organization of knowledge and its institutional "business-as-usual". It is effectively embedded in its own conceptions in ways that minimize the possibility of innovation -- despite vigorous claims made in relation to its role in the "advancement of human knowledge". There is little interest in modelling the factors enabling and inhibiting creativity, despite the investment in technopoles and business incubators with their rather particular biases in relation to their industrial complicity and dependence. (Thomas Homer-Dixon, *The Ingenuity Gap: facing the economic, environmental, and other challenges of an increasingly complex and unpredictable future*, 2000)

- **Intellectual property**: As noted above, the greatest importance is attached to intellectual copyright and patenting as a means of eliciting and managing intellectual resources. Science might be said to be directly complicit in property creation, management and restriction of access to it. As with enabling creativity, this is evident in the controversies surrounding the peer review process and the access to scientific knowledge acquired with public funding by tax payers. Missing is any effort by science to simulate the emergence of property and denial of claims to it.

Management of distinctions and boundaries

As noted above, science offers the extraordinary spectacle of enthusiastically seeking renown through exploring the origins of the Universe and of Life on Earth -- or travelling to the Moon, Mars, or further. These projects are promoted as exciting to the imagination of the young from whom recruits are sought -- even though real jobs may be few and far between.

Using the metaphor of the "sphere of knowledge" which science seeks to develop, it is appropriate to note that in geometry a sphere is an example of a surface which is "finite but unbounded". Understood as "finite", this clarifies and defines the nature of the specific methodology of science. Understood as "unbounded", this suggests that the methodology is in a special sense unconstrained by any boundary to which that methodology may lead. Unfortunately this metaphor obscures the manner in which the situation is quite otherwise. This might be better framed by considering a transformation of the geometrical metaphor within which science operates, namely to: "infinite but bounded".

This transformation clarifies the manner in which science sees itself as free to pursue everything under the Sun, and to the ends of the Universe -- to infinity. However it also highlights the sense in which the methodology is especially bounded in ways which science is unable to recognize -- other than in stressing the primacy of the boundedness of that domain. Understood in this way, science is essentially derivative of that methodology, with consequences which may be argued more generally (*Vigorous Application of Derivative Thinking to Derivative Problems*, 2013).

Science is unable to envisage the geometrical or topological framework within which other modalities of knowing might coexist, as separately argued (*Knowledge Processes Neglected by Science: insights from the crisis of science and belief*, 2012). This failure admirably replicates the methodology of religion which science so vigorously claims to replace. Like the mystics of religion, science has its geniuses who confirm the reality of its bounded framework.

This boundary-challenged nature of science can be understood from the examples above of arenas into which science has little inclination to venture -- in contrast with going to Mars. Other examples of boundary challenge include:

- **Interdisciplinarity**: Between the disciplines of science itself, there is a long-standing challenge of how best to engage with any other discipline. The problem can be framed in terms of inter-disciplinarity, cross-disciplinarity, multi-disciplinarity or trans-disciplinarity, for each of which there is an extensive literature (see Integrative Knowledge Project). Irrespective of the prefix, the challenge remains without any scientifically elegant approach to it. Worse, the defensive turf-dynamics not only replicate those to which politics addresses itself, but helps to reinforce the unimaginative approach by politics -- with all its bloody consequences.

- **Asystemic conceptual gerrymandering**: As the argument above indicates, specialists in any discipline are necessarily highly skilled at framing matters of preoccupation in relation to their own discipline -- or declaring them to be outside that mandate, if not irrelevant. Part of the process, as in the gerrymandering of electoral constituencies, is to redefine boundaries to include (or exclude) what is most convenient (or least convenient). Science has no capacity to address this tendency (*Scientific Gerrymandering of Boundaries of Overpopulation Debate: review of The Royal Society report -- People and the Planet*, 2012) . Whilst the possibility of "drill down" techniques is obvious, the integrative challenge of "zooming out" (for which there is not even an equivalent term) is far from resolved -- given the constraints on human cognitive capacity and the limited ability to recognize larger patterns. One possibility has been partially envisaged through inverting the "telescope" metaphor (Joel de Rosnay, *The Macroscope*, 1979). However the pattern is replicated more dubiously in other domains (*Systematic Gerrymandering of Declared Threats and Legality of Response: opportunistic exceptionalism underlying promulgated rules of governance*, 2013).

- **Pseudoscientific disciplines**: Whereas the turf-dynamics within science are widely recognized, so are those in the interaction of "science" with disciplines defined as unscientific by "science", even when those disciplines may explicitly frame themselves as "sciences". Science then frames them as pseudosciences. Ironically, those disciplines low in the pecking order of sciences, may be framed by the harder sciences as pseudosciences. The tendency is even more pronounced with respect to other modes of

knowing, as highlighted in the work of Paul Feyerabend (*Against Method: outline of an anarchistic theory of knowledge*, 1975). Again science has no means of considering such boundaries with any methodology embodying forms of conceptual intelligence might which otherwise be considered appropriate. Curiously it is the "information sciences" which are obliged to address the matter in organizing "knowledge" -- whatever the topic or methodology -- and enabling search engine access. It is however extraordinary to note that mathematics is not used to derive more appropriate modes of organization of the rich complexity of mathematical knowledge itself, as discussed separately (*Towards a periodic organization of the Mathematics Subject Classification*, 2009; I*s the House of Mathematics in Order? Are there vital insights from its design*, 2000) ***Sokal

- **Territoriality**: In systemic terms, science has proven to be no more skilled than religion in enabling more insightful relations between its denominations, sects and heretical movements. It continues to be faced with metaphorically bloody conflicts between its "Protestants" and "Catholics, or its "Sunnis" and its "Shiites". Ita failure reinforces the pattern of behaviour as it con tinues to play out through those of religious inspiration. The dynamics of the creationism/evoltion interface has not benefitted from scientific reframing -- with science effectively framing itself as but another religion. It follows from the previous points, that science (and notably mathematics) is essentially useless in responding more creatively to the many territorial conflicts with which humanity is confronted at any one time., as discussed separately (*And When the Bombing Stops? Territorial conflict as a challenge to mathematicians*, 2000). Current complicity of science in occupation of the surface of the Moon is already highlighting the unresolved issues of territoriality there -- replicating the issues in which science is effectively complicit on Earth

- **Asystemic problem framing**: As an extension of the tendency to conceptual gerrymandering, science tends to avoid consideration of disciplinary boundedness by adopting and advocating an issue specific, case-by-case approach. Various disciplines can then be "called in" as is deemed appropriate in the moment to provide a degree of interdisciplinarity defined by the issue -- but not by any interdisciplinary conceptual framework. In this way hard sciences can briefly relate their concerns to the psychosocial sciences without calling their respective boundaries into question. Unfortunately this leads to a situation in which there is no possibility (or methodology) of a comprehensive simulation of complex systems of perceived problems. The modelling exercises associated with world dynamics and the *Limits to Growth* project can be considered as demonstrations of this inadequacy. It is noteworthy that such comprehensive simulations have now been abandoned in favour of the kind of approach of interest to g;obal intelligence surveillance and the detection of social unrest.

- **Quest for alien life**: In the light of the above arguments, it is potentially amusing to question whether science would be capable of recognizing the "alien life" for which it claims to be questing so desperately on Mars and on distant exoplanets. The amusement derives from the nature of the challenge to science of recognizing and engaging with "life" on Earth -- if, as may be the case, it is best understood as challenging the boundaries accepted by science. This is even more the case with respect to "conscious" life. Life, as it may become understood by the science of the distant future, may not be as confined to bounded containers as science would tend to have it, and as argued separately (*Sensing Epiterrestrial Intelligence (SETI) Embedding of "extraterrestrials" in episystemic dynamics?* 2013; *Encountering Otherness as a Waveform: in the light of a wave theory of being*, 2013). The point may be more tragically made with respect to the primates on which humans experiment so enthusiastically, possibly through deliberately bonding with them, only to abandon them to a caged retirement -- if they are not destroyed. Even the terminology is significant, namely in the use of "wildlife reservations" -- echoing that used with respect to reservations for indigenous populations, with whom communication also tends to be problematic once the interest for research is exhausted. The favoured outcome is "assimilation" and "domestication" -- otherwise a potential threat is perceived.

Otherness: The argument might be considered more generally in terms of the problematic nature of the engagement with otherness of any kind. This could be characterized by the inhabitual and any failure to conform to explanations accepted by authority. The purported willingness to encounter extraterrestrial intelligence is ironic given the much challenged capacity to engage with terrestrial alternatives. The case is remarkably made by the well-documented reaction of Linus Pauling (Nobel Laureate) to evidence for quasicrystals as presented by Dan Shechtman -- for which he received the Nobel Prize. This is a pattern exemplified by US foreign policy and succinctly framed by Margaret Thatcher as TINA (There Is No Alternative). This pattern, reinforced by science, plays out in such domains as creationism, alternative medicine, or alchemy -- all with otherwise respectable advocates. Science can only trumpet its deprecation, reframing all disagreement as evidence of ignorance of the truth -- remarkably reminiscent of the earlier religious pattern. This is notably evident in the case of indigenous knowledge systems (Darrell A. Posey, *Cultural and Spiritual Values of Biodiversity: a complementary contribution to Global Biodiversity Assessment*, I999).

Planetary boundaries: The challenge to science of such boundary issues is usefully exemplified by the fact that it is only very recently that the environmental challenges to human civilization and the planet have been framed in terms of "boundaries", currently of concern with respect to measureable "planetary boundaries" (Anders Wijkman and Johan Rockström, *Bankrupting Nature: denying our planetary boundaries*, 2012). This could be understood as a reframing of the "limits" first highlighted by the report *The Limits to Growth* (1972). The limited capacity of science to respond to the implications of that report are apparent from the study by Graham Turner (*A Comparison of the Limits to Growth with Thirty Years of Reality*, CSIRO, 2007).

Curiously however there is little concern with regard to the more intangible boundaries inhibiting remedial action (*Recognizing the Psychosocial Boundaries of Remedial Action: constraints on ensuring a safe operating space for humanity*, 2009; *Pointlessness, Unboundedness and Boundaries*, 2012). This criticism was previously framed with respect to "limits", especially with respect to psycho-social limits (*Societal Learning and the Erosion of Collective Memory: a critique of the Club of Rome Report: No Limits to Learning*, 1980; *Limits to Human Potential*, 1976).

No Man's Wasteland: Consistent with the asystemic approach to boundaries, there is an evident tendency of science to export responsibility for problematic outcomes (within any bounded disciplinary domain) across boundaries into a form of "no man's land" --

beyond the responsibility of science. The reinforcement by this pattern of waste dumping engendering environmental pollution has been made especially evident in the case of Antarctic research stations (*Human impacts: prevention, mitigation and remediation*, Australian Antarctic Division, 27 September 2013; *Trash Threatens Fragile Antarctic Environment*, *Smithsonian*, 12 February 2013). It is also evident in the case of the accumulation of space debris as a result of initiatives in which science has been highly complicit. Science is also complicit in the advocacy of questionable dumping of radioactive nuclear waste. The Antarctic case offers unfortunate literal support for the metaphorical need for science to "get its shit together".

Competitive dynamics between explainers: For those otherwise called upon to live in anticipation of the ultimate explanation, or to "buy into" one of the belief systems on offer, it is a question of whether it is wise to sit around waiting for a comprehensible resolution of the competitive dynamics between those authorities claiming competence. As argued by Nicholas Rescher (*The Strife of Systems: an essay on the grounds and implications of philosophical diversity*, 1985):

> For centuries, most philosophers who have reflected on the matter have been intimidated by the strife of systems. But the time has come to put this behind us -- not the strife, that is, which is ineliminable, but the felt need to somehow end it rather than simply accept it and take it in stride.

Framing such competition in a manner little different to that between the marketing of consumer products, or to that between football teams, seems unworthy of the existential challenge with which many are faced -- and of the global civilization within which they dwell (cf. Nicholas Rescher, *Ignorance: on the wider implications of deficient knowledge*, 2009).

Science upgraded? Especially intriguing is the sense in which science is unable to envisage how its own methodology may eventually prove to be dated, or become increasingly seen to be so. In contrast with the vigour and frequency with which technology, and especially software, is defined as obsolete and needing to be updated, science has no understanding of "***Scientific Methodology 2.0***" -- perhaps usefully contrasted with the Science 2.0 initiative regarding open research publishing. Despite its engagement with paradox, ***Scientific Methodology 1.0*** is unable to sustain reflection on the emergence of 2.0 -- a new form of conceptware -- or the metalogic through which this might call for consideration. This is despite the long-standing debate on "scientific revolutions". A notable exception is perhaps the focus of a recent special issue (*Beyond the Limits of Science*, *Scientific American*, September 2012, special issue). How might mathematics best contribute to engagement with with what is "beyond limits"?

The contrast with the pattern of software upgrading may be provocatively developed (*Internyet Nescience? Self-referential upgrading of obsolete Internet conference processes inhibiting emergence of integrative knowledge*, 2013). As a caricature, science would tend to imagine its methodology -- in the form of keynote speeches, peer review publication, copyright, roundtables, and the like -- as projected unchanged, millions of years into the future. The scenario of a "conference at the end of the universe" could be adapted from the imagination of Douglas Adams (*The Restaurant at the End of the Universe*, 1980). In such terms, scientific intercourse might be caricatured in terms of a so-called "missionary position" of concept delivery. This icould be considered as accompanied by a degree of concern for "contraception" and sensitivity to the risk of "infection" -- in memetic terms.

Wicked problems and the renunciation of science

As clarified by *Wikipedia:*

- a wicked problem is a term originally used in social planning to describe a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize. The term "wicked" is used to denote resistance to resolution, rather than evil. Moreover, because of complex interdependencies, the effort to solve one aspect of a wicked problem may reveal or create other problems.
- renunciation is the act of renouncing or rejecting something as invalid, especially if it is something that the renouncer has previously enjoyed or endorsed. In religion, renunciation often indicates an abandonment of pursuit of material comforts, in the interests of achieving spiritual enlightenment.

Many problems of society can be fruitfully explored as "wicked problems". The argument here is that science has effectively renounced its engagement with them -- seemingly in the pursuit of higher truth and the purity of the associated knowledge. The disciplines active in the exploration of wicked problems tend to be those which science would not recognize as sciences. The point is well made by the fact that the key papers framing such problems for the explorations that followed (see multiple references) are those of C. West Churchman (Wicked Problems, *Management Science*, 1967) and of Horst W. J. Rittel and Melvin M. Webber, *Dilemmas in a General Theory of Planning*, *Policy Sciences*, 1973). The term is recognized in the *Financial Times Lexicon*. The journals subsequently carrying such studies are not those of "science" (for example, *Working with wicked problems in socio-ecological systems: awareness, acceptance, and adaptation*, *Landscape and Urban Planning*, 110, 2013).

From the perspective of science, neither "management" nor "policy" is a science, irrespective of any claims made by such authors to be "scientists". Any "wicked problem science" is effectively not to be understood as a science. Confusion is however evident from the response of Jay Rosen, highlighting *Wicked Problems*, to the 2011 Annual Question formulated by the Edge Foundation: ***What Scientific Concept Would Improve Everybody's Cognitive Toolkit?***

Rittel and Webber's formulation of wicked problems in social policy planning in 1973 specified the following characteristics:

1. There is no definitive formulation of a wicked problem.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not true-or-false, but good or bad.
4. There is no immediate and no ultimate test of a solution to a wicked problem.

5. Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial and error, every attempt counts significantly.
6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
7. Every wicked problem is essentially unique.
8. Every wicked problem can be considered to be a symptom of another problem.
9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution.
10. The social planner has no right to be wrong (i.e., planners are liable for the consequences of the actions they generate).

The concept of problem wickedness was much later generalized to areas other than planning and policy by Jeffrey Conklin (*Dialogue Mapping: building shared understanding of wicked problems*, 2006) who defined the characteristics as:

1. The problem is not understood until after the formulation of a solution.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not right or wrong.
4. Every wicked problem is essentially novel and unique.
5. Every solution to a wicked problem is a "one shot operation"
6. Wicked problems have no given alternative solutions.

For John C. Camillus (*Strategy as a Wicked Problem*, *Harvard Business Review*, May 2008):

> Wickedness isn't a degree of difficulty. Wicked issues are different because traditional processes can't resolve them... A wicked problem has innumerable causes, is tough to describe, and doesn't have a right answer, as we will see in the next section. Environmental degradation, terrorism, and poverty -- these are classic examples of wicked problems. They're the opposite of hard but ordinary problems, which people can solve in a finite time period by applying standard techniques. Not only do conventional processes fail to tackle wicked problems, but they may exacerbate situations by generating undesirable consequences.

For Jon Kolko (*Wicked Problems: problems worth solving -- a handbook and a call to action*, 2012):

> A wicked problem is a social or cultural problem that is difficult or impossible to solve for as many as four reasons: incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnected nature of these problems with other problems.

Science, especially in the case of mathematics, has long highlighted the existence of unsolved problems, for which *Wikipedia* offers the following checklists:

- Unsolved problems in biology
- Unsolved problems in chemistry
- Unsolved problems in mathematics
- Unsolved problems in medicine
- Unsolved problems in neuroscience
- Unsolved problems in physics
- Unsolved problems in economics
- Unsolved problems in linguistics
- Unsolved problems in philosophy
- Unsolved problems in statistics
- Unsolved problems in computer science
- Unsolved problems in artificial intelligence

The problems in the above checklists are not understood as "wicked". The status of their source disciplines as "sciences" might be challenged in the case of those on the right. By contrast, **intractable problems** are problems in computational complexity theory that can be solved in theory (e.g., given large but finite time), but which in practice take too long for their solutions to be useful. That theory is also known for its recognition of a so-called **hard problem**: *A problem X is hard for a class of problems C if every problem in C can be reduced to X. Thus no problem in C is harder than X, since an algorithm for X allows us to solve any problem in C.*

With respect to the degree of complexity, Alexander N. Christakis (*Structured Dialogic Design: a process science for social system design*) notes that in situations characterized by "wicked complexity" the normal rules for the practice of dialogue break down. He argues that wicked complexity leads to underconceptualization, specifically that:

- Wicked complexity is characterized by large numbers of issues, large numbers of interconnections among issues, and limited transparency of both the issues and the connections
- When stakeholders seek to assign priorities to lists of issues without sufficient conceptualization of interdependencies among those issues, stakeholders select erroneous priorities which then lead to ineffective actions (Erroneous Priorities Effect)
- Systematic and systemic exploration of issues and relationships among issues assures evolutionary learning

In asking "how complex is complex", Christakis defines a Situational Complexity Index as: **DK (N-7) / R (R-1)** where

- N = Number of total observations by all observers
- R = Number of observations included in the problematique
- V = Number of observations with 1 or more votes
- K = Number of distinct links among observations
- D = Divergence or "spread think" of importance votes (V-5) / (N-5)
- factor 7 is the "Miller numbe (7 ± 2)
- factor 5 is the "Warfield spread think number"

In work related to that of Christakis, but without using the Situational Complexity Index, the Institute for 21st Century Agoras reviews a set of **continuous critical problems** (Thomas R. Flanagan and Kenneth C. Bausch, *A Democratic Approach to Sustainable Futures: a workshop for addressing the global problematique*, 2011). Presumably all to be considered by science as "more challenging than going to Mars", these include (emphasizing keywords in highly abridged titles):

Continuous critical problems		
1. Explosive population growth	18. Irrelevance of traditional values	35. Irrational agricultural practices
2. Widespread poverty	19. Inadequate shelter and transpiration	36. Irresponsible use of chemicals
3. Increase in weapons of war	20. Discriminatory income distribution	37. Manipulative use of information
4. Uncontrolled urban spread	21. Wastage of natural resources	38. Fragmented monetary system
5. Malnutrition	22. Growing environmental problems	39. Development gaps
6. Illiteracy	23. Alienation of youth	40. New forms of warfare
7. Mechanization and bureaucratization of human activity	24. Disruption of physical ecology	41. Lack of participation in decision-making
8. Inequalities in distribution of wealth	25. Inadequate institutional arrangements	42. Unimaginative world order
9. Insufficient medical care	26. Limited understanding of feasible remedies	43. Irrational distribution of industry
10. Discrimination against minorities	27. Unbalanced population distribution	44. Reliance on remedial technology
11. Prejudices against cultures	28. Ideological fragmentation	45. Obsolete world trading systems
12. Affluence and its consequences	29. Increasing anti-social behaviour	46. Misuse of international agencies
13. Irrelevant education	30. Inadequate law enforcement	47. Inadequate international authorities
14. Environmental deterioration	31. Widespread unemployment	48. Irrational resource investment
15. Lack of consensus on alternatives	32. Spreading social "discontent"	49. Insufficient understanding of continuous critical problems
16. Failure to stimulate creativity	33. Impacts of military power	
17. Deterioration of inner cities	34. Obsolescence of political processes	

Further details on application of the Situational Complexity Index (SCI) are presented elsewhere by the above authors (Alexander N. Christakis and Kenneth C. Bausch, *How People Harvest their Collective Wisdom and Power to Construct the Future*, 2006) where it is noted that the largest SCI observed in forty years of its application is equal to 55, the minimum is 9, and the average is 34.

Science does not engage in analyses to assess problems with which to engage. Science, as it currently defines itself, is only capable of engaging with well-defined problems. People are however currently obliged to live in a problematic context whose problems do not lend themselves to ready definition (*Living as an Imaginal Bridge between Worlds: global implications of "betwixt and between" and liminality*, 2011). Worse still, as noted by H. L. Mencken, **for every complex problem, answers are readily proffered that are clear, simple, and wrong**. Many such are enthusiastically promoted.

In the case of fundamental mathematical problems, much is made of the so-called Millennium Prize Problems for the solution of each of which a reward of one million dollars is offered. It is noteworthy that there is no suggestion that any such reward should be envisaged for the problems of society cited above as examples, nor for the (re)solution of "wicked problems".

Within this context, it is appropriate to note that complex "wicked" problems can be reframed into relative simplicity by focusing on the management crisis they constitute. This is a one widely accepted means of avoiding the intractable challenges of interdisciplinarity (noted above). The inadequacy of this approach is recognized in strategic terms as "fire-fighting" -- rather than responding to the problematic situation by which the "fire" is engendered (see *From Reactive to Proactive Management: getting out of "firefighting" mode*, *Mind Tools*; *Vigorous Application of Derivative Thinking to Derivative Problems*, 2013)

The issue is relevant to the science-inspired approach to risk, as in the case of two recently announced projects, that of the?Cambridge Centre for Risk Studies and that of the formation of the Centre for Study of Existential Risk by Martin Rees (*We Are In Denial About Catastrophic Risks*, *Edge*, 16 January 2013). The question with regard to such initiatives is not what they so admirably choose to focus on as being well-defined, but rather what they exclude from consideration and how that is to be recognized -- together with its systemic implications.

This question can be used to distinguish between:

- problems considered challenging and of interest to science
- problems considered challenging to planners and policy-makers, namely the wicked problems outside the scope of science
- unforeseen problems which constitute a surprise to authorities, as variously noted (Nassim Nicholas Taleb, *The Black Swan: the impact of the highly improbable*, 2010; Karen A. Cerulo, *Never Saw It Coming: cultural challenges to envisioning the worst*, 2006)
- problems recognized by particular constituencies worldwide, but considered of little interest to science or other authorities

As with the framing of certain countries by the international community, wicked problems are best understood as framed by science as "basket cases" -- effectively as "failed states", understood in systemic terms. In that respect, *Wikipedia* reproduces a *List of countries by Failed States Index* -- an index produced by the US Fund for Peace. Such framings raise the question as to whether science, or any of its disciplines, merit evalutation in similar terms -- given the exhibited cognitive capacity to respond to the conditions of the world in preference to indulging in escapist dreaming of Mars and the origins of the Universe. Perhaps a *Failed Disciplines Index*? Failure might however be framed otherwise, as indicated by the extreme examples of the USA and the Catholic Church (Noam Chomsky, *No Wonder the World Is Terrified of America -- We're the Biggest Threat*, *Alter.net*, 5 February 2014; *The Pope's Sex Problem: Catholic Survey Reveals Frustrated Flock*, *Spiegel Online International*, 27 January 2014). In such terms, is science as practiced the problem -- rather than the solution?

Whether seen as "wicked" or not, in order to encompass the variety of problems, the World Problems Project of the online *Encyclopedia of World Problems and Human Potential* (commentary) took the approach of profiling and interrelating some 56,000 "problems" as

perceived by international constituencies, irrespective of how seriously they were variously taken. These were matched with profiles of some 32,000 "strategies" envisaged as remedial responses through the related Global Strategies Project. Particular attention was devoted to the detection of feedback loops amongst the problems -- presumably an indicative characteristic of their "wickedness". This suggests that that initiative might be more appropriately renamed as the *Encyclopedia of Wicked Problems and Human Potential*.

Management of disagreement and self-reflexivity

The above examples are all indicative of the inability of science, as "science" to reframe creatively and usefully any understanding of **conflict** between bounded domains. This is left to other disciplines -- whether pesudosciences, or those which are "beyond the pale" from a scientific perspective

Disagreement: In the light of the above, a distinction could be made between:

- disagreement within and between sciences understood to be core (hard) sciences
- disagreement between science and sciences typically framed as questionable or dubious -- typically the so-called social sciences
- disagreement between science and what are framed unquestionably as pseudosciences
- disagreement between mainstream science and:
    - those continuing to favour scientific paradigms elaborated in the past
    - those favouring new paradigms for which there is as yet limited acceptance
    - application of this time-sensitive distinction to the above-mentioned questionable sciences and pesudosciences, most notably theology
- disagreement between icons of the core sciences, well-recognized as often of a highly personal and irrational nature
- disagreement based on:
    - miscommunication
    - inadequate learning
    - cognitive biases and preferences
    - lack of time
    - language differences
    - influential differences in perceived status

Deniable factors: Of particular relevance is the manner in which recognition of the above dynamics is carefully designed out of public discourse, or carefully confined to certain arenas. This is a direct reinforcement of such behaviour by other "non-scientific disciplines". Science has no more elegant pattern to offer and sees no obligation to do so.

Such pretence regarding conflictual disagreement is further exacerbated by:

- arrogance and discrimination, exclusion etc
- pressures from vested interests (political, military, commercial, religious, etc.), potentially involving what might be framed as corruption (Naomi Oreskes and Erik M. M. Conway, *Merchants of Doubt: how a handful of scientists obscured the truth on issues from tobacco smoke to global warming*, 2010)
- competitive quests for funding, status, intellectual property and institutional territory

Rather than such phenomena being considered within a scientific methodological framework, their existence is carefully framed as being outside the preoccupation of such a framework -- in a grey area (a no man's land or *terra nullius*) whose very existence is questionable from a scientific perspective.

Destabilizing factors of deniable scientific relevance: Especially questionable are:

- the widely acknowledged competitive struggle for publication and prizes
- inability to constrain in a significant manner those acknowledged to have engaged in fraud or abuse
- inability to learn from historical errors
- weak response to:
    - evidence regarding environmental irresponsibility (Antarctica, space junk, etc, nuclear waste, fertilizer pollution, etc)
    - human experimentation
    - so-called scientific whaling

Controversial issues: Especially significant, and in principle an interesting scientific challenge for that reason, are the disagreements which are highly controversial and sensitive. These might include, given the variety of positions in that debate:

- decision-making appropriate to assessment of the case for:
    - euthanasia, Euthanasia vs religion
    - abortion
    - capital punishment
    - torture
    - human experimentation
    - animal experimentation (vivisection, etc)
    - complicity in: design of weapons of mass destruction, system degradation, invasive electronic surveillance, torture (APA)
- engagement with death, whether experienced:
    - personally, through anticipation, or through that of relatives
    - enabled through design of weaponry

- as a form of collateral damage resulting from scientific initiatives

The solidity of the evidence for these phenomena, which is far from lacking, is of less significance than the perception of the reality of these phenomena. Whatever the probability of their reality, what is significantly lacking is any capacity to hold such information within any database such as to enable exploration of its significance, taking into consideration the probability of its validity.

Learning from history to reframe the challenges of science?

Much is made of the manner in which science emerged to replace the deficiencies and inadequacies of religion. However, in systemic terms, many of the features of religion are only too evident in science as it is practiced. It is possible to recognize equivalents of: revelations, doctrines, (primarily male) priesthoods, acolytes, sanctuaries, condemnation of heresy, exclusivism, efforts to subsume the insights of others, and the sense of being specially chosen and uniquely mandated.

Could it be said that science is progressively entrapping itself -- especially in its failure to engage with "wicked problems".

There is some irony to the fact that religion, especially Christianity has been specifically concerned with "wickedness" and "evil". Presumably with the full support of his science advisors, it was to evil that Barack Obama specifically referred in the course of his acceptance of the Nobel Peace prize: *For make no mistake: evil does exist in the world.* (*Remarks by the President at the Acceptance of the Nobel Peace Prize*, 10 December 2009). This is consistent with the current controversies regarding evil, variously considered to be embodied by the US, its critics, and its opponents. Science has proved to be unable to reframe such perceptions -- other than might adopting an assertive mode reminiscent of that of religious authorities.

In engaging with the world in this way, science trap itself in the process identified by George Santayana: *Those who cannot remember the past are condemned to repeat it*. Where are the comparative analyses of religion and science from the perspective of collective learning -- in order to highlight the vulnerability to such pattern replication?

Science is articulate in claiming the "end of religion", over which it claims to have triumphed -- vainly in the eyes of many. In noting the demise of religion, science tends however to be blind to the manner in which it may be ensuring its own demise, as separately discussed (*End of Science: the death knell as sounded by the Royal Society*, 2008).

Especially noteworthy is the manner in which science has proven to be incapable of managing initiatives conducted in its name -- esteemed by many to be abusive, as noted above. The complicity in the design of weapons of mass destruction is indicative. At the time of writing the process of "scientific whaling" continues unsanctioned. The case of the American Psychological Association is worthy of particular note, given its resemblance to the historical implication of religion in torture (Roy Eidelson, *If Not Now, When? -- APA Fails to Sanction Psychologist in Guantanamo Torture Case*, *Transcend Media Service*, 10 February 2014). Related examples are to be found with respect to scientific fraud and its denial. As the scandal of sexual abuse by clergy has demonstrated, scientists are as likely to be excommunicated (or defrocked) as are those implicated in such processes.

The argument above with respect to "science" is complicated and partially undermined by the fact that "science" does not follow the pattern of the Catholic Church in being hierarchical and well organized. Those who speak for it may choose to imply some such organization and various patterns of academic organization reinforce this. However these academies have their own problems in acting coherently together in the name of science -- or in defining its limits. They are usefully to be compared with the variety of religious denominations, or the extensive range of Catholic orders and institutes claiming a complex degree of dependence on papal authority, whilst defending their independence.

Science does not have a Pope, although some scientists have created the impression of taking on that role in defence of science against religion (Richard Dawkins, *The God Delusion*, 2006). However the very nature of that debate, as sustained by science, suggests that it is itself adopting systemic behaviour resembling the continuing conflict between religions. Science has converted itself into a belief system without addressing -- and transcending -- the tragic dynamics of interfaith discourse. Its methodology has not demonstrated that science constitutes an exemplar of a more fruitful modality.

In lacking a Pope, institutional science bears a greater resemblance to Islam. This impression is reinforced by comparison with the acknowledged capacity of individual *mullahs* to make pronouncements in the name of Allah -- even to issue *fatwas*. Dawkins could then be understood to be acting as a mullah. How is the vision of Islam -- and its heaven -- to be compared with that of science in its quest for an epiphany of human knowing? How do the "icons" of religion and science then merit comparison?

The lack of self-reflexivity of science as practiced is only too evident in engagement with its critics -- and the oversimplistic example this offers for integration of feedback into consideration of the variety of modes of knowing and organizing. In adopting the religious pattern, this reinforces inadequacies in other arenas which are currently the focus of bloody conflict, as separately discussed (*Guidelines for Critical Dialogue between Worldviews: as exemplified by the need for non-antisemitic dialogue with Israelis?* 2006). There is a considerable degree of irony to the fact that science has little to offer to reframing the current conflicts in Syria, the Eastern Congo, and elsewhere -- and yet science is completely complicit in the design of the weaponry used by the participants to kill and wound each other (*And When the Bombing Stops? Territorial conflict as a challenge to mathematicians*, 2000).

The fact that "science" would deny its failures in this respect is part of the problem. As with the well-known motto of the US National Rifle Association, the motto of science might be: *Science does not kill people, people do* -- justifying corresponding critical analysis (Evan DeFilippis, *Debunking the "Guns Don't Kill People, People Kill People" Myth*, *ArmedWithReason*, 8 October 2013; David Kyle Johnson, *A Logical Take, Psychology Today*, 12 February 2013).

Metascience enabling upgrades to the scientific process?

Presented separately as an annex: *Metascience Enabling Upgrades to the Scientific Process: Beyond Science 2.0 in the light of polyhedral metaphors?* (2014), with the following sections:

The Hubble constant: a mystery that keeps getting bigger (*BBC News*, 2 November 2019) Ooops! -- encountering the universal challenge of humans being "not even wrong"?
Scientists have found a discrepancy in estimates for the rate of expansion of the universe. Why is this and what does it mean? Astronomers have reached a fundamental impasse in their understanding of the universe: they cannot agree how fast it is flying apart. And unless a reasonable explanation can be found for their differing estimates, they may be forced to completely rethink their ideas about time and space. Only new physics can now account for the cosmic conundrum they have uncovered, many believe.

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