The renewed role of ethics in science and technology (and beyond)

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The renewed role of ethics in science and technology

Abstract: The concept of ethics has generally played little role in modern science inquiry and technology development beyond a procedural notion of the term. This is in contrast to nonWestern or traditional knowledge systems of the past where the inductive, experimental and knowledge-building roles of 'science and technology' have often been inextricably linked to prevailing social values and the physical as well as cultural determinations of specific and local contexts. However scientists and technology developers or users have not remained immune to the growing ethical concerns of different kinds of people around the world in light of the threat of 'climate change' and related challenges of environmental and even economic sustainability. Governments and private sector corporations as well as local social contexts everywhere have recognized the renewed importance of a common or global ethics needed to better reconcile human imperatives of development and sustainability. Thus, as reflected by an associated diagrammatic progression, the paper's discussion of policy studies as exemplary framework for the renewed role of ethics as well for 'global knowledge convergence' refers to how the same three basic pillars which reflect a framework paradigm shift in science and technology studies also inform a related transition from *rational* or *ad hoc* to *emergent* policy-building – *innovation, sustainability*, and *social relevance*.

Keywords: ethics, science and technology, policy studies, sustainability, innovation, social relevance, paradigm shifts, knowledge ecology emergence, global knowledge convergence

Introduction: The policy implications of the renewed role of ethics in science and technology

The past decade has seen the evolution of new interdisciplinary research areas – bioinformatics, synthetic biology, nanobiology, computational biology, tissue engineering, biomaterials, and systems biology are examples. These new fields share a comparable, underlying research model, convergence, and there is a need to see them as a unity in order to ensure their continued progress. The successful application of this model will require not simply collaboration between disciplines, but true disciplinary integration… ***However convergence faces a series of policy challenges that must be resolved to allow it to emerge*** *at a scale that could be truly transformational* – MIT (2011) [our emphasis].

In the modern age scientists and technology developers or users have generally had little interest in either ethics or policy implications beyond professional standards of duty and veracity as well as scientific standards of procedure and objectivity. This is especially so for those who have exclusively subscribed to a positivist model of retrospective explanation, a pragmatic model of progress for its own sake, or a commercial model with a profit rationale as an end in itself. However

this situation is changing. To get research and also development funding scientists really do need to be aware of policy priorities in both the public and private sectors (e.g. MIT,

2011). Conversely, as exemplified by the promotion of the concept of 'green technology' (Goodall, 2008), there is growing political and social pressure around `the world for the imperatives of science and technology to be more accountable for consequences and more relevant when it comes to the pressing global challenges confronting humanity and indeed all life on Earth (e.g. Draggan, 2011). The increasing demands for science and technology to be socially relevant and environmentally sustainable is complemented by a related awareness. This is that scientists' should not so quickly or arbitrarily dismiss questions of social accountability and personal conscience or good faith, as was generally common practice in the past. Indeed, the very dilemma that professional or scientific interests may be in conflict with global and not just local social or personal interests is ever a matter of an applied as distinct from procedural (or fundamental rather than superficial or retrospective) concept of the role of ethics in human affairs.

As illustrated by the quote above, an MIT White Paper published in early 2011 articulated a proposal which arguably has quite revolutionary if ambivalent implications for the very concept of human science and technology. Much interest focused on the suggestion of a blurring between what have historically been seen as distinct and unrelated areas or subjects of knowledge - the general fields or specific categories of the life sciences (or biology), the physical sciences and human engineering. Just as significant is the related idea that the future of science and technology lies in various new possibilities opening up which will increasingly require interdisciplinary research, convergent thinking, and collaborative as well as new approaches to education and training for effective project development. Much of the promotional focus of this proposal is upon addressing and coming up with new solutions to pressing issues of social development and environmental sustainability (ranging from food production and health services through to biofuel generation and renewable energies). In such ways it is also clear that the reference above to the 'policy challenges' to be increasingly faced by scientists and technology developers revolves around the ethical dilemmas also inevitably shared by governments, corporations, and human society more widely.

As will be discussed further in the three sections of this paper, the concepts of ethics, policy and also 'science and technology' all share a common and increasingly convergent interest in the applied links between human knowledge and action or decision-making. In this way, any reference to the *renewed* role of ethics in science and technology should not simply 'look back' to traditional or rather non-Western knowledge systems but rather forward to the *policy implications* of various modes of *global knowledge convergence* (Richards, 2011a) – not least the concept of 'convergence science' indicated above. The first section focuses on the implied paradigm shift represented by the influentially emerging concept of 'science, technology and innovation'. This shift might be interpreted as a 'return' to social relevance which reflects a broader and non-positivist yet constructive view of the basic as well as future role of science and technology in human knowledge and activity. The second section explores the ethical implications of how *policy studies* is

inevitably a central and key focus of an emerging new paradigm of science and technology. It does so in terms of a related distinction between the vicious circle of top-down vs. ad hoc policy-making on one hand, and on the other the constructive as well as emergent process of sustainable policy-building. Section three further examines the underlying and ongoing conflict between *positivist* and *ecological* paradigms of the relation between human knowledge and action. This section further explores how an emergent new model of 'convergent science' linking the life, physical and engineering sciences represents an endless series of ethical dilemmas which need to be addressed in an integrated rather than merely rational or ad hoc way.

Traditional vs. modern frameworks linking ethics to scientific knowledge and technology applications

Practical wisdom consists in inventing conduct that will best satisfy the exception that solicitude requires by breaking the rule to the smallest extent possible.
- Paul Ricoeur, *Oneself as Another (1992), p.* 269

The concept of ethics has not been completely lacking from modern contexts and concepts of science and technology typically associated with a dominant 'positivist' paradigm in the wider sense of the term (i.e. to the extent this has become synonymously interchangeable with related 'ideologies' such as reductionism and scientism) for a particular privileged and formal view of knowledge as a system of understanding and explanation (Bunge, 2004). A procedural notion of ethics has generally been applied - even if mainly and superficially focused on the notion that good scientific practice or theorizing should involve a basic intellectual or academic integrity (or at least the appearance of this) to avoid inadvertently selective and imposed interpretations on one hand (e.g. Medawar, 1964), and on the other outright deception in many cases of 'retrospective interpretation' as well as those of obviously fraudulent invention of research results or implications (e.g. Lincoln & Guba, 1987). As Lincoln & Guba suggest, a systematic lack of ethical foundations has arguably been the central failure of modern science and technology. Conversely, the distinct if related main justifications of technology development (the rationale of functionality, the ideology of progress, and the motivation of profit or marketability) should be seen to have some degree of utilitarian justification. Thus reflecting the positivist tendency of reducing or equating all wholes in nature and culture to the mere sums of their parts, a procedural notion of ethics in modern science and technology has been generally devoid of qualitative depth in terms of its typical, exclusive, and reductionist association with quantitative notions of measurement and the presentation of empirical or objective 'facts' in a vacuum.

It is perhaps a related modern prejudice that non-Western science and technology does not really count or compare to the superior achievements of societies influence by concepts of the European Enlightenment, the industrial revolution, and modern individualism. Such a prejudice has most been influentially articulated in Popper's (1963; 1979) influential re-conception of the scientific method in terms of the pivotal concept of empirical *falsificationism*. As epitomized by the

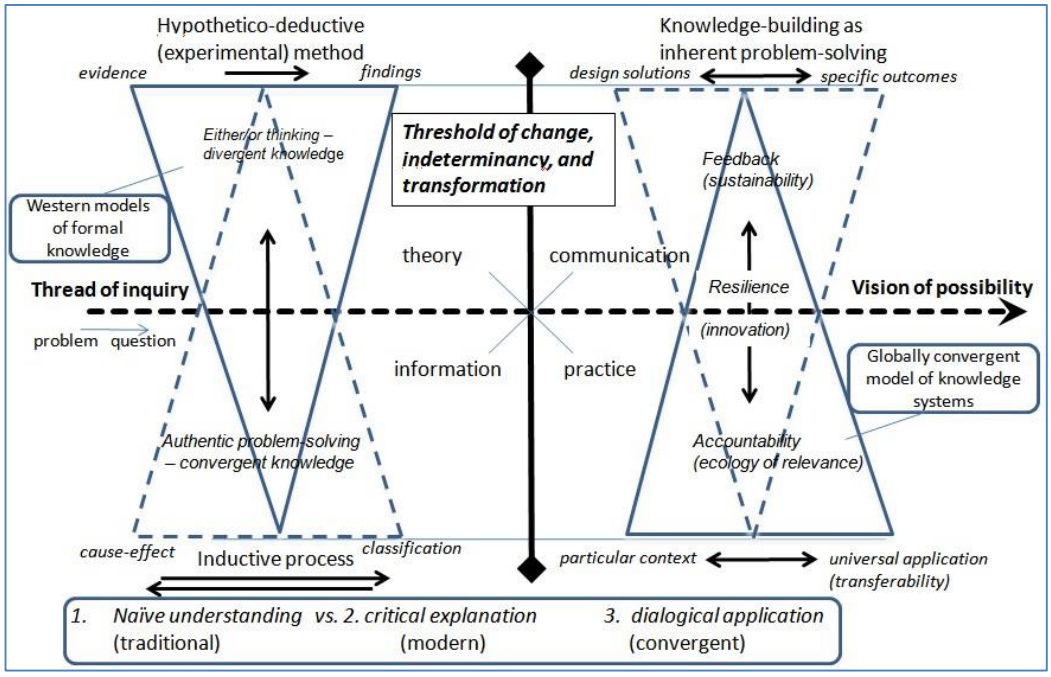
innovative science and technology achievements of great civilizations of the past (Babylon, Rome, China, India, etc.), the traditional knowledge systems of non-Western societies are often also typically based on inductive and experimental foundations as well as the cultural mystification or rationalization of social values and ethics. Yet Popper's model in principle tends to dismiss the basis of such achievements as effectively mere superstition only.

Popper's (1979) influential as well as positivistic re-conception of the scientific or 'hypotheticodeductive' method initially recognizes the fundamental 'equality' of all human knowledge systems in terms of the fundamental principle that 'all life is problem-solving'. However it further added a clause that all knowledge systems which do not also demonstrate (or can be 'corroborated' by) an additional layer of formal hypothesis or deduction must be dismissed as not 'genuinely scientific'. In this way, Popper ostensibly resolved but really further entrenched the fundamental dilemmas and related dualisms (idealism vs. realism, objectivism vs. subjectivism/relativism, rational vs. empirical, etc.) of how a characteristically modern mode of thinking is based on an either-or logic derived from Plato and Aristotle in the Western tradition (e.g. Bernstein, 1983). There are several related reasons also relevant here why Kuhn's (1970) concept of 'paradigm shifts' in scientific knowledge represents a corrective to Popper's generally relativistic model of scientific knowledge construction (e.g. Fuller, 2004). For a start it represents a more constructive and indeed optimistic framework than that provided by Popper which recognizes that there can be gradual as well as transformational improvement as well as on-going change in the human knowledge-building process. What is particularly useful for present purposes is how it represents how 'smaller' or more specific theories fit into 'bigger' organizing and dominant theories in a wider, emergent, and ecological fashion rather than some arbitrary and rational demarcation. Thus the key or rather exemplary paradigmatic shift then is itself between the many specific variations in different fields of knowledge between a general modern positivism and the kind of emergent knowledge ecology paradigm referred to in this paper as outlined or suggested by Bunge, Prigogine, and many others in relation to a variety of areas, disciplines, and perspectives.

Figure 1 outlines a visual attempt to go beyond the 'falsification' model to outline a wider framework of knowledge that builds on Popper's initial insight yet avoids the self-defeating and circular rationale of his additional clause. In this view the applied insights and relevance of the hypothetico-deductive method are not based on the retrospective illusions of abstraction and decontextualization but are rather linked to the inherent universal reference point of human problem-solving formalized as concretely applied yet also disciplined inquiry. Such an extension is thus consistent with the knowledge-building logic, rhetoric and also ethics of Socrates' elenchus method – the prototype of Western and modern methods of scientific thinking and inquiry based on an *emergent* rather than *either-or* notion of knowledge (Sott, 2002) A wider framework thus represents the enterprise of human knowledge-building as fundamentally a process in time open to emergent change (also dynamically linked to principles of indeterminancy and transformation) before a 'spatial' delineation linking the social and collaborative foundations of inductive

knowledge based on experience and actively experimental efforts or innovations based on focused as well as disciplined interventions. As Joseph Needham demonstrated in relation to traditional contexts as well as ancient achievements of 'Chinese science and technology', a selective modern paradigm of science and technology ignores the unique achievements, convergent foundation, and global heritage of non-Western knowledge systems (Richards, 2011a). Direct support for this suggestion is coming from some perhaps unexpected quarters. In cutting edge biotechnology research the superior efficacy of natural fibre composite technologies is being re-discovered in the same way that new appreciation is being given to the pharmaceutical insights of traditional medicinal plants and herbs (Kennedy, 1998; Sefa Dei, Rosenberg & Hall, 2000). As Spence (2011) has suggested from a distinct yet related perspective, the imperatives of 'the next convergence' will involve a re-alignment of the relationship between the developing world and the modern developed countries of the West especially.

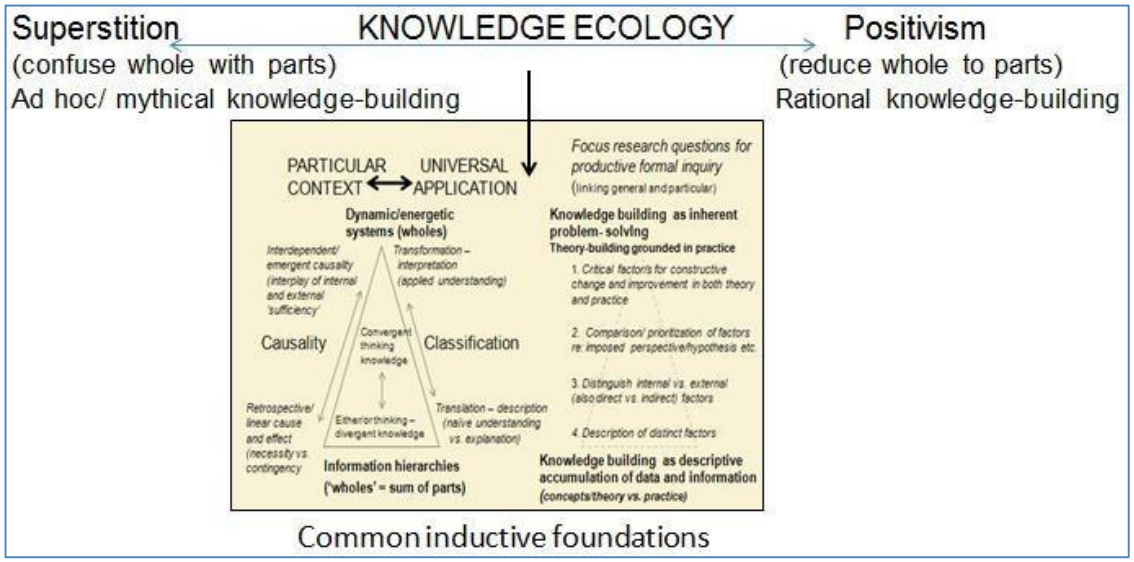
Figure 1. Beyond Popper – Towards a convergent framework of scientific knowledgebuilding



In the retrospective emphases of modern science, the process of recognizing or applying the principle of *cause and effect* (or time more generally) is typically seen as arbitrarily separate to the distinctly and descriptively spatial process of *classification* or *categorization*. Yet even when formally deploying the hypothetico-deductive model of scientific method, the best modern science has always remained fundamentally a process as well as practice of problem-solving involving acts of interpretation mediated by natural human languages and thus the underlying conventions, prejudices and shared expectations of particular communities of practice or social contexts (Bohm, 1980; Bunge, 2004).

As Figure 2 suggests, in between the either/or delineation of traditional superstition and positivistic modern science, a common process of *knowledge ecology* is equally applicable to the applied science and technology achievements of both non-Western cultures and modern society. In the knowledge ecology model, the subject and object of inquiry as well as related aspects of causality and classification are recognized as emergent and interdependent in the manner of the self-organizing systems which inform physical, chemical, and biological as well as human domains of formation (Prigogine & Nicolis, 1977; Ulanowicz, 1997). Thus as Socrates advised, the posing of a relevant question is the universal key to encourage and frame (as a dialogical process transforming interdependent *naïve* and *critical* stages of thought and discussion) formal as well as non-formal knowledge building of all kinds ranging from the process of learning through to the most advanced modes of critical reflection (Ricoeur, 1992; Arendt, 2004). As Norton (2008) further indicates, such an antidote to the positivist assumptions of modern science is the key to the return of a deep-level or substantial ethics in both applied and formal human thinking.

Figure 2. A convergent model of 'knowledge ecology' at the intersection of superstition and positivism



In this way we have identified the convergent process of human knowledge-building at an intersection between the 'opposite errors' in traditional and modern thinking and knowing. Just as traditional knowledge systems were prone to the *superstitious error* of misusing the mythical or conventional forms of social values to confusing a whole with the parts, so too the dominant paradigm of modern science and technology has likewise been prone to the *positivist error* of typically reducing the whole to the parts in terms of an either-or logic of arbitrarily separating the acts and forms of description from the emergently open-ended process of cause and effect. These opposite errors correspond to the related oppositional tendencies of rational or top-down and ad hoc thinking and knowing which – as will be discussed further below – as much epitomize a

fundamental ethical and policy-building dilemma as they are a reflection of the delineation between theory and practice as well as processes of induction and experimentation.

At the intersection between *traditional superstition* and *modern positivism* we can therefore also recognize the complementary elements of a globally convergent model of human knowledge building. In other words both traditional and modern functions as well as distinct 'axes' of knowledge-building are equally and convergently important – and one without the other 'incomplete'. As indicated above however much they were couched in metaphors and models (as Popper's empirical falsification suggests, equivalent in function to scientific theorizing) (Cf. also Hesse, 1970), traditional and especially 'indigenous' knowledge systems generally retain a pragmatic and inductive foundation of knowledge-building grounded in local contexts of experience as well as the shared language, values, and worldviews (Sefa Dei, Rosenberg, & Hall, 2000). Conversely whilst both the specific and general 'theories' of modern knowledge systems are ostensibly focused on the concrete experience of individuals they also involve shared 'communities of practices' and associated conventions of language, social values, and cultural worldviews (including the most specialized academic discourses and scientific communities of practice). To appreciate the distinction it is useful to return to Socrates whose conception of the human knowledge building process so effectively bridged the axis or gap between cultural traditions and Western notions of emergent modernity. For as well as recover aspects of the traditional functions of human knowledge systems, a prospective convergence will also need to deal with the inherent dilemmas of modernity – as exemplified in Berman's (1988) powerful exploration of what he also conceives as the 'Faustian struggle' between an emerging 'freedom of conscience' and a related 'tragedy of modern development' : 'to be modern is to live a life of paradox and contradiction. It is to be overpowered by the immense bureaucratic organizations that have the power to control and often to destroy all communities, values, lives; and yet to be undeterred in our determination to face these forces, to fight to change their world and make it our own'(p.13).

As Arendt (1958; 2004) has suggested, Socrates in many ways deserved the oft-attributed epithet of the father of Western ethics as well as logic, rhetoric, and knowledge generally. This is also in the sense that he conceived a universal standard and reference-point as a bulwark against the vagaries of manipulated morality, merely clever or literal pretentions to knowledge, and various forms of either-or thinking (Richards, 2010; 2011b). In fact Arendt has further suggested that Socrates' great discovery was in fact the human conscience which also translated into applied notions of objectivity and universality. In this way such emergent yet also bureaucratic and procedural Westerns notions as the rule of law, objective standards, and associated notions of 'duty of care' may be compared in a complementary rather than oppositional way with traditional functions of so-called 'honor and shame' societies (e.g. Kim & Triadis, 1994) which have a more fluid and negotiable sense of ethics as well as law and social values in the circulation of convention, idiom, and reciprocal obligation. As Arendt understood so well, the price of the emergence of a modern urbanized and consumer-focused mass society in which individuals felt liberated but

alienated was the loss of the functions of community solidarity, convention, and shared values of future sustainability (Cf. also Berman, 1988; Bauman, 1993).

Figure 3. Traditional vs. modern ethics

As the cross-cultural researcher Edward Hall (1977) conceived, the traditional ethics of past non-Western societies and cultures tended to function more in terms of *externalized* controls and exchange in contrast to the *internalized* yet also typically objective reference-points for modern notions of ethics based around the concept of 'conscience'. As Figure 3 depicts, we may recognize the complementary distinction between a traditional ethics of human reciprocity organized around the interplay of body and society and a modern ethics of accountability focused on the collective as well individual mind's struggle with the concept of universality. On this basis we may also appreciate the great 20th Century philosopher Paul Ricoeur's (1992) related distinction (following Socrates) between a universal ethics and the vagaries of social constructions of morality open to use and abuse or distortion and manipulation – with modern 'bad faith' the equivalent to the traditional circulation of values open to corruption. Figure 3 uses such a complementary distinction to also recognize how the various competing notions of ethics (utilitarian consequences vs. deontological duty, pragmatics vs. virtue ethics, etc.) can be reframed into an integrated model of the developmental ethical stages as well as distinct perspectives elements of ethics applicable in cross-cultural contexts as well as convergent knowledge systems. Thus it usefully integrates such models as Kohlberg's (1981) stages of moral development corresponding to the different stages of a child maturing to an adult where an initial behaviorist emphasis on punishment and rewards (or consequences) gradually but not inevitably gives way to emergent notions of personal responsibility for actions or agreed upon social standards and pragmatic conventions of morality.

Of course, all such distinctions derive from the well-known 'golden rule' convergently applicable to traditional and modern ethics as well as initial and mature moral development – related versions of the basic principle 'don't do to others what you don't want done to you'. In light of related threats or consequences such as extreme weather and climate change, this dictum might be revised to include the additional clause 'don't do to nature what you don't want nature to do to you'. In its implied reconciliation of the distinction between morality and ethics, the golden rule represents the universally-applicable foundation of an ethical and not just moral compass.

The Biotech Century: **Anticipating the recovery of an ethical compass in human knowledge?**

The Biotech Century comes to us in the form of a grand Faustian bargain… the risks attendant to the Biotech Century are least as ominous as the rewards. Wrestling with the light and dark sides of biotechnology will test each of us in our own way… the genetic revolution and computer revolution are just now coming together to form a scientific, technological, and commercial phalanx, a powerful new reality that is going to have a profound impact on our personal and collective lives in the coming decades... Each new synthetic introduction is tantamount to playing ecological roulette… - Jeremy Rivkin (1998), *The Biotech Century*, p. xiv

Jeremy Rivkin's book *The Biotech Century* (1998) anticipated by a decade or so the MIT Press projection of a fundamentally new applied science and technology paradigm. As in his other powerful studies (e.g. 1992, 2002, 2010) Rivkin in this book focused on the social and policy implications of new and anticipated developments in science and technology. In this particular work Rivkin recognized that the 'new age of biotechnology' represents a radical transformation in human knowledge with deep ethical and policy implications, dilemmas, and challenges. There are several key related arguments in the book which emphasize the exemplary importance of the challenges of the Biotech Century for recovering an 'ethical compass' in science and technology as in human knowledge more generally. For Rivkin the new ethical, social, and environmental challenges represented by or rather unleashed by the Biotech Century bring to a head the clash between the implications of convergence and requirements of ecological sustainability on one hand, and on the other a positivist model of knowledge driven by a related ideology of development or progress for its own sake as well as the profit motive of rampant commercialization (Cf. also Nisbert, 1994). At the heart of this contrast is how the 'modern enclosure movement' linked to the historical and global privatization of land, property and 'living things' has also served to replace enduring values of long-term future sustainability with a perpetual short-term prioritization of immediacy, efficiency, and the profit motive for its own sake (Rivkin, 1998, p.41).

Rivkin's concern for the implications, dilemmas and challenges of new developments in biotechnology build upon and link to what Rivkin in his previous works has referred to as an alternative 'biosphere' model of convergent social and environmental sustainability. Thus his reference to the 'ecological roulette' of much biotechnology research and development refers to a

number of related ideas. Above all else he refers to how the consequences of engineered modifications to plant, animal and even human genetic information cannot be ultimately be anticipated or really controlled. In other words, when it comes to initial experiments or explorations of possibilities in genetic engineering so-called clinical trials or pilot studies cannot ultimately be controlled and run real risks of unleashing catastrophic consequences. Besides the unleashing of new kinds of viral, bacterial, and fungal diseases, perhaps the most damaging and self-defeating outcome might be actually to critically degrade both species and environments. In particular Rivkin cautions on the topic of how the natural biodiversity resilience as well as emergent adaptations of plants, animals and thus the human food chain has been allowed to be run down or degraded in terms of the commercial rationale of immediate profits and short-term opportunism rather than long-term sustainability and adequate accountability (p.107). The suffering of animals in biotechnology research is taken up by Rivkin as an exemplary focus of not only the careless approach of many scientists towards any procedural notion of 'duty of care' but also towards more fundamental notions of scientific accountability - in such terms as a similar general disregard for the concept of 'species-ness' and thus any larger 'duty of care' to the sustainability of all forms of life in the biosphere (p.99). Conversely, Rivkin also points out how such new developments in science and technology are also often associated with a related corruption of academic integrity, procedural ethics, and public policy relevance as well as accountability or leadership in tune with social and environmental sustainability.

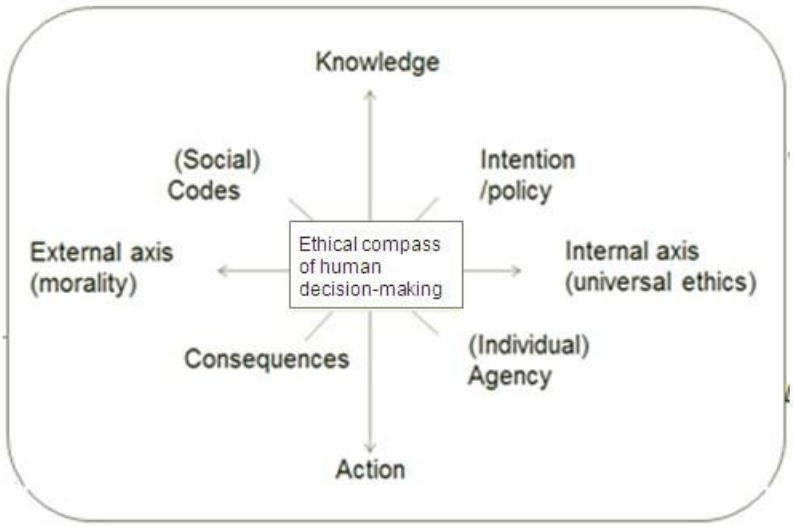
In contrast to how MIT Press's projection of convergence science balances its general optimism with a covering caution, Rivkin's critical and in-depth exploration of often negative implications, challenges, and dilemmas is presented with an ultimately optimistic prognosis of how future science and technology can be reconciled in terms of ethical and policy imperatives of ecological sustainability. Thus Rivkin ends his book with the prediction that:

> *The Biotech Century will ultimately belong to the systems thinkers, those who see biology more as 'process' than 'construction' and who view the gene, the organism, the ecosystem and the biosphere as an integrated 'super organism' with the health of each part dependent on the health and well-being of the whole system. That is why the genetic engineers might eventually lose their dominant position to the ecologists whose thinking is more in tune with a biospheric consciousness. (p.234)*

In its descriptions of the ethical dilemmas present by on-going biotechnology research and vast potential for disastrous consequences Rivkin's book thus projects the need for scientists and technology developers to re-discover a sense of ethical responsibility or accountability in relation to the related challenges of future social and environmental sustainability. This is the prescription suggested to address the overriding challenge of how 21st Century science and technology is effectively 'playing God' by hastily and uncritically succumbing to the forces of commercialization in terms of interfering with nature in general and 'the Earth's gene pool' in particular – that is, how scientists are 'without a compass… lost and adrift in this artificial new

world we're creating for ourselves in the Biotech Century' (p.115). As Rivkin points out, the academic foundations for biotechnology policies in the US (i.e. the National Academy of Sciences) are influentially driven by 'industry affiliations' and associated commercial considerations which tend to subvert not just a sense of objectivity but also larger ethical considerations. Thus Rivkin directly points out how a renewed ethical sense of accountability, responsibility, and anticipation of consequences (i.e. what we might call an 'ethical compass') is required in relation to the related process of human decision-making, planning and thus policy directions when it comes to the associated commercialization of scientific knowledge and technology research and development.

Figure 4. Re-discovering the human ethical compass

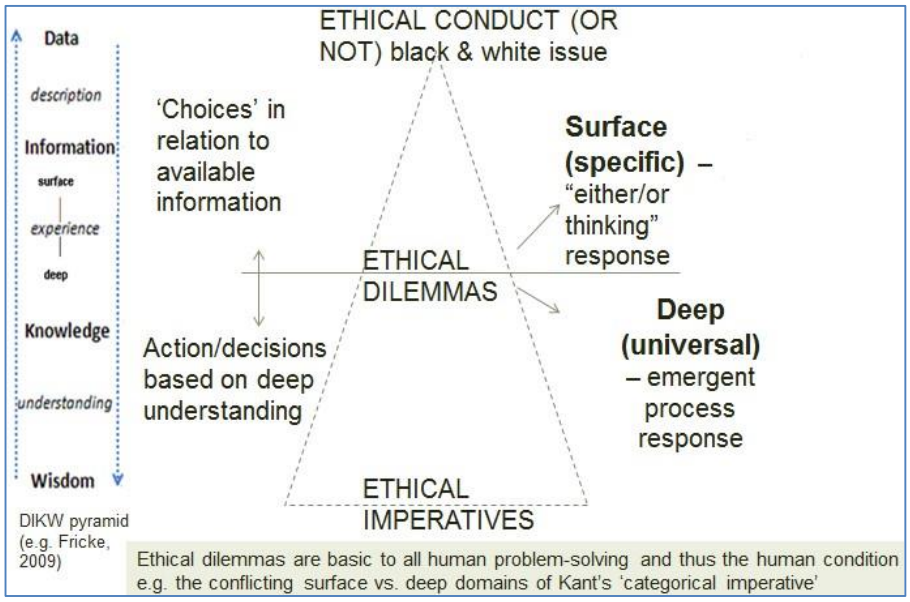


Following up this suggestion, Figure 4 depicts the challenge in terms of the need to overcome an either/or and also traditional vs. modern delineation between distinct internal and external axes of ethical reference (i.e. the complementary function of an ethics of reciprocation and an ethics of conscience). In other words, the *surface level* aspects of a merely procedural concept of ethics and also a socially variable morality open to manipulation or persuasion might both be re-framed in relation to the common and convergent aspects of a *deep-level* 'universal' ethics. The concept of an innate human ethical compass presumes the need to find a convergent alignment between the often conflicting organizing principles of individual agency on one hand, and on the other social codes, standards, and notions of either reciprocal or imposed morality. As well as reconcile the related concepts of morality and ethics (as well as traditional functions of reciprocation and a modern sense of 'good faith'), the ethical compass ultimately refers to a connection between knowledge and action in human affairs in which the modern scientific preoccupation with description or information accumulation and theory generation or rationalization is superseded by a larger policy-building context.

A merely either/or projection of the connection might be replaced by rather an interdependent appreciation of the connection between individual or collective human 'intentions' or 'policies' and the consequences of particular actions, plans and decision-making. For instance, a typical either/or framework attempts to decide whether a particular action, plan, or decision should be judged as appropriate or even 'ethical' in terms of either the greater good or some intrinsic standard and duty (i.e. utilitarian justification vs. deontological and related ethical standpoints). In terms of how human life is inevitably and perpetually a series of ethical dilemmas, Figure 5 depicts an alternative perspective to merely superficial or procedural notions of ethics referenced in terms of either/or choices similarly defined in terms of merely 'available information'. Instead of defining an ethical response to any or every particular event and situation inevitably in terms of some kind of timeless either/or choice, a deep level rather than surface level response to a particular dilemma or problem may be considered an emergent process appropriate (or not) to the particular and local context at hand (e.g. Diamond, 2005). In other words the response of particular decisions or plans should not be made in a vacuum but be guided by a convergent rather than merely imposed ethics. In this way we might better appreciate Ricoeur's (1992) insight and advice of the 'necessity for the ethical aim passing through and being tested by morality'. Ricoeur's convergent prescription represents an antidote to the confusion between ethics and morality (and superficial reconciliation of rationalism and empiricism in terms of yet another imposed rather than emergent mode of universality) in Kant's famous modern concept of a 'categorical imperative' – that is, that as 'rational beings' modern individuals should always act or talk in any particular situation as if 'that it would be a universal law without contradiction'. Above all else then a convergent notion or model of ethics epitomizes how an emergent approach to knowledge-building represents an antidote to the mind-body split in modern knowledge systems.

Actual or concrete human decision-making and planning process should be appropriate to a particular knowledge ecology which attempts to reconcile or converge an immediate consideration of options based on available information and a rather more enduring understanding of the link between future implications and past experience. We have adapted here two related concepts of knowledge-building in a convergent way in Figure 5 to depict the role and function of the human ethical compass in dealing with endless human dilemmas. Firstly the larger concept of a knowledge building ecology might be usefully appreciated as an applied reconciliation of the distinction in education theory between the *surface* learning of discrete information or practical skills and the *deep* understanding and application of knowledge (Brown & Duguid, 2000; Weigel, 2001). On this basis we might further appropriate and adapt the related concept of the 'data-information-knowledge-wisdom pyramid' which is typically used in an ironic or superficial way in information or management theory to describe how human decisions and plans can be overwhelmed in terms of information overload (e.g. Fricke, 2009). As *Mosse, Farrington & Rew* (1998) put it in grossly understated fashion, 'it is not at all self-evident that an increased availability of information will improve the quality of decision making and action… or increase accountability'.

Figure 5. Surface vs. deep level knowledge-building responses to ethical dilemmas

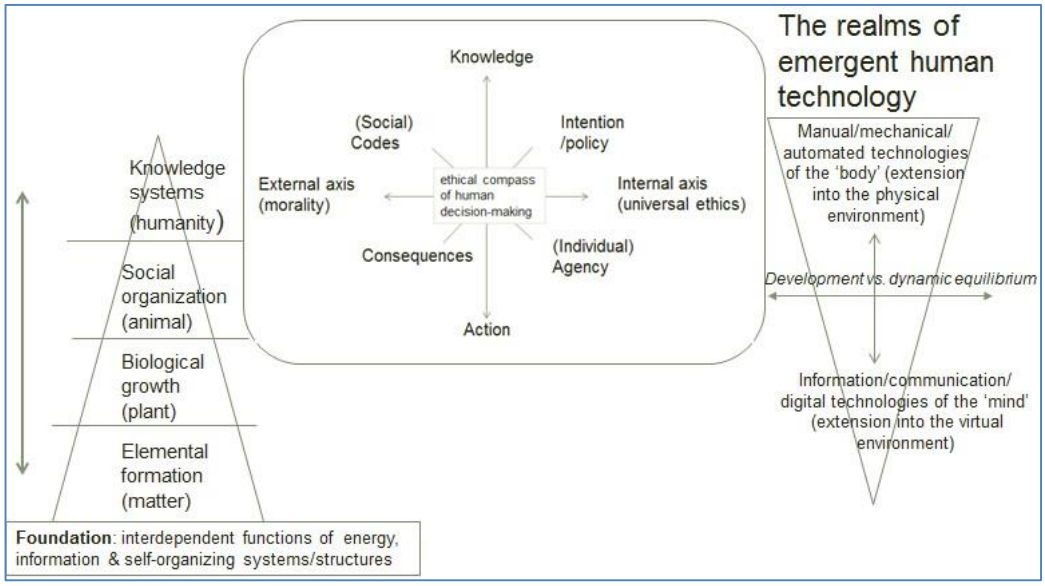


In our convergent framework here the alignment of internal and external axes of ethical reference inform as well as correspond to a related reconciliation of surface and deep level orientations to the experience of and response to particular events and situations. Thus, the most useful way of explaining how the knowledge-building process of any kind of knowledge system (including the conceptual paradigms and corroborative conventions of any particular modern science paradigm) can and should remain a fundamental and not just procedurally ethical process remains Socrates' elenchus method for dealing with even the most ostensibly intractable dilemmas and challenges of knowledge – that is, to develop a 'problem-solving' thread of inquiry, thought, and reflection which links particular issues and contexts to an emergently indirect principle of 'dialogical' response which productively negotiates the gap between individual and collective knowledge and ignorance (Richards, 2010). In this way – in relation to the Socratic knowledge-building gap between 'what we know and 'what we don't know' - circular definitions and negative selffulfilling prophecies of failure might be transformed into a more productive, potentially innovative, and possibly sustainable process of knowledge-building. Thus perhaps anticipating the aspect of paradigmatic 'blindness' in modern science and technology (and Western modernity more generally), Socrates' consistently insisted that people sufficiently aware of and able to acknowledge the basic human ignorance ultimately have an advantage over not only those unaware of this but those for reasons of condescension and arrogance would not or could not acknowledge this.

Figure 6 outlines a suggested framework for going beyond a merely procedural perspective to rediscover a more substantial and applied relation of ethics to the related fields and functions of science and technology. The earlier mentioned distinction and convergence between an external ethics of reciprocity and an internal ethics of accountability, conscience, and good faith represents a fundamentally and convergently interdependent relation which is basic to the knowledge-

building process. Human societies, cultures, and knowledge systems (i.e. the realms of the mind') cannot ultimately be seen as arbitrarily separate too or divorced from the biological processes as well as cognitive imperatives of genetic development and behavioral determination. Thus as discussed earlier diverse factors of biology, psychology, and society all influence but ultimately do not define the concept of human ethics, which is why a more integrated or convergent model is required.

Figure 6. Re-locating the human ethical 'compass' in the interdependent realms of science and technology



The need to further reconcile distinct traditional and modern ethical 'axes' in order to initially recognize and further promote a globally convergent model can be usefully appreciated in terms of how different kinds of human knowledge system arguably share a generic foundation of emergence as forms of self-organizing (or self-regulating) system'. As Rycroft and Kash (1999) for instance have argued, optimal or innovative human knowledge systems share many of the related functions (i.e. the emergence of order or patterns in terms of spatial-temporal structures adapted to particular local environments or contexts) common to all orders of life including the material formation of the physical universe, the evolution of life, and also distinct as well as related animal and human orders of social organization (Cf. also Luhman, 1990). The concept of *self-organizing systems* – that is systems which generate increasing orders or levels of complexity - is more useful as its implications and functions go beyond the feedback loop function of self-regulating systems linking internal and external states. Whilst a narrow notion of self-organizing systems suggests a direct function, we think that a wider notion usefully appreciates how technological systems also function as an extension of human capacities for self-organization and likewise how apparently accidental formations of energy patterns and physical systems also involve a convergence or interaction of internal and external imperatives.

In a related way we might attempt to re-locate the human ethical compass within the various interdependent realms of science and technology. As discussed further below, on closer inspection the various 'realms of natural science' which provide the interdependent foundation of human emergence or development all involve some kind of related of emergent interplay of distinct internal and external axes of organization in time (beyond axes of symmetry and orientation which inform abstract or concrete space). Such an interplay is most notably epitomized in terms of various versions of the so-called nature vs. nurture 'debate' – including basic Darwinian vs. Lamarckian accounts of the systemic evolution of life. On such a basis we might also appreciate how a convergent model of ethics represents a higher order and ecological extension of the natural order – not an ad hoc repudiation or rational denial of this. Likewise on such a basis we might attempt to re-locate the human ethical compass within the various interdependent realms of scientific knowledge and technology development.

As discussed further below in terms of a policy studies framework which focuses on the link between human knowledge and action, human knowledge systems inevitably involve a general self-organizing function despite specific differences. When sufficiently activated this should be reflected on an inherent resilience conceived in some specific or local adaptation involving organizing functions of accountability as well as feedback. In this way the diverse and ostensibly contradictory ethical interests and tendencies of individual and society as well as tradition and modernity may be reconciled in practice within a larger, convergent framework.

This might be further appreciated in terms of how within and across the different natural 'realms of science' there are inherently conflicting imperatives and structures reflecting an emergent process of 'order out of chaos' - as Prigogine & Stengers (1984) put it when describing how chemical systems can effectively reverse the principle of physical entropy - ostensibly at odds with the inertia of time, the determination of environment, and the assumption that energy inevitably runs down or out. This is in similar fashion to how the so-called *nature vs. nurture* debates in biology and psychology exemplify a related *rational vs. ad hoc* failure (and negative self-fulfilling prophecy) of *either-or thinking* in terms of biological evolution, psychological development, and even the sociological formation of cultural systems defined in relation to arbitrary or de-contextualized notions of context and environment. Prigogine's insights into the open and emergent systems of nature provide a powerful antidote to Popper's insistence that authentic knowledge can somehow be decontextualized and formalized. As Bunge (2004) has likewise explored, the 'self-organizing systems' framework is also particularly useful for recognized the convergent and complementary rather than inherently oppositional or confliction relation between functions of growth or emergence on one hand, and on the other functions of dynamic equilibrium or homeostasis.

There are two related ideas about the inherent geometry of nature which usefully exemplify the underlying systemic convergences across distinct abstract and concrete realms as well as the various realms of natural science. The insights and applications of fractal geometry and equations

demonstrate the interdependent as well as recurring and 'self-similar' correspondences of part and whole in the organizing patterns of various realms of nature at both macro and micro levels (Mandlebrot & Freeman, 1983). Indeed the principles of fractal patterning (and the related concept of 'chaos theory' in science) have been applied just as productively to better understanding the inherent principles of regularity and also dramatic systemic change in human behavior (Mandlebrot & Hudson, 2004). However particularly useful for our purposes is how the logarithmic spiral otherwise traditionally known as the 'golden' mean or proportion exemplifies the optimal convergence in time as well as space (i.e. as perhaps actual as well as symbolic reconciliation of growth and equilibrium). It does so in terms of internal and external axes of orientation and symmetry transforming into a self-organizing function involving the progression also from two and three dimensional abstraction to actual transformations of nature. The logarithmic spiral mean is not only a significant function of number in terms of the famous Fibonacci series but appears in the geometric patterning of various realms of nature extending from crystal structures to aspects of organic growth (e.g. Livio, 2002). In short it represents a universal reference point in unfolding time as well as emergence in space – exemplifying the inherent or underlying proportion, balance, and harmony of nature which is often lost but always recoverable or re-discoverable. It is such an exemplary symbol also of the essential thread of natural integrity (and thus a convergent ethics).

Conversely, an inherent ethical dimension to technology development and application might be recognized in terms of the ultimately interdependent relation between technology conceived as a manual or physical extension of the individual and collective human body in the form of tools and machines on one hand, and on the other rather the associated virtual and cultural extension of both individual and social construction of the human mind as identity and ideology through the processes and constructions of information, communication, and particular knowledge systems – all mediated through the virtual knowledge ecologies of shared languages, social values and cultural aspirations defined in terms of the axial interplay of tradition and modernity (e.g. Jaspers, 2003). As Rivkin reminds us a 'computer revolution' as well as a genetic revolution informs an emerging Biotech Century so in need of the rediscovery of the human ethical compass (Richards, 2011b). In related fashion to the pivotal transformations associated with such inventions in the past as writing and mass printing, new digital technologies are a key to the emergence of a global new networked 'knowledge society' as the foundation for sustainable requirements as well as innovative possibilities of future science and technology (Castells, 2000).

Policy, ethics and the emerging science and technology 'paradigm shift'

Change in complex systems, whether they are ecosystems or stock-markets, often takes place not in a smooth progression but as a sequence of fast catastrophic events… States matter less, interconnections make it very hard to trace simple lines between cause (home mortgages) and effect (declining oil prices) and, as we've seen, the smartest-looking policies backfire over and over again - Joshua Cooper Ramo, *The Age of the Unthinkable* (2010), p.16.

The new and emerging field of 'science, technology, and innovation' (e.g. Conceicao, Gibson, Heitor & Shariq, 2000; OECD, 2006) can be interpreted to represent a significant paradigm shift in the concept of science and technology. There are two related models of science, technology and innovation. One model typically emphases the role of innovation in scientific knowledge and technology development in terms of a policy focus on both national economic and corporate commercialization strategies (e.g. Lundvall & Boris, 2005; Wessner, 2009). The second is perhaps more significant in its connection to the growing global commitment to 'green technology' and related scientific inquiry for sustainable product or system solutions which might reduce greenhouse gas emissions, minimize the degradation of the environment and promote renewable energy alternatives. Also encouraged by the World Bank and reflecting its changed approach to policy-building (World Bank, 2010), this particular model emphasizes the use of science and technology in developing countries especially to support sustainable growth and capacity-building (Nusbaum & Sen, 2005; Watkins & Ehst, 2008; Fuchs & Shapira, 2010).

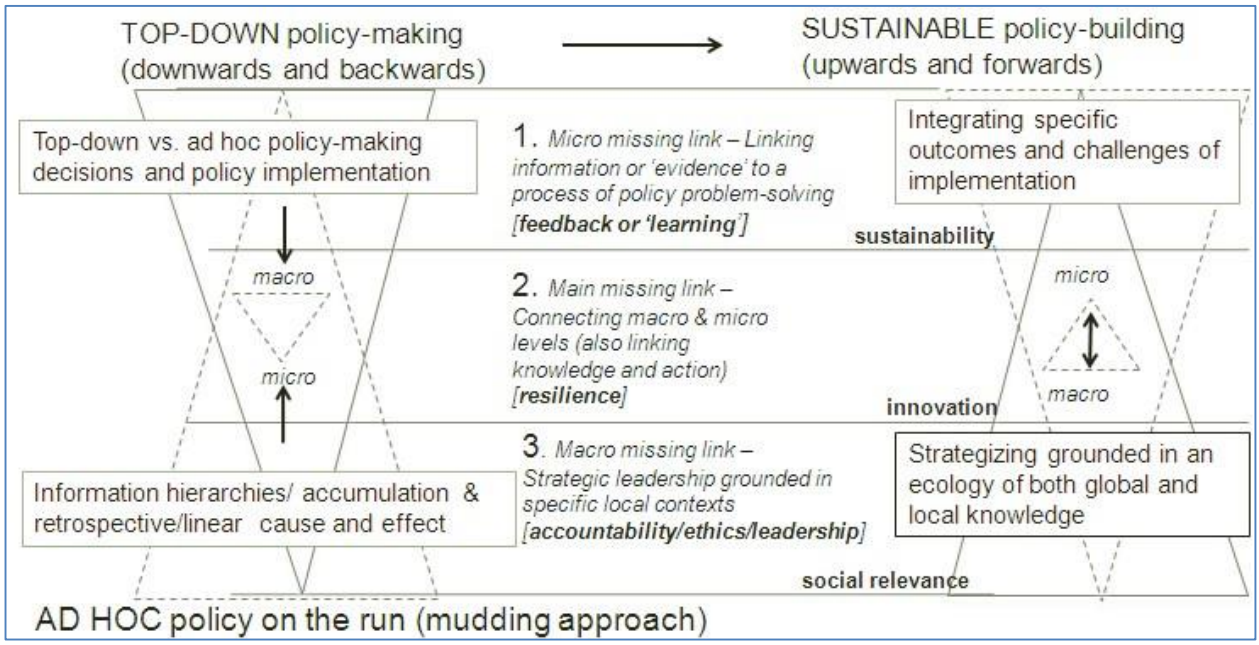
We believe that these related international developments may be convergently interpreted to represent a paradigm shift from the dominant modern paradigm of science and technology referred to at the outset of this paper: an alternately positivist and mechanical concept of knowledge, an ideology of progress for its own sake, and merely self-interested privatization linked to commercialization. In contrast emergent notions of 'science, technology and innovation' increasingly tend to emphasize the futures-oriented and ecological perspective of a global knowledge society trying to reconcile private sector enterprise and public standards of accountability. As Friedman (2007) and others have pointed out, the future promise of 'green technology' (and related scientific enterprise) to achieve socially as well as environmentally sustainable development solutions is increasingly being led by a private sector recognizing new opportunities for innovation in a new emergent 'win-win' paradigm of development. This associated reconciliation between the inherent human capacity for innovation as well as problemsolving on one hand, and on the other economic principles of privatization and marketization (as distinct from 'growth' for its own sake) is crucial because of the enveloping global as well as local policy paralysis of government bureaucracies around the world.

Such a development recognizes the renewed importance of ethics and social accountability as critical and central policy requirements in the various related debates which today are inevitably linked to the application as well as study of science and technology. In light of the global challenge of climate change and increasing requirements to evaluate 'environmental impacts', all scientists and technology developers need to be aware of new or emerging policy requirements, imperatives and initiatives to ensure approval and funding support for undertaking research and development. In this way they have a much better chance to influence governmental policymaking and corporate research and development initiatives. 'Science, technology and innovation' policy research is thus in many ways an exemplary as well as useful concept for addressing and overcoming the traditional either-or gap between pure and applied 'science and technology.

A similar paradigm shift in policy studies is being called for (e.g. Giddens, 1998; Mowery, Nelson, & Martin, 2009; Ramo, 2010) to seek out innovative, sustainable and socially relevant design solutions to the myriad policy challenges confronting the world at both local and global levels (Moss, Farrington & Rew, 1998; Friedman, 2009). We have elsewhere discussed how the typical conflict between top-down and ad hoc or 'muddling' approaches to formal policy development, planning and decision-making typically represents a negative or vicious cycle of inevitable failure and policy paralysis as much as it also does the either/or thinking of a particularly modern notion of scientific knowledge-building (Richards, 2011d). In contrast we have outlined the requirements and rather 'upwards and forwards' (rather than downwards and backwards) approach to strategic policy building as a mode of problem-solving. In other words, policies should not only provide a sustainable connection between knowledge and action but involve forms of research or study which are directed at design solutions to policy challenges. When this is effectively done a negative policy cycle may be transformed into a constructively positive strategy. Such a model usefully re-frames dominant models of public policy research based on the retrospective study of past policies or (in imitation of positivistic science) the selective use of evidence-based policy research (Nutley, Davies, & Walter, 2002, Parsons, 2002).

A convergent framework recognizes that the related macro, micro and interactive functions of *interdependence* (or *accountability*), *feedback*, and *resilience* are as much the strategic requirements of effective policy-building in social contexts as they are of natural systems (materials, biology, energy, etc.) in science and technology studies (Easterly, 2006). Ramo (2010) has proposed that the main priority of policy-building should be to instill a general or generic *resilience* in individuals as well as particular industries, organizations or other local contexts as well as the global community to develop or evolve in the face of the unexpected and the associate 'threshold of change' which functions as the convergent axis of self-organizing systems: 'Resilience will be the defining concept of 21st Century security, as crucial for your fast-changing job as it is for nations… think of resilience as a measure of how much [change] a system can absorb before it… snaps' (Ramo, 2010, p.172). This advice dovetails with the insights of Easterly (developed in relation to the failure of Western Aid programs) that 'downwards and backwards' policy making generally tends to fail because of the lack of either *feedback* or *accountability* (Easterly, 2006). Thus Figure 6 outlines a framework for not only recognizing the distinction between but also a prescription for going beyond past failures of policy-making to achieve more sustainable future policy-building. It does so in terms of a related view of the interdependent rather than conflicting relation between macro and micro domains of any particular knowledge system or policy initiative – that is, any specific knowledge-building process involving planning and research or decision-making.

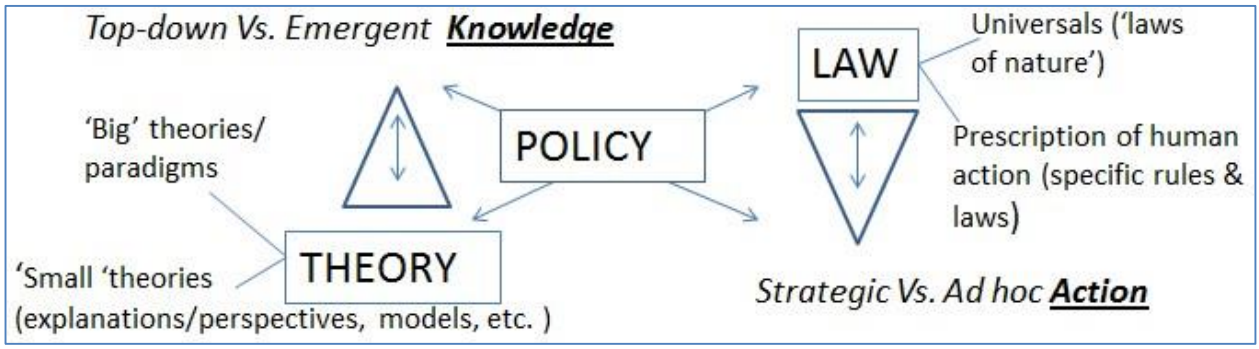
Figure 6. From top-down vs. ad hoc policy-making to sustainable policy-building



Adapted from Richards (2011b)

Figure 7 further outlines an even more specific framework for re-discovering the inherent as distinct from procedural role of ethics in science and technology. The basis for locating policy at the intersection of theory and law lies in how an integrated definition of the term (to refer to either a strategy of action or principle to guide decision-making, plans, and actions) that goes beyond the public policy perspective of governmental agencies to also include various 'smaller', more informal and applied decision-making and planning - ranging from the informal strategies of every individual and all forms of organizational decision-making through to the more formal *policy and procedures* of various forms of social, professional and corporate or commercial institutions. 'Policies' in this more generic sense of the term include both aspects of theory and law but are mostly important in their own right in terms of the strategic actualization of the link between knowledge and action. That is, a problem-solving orientation provides the link between the macro level of organizing or 'big' theories on one hand, and on the other the micro level of reflective generalization in terms of either an inductive or 'hypothetico-deductive' basis. Conversely, micro dimension policies often function as or even use laws to direct people's action or conduct. Thus Figure 7 serves to depict how a generic notion of 'policy' links the strategic function of law to meaningfully frame human conduct or action and also the emergent function of theory to likewise innovate as well as sustain global networks of local knowledge ecology.

Figure 7. Human policy-building at the macro-micro intersection between theory and law

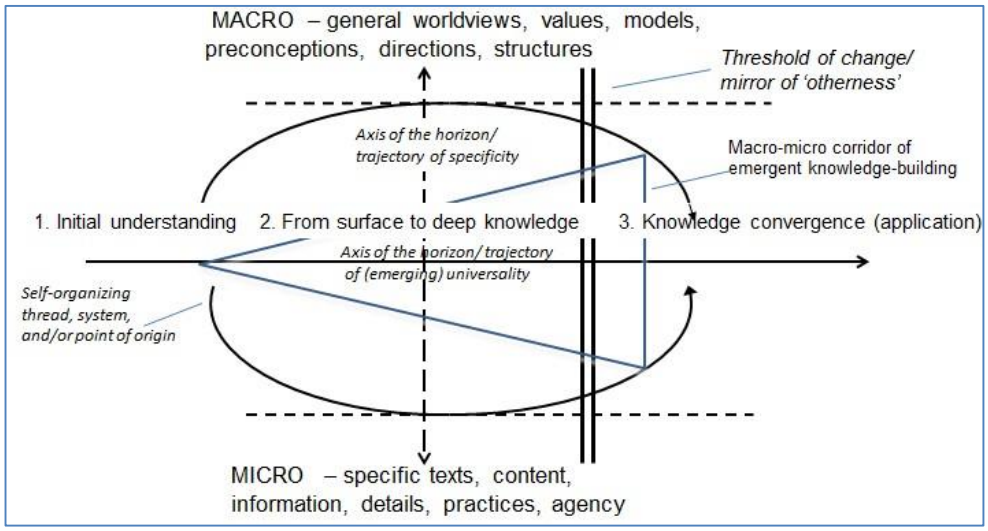


In both macro or micro senses of the term 'policies' transform the gap between knowledgebuilding theories and legal prescriptions of human action in terms of the perpetual human negotiation of past and future. Figure 8 represents a fuller picture of the essential anatomy of any (self-organizing) human knowledge system – ranging from traditional to modern/scientific on one hand, and on the other applicable to both individual/cognitive and collective/social processes of knowledge-building. It develops further the earlier complementary distinction and potential for convergence between 'internal' and 'external' axes of knowledge orientation, symmetry and organization. It posits a related distinction between axes of universality and specificity organized around alternately (or simultaneously) collective or virtual and individual and concrete notions of the body in space and the mind in time..

The emergent trajectory of the axis of specificity in knowledge systems is most usefully understood as an interdependent interplay of macro and micro aspects. The usefulness of the macro-micro framework of interpretation is exemplified by Giddens' adaptation of this in sociology to describe an interdependent interplay of social structure and individual agency. On such a basis Giddens (1998) envisaged an often misunderstood 'third way' emerging out of the intersection between tradition and modernity to 'help citizens pilot their way through the major revolutions of our time: globalisation, transformations in personal life, and our relationship to nature'. On one hand there are the macro directions or aspirations of specific and shared or corroborated knowledge structures, values, and preconceptions. From an ecological rather than top-down or ad hoc perspective the macro dimensions of the knowledge-building process need to be appreciated in terms of the related micro details which are to be found, described and interpreted in the particular forms and aspects which make up the whole as an interplay of time and space, cause and effect, and open and closed systems. Thus the paper has proposed that an

'upwards and forwards' or emergent notion of human policy-building represents an inherently ethical stance or practice applicable to a related new science and technology paradigm.

Figure 8. The generic anatomy of a human knowledge system



This can be further appreciated in terms of how the inherent strategy and inevitable requirement of 'problem-solving' also represents a key to productively dealing with the endless ethical dilemmas which constitute the human condition. In other words to the extent that 'policybuilding' might be said to be generically synonymous with the human capacity for applied problem-solving it is also arguably also the key to the most effective or optimized building of a human knowledge system. When the stage for decisions and action comes, mere 'theories' are no longer enough. A similar insight was developed by Schon & Rein (1994) in their exploration of

'frame reflection' as the key to the resolution of 'intractable policy controversies'. Schon & Rein's use of the term particularly refers to situations or examples where there is a clear gap between selective evidence and contested policy decisions. But the model is equally useful to address those endless individual and social dilemmas (from *small* through to *big* 'policy') where such a gap is confused or muddled. The process of frame reflection in many ways exemplifies the optimizing strategy of Socrates' elenchus method for dealing with 'aporia' or difficult practical as well as conceptual problems. Thus the trajectory of the axis of universality is most usefully conceived in terms of three basic stages of knowledge building which serve to organize any process of knowledge construction or inquiry (including naïve and critical as well as dialogical modes) as a self-organizing system. As Ricoeur appreciated, the practical wisdom of 'optimal' policy-building as well as learning and other modes of knowledge building (including scientific knowledge and technology development) can be approached or proximately achieved in practice in terms of the alignment of an interplay of macro and micro strategies with this larger universal axis.

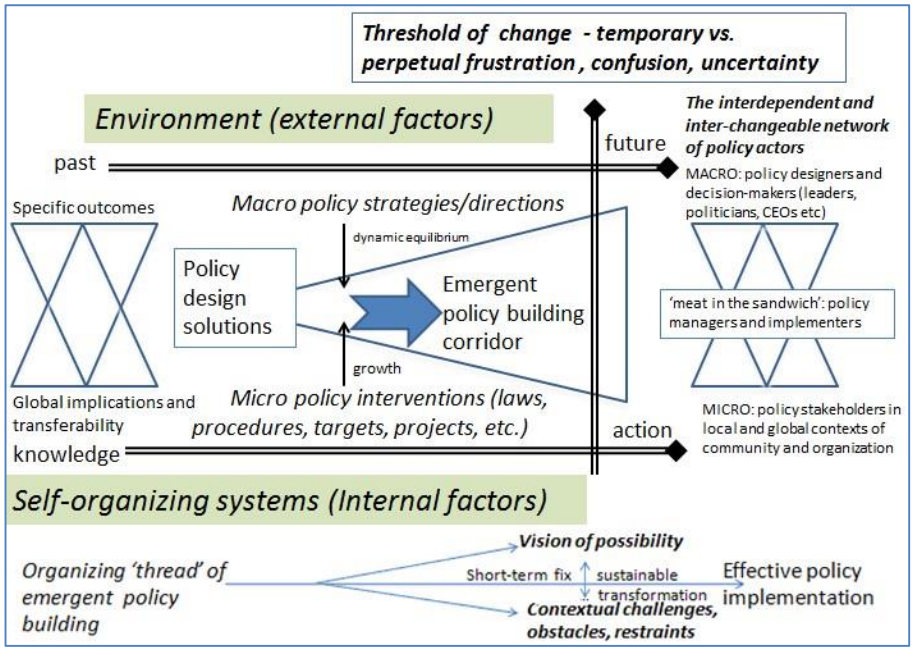
As also epitomized by how human are inherent problem-solvers who also perpetually deal with ethical dilemmas, 'intractable policy' dilemmas are perhaps ultimately an intrinsic condition of the policy-building process and more obviously so in 21st Century contexts of a growing global sense of economic and environmental crisis one hand, and organizational policy paralysis, cultural fragmentation, and social conflict on the other. In terms of both macro and micro policy contexts

in various organizational as well as governmental or public policy contexts, Schon & Rein thus focus on the potentially dialogic or negotiated connection between the different frames or perspective of all the 'policy actors' involved. Such a view resurrects Kurt Lewin's idea that a distinction can be made between the positive or negative condition of the inevitable macro and micro 'interdependence' of actors within any group at either local or global levels.

This can be further clarified in terms of the internal and external axes of correspond to the related and interdependent *leadership and learning* functions of accountability and feedback in the design and/or development of solutions to any particular or general policy challenge (including ethical dilemmas). In other words – reflecting the deep-level educational purposes of Socrates' elenchus method – the most effective leaders and teachers (as well as scientists and technology developers) aim to achieve an *emergent corridor* of knowledge building in their efforts to link or reconcile macro and micro aspects. As indicated earlier this process reflects how an applied problem-solving approach to knowledge construction in practice overcomes and transforms the self-defeating limits of 'either-or' thinking. Thus the most effective policy-builders dynamically balance the interplay of macro directions, aspirations and desired outcomes on one hand, and the micro policy interventions of particular 'carrots or sticks' (laws, procedures, targets, projects, etc.). In this way optimal policy-building (like 'optimal learning' and related modes of knowledge-building) might be understand as an ecological process which at both the macro and micro level alike involves a productive interaction between necessary and sufficient causes (as well as conditions) rather than the typical oppositional delineation between rational necessity and ad hoc contingency.

Figure 9 also outlines the inevitable interplay of macro and micro aspects and elements in the design, management, and implementation of any policy direction and strategy. There is a corresponding knowledge-building pyramid in which 'policy managers and implementers' naturally mediate (i.e. as the 'meat in the sandwich') between the top-down positioning of 'policy designers and decision-makers' (leaders, politicians, CEO's, etc.) and the bottom-up interests and contexts of 'policy stakeholders' (i.e. civil society or the public at large in local or global contexts of community and organization). In the transition from a hierarchical framework of the past to a future networked society model (e.g. Castells, 2000), this inevitable interplay is also the basis for anticipating, recognizing and accounting for the *interdependent* and also *interchangeable* nature of the intrinsic relation between these macro and micro aspects and elements, between functions of leadership and learning, and between policy designers and decision-makers and policy stakeholders. In the network society model, each individual and group are not only inextricably and interdependently linked but retain their relative autonomy or agency and thus 'interchangeable' responsibility for feedback, accountability and global as well as local resilience (e.g. Rutland & Aylett, 2008).

Figure 9. The emergent corridor of sustainable, innovative, and socially relevant policybuilding solutions



In the model of 'convergence and emergence' (as Bunge puts it) innovation and sustainability are reconciled in terms of a systems model which similarly reconciles the alternate principles of growth and dynamic equilibrium. As discussed earlier, modern science and technology has been informed by the alternate rationale of an ideology of progress on hand, and on the other rational de-contextualisation (i.e. non-dynamic equilibrium). Such a systems view as outlined by Bunge and others thus corrects the upside-down view of knowledge in the positivistic rational vs. ad hoc conception. Likewise versions of innovation theory which recognize and encourage emergent 'life-cycle' models of technology development (e.g. Rycroft & Kash, 2004 **)** have dovetailed with a similarly emerging 'design research' paradigm (e.g. Design-Based Research Collective, 2003; Richards, 2011c) to provide similarly more productive frameworks of inquiry, experimentation and project development also along the lines of the principles of self-organizing systems. As Moore (1999) has pointed out, the famous Everett Rogers model of the innovation (and technology) adoption lifecycle is not really a linear process of diffusion but inevitably involves a gap between initial vision and viable uptake (i.e. a 'threshold of change') which needs to be crossed in relation to new ideas and products entering what have earlier referred to as a generic corridor of emergence. A particular useful exemplification of this process in relation to the link between the macro directions of technology policy and the micro aspects of innovation development is Sagar & Van Der Zwaan's (2006) study of technological innovation in the energy sector.

Conclusion

The inquiry of this paper has explored and developed two related proposals in particular. The first is that at the beginning of the 21st Century and in light of the widespread and increasing challenges facing human and other life on earth, there is a basic need as well as growing aspiration around the world to rediscover the role of ethics in science and technology as in various other domains of modern life in terms of the related challenges of social, economic and technological progress. The related proposal is that in the generic sense of focusing on the challenge of better linking human knowledge and action, policy studies represents an exemplary focus for locating or framing the renewed role of ethics in science and technology. Thus we have developed this proposal in relation to the convergence of different kinds of human knowledge system reflected by the common three pillars of a related paradigm shift in the concept of science and technology on one hand, and on the other the very notion of policy studies – that is, in terms of the integrated principles of innovation, sustainability and social relevance as the keys to the most productive or optimal knowledge-building.

Likewise the paper has articulated and developed the related idea that we can go beyond a merely procedural view of ethics in modern science and technology in relation to how the interdependent functions of accountability, feedback and resilience are the key to effective policy-building as well as effective 'leadership and learning' in various other kinds or modes of knowledge-building. It has done so in relation to the three sections of the paper which have further explored the various emerging knowledge convergences which require as well as reflect a larger integrative convergence between ethics, policy, and 'science and technology'. The first section proposed that a 21st Century convergence between traditional and modern notions of ethics is a particularly useful and indeed necessary dialogical foundation for a deep-level renewal or rediscovery of ethics in scientific knowledge and technology development. The MIT proposal of an emerging 'convergence science' was explored in relation to the work of Jeremy Rivkin (and in particular his concept of a 'Biotech Century') as an exemplary basis for recovering or recognizing afresh the inherent 'ethical compass' which should inform all forms of human knowledge-building – along the lines of self-organizing systems in every domain of nature.

The third section of the paper explored more fully the applications of a convergent ethics in terms of the common pillars of innovation, sustainability and social relevance reflect reflected associated paradigm shifts in the concept of 'science and technology' on one hand, and on the other the generic model and aspiration of 'policy studies' as a focus for restoring a globally optimal as well as convergent model of human knowledge-building in the future. In these ways the paper has outlined how a policy studies framework for appreciating how an emerging new paradigm of science and technology can provide a renewed foundation for re-discovering, for appreciating, and for encouraging the importance of personal and collective integrity and accountability beyond a merely procedural notion of ethics.

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