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Phenomenological Turbulence and Innovation in Knowledge Systems

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ABSTRACT *Most considerations of knowledge management focus on corporations and, until recently, considered knowledge to be objective, stable, and asocial. In this paper we wish to move the focus away from corporations, and examine knowledge and national innovation systems. We argue that the knowledge systems in which innovation takes place are phenomenologically turbulent, a state not made explicit in the change, innovation and socio-economic studies of knowledge literature, and that this omission poses a serious limitation to the successful analysis of innovation and knowledge systems. To address this lack we suggest that three evolutionary processes must be considered: self-referencing, self-transformation and self-organisation. These processes, acting simultaneously, enable system cohesion, radical innovation and adaptation. More specifically, we argue that in knowledge-based economies the high levels of phenomenological turbulence drives these processes. Finally, we spell out important policy principles that derive from these processes.*

Keywords: complexity theory, knowledge management; knowledge systems; public policy; self-organisation; self-referencing; self-transformation.

Introduction

In economics and management, change has tended to be treated simply as 'difference', as if change were a category that exists without reference to other socio-economic features such as stability and inertia. Change is not only about difference however, it is about processes of 'becoming' with long and at times obscure, cause-and-effect patterns that extend deeply into history, geography and culture.[1]

Therefore, our approach is to not look at change (or innovation and creativity) as the unit of analysis, but at the growth and decline of systems—in this case, knowledge systems. This task is more complex in knowledge systems because one must go beyond material (say, technological) change and quantitative analysis,[2] to consider fluctuating beliefs, values, sentiments, and so on, the source of phenomenological turbulence. For example, it may be useful to consider not

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simply the act of buying (consuming), but also consumer sentiment—a mix of awareness, attitudes, values, intuitions, fears, desires, emotions, etc.—which comprises one part of the phenomenological conditions in which we are interested. We need, in other words, to consider the phenomenology of knowledge systems.

The term knowledge system can be applied to nations, regions, industries, firms, and even individuals. Smith[3] suggests that:

> The overall innovation performance of an economy depends not so much on how specific formal institutions (firms, research institutes, universities, etc.) perform, but on how they interact with each other as elements of a collective system of knowledge creation and use, and on their interplay with social institutions (such as values, norms, legal frameworks, and so on).

Knowledge systems, then, are not simply collections of data and information, although data and information are part of such systems. Knowledge systems are also systems of ideas and meanings—the nature of such a system is that actors must apprehend the meaning aspects of the system subjectively. Moreover, because such systems derive or create new meanings from the way one person's meanings are related to others' meanings, the system is inter-subjective in nature. Consequently, in an inter-subjective human system, imperfect and idiosyncratic awareness (consciousness) is a further complicating factor. The precise combination of inter-subjectivity and awareness (the phenomenological) is to a large degree indeterminate, transitive and capable of considerable fluctuation or turbulence.

It is well known that turbulence occurs in fluids under acceleration and results from the aggregation of various modes of oscillation. In economic systems, these modes of oscillation are regarded as deriving from new technologies, new industries and the coupling of economic systems through trade. However, new knowledge, changing beliefs, values, etc., should also be considered as modes of oscillation. This is what we call phenomenological turbulence. Hence, fluctuations in consumer sentiment, voting patterns, capital market behaviour and so on are all examples of phenomenological turbulence in knowledge systems. We argue that the social sciences generally and, more particularly, economics have inadequately understood phenomenological turbulence at the macro socio-economic level. Elsewhere[4] we have described a complex systems model of change in knowledge systems. In this paper, we go beyond that description and further develop the idea of the phenomenology of complex systems, by addressing in more detail how different knowledge systems are selected in an evolutionary sense and the role of system identity in that evolution.

The Phenomenology of Knowledge Systems

The idea that a system exists in relation to its environment is a widely accepted part of thinking about change in systems in general, and in knowledge systems in particular.[5] System environments can be categorised, after the original work of Emery and Trist,[6] by their causal texture. Thus, for instance, a system's environment can be understood to be simple and stable. Change still occurs within stable environments: systems may grow and decline according to structural and functional imperatives, or may face environmental change. A number of dimensions are relevant to describing such change. For example, Emery and Trist spoke of the number and placement of goals and noxiants as key characteristics of

the environment a system faces (one could also use the term 'opportunities and threats'). As the opportunities and threats shift location and number, a system's responses are accordingly affected. Finally, environments may be subjected to change in both the location and timing of noxiants and goals, or what Emery and Trist characterise as turbulence.

This model of change in a system is certainly useful. It is arguable, however, that it is inadequate to describe the changes that are currently affecting knowledge systems. Innovations in knowledge often proceed from unprogrammed activity: new ideas and breakthroughs are not completed to order, creativity often proceeds unpredictably,[7] knowledge development proceeds in networks of dense connectivity, and boundaries between knowledge domains do not last long.[8] It is, paradoxically, also true that innovation also requires some stability and security in the form of such things as organisational structure, discipline and focus. We posit six ways in which the traditional view needs to be updated to explain what might be called the phenomenological turbulence that knowledge systems must navigate.

Subjectivity

The first inadequacy of the traditional view is that environment changes are thought of as being objective changes. Primarily, this is expressed in terms of rates of change of, for example, economic indicators, or social demography: describing the education completion rate of the population, or the success rate of new enterprises, for example. We assert, however, that in addition to objective characterisation of a system's environments we must also consider the phenomenological, subjective and intersubjective meanings of environment changes. For example, immigration is an issue not simply described in numbers, but also in the meanings the electorate gives the process in any one era. Or, consider the shift in phenomenology, (not in youth demographics) that lead to the Levis Jeans company, once the cultural symbol of choice for the youth market, missing the next shift in 'cool' and struggling in the market place.[9] In knowledge systems, then, events thought to be opportunities may become threats and threats may become opportunities. For example, in a stable environment seeking to maximise efficiencies, deviations in process are threats, but in a changing subjective environment they may become sources of innovation.[10]

Moreover, the phenomenological complexity of knowledge environments may make the perception and recognition of opportunities problematic or even disguise them.[11] For example, knowledge production environments comprise terms such as 'negative growth', 'downsizing' and 'outsourcing', linguistic distortions that serve to obscure and euphemise; they deny the realities to which they simultaneously refer. The elimination of words—indeed, whole ways of thinking—from the social lexicon similarly acts to maintain the public invisibility of outcomes. If, for example, ethical concepts are displaced by purely economic ones, the erosion of ethical practices becomes less detectable.[12] Innovations in communication technologies, in particular, have added to the complexity of meaning environments, and not only because of the delivery speed, complexity and scope of the information they present.[13] In addition, these innovations change the context of the presentation of information, reversing private and public contexts (for example, the consumption of pornography at work, the accessing of a library catalogue from one's bedroom). New genres (email) are invented, and notions of

the authority of information sources challenged. The Internet is perhaps the most potent symbol of phenomenological turbulence. Overall then, the simple location and duration of opportunities and threats is inadequate for describing the real environment human systems face. The environments we inhabit are socially constructed domains of great linguistic and conceptual complexity, interrelatedness and at times, fluidity. A human system's environment is thus not made up only of objective opportunities and threats, but issues, attitudes and, more broadly, the subjective cultural connotations of each and every event.

Interconnectedness

The second aspect of complex turbulence to be considered is the degree of interconnectedness between the elements of a system's environment. This interconnectedness is much denser than has been assumed in traditional systemic descriptions.[14] Shifts and effects in one part of the system can quickly cause effects in another section and these systems may not necessarily be co-located geographically:

> Today the world is more like a cacophonous city, connected in a million ways. Continents are crisscrossed with roads and railways, airports and distributions centres. Telephones, computers, faxes, television sets, mobile devices, even electronic tags on consumer goods or clothing can all be connected together, so the world sometimes seems like the marketplace of a medieval city, a buzz of messages, letters, newspapers, complaints and requests, small advertisements and bombastic slogans.[15]

Monetary systems, for instance, are complex and dislocated in conventional senses of geography yet are accepted as being highly interconnected.[16] Change in one currency affects change in another. Similarly, events in one part of the world can send tremors through another. Terrorist activity—part of the political sphere—can dramatically affect the economics of tourism or airlines anywhere on the planet. For organisations and businesses, the interpretive communities that were once distinct now overlap (for example, the roles of shareholders and staff, once independent stakeholder groups, now often overlap). Explosive growth in information is associated with the growing importance of connectivity. Interconnectedness is important because it facilitates the establishment of networks of mutually adjusting and mutually beneficial relationships between nodes (firms, individuals) of the network.[17] That is, the presence of a critical mass of users is basic to network usefulness and affects not only diffusion and failures, but also the value of the network through network externalities.[18] One of the economic characteristics of information is that the cost of producing it is independent of its scale of use: greater use of information increases economic return.[19] This interconnection not only requires physical links but also a shared language and set of understandings for participation.

The Fragmentation of Meaning

The third dimension of complex turbulence is the increasingly fragmented nature of the meaning environment, even as interconnectedness grows. Indeed it is interconnection that may be at the heart of the problem of multiple meanings.

While meaning systems existed in isolation, they could act as though their consensus was universal. Now, it is rare for events to have one agreed, universal meaning; they are subjected to multiple meanings. For example, multiculturalism is a feature of most societies. Even within a single organisation multicultural workforces are increasingly common. This is especially true in global corporations. And even within monocultures the variety of meanings represented has increased as overarching universal beliefs have given way to a multitude of local interpretations. Meaning fragmentation is not just a feature of ethnic difference but manifests in many social cleavages. Hence, rapid technological and cultural 'turnover' means that generations are truncated and see the world in different ways.

Non-linear Change

Fourth, change in the environment of knowledge systems is increasingly non-linear.[20] Linear change proceeds by regular increments at regular intervals. Non-linear change is characterised by irregular progression or regression so that both growth and collapse become features of the changing environment. In other words, change is not a uniform process. Change can have many different qualities and many qualitatively and quantitatively different change processes can occur simultaneously. In fact, environments cannot be exclusively thought of as complexly turbulent: rather, complex turbulence co-exists with stability. Thus, change and non-change co-exist within systems and within environments.[21] Rapid acceleration and deceleration of phenomena are common, especially in the world of digital technologies. Unlike many technologies, digital technologies do not have stand-alone functionality. Utility requires connection with others. Thus, because usefulness depends on reaching a critical mass of connected users, technologies can have very rapid take up paths, (as well as collapses when critical mass is not reached).

Relationship to Environment

The fifth dimension of complex turbulence is that system and environment may no longer make sense as separate entities.[22] The environment of each system is made up of other systems, not by some amorphous field,[23] and the boundaries between systems are porous. For example, should customers be seen as part of the environment of a business or as part of the business itself? Moreover, all related systems are proactively seeking to create their environment, while at the same time responding to it. Allen[24] suggests, therefore, that change should not be viewed as progress in a given landscape, but as the creation of the landscape itself. For example, changes in one organisation can directly cause change in competitor organisations and even the notion of competitors must be continually renegotiated as competitors become collaborators to compete together in new alliances.

Change as Emergent

The final reconceptualisation that is required is that of causality itself. Systems thinking—as we have noted here—speaks in terms of causes, implying that events or changes are caused and can be predicted. In fact the behaviour of knowledge systems is often unpredictable or emergent:

> Emergent structure is not only an outcome, but may also influence future events making possible the evolution of qualitatively different kinds of systems. This can occur both through the influence of emergent phenomena on the paths, such as the effect of culture on individuals and through the emergence of entirely new dynamics within the system.[25]

Like ecological systems, knowledge systems demonstrate multiple causal pathways, and are influenced by a host of interacting factors that come together to determine different patterns of equilibria.

These six factors describe what we mean by the term phenomenological turbulence. Their description (for example in terms of non-linearity, emergence and boundary porousness) provides grounding for the next part of our analysis, namely the formulation of an understanding of knowledge systems specifically as complex systems. The foundational ideas of complex systems thinking have been explicated elsewhere.[26] Here, we will attempt to apply complex systems thinking specifically to knowledge systems, building an argument from first principles, without assuming too much knowledge of complex systems on the part of the reader.

The Trajectory of Systems in Complex Turbulence

Knowledge systems, be they individuals, firms, industries or whole economies, have to 'plot a path' over time through the complex and turbulent phenomenological landscape we have described above. There are four distinguishable possibilities for systems as they evolve through time. First, they can remain essentially the same. Second, they can change via adaptation, in response to change in their environment (for example, via growth and decline or minor modification of their processes). Third, they can transform themselves more radically (for example, by innovating new processes). Finally, although we will not pursue it here, they may cease to exist altogether.[27] While we acknowledge the difficulties of analysis by analogy and that different metaphorical extensions sometimes result in confusion,[28] we suggest these four options have been described in complex systems theorising about social systems[29] as:

1. self-referencing;
2. self-organisation;
3. self-transformation; and
4. extinction.

The idea of self-referencing grows out of the theories of autopoiesis. Autopoiesis is the term biologists Maturana and Varela[30] used to describe the processes whereby living systems reproduce themselves. Put another way, the theory of autopoiesis is a reconceptualisation of living systems, particularly in terms of system environment relations. A number of ideas already discussed above—such as questioning the notion of the boundary between system and environment—are incorporated in the term. However, for present purposes the aspect of autopoiesis that we wish to focus upon is the process whereby a system's identity is maintained over time—the idea of self-referencing. In this sense, self-referencing can be argued to be a non-evolutionary process in that it is a force for continuity. Morgan[31] describes the process as one in which:

> Living systems close in on themselves to maintain stable patterns of relations and it is this process of closure or self-reference that ultimately distinguishes a system as a system.

With reference to organisations, Morgan further suggests, 'organizations are always attempting to achieve a form of self-referential closure in relation to their environments, enacting their environments as extensions of their own identity'.[32] For example, a considerable amount of social and political agency is needed to stabilise identity and maintain relationships in knowledge systems. Thus we use the term self-referencing to refer to the way a system maintains its boundaries and asserts its identity in the face of environmental changes.

Self-organisation, on the other hand, is essentially adaptive and change oriented. Moreover, self-organisation is the term given to describe a process of communication between parts of a system that brings the system as a whole to new patterns of coordination and concerted common behaviour. Stacey describes mutual adaptation in the business setting in terms of 'the spontaneous formation of interest groups and coalitions around specific issues, communication about those issues, cooperation and the formation of consensus on and commitment to a response to those issues'.[33] Self-organisation is essentially, therefore, the adaptive response of *existing* subsystems to new *environmental conditions*; a fundamental survival feature of self-organising (knowledge) systems is communication between elements of the system. In order to self-organise, information regarding changes in each sub-system must be passed back and forth between sub-systems so adjustments can be made.

An example of self-organisation in the knowledge era is the rise of networks of relationship across industries and supplier–customer webs.[34] There are a number of reasons for this. First, the rate of change of the meaning of knowledge means that knowledge intensive organisations will need to be able to respond appropriately, developing extensive communicative networks for gathering intelligence. Networks are ideal information resource allocation mechanisms, and provide horizontal links that cut across institutional boundaries.[35] Networks also help create adaptive information, because they encourage the rapid building on and juxtaposition of ideas.[36]

This view of self-organisation is also consistent with recent theorising that has questioned neo-classical accounts of modern economics. Thus, for Paquet:[37]

> an economic system is a set of conversations, rationales, protocols, conventions, organisations and institutions providing the coordination and orientation maps to ensure a viable process of production, allocation and distribution of goods, services and information for a population. It can also be defined as the communication system that underpins this process of coordination of production and exchange.

Paquet further argues that a new paradigm of economic activity must 'ensure that the centrality of cognition as a neural and social process is factored into the analysis'.[38] Here, too, considerable social and political agency is needed to do the self-organising, coordinating, communicating and adjusting, and policy should be concerned with facilitating and undertaking these activities.

Finally, in contrast to both self-referencing and self-organisation, self-transformation, as we are defining it,[39] is inaugurated independently of the pre-existing

relationships between parts of a system, independently of any pressure from the environment, and independently of a system's self-referencing tendencies.[40] In considering change, Allen distinguishes between deterministic processes, self-organising processes and evolutionary processes. Evolutionary processes, the inspiration for our term self-transformations, are not just adaptive (like those of self-organisation) but genuinely novel. The distinction between self-organisation and self-transformation is an important one because both involve innovation, in the lay sense of that term. By way of explanation, consider that human beings and social systems change in two distinct ways. First, change may be driven exogenously, that is, by factors outside the person or system. For example, a person loses their job suddenly, or an organisation benefits because a company it can do business with relocates near by. In this case, it makes sense to think of change as occurring in response to the environment or as an adaptation to a changing environment. Alternatively, change may occur endogenously—without cause or stimulus from the environment. Such change could occur simply because of the growth of a person or system—the unfolding of potential for development within the individual or system—the direction and sequence of development is latent within the system rather than within the environment. This type of change could, therefore, be thought of as an unfolding or a 'natural progression'. For example, an individual masters his or her fixed job requirements, becomes bored with the job and moves on. Novelty seeking, curiosity, or even serendipitous mutation could stimulate other forms of endogenous change; for example, a company may invent or accidentally discover a new product or process. People and systems are changing all the time, endogenously, regardless of their environment. And, people or systems may develop in one direction even when the environment dictates development in another. For example, a student may become fascinated with sculpture and pursue this even when the labour market for sculptors is not buoyant. A political party may become increasingly ethnocentric even while its broader constituents are becoming tolerant of multiculturalism.

Self-transformation, as we are using the term, refers to change that occurs endogenously. The system analogues are new products, ideas, services or firms that arise endogenously and then exert an adaptive effect on other participants in an industry.[41]

Of course, the tendency to split endogenous and exogenous change, or indeed to seek the pre-eminence of one over the other, is ill-founded.[42] Discussions of change that focus on environmental adaptation often ignore the endogenous processes that might well create the innovation needed for change to occur. Alternatively, an emphasis that ignores the environment can be equally dangerous. Success within the environment (that is, selection) is ultimately necessary for endogenous changes to endure. Therefore, both processes are ongoing in the life of a system. Moreover, self-referencing, self-organisation and self-transformation are not independent but coexist in all changing social systems.

Goodwin[43] suggests that, in evolutionary terms, it is the environment that selects which novel genetic attributes are amplified. Alternatively, we can say that, in self-organisation, it is not individual elements of the environment that select, but it is the system and the context within which change occurs that selects and creates new behaviours and attributes. In other words, self-referencing and self-transformation can be thought of as being at opposite ends of the system change process, with the former acting to maintain system coherence and the latter bringing about creative transformation. Self-organisation is sometimes used to refer to processes of

adjustment within the market, (as in self-regulation); the frame of reference in this paper, however, is a whole of social system view rather than just an economic perspective. In this context, self-organisation can be thought of as a mediating process between self-referencing and transformative processes. Innovation sets up the necessity for systems to adapt. To reiterate, avoiding destructive antagonism between self-referencing and transformative processes requires effective self-organisation.

These three processes have analogues in economic thinking that emphasise creative destruction in a free market (self-transformation) as being in opposition to governmental and other regulation that seeks to maintain coherence in the system. Bryant and Wells[44] note, for example, that variety and competition exist in a 'tense relationship'. Self-organisation occurs, in our terms, via negotiations, political processes, and other communicative and educative mechanisms of adjustment between different aspects of the social system as a whole as well as through price information via the market.[45] Policy choices can emphasise either innovation (via, for example, the reduction of trade barriers), or government regulation (via, for example, social or environmental regulation); in any event, self-organising processes will arise to make adaptations. For example, policies that emphasise global deregulation with attendant growth in economic activity but loss of employment, have given rise to democratic political movements to bring about adjustment of various kinds. A number of principles for policy-makers flow from understanding the three fold processes of innovation, adaptation and system cohesion.

Policy Principles for Innovation, Adaptation and Cohesion

Knowledge system change is best understood as complex system evolution[46] and, as such, is largely outside the direct control of individual agents (including policymakers).[47] Knowledge is socially constructed; it is about ideas and meanings that have evolved through social interaction and communication. These very acts are outside the control paradigm and introduce additional uncertainty and complexity. The point here is that order cannot be imposed externally on a system. Morgan, and Bryant and Wells[48] suggest that policy should be 'process-oriented, focusing on system design'. We argue that the key to this system design is to recognise that all three of the underlying processes set out above (self-referencing, self-organising and self-transformation) collectively constitute the vital processes of complex systems. That is, the fundamental role for policymakers is to shape and create contexts in which appropriate forms of self-referencing, self-organisation and self-transformation can occur so that desirable patterns can emerge. It is Morgan's view that policymakers may shape the parameters that define the appropriate context while allowing the details to unfold. In complex systems terms, policy-makers establish the attractors to create a pattern of operation that is sustainable. On other occasions, they may need to break a dysfunctional context by destabilising the established attractor and re-establishing the attractors via new parameters that establish a new context: 'new understandings can transform the autopoietic processes of self-reference through which a system produces and reproduces its basic sense of identity'.[49] This is important, because 'Complex systems seem to have a natural tendency [to fall] under the influence of different attractors that ultimately *define the contexts in which detailed systems behaviours unfold*'.[50]

Attractors are what define the context of a situation and provide the focal point for the definition of coherence and identity. Furthermore, according to Morgan, even small policy change can have large effects. The idea here is to search for achievable high leverage initiatives that can trigger a transition, or cascade of events that shift systems from one attractor to another. In a meaning based system that is sensitive to culture this is easier said than done. The experience of identity is itself phenomenological, and in a knowledge system it almost *is* the system. Thus, when considering changes in the policy settings, policy professionals must consider how they will change the systems identity and how the systems identity will either hinder or help those changes. This may be particularly true when we face choices between alternatives that create tensions within the communities of interest. That is, changes in social and intellectual identities, which by definition are profoundly phenomenological and central to knowledge systems, must be considered in the context of phenomenological turbulence surrounding identity issues. Policymakers may be able to identify the identity dynamics of knowledge systems and choices that are achievable and have long-term effects on the system as a whole. However, the questions remain, how do we make apparent, scrutinise and become engaged with the phenomenological realm? And to what extent is government involved in shaping the identity issues associated with cultural climate, national character or national sentiment and debates about them?

This thinking suggests that the neo-liberal doctrines of deregulation, privatisation and faith in the market are fundamentally flawed as policy principles for knowledge economies. One such flaw is that these policy approaches only concern themselves with the innovation process and ignore the needs of society for self-reference and self-organisation. But, more importantly, markets by themselves do not cope well with the fundamental features of the knowledge economy, namely: complexity and phenomenological processes. A market system copes best when problems are well defined, information is standardised, and when there is a low level of uncertainty. In the knowledge economy the level of difficulty of finding market values for intangibles may become unsustainably high because intangibles are not understood when they are seen in a purely economic (market) way. Erratic mobile phone pricing regimes in many countries and volatile capital markets are examples of the difficulty a market has in self-regulating in a complex information environment. Similarly, the market left to itself will not provide vision and direction because it lacks adequate information and communication about the system as a whole. As Bryant and Wells[51] demonstrate, the neo-classical market is an incomplete model that cannot rightly be said to be a good representation of a knowledge system.

Knowledge, consciousness, awareness, consumer sentiment and so on evolve over time. Campbell[52] argues that knowledge is formed through: '(a) Mechanisms for introducing variation; (b) Consistent selection processes; and (c) Mechanisms for preserving and/or propagating the selected variations'. More specifically, for the purposes of understanding how a phenomenological system evolves, Campbell argues that all animal species discover:[53]

> that the environment is discontinuous, consisting of penetrable regions and impenetrable ones, and that impenetrability is to some extent a stable characteristic. The animal has 'learned' that there are some solvable problems. Already the machinery of knowing is biasdly [sic] focused upon the small segment of the world which is knowable, as natural selection makes inevitable.

Furthermore, 'Lorenz, and many of the others, have argued that the mind has been shaped by evolution to fit those aspects of the world with which it deals, just as have other body parts',[54] and that:

> our central nervous apparatus for organizing the image of the world is adapted to the real world with which man has to cope. Just like any organ, this apparatus has attained its expedient species-preserving form through this coping . . . during a species history many eons long.

The question then arises, if such cognitive and phenomenological evolution occurs over a long biological time scale, how do we cope when change in the phenomenological environment occurs at an 'unnatural' rate? The question is an important one. Business and the media—through marketing and advertising campaigns, and other mass media conduits—seek to influence and alter the phenomenological conditions in which we live. An effect of this is that the phenomenological landscape today is perhaps too vast, too complex and too changeable to be known and acted on effectively (given the limits of our bounded knowledgeability) to create the coherence (self-referencing) and smaller time-scale adaptations (self-organisation) that are necessary for a system to have an identity. The competitive colonisation of the most intimate areas of human life, thought and human nature (sense of self and social and intellectual identity) has progressed quickly to a state that is unprecedented in history.[55] In this process, we have learnt to treat the phenomenological as increasingly abstract 'things' (resources, commodities) and to place them more than ever in the centre of commerce and production in the form of social capital, cultural capital, customer capital and intellectual capital. This assault on the sense of self and social identity of individuals and societies is likely to be unsustainable and this unsustainability is likely to be manifested in social and cultural dysfunction.

Commercial success in the pursuit of growth from exploitation at the phenomenological level is undeniable and Campbell[56] (if we substitute the term market research for science) presents a rather Darwinian explanation of it:

> The opportunism of science, the rushing in and rapid development following new breakthroughs, are very like the rapid exploitation of a newly entered ecological niche. Science grows rapidly around laboratories, around discoveries which make the testing of hypotheses easier, which provide sharp and consistent selective systems.

The sort of opportunism exemplified above is understandable in a competitive environment but it is also unsustainable in the case where the environment is changing—in evolutionary terms—too rapidly. From a policy perspective, this presents two sets of questions. One set is about competition to exploit the phenomenological realm of human activity, and one is about the way we have changed the phenomenological environment to suit commercial interests. These questions are not just of a commercial and economic nature, they are also ethical, cultural and social.

We assert that in knowledge systems policy principles are needed that will mutually enable the market, citizens, governments and firms to operate effectively in the transition to the knowledge intensive economies. Policy principles can be

derived from each of the component processes of complex system change, namely: self-referencing; self-transformation; and self-organisation.

In general the self-referencing function of policy needs to:

- reduce the risks of loss and harm;
- ensure that the social and economic implications for all facets of society are considered as we move towards a fully knowledge intensive society;
- help regions shape their own unique future based on their own circumstances and needs;
- build social coherence;
- maintain institutional and regulatory coherence;
- take a long-term view for the public interest and for building stocks of social capital;
- specify and conserve identity, fundamental assumptions and values.

Policy that encourages self-transformation should:

- consciously allow for sub-optimal frameworks that facilitate the indirect presence throughout the system of diverse points of view and even seemingly irrelevant knowledge, thereby bestowing long-term vitality and adaptive capacity on the system;
- create and maintain social and economic micro diversity;
- attract and seed new, local small business and new alliances between existing stakeholders especially in concert with traditional policies of attracting head offices and multinational enterprises;
- encourage innovation in a broad sense. Government can show leadership by innovating in the management of change and in the delivery of services. Crucially, there is a need to recognise the opportunity that technological change offers to redesign inadequate social institutions;
- transform identity by specifying possible new fundamental assumptions and values.

Policy frameworks that are directed at self-organisation in knowledge systems should:

- undertake institutional reform to lower transaction costs;
- facilitate access to skills and knowledge bases so as to enhance diffusion and promote learning;
- provide visions and processes for community transition via think tanks (anticipatory research and other participative strategies are important ingredients). Community–wide goals or visions for the future have already demonstrated their relevance in the Asia–Pacific region in, for example, Japan, Malaysia, Korea, and Taiwan;
- invest in human capital to enable capable participation in the knowledge economy. Investment in education and training activities, and facilitation of learning and communicating among key stakeholders, will yield long-term benefits;
- characterise and signal the direction and degree of the incremental evolution of identity and the fundamental assumptions and values of the system.

Conclusion

The boundaries of a system are always negotiable. That is, the system under examination is defined by the observer.[57] While it is true that economies can be considered to be systems (and be said to be self-organising, requiring no intervention or regulation), our analysis posits society—rather than the economy *per se*—as the primary system for analysis. Economies exist within society. Economies may be self-organising within their own boundaries but they require overarching legislative and institutional frameworks to enable this self-organisation to occur (in the form of legal, ethical, cultural and political systems). Thus the three mechanisms of a knowledge society (indeed all societies) are self-referencing, self-transformation, and self-organisation.

Policy frameworks are not determinative of these processes but in concert with other processes (technological change, ecology, operation of markets, political and military affairs and institutional processes), contribute to the operation of these mechanisms. Policy making is systems design, and policy development for a knowledge society must pay attention to all three processes.

It is our contention that policy frameworks tend to emphasise either self-referencing or innovation—at the expense of each other. Furthermore, we contend that an *adequate* policy regime for the knowledge economy will deal with issues of self-reference as much as issues of innovation. The tensions inherent in these two processes can be managed effectively by recognising and providing public support for the processes of self-organisation that will naturally mediate between self-referencing and innovation.

Phenomenological turbulence is a central aspect of knowledge systems, it is subject to the forces of self-organisation, self-reference and self-transformation. It is beyond direct control, and is intangible but cannot be ignored in the knowledge-related policy context. And, it can be influenced.

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