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**Creative Destruction and the problems of valorising Tacit Knowledge as an Asset Base in the Knowledge Economy**

In this paper we first outline the distinction between Schumpeter's theory of Creative Destruction and other theories of market mechanisms, both equilibrium and non-equilibrium. We then examine the concept of tacit knowledge, first in the specific form developed by Michael Polanyi, then in the wider senses of the term used by organisation theorists, some of which are seen to be related to Granovetter's "embeddedness". The "tacit knowledge" of the market which is the basis of the action of the entrepreneur in Schumpeter's first theory of creative destruction is contrasted with the corporate "R&D"-led approach outlined in his second theory. Tacit knowledge is related to the questions of firms' core competences and comparative advantage. In this context we examine developments in the investigation of implicit learning and distributed cognition as characteristic features of teamwork. We return to the question of the effects of "creative destruction" and other forms of market-led or technology-led innovation on stocks of "tacit knowledge" and other knowledge assets. Different theories of the working of competition also lead to different estimates of the importance and value of the tacit knowledge of entrepreneurs.

This paper is one of a series in which we are attempting to develop a political economy of the Knowledge Society drawing on Schumpeterian and other versions of evolutionary economics, transaction cost economics, Austrian-derived theories of entrepreneurial search, social capital theory, and contributions from system theory and media theory. The topics covered in this paper draw attention to the specific nature of the tacit knowledge of entrepreneurs in the context of different kinds of market processes. We hope to develop the arguments further in a number of papers which will apply the approach developed here to distinctions between the tacit knowledge of entrepreneurs and employees, and between the skills and knowledge involved in production processes and that involved in knowledge of market processes, which would in turn lead into the questions of how increasing the transparency of human capital accounting in regard to both explicit and tacit knowledge could lead to better mechanisms for relocation or retraining when knowledge assets are destroyed by the "gale of creative destruction".

**KEYWORDS:** Creative Destruction, Tacit Knowledge, Implicit Learning, Embeddedness, Core Competence, Competitive Advantage, Knowledge Asset, Technological Innovation, Market Innovation.

**KEYREFERENCES:** Boisot, Granovetter, Hayek, Kirzner, Nelson & Winter, Nonaka & Takeuchi, Penrose, Michael Polanyi, Porter, Reber, Schumpeter.

Why should we want to begin a discussion of the valorisation of tacit knowledge with a review of theories of competition? We could begin by investigating the different kinds of tacit knowledge in existence in different contexts and work towards a taxonomy and a mapping of the population of different kinds of tacit knowledge in time and on different levels of time and vectoral (here: sectoral or cultural) space. Instead we are attempting to identify particularly interesting problems around which to organise our investigations.<sup>1</sup> Theories of competition are meant to be models of how competition works in reality, although they begin by making a whole raft of abstractions in order to focus on specific aspects of reality (hopefully). We are picking up on this thread because we suppose that it might be possible to identify interesting patterns of association of different kinds of tacit knowledge with the workings of different kinds of markets. This would be useful enough if it allowed us to map tacit knowledges onto areas which appeared to exemplify the workings of different kinds of market mechanisms in parallel through time, that is, in different sectoral or regional groupings. Schumpeter's theory of Creative Destruction, in its development through his lifetime, adds two extra twists to this, in that he first suggests that there is a mechanism which leads the nature of markets to change on a cyclical pattern, and later suggested there might be some developments - essentially the 'industrialisation' of research and development - which might lead to a lessening of the power of these cycles. Finding out whether these cycles exist and if so whether their strength or frequency are really being affected by new developments would help us identify possible fields of application or opportunity for varying patterns of tacit knowledge.

Schumpeter is also associated with a special theory of the importance of one particular kind of skills, those of the entrepreneur. In his early work Schumpeter makes a unique distinction of the skills of the entrepreneur from those of the inventor, the manager, and the capitalist. Although any or all of these roles are often exercised by the same person, simultaneously or through time, Schumpeter alone has based his theory of the market and of profit and economic growth on drawing a very clear distinction between the capitalist and the entrepreneur. Capitalists are the owners of capital who invest on the basis that they retain any surplus and bear any loss. Their skill is in the choice between different kinds and levels of risk. Entrepreneurs are those individuals who are capable of both seeing the possibilities of what Schumpeter calls 'new combinations'<sup>2</sup> and of making them into reality by organisation and intervention. Schumpeter sees a symbiotic relationship between capitalists and entrepreneurs as the fundamental characteristic of western capitalist society: Entrepreneurs have the vision which allows the constant discovery of new sources of profit (which however are soon eroded by 'normal' competition Schumpeter 1934 p.132), while the demand of entrepreneurs for speculative but essentially productive investment calls into existence the mechanism of banking and stock trading which ensures that all available individual surpluses are mobilised.

In his later works Schumpeter appeared to accept the inevitability of socialism on the basis that the work of the entrepreneur was being increasingly absorbed into the corporation in the form of institutionalised research and development. On the other hand the work of the capitalist was itself in a parallel process being reduced to the decisions of banks or insurance societies, on the basis of their own institutionalised decision processes, to invest, directly or through the stock market, in one corporation rather than another. Schumpeter considered that these processes could lead to a lack of political will to maintain private capitalism. Some of his formulations suggested that the sources of technological innovation were themselves nearly exhausted (although in his extended treatment of this topic he vigorously rebutted this view, 1942 pp.. He also appeared to concede that the institutionalisation of research and development could lead to a spreading out of the introduction of innovations, leading to reduction of the power of successive waves of creative destruction.<sup>3</sup>

The purpose of this paper is to investigate the ways in which these considerations can be usefully drawn on to analyse changes in the patterns of skills, and particularly of tacit, implicit and shared knowledge, in the areas of entrepreneurship and innovation.<sup>4</sup> The debate about the 'Japanese' model

of the learning organisation can perhaps be seen in a different light when it is realised that the roles of the entrepreneur, who on Schumpeter's scheme is essentially an employee of the capitalist, can not only be exercised by a collectivity, in the form of a special research and development department, but by the entire workforce. At the same time we will try to identify some of the ways in which different patterns of market organisation and different ways of integrating the entrepreneurial activity will create and reward different kinds of tacit knowledge.

This paper will mention and discuss a number of economic theories. We do not regard this paper as itself making a contribution to theory. It is rather a pre-theoretical or conceptual attempt to establish taxonomies in a new area of investigation. The area with which we are concerned is that of skills. The kind of distinctions and classifications which we are trying to establish concern the skills of economic creativity, leadership and innovation in the widest sense. These skills may be exhibited, under a fully developed division of labour and roles, as those of inventors, entrepreneurs, capitalists, and managers. The skills of management may in turn be classified as those of the management of endogenous and exogenous change. Whether all of these skills will be embodied in separate persons and roles will depend on the wider systems of law and governance, patterns of the internal organisation of the firm, and the lifecycle of the individual firm.

### **Models of the Market Mechanism**

We will first outline the distinction between Schumpeter's theory of Creative Destruction and other theories of market mechanisms, both equilibrium and non-equilibrium.

In the first instance we may refer to the theory of General Equilibrium. In its pure form this model abstracts from many features of the real world such as imperfect competition, bounded rationality, the real costs of transactions and information, the institutionalisation of markets, and the ineradicability of ignorance and uncertainty. It nevertheless posits the real existence of a pattern of consumer preferences to which there is a real tendency, created by patterns of differential incentives, for producers to adapt. Allowing for the fact that consumer preferences are a moving target, this gives adaptation a direction and thus allows a definition of fitness. We are not here concerned with the criticisms of what equilibrium theory leaves out or with various attempts to make its assumptions more realistic. Instead we take as a contrast the Austrian school which posits that there is no pre-existing pattern of preferences to which entrepreneurial and competitive activity constitutes a path of approximation. The economy is a process in which preferences, needs, ends, and means are always simultaneously undergoing redefinition.

Nevertheless there are many regions of the real economy in which an approximation to the outcomes predicted by equilibrium theory may be found. These are generally areas such as raw materials, universal components, foodstuffs and some other basic commodities and services. These may be seen as markets within which it really is a question of meeting given needs with given means, while changes in factor supply, product demand, and technological innovations can be seen as external disturbances to which the market rapidly and easily adapts. There have been many studies of the real working of competition to create more-or-less optimal equilibrium outcomes in these kinds of sectors. This will give rise to a situation where the premium skills and knowledge will be those of detailed familiarity with both existing technologies and market structures, and familiarity with the finely graded qualities of the commodity in question<sup>5</sup>. Within this context the diffusion and assimilation of innovations will generally leave a core of previous practices unchanged and will thus not seriously devalue the formal and tacit knowledges embodied in existing patterns of activity.

In contrast with this we can outline the Austrian model of entrepreneurial search as a model of a market which does not merely adapt to external disturbances. The task facing each individual entrepreneur is to find a new combination of economic factors which will succeed in a future situation which is not strictly predictable. This may be done by producing a new product, by using a new

technology, or by combining inputs in a new way. The important factor is that all such new undertakings are essentially speculative: they do not necessarily adapt to existing structures of supply and demand, but are based on expectations of how markets will or can develop or be developed. This introduces a source of endogenous change into the market mechanism itself: over and above changes in supply, demand and technology, there is an element of intrinsic uncertainty in the market which can be seen as the outcome of all entrepreneurs second-guessing what others, producers or consumers, will or might do. In this context the skills of ‘reading’ the market and ‘feeling’ the development of fashions and trends will become more important than finessing production methods. Another way of understanding this approach is to say that it is impossible to define ‘given’ needs and means, since no-one knows exactly what products and tools are or can be used for. It is therefore inevitable that new uses and combinations will arise, by fruitful misunderstanding if not by deliberate search. The entrepreneur is the person who sets out to investigate these possibilities, if indeed they are not simply following their own private obsession.

The preceding position is intended to largely reflect the position of Hayek.<sup>6</sup> It is striking that while largely agreeing in the description of what actually occurs in competition and in entrepreneurial activity, Kirzner makes the dynamics of the process appear to be completely the reverse, because he takes equilibrium rather than disequilibrium as his point of reference. Kirzner argues that entrepreneurial activity is equilibrating rather than disequilibrating. In order to do so he suggests that there are constant ‘mistaken’ choices which create the possibility for entrepreneurs to act as repairmen. For Kirzner the fact that the economy is essentially a non-equilibrium process is the result of the constant reappearance of these ‘mistaken’ choices and decisions among individuals, based on the inevitable existence of a certain amount of ignorance about the actions and decisions of others (Kirzner 1973 pp.11-17). Whereas Hayek’s position sees the entrepreneur and entrepreneurial search as the creative power in the formation of markets, Kirzner’s writing sometimes seems to make the entrepreneur into a NEP-man or fixer of the deficiencies of market information reminiscent of the pre-modern merchant.

Nevertheless Hayek (who refers to an intimation of his approach in an article by Wieser, Hayek 1978 p.179 note 2) and Kirzner (who considers his position to be based on that of Mises, Kirzner 1973 pp.84-87) both agree that markets are ‘churning’ as a result of internal processes rather than simply reacting to external shifts in preferences and technology. They also both agree that individuals as economic actors and individuals as human beings whose aims and desires are constantly evolving cannot be rigorously separated, so that there is no external data of preferences towards which market forces converge.

In contrast to these approaches the Schumpeterian model does not begin from any assumption of equilibrium in the sense usually understood in modern equilibrium theory but rather from a picture of economic life as a cyclical reproduction based on habit and custom. In a manner analogous to Marx, Schumpeter explains modernity as the irruption into this system of entrepreneurial activity as initially something interstitial. Entrepreneurship is seen as essentially innovative.

Schumpeter directs his whole argument towards explaining innovation and suggests that there are reasons why innovation does not take place uniformly but in waves. It further suggests that these waves of innovation can be correlated with and seen as the cause of at least some of the business cycles within capitalist systems. In the first instance this is because there are some innovations which immediately create an environment conducive to further innovations. There are ‘leading’ technologies which create a demand for new infrastructures of supplies, components, transportation, storage and maintenance. They also spill over into uses not initially envisaged. Initially the additional demand, financed by credit, which arises as entrepreneurs grasp the implications of new possibilities, energises the entire economy, even though some old technologies are made obsolete by the new ones with attendant shrinkage and closures of old businesses. This is the ‘boom’ phase of the cycle. Eventually there is a tendency for this expansionary phase to lose its impetus. This is

seen as arising from the combination of several factors, the repayment of debt by those firms which have successfully ridden the boom wave coinciding with the collapse of older firms which have failed to adjust to the new situation. But while Schumpeter believes that some retrenchment would in any case be necessary and lead to cycles, he believes that the main reason why booms are generally followed by crashes is informational.

It could be supposed that the demand for goods previously generated by the older failing industries and the demand for capital previously generated by the new industries which are now becoming profitable and self-financing could be continued by the appearance of a new wave of innovation. Schumpeter believes that the main reason why this does not happen is that in the wake of the disruption caused by the first innovative wave, no-one is in a position to make rational calculations about the viability of further innovations. There must be a period of stabilisation before a new wave of innovation can begin. Schumpeter does not believe that the crash, although often heralded by a series of disastrous mis-investments, can be seen as the result of a lack of wisdom on the part of the initiators of such projects. While many projects which appeared rational during the boom may founder after the crash, this does not mean that these projects were over-optimistic or represented an over-extension of the boom technologies. Rather it is the difficulty of rationally estimating the viability of genuinely new innovations which prevents entrepreneurs from initiating more radical innovations and to some extent leads to over-investment in me-too enterprises. The real reason for the depression is not mistaken mis-investment but wise non-investment. It will be suggested here that this could usefully be interpreted as the exhaustion of the value of the entrepreneurial 'tacit knowledge' acquired within the older market situation in the newly given situation.

Schumpeter further proceeds to argue that innovation financed by credit is both the defining characteristic of capitalism as it has actually existed in Europe since medieval times, and is the only source of all profit and non-usurious interest. He sees all profits as quasi-rents on innovations, which the market process will begin to erode as soon as knowledge of the innovation is diffused. He regards interest as the price which entrepreneurs pay to divert purchasing power from existing undertakings into new ones. He considers that in a stationary economy, there would be no innovations and thus no profits, and no demand for capital and thus no interest. Schumpeter does not believe that profit is the reward for either risk (which can be insured against 1934 pp.32-33) or for waiting (as more productive methods involving waiting will completely replace less productive ones 1934 pp.36-38). Rather like Marx, he believes that all operating profits are redistributed shares of a common surplus, except that he believes that this surplus is generated by innovation and does not exist at all in a stationary society.

His prediction that capitalism would give way to socialism was based on the assumption that the sources of innovation would eventually be exhausted, at which point there would be no rationale for the continuation of capitalism. Even in purely technological terms this expectation and prediction would seem to have been mistaken. However, it is relevant to our purposes here to note that whereas in his more general discussions of the business cycle Schumpeter is careful to always mention organisational and market-oriented innovations alongside technological innovation, his statements about the exhaustion of innovation appear to focus exclusively on technological sources of innovation. This would explain why he did not follow the path of Hayek, who argued that even if all scientific truth were discovered once and for all, there would never be a shortage of suggestions for reorganising production in ways which would produce more profit than continuation of existing patterns. It may be that Schumpeter simply considered that the permutation of organisational innovations would not be sufficient to generate the ideological support necessary for the continuation of capitalism.

Schumpeter's notion of 'waves of creative destruction' is thus the result of a kind of quantum constraint on the interface of economics and technology, which arises because there are certain innovations which necessarily have a certain 'scale' attached to them. The pure equilibrium model

sees the market as a process which adapts to external shocks but is intrinsically both static and stationary. The entrepreneurial search model sees an intrinsic source of equilibrium within the economic process itself, and in some of Hayek's formulation suggests that the economy will not remain static even if it is close to stationary in real terms. Schumpeter's model sees technology as only one source of entrepreneurial innovation among others, but with the specific difference that some technologies are so basic that their introduction disrupts the process of economic calculation, which is only re-established after a period of stabilisation. This is why each of the major periods of boom and depression in the modern world economy can be correlated with the introduction and spread of a number of new technologies, particularly those of basic power provision, materials, transport and communications.

Schumpeter's model leads to the assumption that there will be considerable movement in the population of firms, since survival is dependent not merely on efficiency in day-to-day terms, but also on the rapidity with which firms respond to the possibilities offered by new technological and market trends. Entrepreneurial profits in Schumpeter's sense are likely to be reinvested in growth within the originating firm and lead to monopolies in the markets for the new products.

The skills which would be associated with the working of a Schumpeterian model in the boom period would be those of rapidly grasping the possibilities of new technologies, not as solutions to existing problems, but as the basis for completely new paradigms.

In summary, the simple Walrasian system suggests that the capitalist market economy is an embodiment of a principle which leads to equilibrium, but which must constantly adapt to external influences in the form of preference shifts and technologies. The Austrian systems suggest that the capitalist market economy is a system which produces within itself tendencies to disequilibrium. Kirzner's interpretation sees entrepreneurial activity as the major force leading to the establishment of equilibrium, which however is never achieved because the homo agens as opposed to the mere homo economicus does not separate the processes of preference formation from those of need satisfaction, so that in any case necessarily imperfect information on which the majority of economic actors base their decisions must constantly be revised. Hayek's version regards entrepreneurial activity as the only way in which economic activity is coordinated, and therefore as establishing the universal system of prices and standards which is the basis of the idea of equilibrium, but he does not suppose that this process is an adaptation to any external given set of needs or preferences. By contrast with these approaches Schumpeter sees two distinct questions: the equilibrium nature of natural economies, which is largely a product of the power of habit and custom, within which there is evolution and adaptation but only on very long time scales, and the capitalist system, within which the entrepreneur and the capitalist in combination create a dynamic of innovation and of capital formation which only arises from the profits of innovation.

We will return to the question of the specificity of the skills and knowledges which could be involved in the market process according to each of these models after outlining the concept of tacit knowledge.

## Tacit Knowledge and Explicit Knowledge

We examine the concept of tacit knowledge, first in the specific form developed by Michael Polanyi, then in the wider senses of the term used by organisation theorists, some of which are seen to be related to Granovetter's "embeddedness".

Michael Polanyi developed his concept of Tacit Knowledge (Polanyi 1958a, 1966, 1969) as part of a much wider philosophy, most of which is not usually referred to by writers who use the concept (see Polanyi 1951, 1958b, 1964, Polanyi & Prosch 1975). He saw tacit knowledge as an irreducible part of personal knowledge. The part of his theory which is most widely known and transmitted states that the greatest part of our knowledge of the world is necessarily inexplicit. The reason for this is that we only focus on a small part of the world at any time, while all of our background knowledge of the rest of the world, while necessary for our unconscious and subconscious calculation of our actions in relation to the world, must remain implicit in order not to distract us from the focus of our conscious attention. Whatever we learn about the world, those things which we learn by deliberate instruction as well as those which we acquire by subliminal familiarity, becomes part of our fund of tacit knowledge. Tacit knowledge is therefore not reducible to that knowledge which arises within and is only relevant to a very specific context. There is a core of tacit knowledge in every life situation and every practice, no matter how ubiquitous and universally applicable it may be. Tacit knowledge only appears to be attached to particular situations because it is often in the confrontation of individuals with different experience that differences in tacit knowledges are or may be exposed.

One consequence of the existence of tacit knowledge is that "we know more than we can tell". This means that in many instances there can only be induction of one person by another into a practice, rather than instruction. Polanyi discusses this under a number of different aspects, several of which are relevant here. One is that our competent performance is often dependent on not paying direct attention to what we are doing. Whenever we do so we lose our stride and are unable to perform. Since our learning of the skill may itself have been part of an unconscious process, we may never have access to the process by which we learned it. Under these circumstances our verbal description of what we do may be a confabulation or the recital of what we were ourselves told before we learnt the skill, but which had no real role in our learning it.<sup>7</sup>

There is another aspect of his theory which has been less widely reported and which does not appear to be sufficiently taken into account in the uses of his work made by economic and business writers. Polanyi also suggests that when we learn to use tools to carry out an operation, we simultaneously learn to use them as extensions of our senses, providing us with information about the situation in which we are working, as in the case of a screwdriver providing information about the texture and grain of the material into which the screw is driven and about the quality of the material and form of the screw itself. The tool is integrated into the economy of the perception of the user, whose perceptions of the entire process are mediated by their 'default' perceptions of their own internal states. The screwdriver is not simply a tool but also a sensory prosthesis like the blind person's stick. Polanyi argues that 'interpretative frameworks' are analogous to physical tools in that they come to function as prostheses through which we become used to processing all information of a particular type. Polanyi's 'tacit knowledge' and 'tacit inference' should therefore not be taken as labels for bodies of mental contents no matter how unconscious. They are also processes and heuristics in which body and mind are tuned and sensitised to generate new knowledge by interaction of body, mind, tools and materials.<sup>8</sup>

Polanyi draws a distinction between the subsidiary and focal modes of attention which could be relevant to the skills of the entrepreneur in 'seeing' opportunities which are missed by others.<sup>9</sup> The ability to 'gestalt' wider situations without being locked onto the everyday or customary uses and meanings of things is not an innate gift but a result of familiarity with a wide range of both situa-

tions and transformations. The gift of seeing ‘new combinations’ in Schumpeter’s words is a version of the ability to gestalt switch between wholes and parts (although Schumpeter makes it clear that practical energy to bring about the new combinations is also necessary for the entrepreneur). The ability to see that a firm or project is not working and why can easily be accommodated into Polanyi’s understanding of the inseparable nature of perception and judgement.<sup>10</sup>

Nonaka and Takeuchi (1995) took up Polanyi’s distinction of tacit and explicit knowledge and attempted to make it more “practical” (p.60). This might seem unfair if it suggests that Polanyi’s own work remained unpractical: Polanyi used the most up-to-date psychological and neurological research in developing his concepts, but his interest in the practical use of tacit knowledge was largely expressed in terms of the tacit knowledge of scientists and doctors. Nonaka and Takeuchi are concerned with the organisational environment of knowledge in business, and with discovering procedures for creating new knowledge by unusual combinations of existing knowledge. They set up a grid of the possible interactions between tacit and explicit knowledges. The process from tacit to explicit knowledge is the standard procedure by which activities are formalised and codified for the benefit of persons who need to acquire the knowledge other than by direct induction; the converse process is the way in which we begin to internalise the schemata and procedures of such instructions when we begin to become familiar with the context and the judgements and actions involved become second nature. They suggest that there is considerable potential in confronting the explicit knowledge held at different levels within the same organisation. In contrast with the ‘western’ model, they suggest that the greatest single gain for the organisation can be from the sharing of tacit knowledge. This is not to be understood as ‘multi-tasking’, which facilitates the transfer of staff in response to demand shifts or emergencies, but as a basic procedure for making all participants aware of the real problems of other parts of the organisation. This is claimed to lead to the overcoming of many of the misunderstandings and failures of communication between the research, development, production and marketing wings of organisations, leading to greater market responsiveness. At the same time they are aware that global organisations in an open labour market situation need a large degree of formalisation of tacit knowledge.

However, this entire discussion is pursued using an equivalence of tacit knowledge with stocks of existing knowledge, if not necessarily in the form of identifiable ‘facts’. The authors often give the impression that tacit knowledge is essentially comprehensible as an internalised familiarity with a particular context which cannot be communicated to others because it is not formalised. Their discussion does not transmit the idea that tacit knowledge should be understood as an altered perception which is active in creating new knowledge because it is sensitised to particular kinds of evidence and interprets this evidence in accordance with particular patterns or schemas.

Boisot develops a threefold model of tacit knowledge (p.57). 1. His first paradigm is knowledge which is ‘taken for granted’. This is knowledge which is so ubiquitous within a particular context that there has never been any need to formalise it. It is only when one ‘culture’ (national, business) comes into contact with another which does not share this knowledge that there is a realisation that this knowledge exists and is not universal. 2. Boisot claims that his second paradigm is that of Polanyi, and characterises it as “Things that are not said because *nobody* fully understands them. They remain elusive and inarticulate”. This seems to miss the dynamic aspect of Polanyi’s idea, which is that although some existing tacit knowledge can always be formalised, the new formal knowledge will generate a new layer of tacit knowledge in its application. More fundamentally it suffers the same deficiency as Nonaka and Takeuchi’s understanding, by which it is probably influenced, when it focuses on ‘things’ being said or unsaid, rather than on the processes of generation of patterns in perception. 3. The third paradigm is that of knowledge which can be articulated, at least by some people, but only at a non-trivial cost. Boisot considers that this is the kind of knowledge investigated by Nonaka and Takeuchi.

Granovetter had reminded us that throughout the thirties, forties and fifties a series of sociological investigations had shown that there was a considerable degree of co-operation, trust, negotiation and sharing of knowledge both within and between organisations which was ignored by normative organisational theory but which was often essential to meeting the targets of organisations and their component units. The knowledge involved in these contacts is in many cases tacit knowledge, both in the sense that it is the kind of knowledge which is largely acquired unconsciously, and in the sense that it is often not reported not because it is illicit (though this may sometimes be the case) but because it is ‘taken for granted’. Reading of more recent literature on governance<sup>11</sup> suggests that Polanyi’s wider understanding of tacit knowledge as the development of a series of schemas which allow rapid almost unconscious perception of the implications of situations will have an application to understanding of the way in which people learn to process information differently in different governance contexts. Thus, in Boisot’s terminology, markets, hierarchies, clans and fiefs, or as in other literatures, industrial districts and networks, will give rise to different ‘default’ assumptions about the significance of particular facts and changes. The ability to envision ‘new combinations’ will be relative to such institutional-governance backgrounds.

### Corporate R&D

The “tacit knowledge” of the market which is the basis of the action of the entrepreneur in Schumpeter’s first theory of creative destruction is contrasted with the corporate “R&D”-led approach outlined in his second theory.

Schumpeter always considered the entrepreneurial function to be intrinsically distinct from that of the capitalist, the manager, or the inventor. The entrepreneur is solely that person who conceives and develops new economic combinations. The capitalist is the person who stakes their own money on the success or failure of economic undertakings, whether new or established. The manager is the person who ensures that all the necessary processes are actually carried out on a day-to-day basis. The inventor is the person who originates a new process, product, material or technology. In many instances these functions may be carried out by one single person. The situation becomes interesting when the roles of entrepreneur and capitalist diverge. The capitalist stakes their money and expects to gain whatever profits are produced, less some negotiated payment to the entrepreneur. But the capitalist must have some criteria for choosing which entrepreneurs to support, or which of their projects to support, or a strategy or method for how to spread their investments between different entrepreneurs and projects. The capitalist or their advisers must therefore have or suppose that they have some access to a ‘meta-entrepreneurial’ knowledge which allows them to decide which entrepreneurial suggestions are plausible and viable. The crudest method is to support projects put forward by experienced and proven entrepreneurs.

In his book *Capitalism, Socialism and Democracy* (1976, 1st ed. 1942), Schumpeter put forward the view that the entrepreneurial function could be routinised<sup>12</sup> - a proposal which is generally discussed in terms of the prevalence of “corporate R&D” organised in large divisions within capitalist organisations. He also suggested that this could lead to a more regular flow of innovation, to some extent evening out the ‘waves’ of creative destruction. Fifty years later, during which we have experienced another boom apparently based on air travel, transistorisation and pharmaceuticals,<sup>13</sup> we must suppose ourselves on the brink of another wave based on digitisation, genetic engineering, micro-engineering and new materials. While these inventions have mostly been the result of massive corporate and government-led R&D, their application to business has often been led by small firms which are entrepreneurial in precisely Schumpeter’s sense of combining knowledge of new technologies with a vision of how to use them in the current market context (often based on insight into communicational, entertainment and other consumer uses for what had been envisaged as ‘big’ technologies).<sup>14</sup> The corporate R&D which is applied to the investigation of the market as such has by contrast been found to be most successful only within the established tracks of firm-specific capabilities and competences, and even here success is far from secure (Pavitt 1994 pp.357-358). It

does not prevent new products and new markets growing up outside the control of the large organisations (evidenced most disastrously by IBM and the PC market). There is therefore still a role for the skills of the 'non-corporate' entrepreneur.

### **Core Competence and Comparative Advantage**

Tacit knowledge is related to the questions of firms' core competences and comparative advantage. In this context we examine developments in the investigation of implicit learning and distributed cognition as characteristic features of teamwork.

The major premise of the debate about core competency and comparative advantage is that firms build up a stock of skills which is tailored to a specific field of activity and can only with effort and difficulty and a significant possibility of failure be transferred or even extended into other areas. It will be useful to consider this problem from the perspective of Boisot's threefold categorisation of tacit knowledge: that which can only be made explicit at a cost, that which is ineradicable at least in the sense that it builds up again around any core of explicit knowledge, and that which is so taken for granted that it only becomes apparent against the contrast of a new environment. In each of these cases it will be seen that the problem is compounded when some of the tacit knowledge is actually distributed knowledge. In this case the knowledge is only embodied in action by a team, whereby it is difficult to separate the knowledge generated by the particular makeup and division of labour of the particular team from that which might be generic to different circumstances.

The arguments of Penrose and Porter suggest that tacit knowledge would be a large part of the package of 'core competence', because the knowledge involved in firms which pursue a course of development in new products and processes within a particular branch of a particular sector will include knowledge both about what they do well and how, but also about what they have found to be the problems about attempting to expand into neighbouring areas and why it is not worthwhile. This knowledge of all the things which went wrong and were seen to be unworkable is the kind of knowledge which can be made explicit only at a non-trivial cost.<sup>15</sup> Of course it is also the case that this type of knowledge may only be 'true' from a particular perspective on a fitness landscape, i.e. that a new product or process may only be unattainable from where this particular firm is at present, but the point is that the firm is actually there now and cannot transplant itself directly into a different starting point from which the ascent to the new product or process would be easier. This applies even when there are written records of failed projects, whether scientific, technological or process-oriented - it is the tacit knowledge which is embodied into the insight that a particular suggestion is in danger of setting off down a road to failure which is important rather than the simple facts about previous failures which is important.

Nelson & Winter (1982) contains the most extensive discussion known to us in the economic literature of Polanyi's concept of tacit knowledge (based on Polanyi US 1962 = UK 1958 and US 1967 = UK 1966). This is in a context of the extended analogy drawn between the skills and routines of an individual and of an organisation, here a firm (developed over pp.72-138, see pp.76-82 for the detailed examination of tacit knowledge). This includes a rare recognition of the necessary interrelatedness of 'psycho-motor skills' and active patterns of perception (pp.76-78). The authors use the concept of tacit knowledge to argue against an exaggerated estimation of the role of choice in economic life, suggesting that tacit knowledge involves implicit perception of factors which mean that the scope of choice is often much less than would be suggested by consideration of the formally available possibilities, so that for the skilled person choice is often automatic or not a real factor at all (pp.65-71, 82-85).<sup>16</sup>

In the further development of their argument, the authors are not concerned with specifically entrepreneurial skills. They consider a model in which firms have developed routines between which they can switch resources, whereby one of the routines is precisely Schumpeter's 'routinized innovation' aiming at leading technologically, while another is R&D directed to imitation. They pro-

ceed to investigate the advantages of various allocations of resources between these applications of R&D. Leading into this, in the chapter Routine as Organizational Memory (pp.99-107) the authors develop the claim that “organizations *remember* by *doing*” in terms of how routines function not merely as rituals or rhythms but as signalling devices, and conversely how individuals develop the ability to interpret these signals as such and perform the appropriate actions. Although no longer explicitly referring to Polanyi, the situation described is one in which individuals have made the routine of the organisation into a prosthesis or heuristic for their own actions, proceeding from formal instructions or from a variety of implicit inferences to interpret the signals generated by the progress of other parts of the wider process as indications of the need to follow one particular procedure rather than another in particular cases.

### **Implicit Learning, Tacit Knowledge and Shared Cognition**

A recent overview of the development of scientific work on Implicit Learning and Tacit Knowledge acknowledged the contribution of Michael Polanyi (1958) and Friedrich von Hayek (1962) to the early formulation of the problems (Reber 1993 p.12).<sup>17</sup> Polanyi’s concept of tacit knowledge can be seen to cover knowledge acquired in two different ways: that which is first acquired explicitly and later through routine becomes internalised and tacit (‘skills’), and that which is acquired by ‘osmosis’, actually by implicit inference from data and stimuli which may not be consciously registered or regarded as meaningful. The latter process is ‘implicit learning’ in Reber’s sense (Reber 1993 p.26).<sup>18</sup> However, it can be the case that ‘explicit learning’ can be to a greater or lesser extent a meaningless charade while the real learning actually proceeds implicitly - and where the content of the implicit and explicit learning is different or contradictory this gives rise to the educational concept of ‘hidden agendas’. This would be of especial relevance where the explicit instruction is in the form of ‘retraining’, that is, where the purpose is to replace one set of skills with another. If this takes the form of confrontation and comparison of two sets of explicit formalisations of skills or knowledge, the implicit knowledge base and skills are likely to be completely uninvolved.

Reber hypothesises that implicit systems would have the following characteristics (p.88):

1. Robustness ... robust in the face of disorders and dysfunctions that compromise explicit learning and explicit memory
2. Age Independence ... compared with explicit learning, implicit acquisition processes should show few effects of age and developmental level
3. Low variability ... population variances should be much smaller when implicit processes are measured than when explicit processes are.
4. IQ Independence ... implicit tasks should show little concordance with measures of ‘intelligence’ assessed by standard psychometric instruments...
5. Commonality of process ... underlying processes of implicit learning should show cross-species commonality.

Essentially, since explicit, formal methods of learning and communication are all evolutionarily later than implicit methods, it follows that they will be less robust and therefore show greater variability between individuals and contexts. Implicit systems will operate in a greater variety of situations, their variation with age will not map onto that age-variation which is specific to the phases of the learning of formal symbolisation, their variability will not map onto the variability in facility of using these symbolic processes. The obvious implication is that learning-by-doing will be applicable in a wider set of contexts than formal learning.

This topic can be related to the question of knowing-how and knowing-who. It is a commonplace that knowledge of people and of what they can or cannot do is as important or more important than what each individual knows how to do themselves. It may be that much of this knowledge is itself implicit and in turn concerns knowledge about the knowledge of others which is also implicit. This

throws a new light on the importance of Granovetter's embeddedness and on 'insider' knowledge of networks, markets and bureaucracies.

All complex human organisations are characterised by the existence of shared, distributed tacit knowledge. This is knowledge which depends on particular channels of communication or particular assignments of responsibility. It is a function of the division of labour but this must be understood to be itself a compromise between technological constraints and systems of governance. The exact demarcations between the role of different individuals may be specific to a particular team and a particular environment, and may be tacit knowledge in Boisot's third sense that no-one has ever asked themselves why it done in this particular way. Within this context, inputs - problems or pieces of work - which are not worked up into a particular state of maturation by the previous contribution of others having particular different kinds of knowledge than other persons with knowledge contextually appropriate for that particular system will be unable to take them further.

### **The Tacit Knowledge of Entrepreneurs**

Different theories of the working of competition lead to different estimates of the importance and value of different kinds of tacit knowledge for entrepreneurs.

One of the answers to the problematic of whether firms are truly profit-maximising was that intentions were less important than outcomes; only those firms whose behaviour approximated to that expected on the basis of profit maximisation would survive, so it did not matter by what reasoning or other processes decisions are arrived at. This can be equated with the investigation of the behaviour in the biological sciences: long-term investigation of animal behaviour, whether in controlled experiments or in observation of natural behaviour, suggests that choices approximate to optimal payoffs under circumstances where the individual animals are not assumed to be operating conscious utility rankings and preference curves. However, this means that a significant number of individuals must be making decisions which in fact lead to the survival of their organisations under the given circumstances. These decisions may not lead to maximising of any parameter, but may nevertheless keep the firm competitive. It may be assumed that many of these decisions are the result of internalisation of tacit knowledge by implicit learning. The individuals learn to do what their colleagues do within a tolerable margin. Clearly this kind of routine will be less viable in times of general confusion than in times of general stability. Conversely deviating from this pattern will have costs which only strong personal inclination or the clear perception of large potential gains will justify.

Schumpeter saw the skills of the entrepreneur primarily in having the ability and energy to gestalt and practically implement new 'combinations', a phrase which contains by implication the idea that the elements of these new combinations must first be extracted from their previous embeddedness in 'old' combinations'.<sup>19</sup> He does not see 'being an entrepreneur' as necessarily a lifetime activity, on the contrary he often implies that most successful entrepreneurs will eventually settle down as 'managers' of their growing businesses.<sup>20</sup> In order to be able to go beyond merely envisioning a new possibility and to proceed to actively set up new combinations it is generally necessary to have an overview of the availability of inputs. Schumpeter's theory assumes that entrepreneurs are more likely to emerge in large numbers during the depression phase of a cycle precisely because of the existence of unused or underused resources. The entrepreneur is favoured at this time by the relative ease of imagining other more productive uses of these resources. As the boom proceeds with some new technologies experiencing increasing returns and many subsidiary activities riding in their train providing new infrastructural services and goods, there comes a point when it is no longer easy to see how resources could be put to better use. Even if new technologies or products are developed, it is not necessarily easy to see how they can be profitable because the context of their possible use is made uncertain by continuing changes in other related areas. This is the context of the 'informational' side of Schumpeter's explanation of the crash which often leads into the depression.<sup>21</sup>

## Waves of Creative Destruction and ‘Stocks’ of Tacit Knowledge

We return to the question of the effects of ‘creative destruction’ and other forms of market-led or technology-led innovation on stocks of ‘tacit knowledge’ and other knowledge assets.<sup>22</sup> In the past it is clear that the introduction of the predominant new technologies of the ‘machinery’, ‘railway’, ‘electrical’, and ‘automobile’ revolutions led to a massive destruction of infrastructures, skills, and thereby tacit and implicit knowledge. This was associated with a constant reduction in the application and value of ‘rural’ as opposed to ‘urban’ skills and knowledges. This has led to a massive reduction in the familiarity of most modern individuals with a whole range of materials, tools and processes. The last thirty years have seen a steady move from ‘production’ occupations into ‘service’ and office occupations, in terms of real activities, although this effect has been exaggerated by the ‘outsourcing’ of many service activities from industrial organisations. In the past infrastructures have been out of step with new technologies and become a drag on innovation.<sup>23</sup> At the present the major western societies may be said to be running ahead of real technological changes: while there is a genuine shortage of some special skills, the educational system as a whole is apparently geared to speculatively producing a highly-skilled and highly-educated workforce against the assumption that this will be necessary in the competitive world of tomorrow. It may be that this emphasis on formal education is actually eating away at real levels of tacit knowledge which the considerations above suggest are best acquired through learning-by-doing. On the other hand early familiarity with the world of cyberspace may be necessary not in order to simply manipulate and work in this environment, but above all to be able to see the entrepreneurial possibilities within this new paradigm. It is the ability to gestalt switch between parts and wholes which will facilitate the envisioning of ‘new combinations’.

Having built up the background to our argument we now put forward some speculative suggestions about the relationship of tacit knowledge, entrepreneurial skills, and creative destruction. The tacit knowledge which is specific to the entrepreneur will consist in the first instance of knowledge about networks of contacts, about the working of markets, about the actual and potential uses of technologies and systems of work organisation, and about the existence of unused or underutilised resources. Added to this there must be both a heuristic or gestalt-switching ability to imagine elements of various existing systems in new combinations in the service of a new leading idea. There must also be the ability to actually organise individuals and organisations to bring about this scheme, and ability to persuade potential investors of the viability of the project, unless the entrepreneur has funds of their own. These tacit knowledges may be duplicated to a greater or lesser extent by explicit knowledge, but must be extant in the form of tacit knowledge in order to facilitate the necessary degree of tacit inference and gestalt switching which is necessary to rapidly produce and adjust new combinations as a real skill rather than simply as a formal exercise.

There are obviously large areas of overlap between the tacit knowledge and the heuristics of tacit inference which are used in everyday business operations and management and those specific to the entrepreneurial function. The valorisation of these stocks of knowledge in ‘everyday’ use is subject to the general problems of valorisation of skills, one the one hand the cost of creating them, on the other the extent and limitations of their transferability to use with other firms, compounded by the problems of ignorance and misunderstanding between different levels of the same organisation. These problems are all worse for tacit knowledge but not essentially different.

In the Schumpeterian scheme, entrepreneurial activity may be exercised within a division of labour. The central entrepreneurial vision may be carried out by instructions to a number of collaborators through formal directives, or elements of the ‘envisioning’ process itself may be delegated to collaborators who then autonomously produce their own subprograms for carrying out the tasks within the wider vision. The ‘learning organisation’ on the Japanese model is an example of the attempt to spread the entrepreneurial function to the entire workforce. However, there are limitations on this process. Firstly we must remember that for Schumpeter the entrepreneur is not merely

the possessor of a vision must also have the energy and independence to struggle to make it a reality. There is obviously a degree to which the remuneration of managers reflects a potential conflict between the managers' actual value as a manager and their potential value if they used their skills and knowledge as an entrepreneur. There is also the problem of exceeding 'requisite variety', i.e. that entrepreneurial activities within the firm could become too disparate. These factors together may explain the attraction of the American model of relatively easy exit and re-entry from management to independent or spin-off entrepreneurship.

Within the Schumpeterian scheme it is only innovation which produces genuine surplus and profit. The creation of entrepreneurial skills is therefore key to economic growth. However, creative destruction as understood by Schumpeter must have the effect of cyclically destroying the value of much of the tacit knowledge on which these skills are based. The disruption of market channels and of infrastructures of supply, storage, maintenance, repair, training and expertise which follows from the obsolescence of older 'leading technologies' makes rational planning of new ventures more difficult. The tipping which makes the further use of old technologies impossible cuts off some avenues of sourcing. It is difficult to decide whether to commit investment in areas without standards and dominant technologies. The destruction of the relevance of stocks of 'entrepreneurial' tacit knowledge and of the patterns of tacit inference based on them can be seen as playing a role in the Schumpeterian explanation for the failure of booms to continue or to shade more gradually into a following depression.

We currently see a drive to increase education and training in new technologies for the 'New Economy', together with an emphasis on continued development of 'entrepreneurial' competencies within global firms. We can reasonably suggest that these formal skills are the tip of an iceberg compared to the tacit knowledge of markets, technologies and organisational procedures which actually enable some individuals to become effective entrepreneurs. The valorisation of skills including the relevant background of tacit knowledge will remain problematic as long as the contours of the infrastructures and standards of the New Economy have crystallised. But by then the type of entrepreneurial skills which are effective in the upturn may no longer be those most required.

<sup>1</sup> *Theorists should aim to tell the truth in their theorizing, but they cannot aim to tell the whole truth. For to theorize is precisely to focus on those entities and relationships in reality that are believed to be central to the phenomena observed - and largely to ignore the rest. To advance a new theory is to propose a shift of focus, to recognize as central considerations that were previously ignored.* Nelson & Winter 1982 p.134. While we are still at the stage of conceptualising rather than theorising, the thread which has emerged during the development of this paper up to now and which we propose to follow here is that 1. tacit knowledge and tacit inference as understood by Polanyi contain implications which have largely been overlooked by economic thinkers; 2. this is especially important for the activity of the entrepreneur specifically as understood by Schumpeter; 3. that this has significant implications for Schumpeter's theory of creative destruction especially in an informational interpretation of this process.

<sup>2</sup> Namely: new machinery, new working methods, new forms of work organisation, new sources of supply, new products to meet existing needs, new markets for existing products, new uses for existing products, new products which will create new needs (Schumpeter 1934 pp 132-136). This list is not always reproduced exactly in other formulations by Schumpeter (on p.66 of the same work he only lists five: 1. new goods, 2. new methods, 3. new markets, 4. new supply sources, 5. new forms of organisation). Not all examples involve new technology in either the process or the product.

<sup>3</sup> In this paper we have restricted ourselves to citing the three major works Schumpeter 1934 *Development*, 1939 *Business Cycles*, 1942 *Capitalism*, but our understanding of Schumpeter's thought has been greatly influenced by the articles and speeches on related topics in 1951 ed. Clemence and 1991 ed. Swedberg.

<sup>4</sup> At the present time we have not been able to integrate into the paper a discussion of the work of Richardson, in lieu of which we offer the following citation as evidence of this work to the questions discussed here: *It must be admitted, if the analysis of the previous chapter is correct, that there is a crucial deficiency in the traditional model of the competitive economy, the nature of which must now be more carefully examined. Any adequate theory of economic adjustment, whether it be in terms of the maintenance or the attainment of an equilibrium position, must represent entrepreneurs as taking investment decisions on the basis of expectations about the relevant future circumstances. This indeed would probably be widely admitted; what commonly fails to be recognized, however, is that the possibility of forming reliable expectations is not independent of the particular market conditions which define the model employed. In saying that expectations or beliefs are reliable, I imply that they are grounded on adequate information or evidence. It is the availability to entrepreneurs of this information which, I now wish to demonstrate, is a function of the nature of the particular form of economic organization or system within which they are presumed to operate. If the defining conditions of our model are such as to preclude this availability, as I believe to be the case with perfect competition, then we cannot hope to obtain a proper understanding of the process of economic adjustment, or of the factors which will influence its success or failure.* Richardson 1990 p.27.

<sup>5</sup> See Laufer and Glick 1996 for a description of the induction of salesmen into the operations of such a market, that for industrial supply of nuts, bolts and screws, which involves selling, sourcing, buying, and pricing.

<sup>6</sup> cf. the frequently cited papers Hayek 1962 and 1978.

<sup>7</sup> *We can see this best in the way we possess a skill. If I know how to ride a bicycle or how to swim, this does not mean that I can tell how I manage to keep my balance on a bicycle or keep afloat when swimming. I may not have the slightest idea of how I do this or even an entirely wrong or grossly imperfect idea of it, and yet go on cycling and swimming merrily. Nor can it be said that I know how to bicycle or swim and yet do not know how to co-ordinate the complex pattern of muscular acts by which I do my cycling or swimming. I both know how to carry out these performances as a whole and I also know how to carry out the elementary acts which constitute them, though I cannot tell what these acts are. This is due to that fact that I am only subsidiarily aware of these things, and our subsidiary awareness of a thing may not suffice to make it identifiable.* Polanyi 1969 pp.141-142.

<sup>8</sup> *A similar projection takes place in the use of tools and probes, and the process can be studied here more easily, since the stimuli that are projected here can be fairly well observed in themselves. The relevant facts are well known. The rower pulling an oar feels the resistance of the water; when using a paper-knife we feel the blade cutting the pages. The actual impact of the tool on our palm and fingers is unspecifiable in the same sense in which the muscular acts composing a skilful performance are unspecifiable; we are aware of them in terms of the tool's action on its object, that is, in the comprehensive entity into which we integrate them. But the impacts of a tool on our hands are integrated in a way similar to that by which internal stimuli are integrated to form our perceptions: the integrated stimuli are noticed at a distance removed outward from the point where they impinge on us. In this sense impacts of a tool on our hands function as internal stimuli, and a tool functions accordingly as an extension of our hands. The same is true of a probe used for exploring a cavity, or for a stick by which a blind man feels his way. The impact made by a probe or stick on*

*our fingers is felt at the tip of the probe or stick, where it hits on objects outside, and in this sense the probe or stick is an extension of our fingers that grasp it. / The assimilation of a tool, a stick or a probe to our body is achieved gradually, as its proper use is being learned and perfected. The more fully we master the use of the instrument, the more precisely and discriminatingly will we localize at the farther end of it stimuli impinging on our body while grasping and handling the instrument. This corresponds to the way we learn skillfully to use our eyes to see external objects.* Polanyi 1969 pp.127-128.

<sup>9</sup> *These two kinds of awareness — the subsidiary and the focal — are fundamental to the tacit apprehension of coherence. Gestalt psychology has demonstrated that when we recognise a whole, we see its parts differently from the way we see them in isolation. It has shown that within a whole its parts have a functional appearance which they lack in isolation and that we can cause the merging of the parts in the whole by shifting our attention from the parts to the whole.* Polanyi 1969 p.140.

<sup>10</sup> A typical example of how Polanyi conceives perception to be inseparable from ‘judgement’ uses natural science as its example, but analogies in economic life can easily be imagined: *The moment we identify a plant or an animal we attribute an achievement to it. For we recognise it by its typical shape, which it has achieved by growing up healthily. At the same time we will notice any imperfections of its shape. Thus even when we are considering merely their shapes, we can identify living beings only in terms that attribute success or failure to them as individuals. On this morphological level the centre of individuality is comparatively weak. But the manifestations of this centre become steadily more accentuated as we successively ascend, first, to the vegetative level of physiological functions, then to active, sentient and appetitive behaviour; thence to the level of intelligence and inventiveness, finally reaching the level of the responsible human person. Each time we identify the existence of an individual at one of these levels we thereby attribute to him a measure of active, responsible intelligence. We know a normal human being as a person, and the particulars of his physiognomy gain a vivid significance by being known in terms of this person.* Polanyi 1969 p.135.

<sup>11</sup> e.g. North (1990), Williamson & Winter eds. (1991), Langlois & Robertson (1995), Williamson (1996), Whitley & Kristensen eds. (1997), Dosi, Teece & Chytry eds. (1998), Lane & Bachmann eds. (1998), Swann, Prevezer & Stout eds. (1998).

<sup>12</sup> *This social function (that of the entrepreneur) is already losing importance and is bound to lose it at an accelerating rate in the future even if the economic process itself of which entrepreneurship was the prime mover went on unabated. For, on the one hand, it is much easier now than it has been in the past to do things that lie outside familiar routine - innovation itself is being reduced to routine. Technological progress is increasingly becoming the business of teams of trained specialists who turn out what is required and make it work in predictable ways. The romance of earlier commercial adventure is rapidly wearing away, because so many more things can be strictly calculated that had of old to be visualised in a flash of genius* Schumpeter 1976, 1942 p.132.

<sup>13</sup> It is arguable that it is only during the last fifty years that private automobile ownership has become a global phenomenon, which opens the question of the ‘staggering’ of waves, regarded in their purely technological sense, across the different geo-political blocs.

<sup>14</sup> Though this could be a result of the dominance of military concerns in ‘big’ science and technology research, which could in turn explain the ‘success’ of Japan in consumer-oriented innovation (cf. Kleinknecht 1987 p.211).

<sup>15</sup> See Boisot 1998 pp.234-240 on the difficulty of retrieving tacit knowledge from failed projects, using an example from Courtauld’s fibre development.

<sup>16</sup> *Skilful acts of selection from the available options are constituents of the main skill itself: they are “choices” embedded in a capability. Deliberate choice plays a narrowly circumscribed role, limited under normal circumstances to the selection of the large-scale behaviour sequence to be initiated.* Nelson & Winter pp.84-85.

<sup>17</sup> Other sources which Reber thinks it worthwhile to cite as influences are the decision theory tradition as collected in Kahnemann, Slovic and Tversky, eds. (1982), and Herbert A. Simon.

<sup>18</sup> Polanyi’s awareness of the process which Reber calls implicit learning is shown in a passage of Personal Knowledge: *Psychologists have called subception a process of learning with awareness.* Polanyi 1969 p.143, referring to C.W. Eriksen, Discrimination and Learning without Awareness: A methodological survey and evaluation. *Psychological Review* 67 1960 pp.279-300. Conversely, Reber on the parallel with “knowing more than we can say”: *...knowledge acquired from implicit learning procedures is knowledge that, in some “raw” fashion, is always ahead of the capability of its possessor to explicate it. Hence, while it is misleading to argue that implicitly acquired knowledge is completely unconscious, it is not misleading to argue that the implicitly acquired epistemic contents of mind are always richer and more sophisticated than that which can be explicated.* Reber 1993 p 64.

<sup>19</sup> *In particular within the ordinary routine there is no need for leadership. ... This is so because all knowledge and habit once acquired becomes as firmly rooted in ourselves as a railway embankment in the earth. It does not require to be continually renewed and consciously reproduced, but sinks into the strata of subconsciousness. It is normally transmitted almost without friction by inheritance, teaching, upbringing, pressure of environment. Everything we think, feel, or do often enough becomes automatic and our conscious life is unburdened of it. The enormous economy of force, in the race and the individual, here involved is not great enough, however, to make daily life a light burden and to prevent its demands from exhausting the average energy all the same. But it is great enough to make it possible to meet the ordinary claims. This holds good likewise for economic daily life. And from this it follows also for economic life that every step outside the boundaries of routine has difficulties and involves a new element. It is this element that constitutes the phenomenon of leadership. Schumpeter 1934 p.86. We have seen that the function of the entrepreneurs is to reform or revolutionize the pattern of production by exploiting an invention or, more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way, by opening up a new source of supply of materials or a new outlet for products, by reorganizing an industry and so on. ... To undertake such new things is difficult and constitutes a distinct economic function, first, because they lie outside of the routine tasks which everybody understands and secondly, because the environment resists in many ways that vary, according to social conditions, from simple refusal either to finance or to buy a new thing, to physical attack on the man who tries to produce it. To act with confidence beyond the range of physical beacons and to overcome that resistance requires aptitudes that are present in only a small fraction of the population and that define the entrepreneurial type as well as the entrepreneurial function. This function does not essentially consist in either inventing anything or otherwise creating the conditions which the enterprise exploits. It consists in getting things done. Schumpeter 1942 p.132.*

<sup>20</sup> *... being an entrepreneur is not a profession and as a rule not a lasting condition Schumpeter 1934 p.78*

<sup>21</sup> *The second reason explains why a new boom does not simply follow on: because the action of the group of entrepreneurs has in the meanwhile altered the data of the system, upset its equilibrium, and thus started an apparently irregular movement in the economic system, which we conceive as a struggle towards a new equilibrium position. This makes accurate calculation impossible in general, but especially for the planning of new enterprises. Schumpeter 1934 pp.235-236.*

<sup>22</sup> Kleinknecht 1987 is a relatively recent defence of the existence of Kondratieff long waves and of the viability of some aspects of Schumpeter's model as a possible explanation of them.

<sup>23</sup> *(the existing set of technologies) may be expected to shape the educational system and the training of engineers and other technical personnel. The inertial forces here may strengthen the commitment to an existing technology and render more difficult the exploration of new realms of human possibilities. Rosenberg and Frischtak 1983 cited by Kleinknecht 1987 p.201*

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