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LECTURE 6

THE CONTRIBUTIONS OF GREAT ECONOMISTS:

SMITH, MARSHALL AND HAYEK

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The evolution of knowledge: beyond the biological model
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The motivation for generating new ideas is the first element in Smith's theory. He draws attention to **three general human passions**, arguing that people are **disturbed by the unexpected**, **dismayed by the inexplicable**, and **delighted by schemes of thought that resolve the inexplicable into plausible generalisations**, and claims that, in the absence of any assured procedure for attaining correct knowledge, these are **the motives which 'lead and direct philosophical enquiries'**. They are **a long way from the incentives in economists' models,** but perhaps not so far from some of the incentives that shape the behaviour of technologists, and of economists also.

The second element in Smith's theory is **the sequence that is inspired by this complex motivation**: **a combination of imagination and ex-ante selection guides the invention of 'connecting principles' which sort phenomena into categories and link these categories by an explanation which is sufficient to 'soothe the imagination'**. Smith (1980 [1795], pp. 61, 90) shows how the 'equalising circle' in Ptolemaic geometry and Kepler's rule that 'when one body revolved round another, it described equal areas in equal times' appealed to principles of motion that conformed to prevailing conceptions of good order; **most economists accept the notion of 'rational expectations' because it fits their idea of a good theory**; and both technology and business strategy are shaped by what people feel comfortable with. **Ideas must satisfy the selection criteria of the imagination.**

Smith's third element, implicit in the reference to **notions of good order, is the link between emotion and aesthetics.** He explains **the importance of aesthetic criteria both in guiding conjectures**, for example those of Copernicus and Kepler, **and in encouraging their acceptance**, notably in discussing the rhetorical appeal of Newton's theory, which in his *Lectures on Rhetoric* exemplifies Smith's ideal method of 'giving an account of some system' (Smith, 1983, p. 146). **Aesthetic influences in the natural sciences and in economics (signalled earlier by the reference to the elegance of rational choice equilibria**) are occasionally recognised but rarely explored (**see Schlicht, 2000**); aesthetic influences on the design of artefacts are often of major significance. Sometimes aesthetic appeal is a major objective; but of particular interest in an exploration of evolutionary processes is **the extent to which aesthetic criteria are also surrogates for effective performance**; bridges and aircraft are obvious examples, and the flawed design of the Millennium footbridge in London, which caused it to sway so disconcertingly in use that it had to be closed, is a recent reminder that surrogacy should not be assumed.

The fourth element in Smith's proto-evolutionary theory is his proposition that **connecting principles which seem to work well are widely diffused because of our readiness, when in any difficulty or discomfort, to look for guidance from others who seem to know better, and because of our desire to act, and indeed think, in ways that merit the approval of others.** These powerful motivations, **together with the underlying similarity in human mental, emotional and aesthetic processes** which underpins them, are **foundational principles of Smith's (1976a [1759]) *Theory of Moral Sentiments*,** which is itself an essential component of **Smith's complex account of social organisation**, and applicable both to technological evolution and any adequate understanding of organisational behaviour.

However, because by Hume's argument **invented principles, however widely accepted, are not proven truth**—even, as Smith (1980 [1795], p. 105) explicitly notes, when these principles have been

invented by Newton—**they are liable eventually to be confronted with unexpected phenomena which they cannot be adapted to explain**. **At this point, the product of human imagination and design is rejected, and a new search for connecting principles begins**. This is **the fifth element**, which renews the evolutionary sequence.

The sixth element in Smith's system is **the evolution of the evolutionary process itself.** The basic human activity of seeking psychological comfort by inventing and imposing connecting principles **generates an increasingly distinct category of knowledge which comes to be called 'scientific', with its own group of practitioners; and as this category expands, we begin to observe a progressive differentiation between sciences that we might now label speciation. The consequent differences of focus and of criteria for acceptable categories and explanations lead to an increasing variety of problems that are more precisely defined, accelerating the growth of science.**

It is in this scientific context that the effects of the division of labour first appear in Smith's (1980 [1795]) surviving work; it therefore seems natural that in the *Wealth of Nations* **he invokes the division of labour, not as the best way to exploit differentiated skills— which was a very old idea—but as the chief instrument for improving productive knowledge (Smith, 1976b [1776]). This is the seventh element of Smith's evolutionary theory**; and it is easily the most important idea in economics, since the co-ordination problem which normally receives priority among economists would be trivial without the **continuous generation of new knowledge and new artefacts.**

Smith's prime 'connecting principle' of the division of labour was applied to physiological diversity in 1827 (Milne-Edwards, 1827) and this application in turn contributed to **Darwin's vision—a novel connection—that a Malthusian struggle to survive would result in the differentiation of species (Raffaelli, 2001).** The other basic elements in Smith's account of the development of knowledge by motivated trial, error, amendment and diffusion understandably did not, for they go beyond biology. We may therefore suggest that Smith provides a better basis for evolutionary economics than biological models; we may also observe that **different analytical systems, focusing on different patterns of connections, may be most effective in developing different kinds of knowledge, thus explaining the value of speciation among academic disciplines.**

The differentiation of knowledge is a condition of progress in human society. However, it has its opportunity costs, of which I will mention two. **Differences in the structure of understanding, and in the criteria for good theory and good practice**, though providing necessary frameworks for the construction of knowledge of distinct kinds, **may create substantial obstacles to the integration of these distinct kinds of knowledge and impede the combination of technological and non-technological perceptions of any particular innovation**—an issue of particular relevance to public debate on research policy, and the theme of a particularly instructive study (Pool, 1997).

A second opportunity cost of the differentiation of knowledge is the neglect of potentially crucial interdependencies. 'When the compass of potential knowledge as a whole has been split up into superfi- cially convenient sectors, **there is no knowing whether each sector has a natural self-sufficiency** . . . . Whatever theory is then devised will exist by sufferance of the things that it has excluded' (Shackle, 1972, pp. 353–354). **This is a key issue in the management of innovation, as in many other fields**. **Unanticipated technological disasters are frequently traceable to unjustified assumptions (which are usually unconscious, but not always so) about the sufferance of**

something excluded from the processes of design, testing, or operator training. The Millennium footbridge already mentioned is an exemplary demonstration.

The Psychology of Wealth

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For presentation at the University of Milan-Bicocca, 13 October 2003

Organisation and the Human Mind

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For presentation at the University of L. Bocconi, 14 October 2003

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Riorganizzazione del testo di B.J. Loasby per temi selezionati
a cura di R. Cappellin

INTRODUZIONE

Cattaneo's Agenda for Economics

My title is taken directly from the opening of 'Del Pensiero come Principia d'Economia Publica' by Carlo Cattaneo (2001 [1861]); and there is nowhere more appropriate than Milan for a celebration of his work, which has recently been republished together with an English translation.

Cattaneo's purpose was to advocate a fundamental reorientation of economic study. Hitherto, he observed, scholars had successively investigated **the contribution to production of natural resources, the work of man** (especially as rendered more effective by the consequences of the division of labour), **and capital. This analysis Cattaneo described as the physics of wealth;** but he noted (as has since been regularly rediscovered) that **even if these productive forces were equally available across nations, output could nevertheless differ substantially between them. These differences in productivity he attributed to differences in the application of intelligence** and will. It was therefore time for scholars to devote themselves to this new step **– to refocus from the physics to the psychology of wealth (p. 49).**

THE ROLE OF INTELLIGENCE IN INNOVATION

…..the bulk of work in economics, …….still seeks to deduce outcomes directly from convenient specifications of the productive forces of land, labour and capital, and to cope with the repeated discovery that apparently similar productive forces can produce very different results by redefining them. 'Human capital' is a very good example, and particularly apposite to this session**:** it is treated as an augmentation of capital, but **the particular ways in which it affects the productive process and the outputs delivered by this process are left out of focus**. In particular, **no attention is paid to the role of intelligence or will either in the process of decision-making or in the conduct of productive activities**. To do so would call into question **the analytical reliance on 'rationality',** either in the instrumental sense of a precise means-ends relationship or in **the now-dominant methodological sense of internal consistency**.

THE ROLE OF WILL IN INNOVATION

Cattaneo had a lively sense of the ways in which the application of intelligence to economic problems is influenced by the environment, and of how this application may itself help to create a situation in which intelligence is no longer directed towards economic improvement. At this point we encounter **the second major component of the psychology of wealth: the will, which both orients activity and supplies the determination with which it is pursued.**

Cattaneo (p. 101) is confident that 'will directed to wealth must favour the development of intelligence'; it does so both at the level of the individual (where one may think of the combination of intelligence and will that is embodied in Schumpeter's conception of the entrepreneur) and at the level of political and economic organisation, where individual freedom encourages the application of will to find new sources of value and new means to achieve it by the use of intelligence.

THE ROLE OF PURPOSE IN THE EXPLANATIION OF ECONOMIC PHENOMENA

In these two presentations I propose to replace Cattaneo's 'will' with 'purpose'. My principal reason for doing so is **Edith Penrose's** example. **She invoked human purpose as a powerful objection to any explanation of economic phenomena that relies on the direct application of biological evolutionary reasoning, from which any hint of purpose is rigidly excluded**, either as a source of variation or as an element in selection (Penrose 1952).

Purpose is to be understood as the **intent to achieve some change from the present state in accordance with some objectives**; **it is related to process, not equilibrium, and this process entails gaining knowledge and developing capabilities.** That is why 'will directed towards wealth must favour the development of intelligence'. An important implication is the heterogeneity of economic agents; in the second presentation this will lead to the heterogeneity of firms.

THE LESSONS OF GREAT ECONOMIC THINKERS

….**since the development of ideas is not merely cumulative, but is often assisted by the rediscovery of ideas that have been neglected, or even discarded,** we should not be surprised to find, as already noted, that there are several economic giants on whose shoulders we can stand. It is of interest, and a major illustration of Cattaneo's principle that every point of view has its limits, that the most formidable of these giants, **Smith, Marshall and Hayek, all developed their psychological ideas before they began thinking about economic issues.** All were prompted to do so by their encounters with problems of knowledge; and they each responded by developing explanations of the processes by which knowledge is developed. **Moreover they postulated similar kinds of process, leading to the formation of connections within particular domains**. Each recognised that such processes cannot deliver proven truth, and so they envisaged sequences of trial and error within particular contexts, leading to the preservation of patterns which appear to correspond with perceived phenomena, until this correspondence breaks down, when a new sequence of pattern formation begins.

Their theories may therefore be categorised as evolutionary, in the broader Darwinian sense of variety generation and the selection and preservation of particular variants; indeed Marshall's and Hayek's are presented as such, while Smith, though retaining the language of design (which neoDarwinians are inclined to treat as a mark of non-evolutionary thinking), rejected the possibility of designing either knowledge or human society, and had a major influence, both directly and indirectly, on Darwin's ideas about the evolutionary process and the general tendency of its outcomes.

This presentation is organised around Hayek's theory of the human mind, with Smith and Marshall's theories used to provide complements and comparisons. One reason for choosing a primary focus on Hayek is that his theory is the most elaborate, and **explicitly related to neuropsychology (a connection that I propose to exploit);** a second reason is that **I have recently published an article (Loasby 2002) on Smith's theory of the growth of knowledge** as a proto-evolutionary theory, while **Raffaelli (2003) has published what may be the definitive account of Marshall's psychological theory and its influence on his economics.** The application of Marshall's model of the mind to the organisation of economic activity, in his own work and beyond, receives rather more emphasis in tomorrow's presentation.

SMITH

Smith and Marshall

…….**in his exposition of 'the principles which lead and direct philosophical enquiries' Adam Smith (1980 [1795]) had sought to account for the development of mental representations of the physical order. Smith ……. seems to have been dissatisfied with Hume's argument that people were 'excited by nature' to believe in 'constant conjunctions' (Hume 1875, p. 41), and developed an explanation which gave distinctive roles both to the innovative human mind and to human emotions.**

SMITH'S CONNECTING PRINCIPLE

He suggested that it is characteristic of human nature to be uncomfortable when unable to make sense of a particular phenomenon, especially when that phenomenon is repeated; people therefore try to invent 'connecting principles' that will collect unexplained phenomena into categories and provide an acceptable explanation of these categories. Satisfactorily explanations are a source of positive pleasure, especially if the solution is aesthetically pleasing, and are likely to be widely adopted by those encountering such phenomena. A subsequent failure to accommodate some new phenomenon within an established pattern then provides the stimulus to create a new interpretative system by a rearrangement of connections, which may also entail a rearrangement of categories (for example, the set of 'planets'). That Smith, like Hayek, had a conception of knowledge as a set of replaceable theories is most strikingly demonstrated by **his insistence that Newton's theories were the product of Newton's imagination,** not a direct perception of the truth. Smith (1980 [1795], p. 77) even noticed that the desire for theoretical comfort could be powerful enough to override the evidence of the senses, such as the overwhelming sensory evidence of a stationary earth. **Though this supersession of sensory evidence was clearly a major element in the problem that Hayek attempted to resolve, his explanation is focused on the physiological mechanisms and does not incorporate the motivational issues that were so important to Smith.**

DIVISION OF LABOR PROMOTES THE GROWTH OF KNOWLEDGE

Because psychology was at that time closely associated with philosophy, it is not surprising that **Smith** did not attempt to provide a physiological underpinning for what we may now call his **evolutionary theory of cognition**. **He did, however, extend that theory to explain how the division of labour promotes the growth of knowledge.** First, **science emerges as an identifiable category of knowledge with its own practitioners**, and then, as scientific knowledge expands, **specialisation between the sciences simultaneously increases the range of study within the scientific community** and **the attention to detail within each sector**; and at each stage **this closer focus accelerates the perception of anomalies which, by causing intellectual discomfort even when they appear to have no practical significance**, **stimulate the invention of new 'connecting principles' that may accommodate them**. …..**Then Smith (1976b [1776]) transferred his theory of the growth of knowledge from science to the economy through his fundamental proposition that the division of**

labour, because of its powerful effects on the growth of knowledge, **is the primary instrument of economic growth**; **in the process the emphasis switched to the importance of attention to detail as a problem-generator, the solution of productive problems providing sufficiently obvious motivation**. (For an extended account, see Loasby 2002).

KNOWLEDGE AS ORGANIZATION AND THE SMITH'S CONNECTION PRINCIPLE

Why should organisation aid knowledge? The essential point is that knowledge itself is organisation: 'Whatever we call reality, it is revealed to us only through the active construction in which we participate' (Prigogine and Stengers 1984, p. 293). **As Simon (1959, p. 273) observes, if perception is a filter, then 'the filtering is not merely a passive selection … but an active process involving attention to a very small part of the whole and exclusion, from the outset, of almost all that is not within the scope of attention'.** The possibility of establishing 'true knowledge' on an undisputable basis, either axiomatic or empirical, was conclusively refuted by David Hume (if not earlier); and **Hume's friend Adam Smith (1980 [1795]) produced a remarkable psychological theory of the development of human, and eventually scientific, knowledge as a work of human imagination by which order was imposed on otherwise unaccountable phenomena through the invention of 'connecting principles'**. Because, **to use Karl Popper's term, all knowledge consists of conjectures, it is always liable to be confronted with anomalies; and a persistent failure to accommodate anomalies provides powerful psychological incentives to invent a new set of principles that will restore the comfort of understanding. The increasing focus on incentives within economics has not yet encompassed these particular motivations, which seem to be no less powerful than opportunism, and no less significant in their effects.**

SHAKLE'S SENSE OF ORDER AND CONSISTENCY

George Kelly's (1963) ***Theory of Personality*** **is remarkably similar to Adam Smith's theory of science and to Shackle's (1967) reinvention of the latter. A 'sense of order and consistency' (Shackle 1967, p. 286) is a psychological necessity, and this order must be created by the human imagination. Experience is not a sequence of events, but is constituted by the order that is imposed on them (Kelly 1963: 72-4): thus a sequence of events may constitute different experiences for different observers.**

KELLY'S SEARCH FOR COMPATIBILITY AS A STIMULUS TO NEW KNOWLEDGE

For Kelly as for Smith, time is fundamental, because time brings change. We make patterns of what we think might be viable subsystems, and use them as heuristics, both for action and for absorbing (or adapting) new knowledge. All heuristics are limited in their applicability, and these limitations carry the potential for systematic error, especially when faced with novelty – which may not be recognised as novelty. A substantial degree of decomposability, as Simon insisted, is essential, but decomposability tends to degrade with time, as Kelly and Marshall both recognised; and **'time provides the ultimate bond in all relationships' (Kelly 1963, p. 6)** – but not as

domesticated within an Arrow-Debreu equilibrium. Local patterns provide local structures within which to think and act; but compatability between patterns that may be juxtaposed is also a psychological need. **The search for compatability may be a major stimulus to the creation of new knowledge and new skills; but individual failure to achieve or maintain internal coherence may be disastrous, paralysing action and even leading to mental breakdown,** which was Kelly's professional concern. **As we shall see, these human characteristics are significant in explaining the organisation of economic activities, and also in explaining organisational pathologies, from systematic weaknesses to ultimate collapse, as we have seen in individual businesses, industrial districts, and economic systems.**

MARSHALL

THE MARSHALL'S MACHINE

It was this application that attracted Marshall's attention, and not Smith's underlying psychological theory, which Marshall may never have read. However, Marshall had already recognised the possibility of a conjunction between contemporary associationist psychology and Darwin's ideas (which, as has been noted, owed much to Smith's emphasis on the advantages of differentiation), and in the process provided a physical equivalent of Smith's cognitive theory. Marshall's encounter with the problems of knowledge has been explored by Butler (1991), Groenewegen (1995), and Raffaelli (2003); it may be sufficient to note here that this encounter was prompted by a major intellectual controversy about the possibility of demonstrating religious truths, which coincided with Marshall's own religious doubts.

His response was clearly shaped by Alexander Bain's (1864, 1865) major reorientation of psychology from philosophy towards physiology, which had the unintended effect of making it readily accessible to Darwin's ideas, as Marshall quickly realised; he had read *The Origin of Species* by March 1867 (Groenewegen 1995, p. 119). **He did not think of connections between neurons (which was a later pattern of thought), but wondered how far these psychological processes could be represented by a mechanical system, and devised the most elaborate model of his whole life in order to investigate this question (Marshall 1994).**

Marshall's 'machine' is first conceived as a combination of a 'body', which is capable of receiving impressions from its environment and performing actions in that environment, **and a 'brain'**, which has no direct connection with the environment and therefore must operate, as in Smith's and Hayek's theories, by forming selective connections. **Marshall indicates this by restricting the brain to operating with 'ideas of impressions' and 'ideas of actions'; it works by linking the idea of an initial impression received by the body with the idea of an action which the body performs in response, and then linking the latter with the idea of an impression that is interpreted as a consequence of that action. If the latter linkage produces a pleasurable sensation, then the linkage from initial impression to action is strengthened, and if the sensation is unpleasant it is weakened**.

The suggested mechanism, possibly inspired by Babbage's conceptions of analytic engines and automata, to which Marshall refers, **is of wheels connected by bands, which may become tighter or looser in response to the sensation experienced.**

This cumulative trial and error process, which forms associations of contiguity or similarity, is consistent with Bain's account of the physiology of mental phenomena; and **Marshall shows how the process could produce complex patterns of relationships**. **The basic mechanism, including the importance of sensation, also corresponds quite closely with Smith's mentally-focussed account of the growth of knowledge,** though it would correspond even better with an elaborated account of the process by which the division of labour fosters the development of capabilities. Indeed it should be noted that **in Marshall's presentation action is essential to the formation or dissolution of associations; this was to become an important element in Marshall's theory of economic**

development. Not only does every action start with some act of intelligence, as Cattaneo observed; actions favour the development of intelligence.

EXAPTATION: THE USE OF SIMILAR MECHANISMS FOR DIFFERENT PURPOSES

Marshall continues his evolutionary sequence by postulating the emergence of a second level of control within the brain, which uses similar mechanisms for different purposes (an early example of exaptation as a postulated evolutionary mechanism). Ideas of impressions received which have not been linked to any idea of satisfactory action can now be referred to this higher level, which may generate the idea of a novel action and associate it with the idea of an impression of its effects. Expectations appear; but they appear as conjectures. **A pleasurable linkage of contemplated ideas is then transferred to the lower level, where it directs bodily action**; and **if the action produces the anticipated impression the corresponding link between impression and action forms a new routine**. This is a crucial development: **it introduces imagination and the possibility of trial and error within the mind which may improve the chances of success in the environment**, thus opening the path to modern practices of research and development. Since **both the conjectures generated at this level and the internal selection processes applied to them are not random but oriented to problems, the course of development is influenced by human intelligence and human will**. This does not conform to modern neoDarwinian principles of variety generation; but it does not conflict with the broader Darwinian principle of selection at the practical level, as in Darwin's own example of selective breeding.

THE DEVELOPMENT OF ROUTINES AND THE GENERATION OF VARIETY

Over time such a machine may develop a range of closely connected impressions and actions, which we might now call routines; these routines are not the result of anticipatory choice but of environmental selection among actions which, by Marshall's intentional specification of his model, **cannot originate in consequential reasoning**. Although the imprint of his mathematical training is unmistakable in the conception and structure of his 'machine', **he has already moved away from the axiomatic method as the appropriate way of deciding what to do**. To be precise – and this may sometimes be very important, though Marshall does not say so – **selection depends on the environment as it is perceived by the machine**.

In the elaboration of his model **this environment contains other machines that operate on similar principles, but because of differences in initial perceptions and initial actions and the selective reinforcement of what appears to work they may develop different connections. Thus a population of machines constructed to a uniform design may generate the variety which is essential for any evolutionary process.**

EXPERIMENTATION AND GENERATION OF VARIETY

All this applies to organised groups of humans. Directed action within a group relies on pre-existing routines within which no choices, in the normal sense, are exercised; if directed action fails to achieve its objective, the recognition of failure leads either to a modification of existing routines or to experimentation resulting in new routines. Thus knowledge that is already organized into routines facilitates the creation of new knowledge – especially that which builds on the old; and new knowledge which is corroborated by apparently successful application is consolidated into new routines. It is not then surprising that **experimentation should be at one or other of the margins of knowledge;** and these margins will differ according to the past history of the growth of knowledge within each organisation, because this history influences the development of capabilities within that organisation and also of beliefs about these capabilities and about the ways in which they might be most effectively applied. **The generation of variety across organisations is a natural consequence;** and this may be considered an effective response to the underlying and pervasive uncertainty about the likely directions of progress.

MARSHALL'S MODEL OF MENTAL ACTIVITY: AUTOMATIC CONNECTIONS AND CONSCIOUS ATTENTION

Marshall's treatment of organisation matches his early model of mental activity (Raffaelli 2003). Indeed, Marshall's discussion of organisation begins in Chapter 9 of the *Principles* with an account (corresponding to his early model) of the multi-level structure of the brain, in which conscious attention is reserved for problem-solving or the introduction of novelty; the application of solutions or the repetition of new actions 'develops new connections between different parts of the brain' (Marshall 1920, p. 252), which gradually take over the maintenance of these activities, leaving the conscious brain free for new initiatives, including those which utilise these now-automatic connections. The process is illustrated by learning to skate; acquired skills no longer require thought, which may then be devoted to devising and controlling particular sequences of skating (Marshall 1920, p. 251). **Order makes room for creativity, which is stabilised in a new order which combines newly-established expectations and beliefs into a patterned performance. Knowledge which may have been constructed through codification is preserved as tacit knowledge, and the 'codebook' may be lost.**

THE BALANCE BETWEEN ROUTINES AND INNOVATIONS

The total knowledge and skill, and the particular content of knowledge and skill, that is available to a society, depends on the way in which the potential for development at the level of the individual is organised within the economy. The psychology of wealth leads to a particular perspective on this problem of organisation. **We can see at once that it requires a balance between apparently conflicting principles: the coherence, and therefore the effectiveness, of this differentiated system requires some degree of compatability between its elements, but the creation of differentiated knowledge and skills depends on the freedom to make idiosyncratic patterns by thinking and acting in ways which may be radically different from those of many**

other people. The relative importance of compatability and independence, of course, varies enormously across an economic system, and so any tolerably successful system requires a combination of many different kinds of balance. The drastically simplified categories of 'firms' and 'markets' do at least recognise the need for the co-existence of arrangements that emphasise independence and arrangements that emphasise co-ordination; but each category contains many different degrees and kinds of balance between the two, and there are also many arrangements that do not fit easily into either, as Richardson (1972) pointed out.

THE ECONOMISING PRINCIPLE OF SAVING INTELLECTUAL ENERGY

Marshall's formulation has substantial virtues as an evolutionary model which conforms to a basic economic principle: certain regularities of behaviour are selected and reinforced by their success in extracting benefit from their environment, by a procedure which operates at low cost in mental energy. Another economic principle may be discerned in Marshall's distinction between two categories of evolutionary sequences, which we may now distinguish, in Hayek's terms, as the development of the species and development within the individual: this is Smith's principle of the division of labour, which accelerates the growth of knowledge. The evolution of the brain is clearly a biological phenomenon, though the sequence may be explained by the application of basic economic principles to biology. The second level, which is much more energy intensive, requires the prior development of the first as an effective survival mechanism and subsequently as a problem-generator; with this precondition it becomes an important source of potential improvement in the machine's performance, achieved at low overall cost in mental energy by the separation of levels and specialisation between them. The additional effort of generating and checking ideas is undertaken only when the existing set of routines has proved inadequate, and does not disturb those elements in the set which appear to work well; any improvements in performance are stored at the lower level, and thus cease to require active supervision. It is an efficient mechanism for making local adjustments, a precursor of Marshall's partial equilibrium analysis.

A Marshallian view of organisation

'Our logical methods and our endless analysis of things has often blinded us to an appreciation of structure and organization. Yet our physical and social worlds are full of structures, organizations and organisms' (Barnard 1938, p. 317). Moreover, organisation is 'something else than the sum of its parts, wherever human beings are involved'. **Its effects depend on the pattern of connections between the parts of the organisation, precisely because what has to be organised is the interaction between human brains in particular contexts.** It is no accident that changes in organisation were incorporated by Marshall (1920, p. 318) in his definition of increasing return. As Quéré (2003, p. 198) writes, 'Increasing returns do not pre-exist. They are the result of an economic process; that is, a result of the way co-ordination problems are managed over time'. **Our clearer understanding of the relationship between Marshall's theory of the mind and his theory of economic progress** may suggest that he was thinking not only of the reordering of relationships between people but also of the subsequent reordering of relationships within minds; at both levels **the increasing returns are not produced by the elements but by the connections between them. (Failure to recognise this basic point wreaked much havoc on economic theory in the 1920s – and**

continues to cause trouble.) As argued in the preceding presentation, the theory of the mind is an organisational theory; and in the brain as in the economy, organisation matters because it makes a difference. The difference is not always for the better, as Barnard notes: that is why he wrote about it and why it is still studied.

MARSHALL'S PRINCIPLE OF SUBSTITUTION AND PENROSE'S THEORY OF FIRM

Marshall's recognition of this is exemplified by his 'principle of substitution', which is a guide to selective experimentation against a baseline of established practices (Loasby 1990), as in scientific procedures. From an orthodox perspective he appears to confuse changes of resource combinations within well-defined production sets to reflect changes in relative prices (the general equilibrium perspective) with modifications of these sets by economic agents (which in general equilibrium theorising is a privilege reserved to economic analysts); but if human knowledge is formed by the processes discussed in the previous presentation then the production possibilities available to any firm are partly the product of its own activities and are never well defined. This double insight was to become the basis of Penrose's (1959, 1995) theory of the firm; her distinction between resources and productive services may be regarded as an elucidation of Marshall's analysis, and the conjunction of resources and the administrative framework in her definition of the firm introduces a major development of it. **In Penrose's theory, firms grow because of the creation, selective retention and application of resources, including managerial resources; and each resource, instead of constituting a well-defined input into one or more production functions, is a multi-specific asset the potential uses of which have to be discovered, invented, or imagined.**

THE ROLE OF KNOWLEDGE IN PRODUCTION AND CONSUMPTION

It is well known that **Marshall** contemplated a specialisation in psychology, and towards the end of his life expressed at least a passing regret that he had not done so. **His primary reason for preferring economics to psychology was the 'increasing urgency of economic studies,** as a means towards human well-being … not so much in relation **to growth as to the quality of life'** (Whitaker 1996, II, p. 285); and the quality of life was crucially dependent on mental as well as physical factors. **Better knowledge was a primary source not only of increased productivity** (as mainstream economists have rediscovered) **but also of better patterns of consumption (which is still neglected); for Marshall, preference functions, like production functions, were a product of the economic system.** However, to understand behaviour it was necessary to go beyond knowledge of what was available and of its possible effects, to what Marshall called character. In sketching the breadth of potential for his machine he concluded by describing it as 'a moral being' (Marshall 1994, p.129)…

HAYEK

Hayek's *Sensory Order*

The focus of inquiry is on systems of relationships, and the key to Hayek's analysis is the **hypothesis that 'causal connexions' in either classification are linked to 'structural connexions' within the human brain**. It follows that **the sensory and physical orders are linked to different neurological networks,** and that networks of the latter kind are of relatively recent origin; **Hayek argues that they are nevertheless similar in construction and operation**. The essential point to note here is that **connections within the brain are selective, and so connections between human perceptions and the physical world (including the physical world of the brain) are also selective; moreover, being selected within the human brain**, which as a physical system is capable of sustaining alternative connections**, they are 'subjective' rather than 'objective'.**

…….**it also allows great scope for imagination and novelty, through the making of new connections.**

Since connections are formed within the brain, and are necessarily highly selective, it might be supposed that **individuals could develop patterns of connections which are so diverse that they fail to understand each other**; and this is not a possibility that we should ignore. However, Hayek argues that similarities of experience promote similarities of patterns and perceptions, at the level of the individual or the species

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FROM DIRECT CONNECTIONS TO ORGANIZATION OF RELATIONSHIPS

…..**Hayek (1952, p. 40) argues that instead of direct connections between particular stimuli and particular sensory qualities**, **the effect that is produced by any stimulus depends, first, on how (or indeed whether) it is translated into an impulse in some nerve fibre** (Hayek 1952, p. 10) and, second, **on the location of this impulse in relation to other impulses within the network of connections** (Hayek 1952, p. 53). De Vecchi explores the influence on Hayek's thinking of gestalt psychology, which insisted on **the importance of perceptions which are derived not from the parts but from the relationships between them**. **These relationships are 'the result of a process of organization … performed by the nervous system'** (De Vecchi 2003, p. 144), which selects a particular combination of connections.

ALL KNOWLEDGE IS CONSTITUTED BY CONNECTIONS

Any impulse is not a carrier of the initial stimulus but a 'representation', perhaps with some different properties; and this representation is itself interpreted in terms of the relationships which have already been established within the brain: thus 'the qualities which we attribute to the experienced objects are strictly speaking not properties of that object at all, but a set of relations by which our nervous system classifies them' (Hayek 1952, p. 143). Hayek immediately and explicitly draws **on Popper's language to emphasise that '*all* we know about the world is of the nature of theories and all "experience"** can do is to change these theories'; in other words, we create

a different set of connections. **All knowledge, including 'knowledge how' as well as 'knowledge that' (Ryle 1949), is constituted by connections;** it is a particular set of relationships among many other sets that are technically possible, and this set is always potentially subject to replacement – though major changes are not easily achieved, as we have already noted.

SELECTIVE CONNECTIONS ARE THE KEY TO HUMAN COGNITION

Present-day humans therefore embody a partial shift from 'evolution in the course of the development of the species' towards 'evolution in the course of the development of the single individual' – a shift which has been confirmed by natural selection, but which entails other forms of selection (for a discussion of some of these, see Loasby 2001). **This process of learning works through the creation and modification of connections within the brain, for selective connections are the key to human cognition**. If two stimuli are experienced differently, 'this difference must be reflected somewhere in the brain. Every new piece of learning changes the structure of the brain in some fashion, however minor' (Bates et al., 1998). **This is precisely how learning is modelled by Hayek, and also by Marshall (1994). The development of a new system of connections that constitutes a physical order, and which at first supplements and then increasingly supersedes our sensory order in many contexts, may be seen as a consequence of this major trend in selection within the human species**. This deserves some further consideration.

Some implications

Hayek's impossibility theorem warns us that our knowledge is necessarily fallible and incomplete, but it also suggests, as do Smith's and Marshall's theories, how it may be improved and tested, and what kinds of opportunity costs are likely to be incurred along different pathways of attempted improvement. **Knowledge is created by selecting connections which will constitute domain-specific modules;** and we may identify two general principles on which to base this selection, which apply both to everyday cognitive operations and to those special cases in which we are consciously attempting to construct interpretative frameworks, some of which we may choose to call theories. As all four authors indicate, these cases are not so very special; Smith and Kelly explicitly focus, from different angles, on 'man as scientist'. **One principle** directs us towards **fine discrimination in our definition of categories**, at the expense of reducing the breadth of our view and ignoring interactions with the rest of the universe, thus restricting our pattern-making to a narrow domain which we may be able to explore in some depth. **The second principle** points towards **the strategy of aggregating the elements of our universe into broad invented categories** on the basis of similarities that we suppose are significant for our particular purpose, while ignoring the differences which we assume to be of little relevance for that purpose (or which we simply fail to notice), thus creating a domain which is broad but almost empty. Normally, there is some accommodation between these two principles; and all our representations are sub-systems which include both a few external connections and a few subdivisions within their components.

As Hayek (1952, p. 176) pointed out, nothing can be recognised unless it can be assigned to some existing category. Perhaps the clearest, and prior, statement of this necessary principle of contextual similarity, and the implicit dangers of ignoring apparently irrelevant differences in favour of salient resemblances, was provided by Frank Knight (1921, p. 206). Hayek (1952, pp. 145-6) likewise emphasises that all classification must be based on selected elements, so that the resulting 'system of

acquired connexions … will give only a very distorted reproduction of the relationships' which it purports to represent, and 'will often prove to be false', generating misleading expectations; and Simon (1982, 2, pp. 306-7) similarly observes that because of the active filtering involved in both direct perception and the handling of information 'the perceived world is fantastically different from the "real" world'. Hence the importance of a procedure for revising, or even replacing, classifications which no longer seem to work, and of a strong intrinsic (and therefore genetic) motivation for doing so; such revisions are of course the means by which the physical order began to emerge from the sensory order, and new sciences emerged.

RATIONAL CHOICE EQUILIBRIUM

GENERAL EQUILIBRIUM MODEL AND SELECTIVELY-CONNECTED SYSTEMS

Because **its conceptual basis is that of a selectively-connected system, Hayek's theory** is to be **sharply distinguished from general equilibrium models, in which every element is connected to every other**. The completeness of the connections (the equivalent of a 'field theory') is the basis both for analyses of the existence and stability of general equilibrium allocations and for claims about their welfare properties; **all 'market failures' are to be traced to the absence of some connections**.

THEORY OF RATIONAL CHOICE AND NEWDARWINIAN EVOLUTION

Indeed we may now observe an emerging conflict for supremacy in the social sciences between the rival unifying theories of rational choice equilibrium and neoDarwinian evolution. The two stand in a curious relationship. **Both are theories about selection between alternatives and the preservation of what is selected; and in both, selection is based on the consequences of those alternatives which are presented for selection. However, rational choosers, being equipped with rational expectations, know these consequences in advance,** and having made the correct choices they naturally have no wish to change them, but remain in their equilibrium state until there is some shock to the economic system. (Their cognitive system, being already fully connected and therefore perfect, never changes.) **In the neoDarwinian model,** by contrast, no-one knows the consequences of the available alternatives, and any attempt to design alternatives in order to produce desirable consequences is a pretence that is unworthy of science; but **if neoDarwinian processes can discover the best answer that is currently available only after trying all existing (though not all possible) alternatives, nevertheless the best currently available answer will be discovered, and once discovered it will be conserved in the genetic code, which may then be observationally indistinguishable from an equilibrium allocation**. By appropriate allowance for the costs of this process, which is claimed to be the only process possible, one may even be able to make claims for optimality along similar lines to the claims for optimality, **subject to information and transaction costs, that are sometimes put forward in economics.** Thus assumptions which appear to be polar opposites can, with a little sleight of thought, support identical outcomes.

ASYMMETRIC INFORMATION VS ASYMMETRIC INTERPRETATION

The incentive problems of dispersed knowledge, under the title of asymmetric information, have become a major focus of attention in economics, and that in itself is no bad thing; but because full specification (at least of all contingencies and their implications) is necessary for the calculation of system optima it is inevitable, though unfortunate, that **such problems are treated as some kind of 'organisational failure', rather than being part of the pathology of success**.

The apparently-analysable problems of information have diverted attention from the more fundamental issue of interpretation; asymmetric interpretation is at once a threat to co-

ordination, a basis for opportunism and a route to innovation. The recent growth of interest in 'knowledge management' may provide an opportunity for a balanced analysis of the costs and benefits of the growth of knowledge, related to an understanding of the processes of this growth – but not if the management of knowledge is treated as primarily a problem of information technology.

Economic growth and the growth of knowledge both entail the division of labour in order to achieve an effective allocation of resources to the development of appropriate domain-specific cognitive modules within the economy and within society – indeed within many kinds of 'space'. As Darwin learnt from Smith, perhaps indirectly through Milne-Edwards, these are the advantages of the division of labour that have led biological evolution towards the variety of species; they have led human societies towards the variety of knowledge.

From rationality to cognition

I am afraid we must conclude that, in relation to conventional economics, 'bounded rationality' is not a good label for the view of human nature on which Simon wished to base his analysis, because it has been interpreted as an occasional and strictly limited exception to the norm of unbounded rationality, which might be useful in resolving some awkward anomalies such as the existence of firms. Even Foss's proposal to make use of the evidence of psychologists seems to suggest that firms exist in order to cope with a well-defined class of systematic departures from a norm of strictly rational behaviour. But if the adjective is unfortunate, so is the noun; for once we accept that rationality is bounded, **the economic concept of 'rationality' is insufficient,** and 'optimality' is simply not good enough. Quite different cognitive skills are now required. (For a discussion of such skills, see Gigerenzer and Selten (2001), who emphasise the efficacy of 'boundedly rational' **heuristics**.) Therefore **instead of thinking only about remedies for particular deficiencies of rationality we should turn our attention to the means of exploiting the remarkable human cognitive skills of classifying and connecting phenomena and ideas, which Adam Smith identified as the prime instruments of both scientific and economic progress.**

As is well known, Simon gained early inspiration from Chester Barnard; and Barnard had very clear views on the relationship between human nature and the environment. In a lecture on 'Mind in human affairs', printed as an appendix to *The Functions of the Executive*, he emphasised **the importance of such skills in the many situations in which there was no adequate basis for logical operations.** 'Much of the error of historians, economists and all of us in daily affairs arises from imputing logical reasoning to men who could not or cannot base their actions on reason' (Barnard 1938, p. 305) – because, even if the logic is impeccable the premises are typically ambiguous, erroneous or incomplete (Barnard 1938, p. 304). '**The correctness of such decisions must, therefore, depend upon the effectiveness of the mental processes of the type that can handle contingencies, uncertainties and unknowables' (Barnard 1938, p. 312). Logical reasoning has a role** in these processes, **by identifying implications and inconsistencies, but they require a human mind which** cannot be represented adequately as a general purpose information processor, but one **which operates within particular localised frameworks and uses particular criteria, all developed within particular environments** (as discussed in the preceding presentation). As Barnard (1938, pp. 301-2) observes, this **creates difficulties in adjusting to new kinds of work, however complete the advance provision of knowledge, and in achieving understanding between persons or groups**. Barnard cites his own experience in moving between jobs, but such difficulties arise whenever there are attempts to

reorient well-established businesses. **These cognitive and organisational problems provide a rationale for Schumpeter's initial association of entrepreneurship with outsiders.**

Integral and non-integral systems

In the same year in which Debreu published his definitive **analysis of general equilibrium**, Simon observed of **the choice-theoretic tradition in economics** that

> when perception and cognition intervene between the decision-maker and his objective environment, this model no longer proves adequate. We need a description of the choice process that recognizes that **alternatives are not given but must be sought**; and a description that takes into account the arduous **task of determining what consequences will follow on each alternative.**
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> (Simon 1959, p. 272)

Jason Potts (2000) has recently emphasized the fundamental difference between these two conceptions of analysis. General equilibrium exists in integral space, which ensures that every element in the system is directly connected to every other element; thus every preference, resource, commodity, location, date and contingency enters directly into the determination of the solution for the system being modelled. In integral space there is no room for dense clusters of connections, such as those that constitute firms or markets. 'Organisation' as a topic is undiscussable.

RATIONAL CHOICE THEORY IS BASED ON AN INTEGRAL SPACE MODEL

Rational choice theorists have preserved their conceptual system by endowing economic agents with 'rational expectations' which are the equivalent of the analyst's integral model and even allow the set of agents to be collapsed into a single representative agent. The essential incompleteness of connections, which is the precondition of organisation – including the organisation of markets, which are a pure fiction in standard equilibrium models – and the essential incompleteness of knowledge both require an analytical foundation in non-integral space. Simon (1991, p. 27) argues for 'the ubiquity of organizations': I suggest that we delete the final letter, and emphasise the ubiquity of organisation, because **perception, cognition, and decision processes, for individuals as well as firms, are organisational phenomena**. Methodological individualism should begin, not with preference sets and possibility sets, but with evolving cognitive structures. **Connections matter (Loasby 2001).**

NON-INTEGRAL SPACE AND THE ROLE OF ORGANIZATION IN FIRMS AND MARKETS

It is within non-integral space that we can begin to explore the implications of Marshall's (1920, p. 138) linked principles: 'Knowledge is our most powerful engine of production. … Organization aids knowledge'. (This passage dates from the fourth edition of 1898.) Simon's

(1991, p. 28) suggestion that 'organizational economy' is a more appropriate term than 'market economy' is powerfully reinforced by the recognition of the intimate connection between organisation and the knowledge on which an economy – especially a modern economy – depends. This connection also suggests that the familiar contrast between 'firm' and 'market' may be misleading; in addition to the variety of intermediate relationships to which Richardson (1972) drew attention, there are 'market' elements within many firms, and 'markets', like firms, are important features of organisation. The multiplicity of markets reflects the advantages of specialisation in the organisation of particular kinds of transactions, where the classification of transactions is the product of human minds and continues to evolve as a product of experience and imagination. **Markets rest on institutions (Ménard 1995), which emerge from human behaviour, both conscious and unconscious; as Schumpeter (1934) and Casson (1982) noted, they may be the focus of entrepreneurial actions. Both firms and markets are structures that facilitate human interaction by reducing transaction costs through various kinds of investment, and the flexibility of both depends on imperfect specification.**

A SWITCH FROM SYMBOL PROCESSING TO PATTERN MAKING

The switch from rationality to cognition entails, I believe, a shift of emphasis from symbol processing, on which Simon focused his attention by way of computer models of artificial intelligence, to pattern-making and pattern-using. Symbol-processing has the dual virtues of directing our thoughts to how problems are handled and reminding us that our mental processes necessarily take place in the space of representations, and not in the space of real-world phenomena. The correspondence between the two spaces (which Popper called World 3 and World 1) is problematic, and may be extraordinarily flimsy. Simon was well aware of the importance and the fallibility of representations, more aware than politicians, business strategists and economists often seem to be. However, **I suggest that the most promising approach to understanding representations is not by modelling humans as analytic engines but through the human facility for pattern-making, by which representations are created.** (The substantial precedents created by economists for this approach provided the basis for yesterday's presentation.) **This leads us to recognise the importance of locally-connected systems rather than a general processing capability.**

Limited domains

The universal importance of limited domains (in contrast to general equilibrium) is a key concept in the analysis of individual cognition, and therefore in economic organisation. Domain-specificity, the usual label, is misleading, because the term suggests too narrow a range and far too much precision. Although some domains are both narrow and well-defined, usually there is some breadth of application and the limits are not well understood (as Knight and Hayek, for example, make clear in writing of the fallible bases of categorisation). The genome appears to have evolved as a method of constructing a system of domain-specific elements, embodying Smith's principle of the division of labour; but with the remarkable enlargement of the human brain we seem to have a partial but significant movement away from genetically-determined domain-specificity within the brain (which seems likely to include at least a major part of the sensory order) towards a genetically-enabled potential for developing domain-limited processes at the level of the individual, as suggested by Karmiloff-Smith and her associates. Though such individual development may simply modify genetically-endowed patterns, it may also

lead, as Hayek argued, to the creation of novel – and additional – patterns of connections within the brain, such as those that constitute the physical order; and these patterns are produced, as Smith and Shackle notably emphasised, by the human imagination, which operates at the second level of Marshall's 'machine'. Though the results of genetic evolution are still pervasive, there are now significant possibilities for development at the level of the individual to modify, and even sometimes to override, development at the level of the human species.

PATTERNS OF CONNECTIONS AND SIMILARITY AND DIFFERENTIATION

Education in any scientific discipline is intended to produce such influence; so is any commercial organisation. Consequently the knowledge available in any human society depends on organisation – which means on particular patterns of connections – of the kinds listed by Marshall; these exploit the advantages of similarity (which depend not on total homogeneity but on local variation within imperfectly-specified patterns, as in genetic modifications) and of differentiation, which can produce new species of knowledge incomparably faster than genetic evolution. **The distribution and selective connection of domain-limited modules within the economy is a central issue for explaining economic development and for effective policy at the level of firms and governments.**

ORGANISATION AND THE HUMAN MIND

INTERACTION AND SELECTIVE CONNECTIONS

Indeed, **the role of economic agents, however rational, is incompatible with the concept of a fully-connected system**; it is necessarily true that, as Frank Hahn (1984, p. 64) observed, 'traditional economic theory does best when the individual has no importance – he is of measure zero'. **Any interaction within a subset of agents implies non-integral space and highly selective connections, and therefore requires a different category of analysis.** Whether a multitude of such local interactions replicates the deduced allocation is a question which cannot be properly formulated within the conventions of general equilibrium models, as Richardson (1960) demonstrated – not least because **the concept of 'time' as a period during which these interactions take place is categorically distinct from the concept of 'time' as a dimension of all goods which is embodied in the specification of the general equilibrium model.**

PERCEPTION AND COGNITION AS STRUCTURES OF SELECTIVE CONNECTIONS

Perception and cognition have no usable meaning in integral space, since their significance is defined by the selectivity of the connections by which they are constituted. In sharp contrast to the standard assumption that the information available to agents is always a partition of the full information set which corresponds precisely to the configuration of the economy, **the selectivity of perception and cognition results from conjectures (rarely completely conscious) that are imposed on phenomena.** It is not then surprising that 'the decision-maker's information about his environment is much less than an approximation to the real environment' (Simon 1959, p. 272), especially when we recognize that the relevant 'real environment' is nothing less than the total system, including its structure of connections. 'The decision-maker's information' itself rests on perceptions which are themselves structures of connections, and so the knowledge within an economy is always dispersed and incomplete, as Hayek insisted. **That of, course, is why the performance of economic systems depends on the way that they are organised.** What is crucial to our understanding of economic organisation and economic development is that this dispersion and incompleteness is not simply a 'failure', but a condition of success – because of the nature of human beings who, as explained in the previous presentation, are obliged to economise on cognition but **are then able to use it to create new representations and new capabilities within particular domains.**

QUASI-INDIPENDENCE/COGNITIVE DISTANCE AND COORDINATION/COGNITIVE PROXIMITY

The counterpart of quasi-independence is the problem of co-ordination, which arises in two forms: the compatability of separately-produced knowledge, and its comprehensibility to those who have not participated in its production. **The division of labour offers to the innovator the protection of cognitive distance; the integration of what has been divided requires cognitive proximity.**

ORGANIZATIONS AND ROUTINES

SIMON'S DECISION PREMISES AND PROCEDURES

If there are no demonstrably correct procedures for making decisions, then the decisions themselves cannot be predicted without some knowledge of the procedures which are being followed by the decision makers, and nor can the actions which they initiate. Individuals matter, because the individual organisation of knowledge influences both actions and the development of knowledge. An inescapable consequence is that it is impossible to be certain about the decisions of others that may affect the outcome of a choice that one is about to make. **Thus decision-making systems, such as firms, require to be organised, and we are therefore directed towards Simon's theme of the decision premises and procedures by which this is done, and the influences on the quality of the decisions that emerge from them, broadened to incorporate linkages between decision-making systems (for example within networks of firms) and more generally to the role of institutions and informal organisation (which was emphasised by Barnard) in channelling behaviour. Organisations (of many kinds) and institutions matter, because they provide a (fallible) basis for securing compatability between their members.**

Opportunities as well as contingencies and interdependencies may be unknown; where there are no demonstrably correct procedures there is scope for novelty, and thus for the generation of variety that is essential to any continuing process of evolution.

Shackle's contribution is the importance of imagination as the counterpart of uncertainty, though we should not forget **the central role of imagination in Adam Smith's (1980 [1795]) account of the growth of knowledge.** Simon's own insistence that the range of alternatives between which people choose is a product of the decision process leaves ample scope for imagination; and **people differ in their capacity for imagination and in the particular connections that they make.**

The balance between routines/coherence and innovations/independence 21

THE CHARACTERISTICS OF CAPABILITIES AND ORGANIZATION

Richardson also showed how to make sense of this multiplicity of arrangements by analysing the interplay of degrees and kinds of similarity and complementarity between the capabilities (which we may think of as patterns of selected connections) that are required in any modern system of production.

SIMILARITY BETWEEN THE WORKING OF HUMAN BRAIN AND ORGANIZATIONS

In considering how one might effectively organise activities which are to be controlled by many brains, it is helpful to identify some principles which are common to the structure and

working of the brain and of organisations: and we can do this by drawing on the preceding presentation. The natural starting-point for an economist is the importance of economising on what we may call 'the costs of running the system'; the phrase is adopted from Kenneth Arrow, who unfortunately has not given much thought to the costs of running mental systems. These costs impose a requirement to be highly selective in forming connections and thereafter in relying on them, within individual brains, formal organisations, and economic systems (a requirement which was ignored in turn by advocates of central planning and of supposedly pure market systems); they also imply an essential complementarity (as well as conflict) between routine and innovation, to which we will return very shortly. This commonality of problems can in the end be traced back to the simple fact that the formation and the functioning of social organisations (unlike chemical compounds) is strictly (though not exclusively) dependent on the behaviour of the human beings that contribute to their formation and their operation, behaviour which in turn is strictly (though not exclusively) dependent on the functioning of the human brain.

We will now briefly consider some of the issues that arise from this cognitive perspective on organisation.

THE DEPENDENCE OF INNOVATION ON STABILITY

A fundamental characteristic of the cognitive theory underlying this presentation is the intimate dependence of all change on the absence of change. **Systematic development is impossible unless there is a stable baseline from which to begin and a stable environment against which options may be assessed, and which may give direction to deliberate attempts to generate conjectures**.

Routines stabilise evolved patterns, thus releasing mental energy and providing a basis for experiment; this interplay between routine and innovation, within an individual, a firm, an industry, and an economy, is a pervasive theme in Marshall's economics (Raffaelli 2003).

A natural consequence of this dependence of innovation on stability (which is also essential to neoDarwinian theory) is a substantial degree of path-dependency within each cognitive domain – including that of a whole economy, as is indicated by Marshall's (1919) surveys of national systems; but this tendency is partially offset by the variety and the quasi-independence of domains – another consequence of the combined effects of cognitive limitations and the division of labour. **The maintenance of stable baselines within particular domains is a prime function of formal organisations, and the appropriateness of the baseline is a major determinant of organisational success or failure.**

CHANGES WITHIN ORGANIZATIONS AND IN ORGANIZATION'S ENVIRONMENT

In an organisational context, this analysis can easily be extended to include problems of **incompatability between the frameworks which seem to apply in the work environment and those with which each worker is comfortable in other parts of life, and also to problems of incompatability between the changes of framework that seem to be required in different parts of the organisation to cope with major changes in the organisation's environment. 'A breakdown of**

corporate personality' may be an appropriate way to describe what has happened to many organisations (including the Soviet Union).

RIDEFINITION OF ORGANIZATIONAL BOUNDARIES

Success may depend both on bringing some people together and keeping others apart; and this may sometimes require the redefinition of organisational boundaries, both internal and external, as Allyn Young (1928) argued. Richardson's (1972) analysis of capabilities along the dimensions of similarity and complementarity provides a basis for such redefinition. **Adaptability – the capacity to modify connections – is preserved, and sometimes enhanced, by rearranging the connections between units or between levels. Such rearrangements may increase independence or exploit complementarities, thus redefining the cognitive unit, though not without creating new problems.**

COASE'S FLEXIBILITY AND INCOMPLETELY SPECIFIED CONTRACTS

Coase (1937) explained the firm as a set of incompletely-specified contracts which provided resources to be deployed at some date yet to be chosen and within a domain that could be broadly envisaged, thus avoiding the cost and time of making the necessary arrangements at that date; it is an investment in creating capabilities that provide options. Flexibility is preserved by the incomplete specification of both contracts and capabilities. Firms therefore require a combination of discretion and purpose – the scope for choice, and the capability and will to take good decisions and make them effective.

PURPOSE, STRATEGY, PLANS AND GAME THEORY

Purpose is related to strategy in the old military sense of a vision of what is to be achieved, a set of assumptions on which action is to be based, and a set of principles to guide a sequence of decisions. This is very different from the degenerate sense of the term in game theory, in which strategy is degraded to a completely-specified plan. Plans are contingent schemes to implement strategy (and game theory might be used in the process of planning), but as Clausewitz observed no plan survives contact with the battle. A sound strategy, however, may survive to guide a succession of plans.

COASE'S FIRM

A Coasean firm is a combination of purpose and capabilities which retains sufficient degrees of freedom to allow people to take decisions that may make a difference. Like knowledge, decision spaces are representations which have to be created, by defining boundaries and selecting

connections across those boundaries and between the elements within the space. This is Simon's view of organisations as decision-making systems.

DETAILED AND ARCHITECTURAL CHANGE

This distinction resembles that between detailed and architectural change in contemporary writing on strategy and management, and it may be applied not only to a single firm but also to networks or clusters of firms. A similar distinction may be applied to the organisation of knowledge, and changes in the architecture of knowledge may lead to changes in the architecture of both firms and industries. Pharmaceuticals and telecommunications are prominent current examples, and both demonstrate (as have many previous examples) that matching new structures of knowledge with new organisation is not a simple business. The limited domain-relevance of cognitive structures, compatability between domain-limited structures, and the appropriate kinds and degrees of discretion are all likely to be problematic.

NOTEBOOM'S FIRM AS A SENSEMAKING SYSTEM

A firm is a sense-making system (Nooteboom 2001, p. 43); what sense it makes depends on how it separates and connects its ways of organising, creating, and using knowledge, for different structures have different implications, not only for protecting against opportunism but more importantly for creating useful knowledge. Formal organisation is an imposed order, which creates an environment for further order, both as predictable behaviour and as new structures of knowledge.

TACIT AND CODIFIED KNOWLEDGE

CAPABILITIES AS COGNITIVE CAPITAL APPRPRIATE TO A PARTICULAR FIELD

Developed capabilities are configurations that economise on cognition by the creation of cognitive capital that is appropriate to particular fields; Marshall (1920, p. 251) explains how someone who has learnt to skate can employ that knowledge as a unit in constructing more elaborate figures.

The mental orders that are created by our imagination and tested in particular domains (ranging from very carefully controlled experimental settings to casual application – which may itself be very local or a broad commitment) are themselves forms of organisation, for all knowledge is a structure of selected connections.

Tacit knowledge and codification

From institutions as premises and procedures that are rarely questioned there is a simple connection to the theme of tacit and codified knowledge, which may be illuminated by Smith's, Marshall's, and Hayek's theories. All the knowledge that is developed within Marshall's first level is necessarily tacit, since there is no way in which it can be formally represented; though it is codified in the neural system, this code is not accessible to the brain by which it is governed. Anything in the environment which cannot be matched to the neural code cannot be recognised; within the human sensory order, infra-red light and ultrasound are simple examples. It is a crucial feature of Marshall's model that the operations of the second level do not displace the operations of the first; they build upon and complement it, by highly-selective intervention; and the additional knowledge generated as the second level is installed and maintained at the first level, where it necessarily becomes tacit, although recodification is possible if the codebook is not lost. These features are not simply the product of Marshall's fancy, even though his account is the product of his own brain, constructed from ideas supplied by Bain, Darwin, and Babbage, among others, as indicated in the previous presentation.

THE RELATIONSHIP BETWEEN TACIT AND CODIFIED KNOWLEDGE

Tacit knowledge must be the foundational knowledge within biological evolution, and both evolutionary principles and the importance of cognitive economy imply that it remains so in modern humans. Although codification offers a means of selective improvement in the quality of tacit knowledge, the economising imperative ensures that knowledge moves in both directions, **as the philosopher A. N. Whitehead (1948 [1911], pp. 41-2) pointed out in denouncing 'the profoundly erroneous truism … that we should cultivate the habit of thinking about what we are doing. The precise opposite is the case. Civilisation advances by extending the number of significant operations which we can perform without thinking about them'. The conversion of explicit innovations into routines which are no longer verbalised is an essential feature of Marshall's theory of development, and it reappears in Nelson and Winter's (1982) theory.**

THE ROLE OF TACIT KNOWLEDGE IN MAKING NOVEL CONNECTIONS

Whitehead explicitly included the operations of science which are intended to produce highly-codified knowledge within the scope of his proposition. Scientific practice is largely tacit, and parts of the codebook on which each system of practice is based may have been lost, especially when the codebook was compiled by an earlier generation. No one can learn to be a scientist solely by learning scientific propositions, or even by adding to this knowledge the rules of scientific procedure; much of the time taken in becoming a scientist is taken up by learning how to act correctly without thinking about the performance – even to the point of having no accessible way of thinking about it. **Moreover, the very process of codifying cannot dispense with tacit elements.** We can go further. **The actual generation of new ideas (whether good or bad, true or false) is necessarily tacit; although we may construct, as an academic exercise, a codified representation of a system in which all possible connections between its elements are clearly defined, nevertheless for anyone within an existing system, whether it be, for example, a firm, an economy, or a system of thought, the process of making a novel connection is necessarily tacit. We can, as it were, give our brains directions to help us with a particular problem, but there is no procedure by which we can control precisely what they should think. What has not yet been thought cannot yet be codified.**

Turning tacit into codified knowledge may not be at all straightforward. Codification implies classification, which is always problematic. Hayek's (1952, pp. 145-6) principle of necessarily selective and distorted representations allows scope for some dissonance between the sensory order which had been created as tacit knowledge in the course of evolution, extending presumably far back before the emergence of any humanoid species, and the expressed physical order that claims to represent the same phenomena.

THE CHARACTERISTICS AND LIMITS OF CODIFIED KNOWLEDGE

However, even sciences may appeal to the imagination in different ways, and develop coding systems that encourage communication and reduce ambiguity within each group, but at the cost of discouraging communication and increasing ambiguity between groups. Incommensurability, in the literal sense of the absence of any common measure (which does not imply undiscussability), may be the means to advance common knowledge, and the search for a universal codebook is likely to be misguided, since it is likely to be highly restrictive.

Underlying the whole argument is the simple idea that brains which develop selective connections are likely to create representations that are, in some degree, specifically appropriate to their contexts, and that these representations, once developed, may resist transformation. **Moreover, all representations are selective; codified knowledge, no less than tacit knowledge, is an imposed order, and it necessarily simplifies, aggregates, and excludes in some respects**. Even within each group, the possibility of developing some relevant kinds of new knowledge may be constrained by attempts at closure. Codification may usefully provide decision premises, and positive and negative heuristics, but there must be some flexibility, which means ambiguity, in interpretation. **The search for**

codification may have unfortunate consequences. Official standards are almost inevitably defined in terms of present knowledge, and may therefore become an obstacle to innovation. The **progressive codification of economics has not been free of opportunity costs. The first notable casualty was the concept of competition as a process; more recently we have seen the disappearance of innovative activity from the theory of growth.**

The desire for coherence, particularly within Popper's World 3, which is the domain of codification as that is commonly understood, may close minds to the possibility of alternative ways of organising knowledge. That is not to decry codification; it has its own virtues, and even its own potential remedies for its defects. The particular constraints of coherence within a firm may prompt those unhappy within these constraints to create another firm; and **the particular constraints of coherence within standard economics may prompt some defections inspired by the hope of something better.**

THE CREATION OF VARIATION

AN EVOLUTIONARY PROCESS BASED ON GENETICALLY ENABLES CAPABILITIES

The loss of genetic control has allowed cognitive development to be shaped by interaction with particular environments at the level of the individual, on evolutionary principles of variation and selective preservation. Thus the evolutionary process has itself evolved, as genetic determination has been supplemented by genetically-enabled capabilities, in a way that increases adaptation – at least in the short term, in relation to the time scale of genetic evolution (though even within a human lifetime, as Adam Smith realised, the development of domain-specific skills and habits of thought may lead to dangerous reductions of adaptability). The evolution of the evolutionary process, though not precisely so expressed, is also a feature of Adam Smith's psychological theory of the growth of knowledge, in which specialisation between individuals, in both knowledge and capabilities, is a later development that enhances the effectiveness of the powerful motivation to create mental models of puzzling phenomena (Loasby 2002). **The principle that greater diversity requires a relaxation of central control is familiar in studies of organisational design and innovation; and it is, of course, a central principle of Austrian economics**. (It is not good news for economists who rely on general equilibrium modelling.) That this diversity within the human species should apparently be an unintended consequence of the increase in brain size (even though to a neoDarwinian all consequences are unintended) should also appeal to an Austrian mindset.

HUMAN KNOWLEDGE IS DISPERSED AND IS BASED ON DOMAIN SPECIFIC NETWORKS

The possibility of revision implies the ability to conceive of alternative principles of classification on which to construct representations. **What is distinctive, at least in degree, about the human species is that the multifarious forms of the division of labour among its members have produced such an unprecedented variety of these representations and so have enormously increased the collective power of human intelligence and the total of human knowledge**. Hayek's account of the functioning of the human brain and neurocognitive theory both lead to **the conclusion that human knowledge is necessarily dispersed and incomplete; furthermore, the particular potential and limitations of the human brain imply that knowledge can be less incomplete only if it is more dispersed.** The implications for specifying the central problems of economics are not difficult to envisage.

The division of labour exploits the ability of individuals to create domain-specific networks – if they are given the freedom to so. In currently-fashionable terminology that implies delegation and empowerment, or in economic language imperfectly-specified contracts; but the obverse of such discretion is loss of control, which to those concerned with the overall efficiency of allocation, either as analysts or policy-makers, is a serious deficiency.

MARSHALL'S AND WITT'S INTRA-INDUSTRY VARIATIONS

Witt (1999) has suggested that the creation and maintenance of compatible interpretations within a firm is a major entrepreneurial role. Since there is no demonstrably correct procedure for determining the bounds of uncertainty it is not surprising that there will typically be some variation, even between organisations that are apparently engaged in similar activities; such intra-industry variation was Marshall's distinctive complement, inspired by Darwin, to Smith's (1976b [1776]) principle of the division of labour, and it was presented, not as a sign of remediable inefficiency, but as a source of progress.

IMPERFECT SPECIFICATION AND EXPERIMENTS AND VARIATIONS

It is important that the resulting knowledge-domains should also be imperfectly specified. In Nelson and Winter's (1982) evolutionary theory, the primary units of evolution are skills, including skills of organisation, which are treated as cognitive programmes of limited scope; but Nelson and Winter take care to emphasise and to illustrate how ambiguous this scope may be, and use this ambiguity within their theory. Imperfect specification is also a condition of those experiments at the margin, inspired by differences of temperament and interpreted experience, on which Marshall relied for the variations that were 'a chief cause of progress' (Marshall 1920, p. 355), and it is essential for Penrose's (1959, 1995) central notion of the imagination of new services to be obtained from resources and of new productive opportunities to which these services may be directed.

KNOWLEDGE IS MULTISPECIFIC AND CAN BE REUSED

….it may be helpful to apply to structures of knowledge Lachmann's (1978) analysis of capital goods:…..; in other words they are **multi-specific**. **Lachmann's warning also applies: just as the value of capital cannot be maintained simply by maintaining the current set of combinations, so the value of knowledge cannot be maintained simply by perpetuating its current uses. It is indeed a most important characteristic of knowledge that it can be reused, *but in a way that is not simply deducible from current uses* – a consideration which is not prominent in endogenous growth theory, because it is not easily accommodated within the system of thought to which that theory belongs.** Imagination (which Lachmann rated almost as highly as Shackle) is the genetically-derived device by which genetic evolution allows the human species to exceed the limits of genetic evolution.

CHANGES NEEDED TO MAINTAIN INTERNAL COHERENCE

…it is nevertheless true, as the studies reported by Karmiloff-Smith (2002) confirm, that **patterns resulting from development become increasingly rigid**. The reconstruction of a personality to match a drastically-reorganised environment is a formidable challenge. (As a problem for clinical psychologists, it stimulated Kelly's (1963) *Theory of Personality*). **Changing the patterns of all the members of a group in a way that preserves intra-group compatability while adjusting to a different environment is even more difficult**; reconstructing an organisation, formal or formal, of any

size seems to be impossible without making some, often substantial, changes in its membership. Penrosian firms, like individual entrepreneurs, may find that nothing fails like success, because success may entrench belief in the patterns that appear to have produced it. The coherence of larger societies may depend on moderating the demands for compatability;

A PATH DETERMINED PROCESS IS NOT PATH-DETERMINED

This is a path-dependent process, but it is not path-determined; movement is easiest to adjacent states, but typically there are many states that are adjacent to each current position (Potts 2000), so that even individuals or organisations with identical current positions may develop in different ways. In practice, individuals and firms will not have identical positions, even those with similar experiences and engaged in similar businesses, and this increases the potential for variation, as Marshall noted.

ORGANIZATIONAL DESIGN IS BASED ON TRIAL AND ERROR PROCESS

Organisational design exists in the space of representations; it rests on conjectures (often implicit) about the similarity and complementarity of activities to be undertaken. **No organisational structure can be best for all that it does or for all the problems and opportunities that it faces; organisation provides structure for trial and error processes, but is itself subject to trial and error, with a mixture of conscious design and unintended consequences, which may be beneficial, harmful, or simply unexpected.** The future manifestations of this never-ending sequence, which was most forcefully described by Allyn Young (1928), cannot be predicted because they depend on knowledge that has not yet been created; and so the efficiency of an organisation, defined as the ability to adapt to or exploit future events, can at best be defined as a region (Potts 2000, p. 95) within which order may be maintained while permitting changes which are necessary or desirable.

DISPERSION OF KNOWLDEGE AND THE GROWTH OF KNOWLEDG AT THE MARGIN

Smith's, Marshall's and Hayek's psychological theories reveal both the operational constraints and the productive potential of human mental processes, and so provide a basis for examining the effects of organisational and social structures on the performance of human societies. Common to all is the importance of the dispersion of knowledge as the result of developmental processes within the brain: **contrary to the usual (and natural) presumption in theories that idealise fully-connected systems**, this is not a problem (though it gives rise to problems) but an efficient allocation of human cognitive capabilities through the development and effective use of heterogeneity. Science itself, the activity most crucially dependent on cognitive skills, is undertaken by a dispersed community that relies on a wide-ranging *ceteris paribus* clause in order to focus on closely-defined problems, which it attempts to reduce to repetitive patterns (Ziman 2000); and the enterprising business man must likewise be selective in his focus and rely on many established regularities in order to devise and implement new patterns. General equilibrium is not the appropriate concept; **the growth of knowledge is always at the margin.**

MARSHALL'S DIFFERENTIATION OF FUNCTIONS

This 'limited but effective control over natural development by forecasting the future and preparing the way for the next step' (Marshall 1920, p. 248) may be reasonably compared with Darwin's recognition of the significant success of artificial breeding; in both, purposeful though fallible activities, the results of human selection, are subject to the selection processes of the wider environment, and the favoured activities become embodied in routines. **Marshall believed that this process tended to result in ever greater differentiation of function, matched by closer co-ordination, as suggested by Herbert Spencer (Marshall 1920, p. 241).**

EXPERIMENTATION AND GENERATION OF VARIETY

All this applies to organised groups of humans. Directed action within a group relies on pre-existing routines within which no choices, in the normal sense, are exercised; if directed action fails to achieve its objective, the recognition of failure leads either to a modification of existing routines or to experimentation resulting in new routines. Thus knowledge that is already organized into routines facilitates the creation of new knowledge – especially that which builds on the old; and new knowledge which is corroborated by apparently successful application is consolidated into new routines. It is not then surprising that **experimentation should be at one or other of the margins of knowledge;** and these margins will differ according to the past history of the growth of knowledge within each organisation, because this history influences the development of capabilities within that organisation and also of beliefs about these capabilities and about the ways in which they might be most effectively applied. **The generation of variety across organisations is a natural consequence;** and this may be considered an effective response to the underlying and pervasive uncertainty about the likely directions of progress.

LARGER FIRMS AND LOWER ELASTICITY AND INITIATIVE

Among the difficulties that naturally arise from this conception of progress is that of finding an appropriate balance between order and creativity. Marshall saw this as a particular problem with large firms, in which routines are prime supporters of organisational coherence, and especially dangerous because of the valid claims that large firms could achieve greater efficiency through more carefully-planned and larger-scale routines: the means of achieving this efficiency may repress 'elasticity and initiative' (Marshall 1919, p. 324), and therefore the changes in mental and formal organisation that aid knowledge. Moreover, larger firms necessarily imply fewer firms, and therefore a reduction in variety. In standard economics fewer firms may reduce welfare because they reduce allocative efficiency; that they may reduce welfare because they reduce the range of experiments is not compatible with the assumptions that are necessary to sustain the standard analyses of rational choice equilibria. This, however, is a direct implication of Marshall's theoretical system, in which economies of scale should not be confused with increasing returns, as is still too often done.

INDUSTRIAL DISTRICTS AND GENERATION OF NOVEL IDEAS

It is perhaps because of this double threat to initiative and variety that Marshall was so impressed with the virtues of an industrial district, which seemed to ensure the 'automatic organization' (Marshall 1919, p. 600) of highly specialised activities while facilitating both the generation and the active discussion of novel ideas, including ideas for constructing new patterns of relationships between firms. In view of the more recent history of many British industrial districts, it is worth recording Marshall's (1919, pp. 135-7) warning that a network of well-proven routines could impede a major reordering of productive systems, which would then be undertaken by newcomers. Confidently-held expectations provide the assurance to act; but this confidence may prevent the timely revision of those expectations.

The industrial district organises most of the external knowledge on which each firm within it relies. **But Marshall insisted that every firm required some form of external organisation: a set of linkages to customers, suppliers and (perhaps indirectly through trade associations and trade journals) to other firms in the same trade. The development of an appropriate and reliable set of linkages is necessarily a lengthy business (Marshall 1920, p. 500), and requires much conscious attention before it can be taken sufficiently for granted to provide the expectations on which both regular business and experimentation can be based.**

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INSTITUTIONS

Institutions

So far our discussion of the relationship between organisations and the human brain has excluded (apart from passing references) what many people may think is the missing link between the two: institutions.

If we think of institutions as 'the rules of the game', or slightly more precisely as indicating the premises and procedures for deciding what to do, then we can see that this definition can be applied directly to the way in which the developed brain functions according to the ideas of Smith, Marshall, Hayek and Kelly. We may also agree that these premises and procedures are partly genetically determined but in substantial degree installed during the development process of each individual. **The origin of the cognitive role of institutions, as premises and procedures, is therefore to be found in the development of the individual brain.**

INDIVIDUAL PREMISES AND PROCEDURES CAN BE ADOPTED BY OTHERS

Now, as we have seen, the characteristics of the human brain limit the internal creation of premises and procedures, but these characteristics also allow them to be imported from others, either **by observation or direct instruction.** Moreover, we seem to be quite strongly motivated to seek guidance from others. This motivation may be genetically determined, and could have been selected at the level of the species because it accelerates development at the level of the individual. Socialisation could not be as effective as it often is if it were solely dependent on pressure (though in some circumstances there may be formidable pressure); it is often readily acceptable, and sometimes actively sought. For example, some people are very keen to learn how to behave like an economist.

Furthermore the experience of managing interactions by the application of previously-developed principles could suggest how other kinds of interactions might be managed by developing new institutions, which could often be modifications of established individual practices, and also foster the belief that agreement on how to think about matters of common – or even potentially conflicting – interest might well be beneficial.

INSTITUTIONS AS THE PREMISES OF ORGANIZATION

The creation of organisations would be extremely difficult without the pre-existence of institutions to supply some initial premises and procedures which need not be discussed in the process of organisation-building; and indeed there is clear evidence of the severe, and sometimes insuperable, problems that are readily generated by attempts to create organisations that bring together people who rely on very different institutional supports, because they come from very diverse professional, cultural or national backgrounds. **Despite many years of organisation building within the European Union, such institutional differences continue to hinder agreement, most recently by prompting conflicting interpretations of how the recently-proposed new constitution may be expected to work.** There is no possibility of resolving these difficulties by creating an organisation that will

supersede the institutions; on the contrary, formal organisations define a privileged space for the evolution of institutions that will, it is hoped, be particularly appropriate within that space; and since evolution always start from what already exists, pre-organisational institutions are likely to have major influences on post-organisational developments. **This is precisely the issue in interpreting the European constitution.**

In a business organisation such difficulties are mitigated because membership is voluntary – at least in reasonably open economies that are not dominated by monopolies; and **the effectiveness of a business is powerfully assisted by the development of locally-appropriate institutions within that business.**

It may be helpful to recall that the proceedings of learned societies were often published under the title of 'Transactions'; the development, exchange, and application of knowledge within any working group is facilitated by a shared understanding of the procedural rationality of that group.

It is a major function of institutions to maintain coherence within groups by legitimating particular facts, interpretations, procedures, and criteria, and individuals are generally disposed to accept such legitimation as a scarcely dispensable aid to preserving the coherence of their own ideas and thought processes. Opportunism is a serious issue (and there is spectacular evidence that it is sometimes easier in organisations); but what also needs to be acknowledged and explained is the widespread willingness of people to internalise 'a social prescription of some, but not all, of the premises that enter into an individual's choice of behaviours' (Simon 1982 [1958], p. 345). People seek out such prescriptions in many contexts; it is not surprising that they do so within the organisations in which they work. The fundamental explanation, I suggest, lies in the human brain.

SYNTHESIS

KNOWLDEGE AS THE OUTCOME OF A TRIAL AND ERROR PROCESS

These theories are themselves the outcome of a trial and error process in which theories, and the patterns of neural connections which embody them, are **tested by the effectiveness of the actions to which they lead – or**, as we shall see almost immediately, **the effectiveness of their success in interpreting phenomena.** The test, of course, is of sufficiency, not optimality. **Theories that are deemed inadequate stimulate a search for better theories;** since criteria of inadequacy are themselves subjective Hayek provides a foundation for 'Carnegie-type' models in which **search is stimulated by a disparity between achievement and aspiration**, and in which aspiration levels themselves require explanation.

SELECTIVE CONNECTIONS IN MARSHALL AND HAYEK THEORIES

Marshall and Hayek have much in common. Both explain the growth of knowledge by the creation of selective connections, and both are concerned with mechanisms that make this possible, though Marshall is content with what we would now call a constructive existence proof (explaining how it could be done) while Hayek seeks to explain how it is actually done. In addition, **both examine two processes, which are built of similar elements but produce different results. This common source of differentiation is a feature of evolutionary thinking.** However, there is an apparent difference between the pairs. Whereas Marshall's processes, though relying on similar mechanisms, necessarily operate at different levels, **Hayek presents the processes of creating the sensory and physical orders as if they operate at the same level.**

If we accept this, then Marshall's model can be used to supplement Hayek's theory: the physical order, being the product of consciousness, must necessarily come later than the sensory order, which can be produced by pure mechanism without consciousness. Hayek's sequence can therefore be explained by assigning the sensory and physical orders to different levels. (It could also be explained by assigning the sensory order to genetic control and the physical order to development at the level of the individual.)

We may conclude that Smith, Marshall, and Hayek collectively offer a good basis for analysing the psychology of intelligence as a source of wealth….

THE SCARCITY OF HUMAN COGNITION CAPACITY AND THE ROLE OF ROUTINES

Smith, Marshall and Hayek all built their systems on the fundamental economic principle of scarcity; but what is scarce in their systems is human cognitive capacity and the energy that is necessary to drive it. These are precisely the only resources that are assumed to be freely available in most formal models in present-day economics, which thus ignore the most fundamental of all allocation problems that human beings face. It is ignored by the familiar Chicago objection to

regulation, which rests on **the assumed abundance of entrepreneurship**; the Austrian objection is more soundly based on the importance of **incentives to expand the supply** (Audretsch, Baumol and Burke 1999, p. 620). Smith, Marshall and Hayek also effectively, if unintentionally, provide the framework for explaining why **the assumption that cognition alone has no opportunity costs is maintained by most economists**; it is essential to underpin the concept of rational choice equilibrium (as Herbert Simon often pointed out), and thus, in Smith's (1980 [1795] p. 77) words, 'to preserve the coherence of the ideas of their imagination'. **Smith's, Marshall's and Hayek's psychological systems rely on routines and institutions which economise on cognition**, and so do the economic systems that they later considered and which are populated by human beings who are equipped with such systems**. The preservation of such established structures is therefore an important economising principle.** The practice of mainstream economists naturally exemplifies a reliance on rules and institutions in doing economics, and the consequent preservation of existing structures, rather than the principles of global rationality which are apparently embodied in their models.

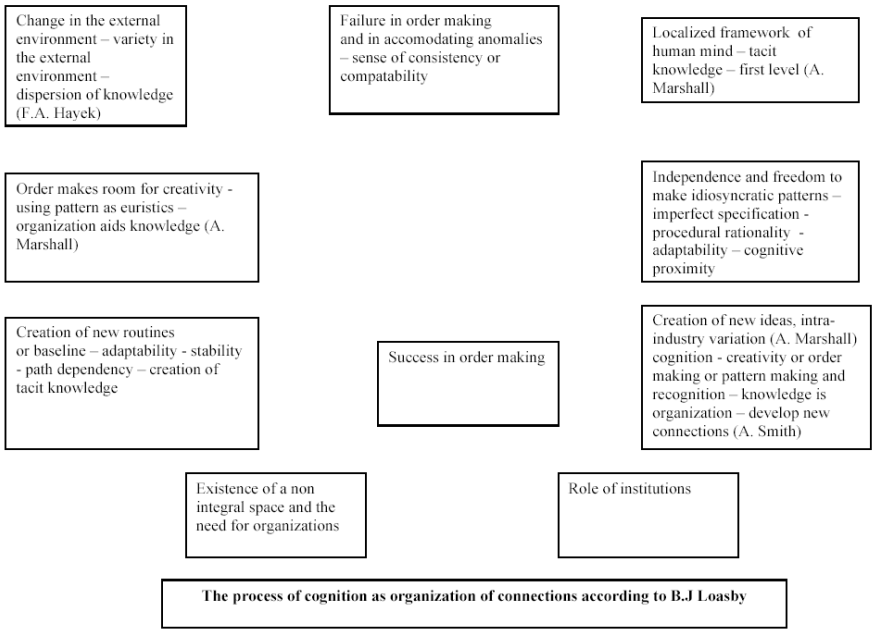
The routines and institutions within Smith's, Marshall's and Hayek's psychological systems have the additional merit of focussing attention on the issues for which they are inadequate at any particular time; consequently these are systems in which **the evolutionary sequence of variety generation, selection, and the preservation of selected variants** in the form of modified or novel routines and institutions is a natural occurrence**. Indeed, one can say that there can be no evolution without routines.** This evolutionary sequence may be handled, in somewhat different ways, at several levels; these may include, for example, genetic and neurophysiological structures, ideas, and organisations, formal and informal, which link together clusters of routines and institutions and provide both the framework and the problems for continuing innovation.

Conclusion

It is no accident that the principles and compromises that are inherent in the use of human mental capabilities are to be found in the organisation of social, economic and political systems, for the operation of these systems entails equivalent cognitive problems, which cause us to rely on abstract systems of rules for the selection and classification of relevant phenomena.

Marshall recognised the connection between the management of co-ordination problems in the economy and the management of co-ordination problems within the brain: both require combinations of routines and novelty, and these combinations are themselves modified by evolutionary processes of trial and error.

Productive organisations are knowledge communities, and all knowledge communities require shared assumptions (which remain problematic).



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