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The Brain and the firm: Perspectives on the networked organisation and the cognitive metaphor

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Abstract
A resonant theme within information system theory and practice in the 1990s has been the desire to identify the key features of organizational design which will provide for the capabilities of innovation, resilience and competitiveness. Many descriptions centre upon ideas of how to rebuild the firm, create new configurations which remove lengthy hierarchies and develop a distributed organization characterised by a narrow, computer-supported managerial structures and multiple horizontal linkages both within the organization and with its customers.

This paper identifies and reviews some of the theoretical developments central to the understanding of the use of combined computer-based systems and quality management applications to gain competitive corporate advantage. The paper develops a perspective of the networked organization as a cognitive model possessing characteristics similar to that of the brain in terms of its capabilities for information processing, self-organizing and change. The cognitive model provides a way to approach the understanding of organizational configuration and design. The value of the cognitive model of the networked organization is not in drawing comparisons between how the brain actually works and organizations, but in using the model to anthropomorphize organizations from the perspective of the observer. In this respect the cognitive model provides a useful tool for both the academic and the practitioner to learn about and understand some of the changes which are taking place within organizations. The cognitive model helps in increasing our understanding of processes of organizational learning and autonomy and in showing the possibilities available to organizations who move beyond the limitations of traditional forms of bureaucracy.

The central proposition of the paper this that the combination of networked computer-based systems and quality management methodologies will replace the technologies of hierarchical control identifiable in the principles of scientific management and result in emergent organizational configurations which may lead to greater workforce flexibility and corporate success. These new configurations may provide employees with the opportunity for participation in decision-making, resulting in greater individual empowerment and personal fulfilment.

Introduction
In the last decade, a major feature of many organizations has been their increasing use of information and communication technologies to allow the decentralisation of operations and production facilities and the improvement of the technical communication links between the organizational membership. In parallel with this development has been the interest in new managerial philosophies derived from statistical process control techniques and translated into the methodological forms as typified by such movements as Total Quality Management (TQM) and Business Process Reengineering (BPR). These doctrines have been promoted as providing the organization with the means of overcoming the tension between a computer-supported structural dominance and the need to develop effective customer oriented business processes. The hope is that the new information-based technologies will allow for the tenets and practices of Taylorism and Fordism, once the basis for industrial development, to be swept away enabling the creation of an organizational environment of commitment and trust.

Viewed from a systems perspective these developments reflect the change from viewing organizations as 'machines', with hierarchical structures of individuals working in a sequential manner, towards viewing the organization as a 'brain' which exhibits of the essential cognitive features of learning and self organization. The metaphoric status of the brain in relationship to both the organization of individuals and computer systems is by no means new. The notion that the organization is like a brain has been explored by Morgan (1986). He identifies that the interest in designing organizations so that they have the capacity to be as flexible, resilient and inventive as the functioning of the brain developed from the post-World War II theories of cybernetics. This change in perspective is also reflected in a move away from 'hard' to 'soft' systems thinking. Many systems designers now assert that their strategy is not the replacement of

human beings with machines (the 'strong' AI model), but the development of sociocybernetic systems (Geyer and Van de Zouwen, 1986) within which a man-machine socio-technical 'partnership' is enabled. In the networked organization this would be exemplified by 'empowered' semi-autonomous units of production where a highly trained and skilled workforce can exercise freedom and authority within a decentralised mode of control and coordination.

Whereas in traditional theories of organization, attention has been devoted to the way such communication links may be established between the different elements of the organization, using the brain as a metaphor for the recent implementations of computer-based information technology IT allows us to regard the networked organization as a cognitive system which embodies a structure of thought as well as a pattern of action. The systems theory which supports this view has been in existence since the late 1940s. The resulting designs attempt to create forms of distributed organization that disperse brain-like capacities throughout an enterprise, rather than just confine them to special units or parts. This metaphor of the human brain, or more precisely the central nervous system as an analogy (or design model) for the effective development of managerial systems, has resulted in discussion of organizational forms based upon the development of cybernetics and self-correcting systems (Ashby 1964; Beer 1972; Wiener 1948), information processing (Galbraith, 1977; Simon, 1960), and organizational learning (Argyris and Schon, 1978). More recent developments include discussions of how the perceptive capability of the brain is a function of many small and relatively simple systems (Minsky, 1989; Dennett, 1991). The parallel, or connectionist, model provides a formal theory for understanding how the brain's processing is achieved through configuring many small processors to connect together in large scale networks with each processor possessing the capability to communicate with any other processor within the network. Similarly the connectionist model provides a metaphor for the networked organization as a distributed or loose coalition of manufacturing and administrative services using integrated computer and communications technologies to link differing groups of personnel for a specific business purpose, then disassembling when the purpose has been met. These collaborative networks make it possible to draw upon a disparate range of resources as needed, regardless of where they are physically located and, as a result, corporations will increasingly be defined in terms of these collaborative network linkages.

The desirable features of the networked organization, which are also apparent in theories of the cognitive model of the brain, include the capability of each individual to undertake many different tasks (multi-skilling), the ability to perform correct actions to achieve objectives and also to question the objectives if necessary (learning to learn) and the ability to rapidly achieve a minimum of critical specification for action (self-organization). Underpinning all these features is the need for the organization to maintain its viability through requisite variety: all individuals within the organization must exhibit the same variation and complexity as the environment within which they operate.

The uses of new forms of information technology should be as enabler for all these features to be developed within the networked organization. In analyzing these developments however, two main problems may be identified while attempting to apply the features of the cognitive model to organizational development. The first consists of the danger of overlooking the conflicts created between the demands of autonomy and existing bases of power within the networked organization. The second is the considerable change in personal beliefs and values which is necessary to effectively implement the cognitive model. From a systems theoretic perspective, designs for the networked organization allow for the decentralisation and dispersion of control together with delegation of responsibility to employees and a definition and delimitation of these interfaces in order to mobilise the knowledge, initiative and energy of individuals throughout the networked organization. However, an over-emphasis upon 'engineering' the culture of the networked organization denies the perspective that the processes within the organization are always dependent on complex patterns of reciprocal connectivity which continue to elude the desires of many management academics and practitioners for prediction and control.

A (Very) Brief History of Cognitive Science

Within the last two decades scientific understanding of human neural functions has changed, mainly through the increased scope and popularity of cognitive science. Cognitive science is a relatively new scientific discipline, concerned with how the brain works. It takes as its reference disciplines neurology, cognitive psychology, computer science, information theory, philosophy and almost anything else that can provide a useful method or metaphor. The emergence of new cognitive models have has important implications for both scientific and popular views of information processing systems.

The concept of the mind and human consciousness has moved from regarding it as a sequential system to one of perceiving mental operations as a patchwork of parallel events. The traditional model of the brain suggests that there is a central location within the brain where consciousness is integrated. Thus, the traditional model suggests that perceptions must feed into a privileged representation or 'conceptualizer' (Dennett, 1991) in order for the brain to be conscious. This model of consciousness has received criticism from philosophers such as Daniel Dennett and Marvin Minsky who observe that the model does not provide a theory for how the conceptualizing process is itself managed: how the brain

chooses to do what it does, that is, how it becomes conscious. The traditional model results in an infinite regression in its attempt to resolve how there can be `thoughts about thoughts'. In contrast Dennett (1991) and Minsky (1989) propose a `functional' view of the mind in suggesting that the functions of the mind, such as thinking, come from non-thinking parts. Recent investigations in the field of cognitive science and psychology have attempted to identify the basis of a materialist perspective of the mind and, in Dennett's words, the strong materialist proposition `blazes the first remotely plausible trails of unification in the huge terra incognita lying between the mind sciences and the brain sciences' (1991 p. 269). The functional perspective suggests that consciousness is an emergent phenomenon arising from the distributed network of many feeble, unconscious neural units or `circuits'. These units may exist either at the neuron or sub-neuron level. Dennett (1991) puts forward a powerful case for understanding the human brain using the analogy of a vast parallel processing computer and suggests that only a theory that explains conscious events in terms of unconscious events can explain consciousness at all. Dennett's central proposition centres upon `Pandemonium Theory' where instead of a single, definitive `stream of consciousness,' there are multiple channels in which the specialist circuits, in `parallel pandemoniums', perform their own operations, creating *multiple drafts* of consciousness as they proceed. The idea of a cacophony of alternative wits combining to form what we think of as a unified intelligence is what Minsky (1989) describes as a `society of mind'. Memories are likened to emergent events which are the sum of the connection of many discrete, neural agents within the brain. Their manner of storage differs substantially from thought to thought and from time to time. The idea of consciousness created from a multiplicity of distributed agents scattered across the mind suggests that both the act of perceiving and the act of remembering are the same. Both acts are an assembly of an emergent whole from many distributed pieces. The resulting concept of consciousness is the product of a constantly changing succession of coalitions of these specialist neural units. Minsky (1989) suggests that these specialist units are part of our evolutionary heritage. They are concerned with some important goal (or instinct) such as securing food, drink, shelter, reproduction, or defense. When presented with unique situations the neural units may be enlisted in new roles for which their specific functions are more or less appropriate to the situation. Individually, each neural unit is limited in its performative capabilities; but together, organized in many different combinations, they can create data structures within the individual brain, shaping its tendencies and thereby turning it into a mind.

Minsky (1989) develops an organizational metaphor in suggesting that `the human brain contains so many agencies and connections that it resembles a great nation of cities and towns, linked by vast networks of roads and highways' (p. 314). The formation of configurations of the differing neural units into data structures may suggest similarities with a hierarchical construct or a `bureaucracy of mind'. However, Dennett and Minsky suggest that the neural units in the cognitive model are continually competing and cooperating for resources and recognition. There is only a very disparate linkage and coordination among the competing elements. Minsky (1989) sees intelligence as generated by `a loosely-knitted league of almost separate agencies with almost independent goals' (p. 316). Those neural units that succeed are preserved, and those that fail are eliminated over time. Thus the control mechanism of the brain, rather than being regarded as a hierarchical, bureaucratic model, may be better conceived as a competitive ecology, where competition breeds an emergent cooperation. This perspective is also supported by Edelman (1994) who presents a Darwinian view of the brain as a constantly developing system he likens to a jungle in which the brain constantly produces variety and selects the most successful approaches for future use. His view of the brain emphasizes its enormous creativity and its central biological nature. The functional model of the cognitive process suggests that evolutionary, cultural and learning pressures provide systems of control that are imposed on all of this neural activity and which are themselves the product of the design.

Using this limited description of some theories in cognitive science it is possible to understand the similarities between the cognitive model and the workings of organizations. From the perspective which views organizational processes as an information-processing system it is possible to identify two main activities. First the memory functions as reflected in the storage of information and second the creation, processing and communication of information which are central to the organizational decision processes.

Self-Organization and Multi-Skilling: the Organizational Memory

The storage of information by organizations may reflect the distributed functions of the mammalian brain and the capability of one area of the brain to replace another in terms of its functions in the event of damage to the organism. In organizational terms this may be reflected in the human employee capabilities to cover for a missing or departed member of staff. The knowledge of the missing members of the organization is duplicated by the remaining staff in the form of using their understanding of the relevant procedures to create new organizational structures to `work round' the deficiency. The capability to continue operating effectively, following disruption to a system and depletion of its sub-units is easily identifiable in organizations. The types of knowledge which are deployed in these situations may be in the traditional form of operating instructions and procedures associated with a particular job but will also include less tangible forms of knowledge. These include the interpretation systems within organization

which produce the concepts of meaning and culture. In general, much of the management literature pays more attention to organizations as decision makers rather than to organizations as interpretation systems that generate meaning. However in dealing with the complexity of their business environments the recurring problem for organizations is often not so much the question of what decision to make as it is a question of understanding the meaning of an event in order that an appropriate decision can be made. This is one reason why the recent interest in organizational culture is important, because it has redistributed the amount of attention that is given to issues of meaning and deciding. This shift in emphasis may be summarized in Cohen, March and Olsen's (1976, p.25) observation that `an organization must be regarded as a set of procedures for argumentation and interpretations as well as for solving problems and making decisions.'

The distribution of organizational memory has important consequences for the development of meaning and interpretation since previous organizational learning directly influences what the organization will do in the future and actions to change an organization must therefore take into account how this knowledge is stored and retrieved. Under the bureaucratic organizational model where control is centralized by rules and regulations or by standardization and hierarchy, information is collected by the lower ranks, collated and presented by middle management to the senior levels who base their decisions on it and issue commands back down the hierarchy. In the most intensive bureaucratic forms of organization lower level employees may be relieved of responsibility for the consequences of their actions, since they act only in accordance with rules and regulations of the system. Often computer-based IT is used to bolster the bureaucratic form of organization where there is an overreliance on the structured data held in, and presented by, the computer system (Wilson, 1994). The data which the computer presents to its users is necessarily attenuated in order for it to be held in the medium. This form of data together with other forms of structured data (operations manuals, algorithms, rule books, etc.) provides an attenuating function in terms of reducing and restricting the type and amount of information available to the organization. This may limit the capability of the organization to effectively respond to the complexities of its environment.

In developing a response to the dysfunctions inherent within an IT intensive bureaucracy, systems theorists and practitioners have increasingly become concerned with the tacit skills of the individual working within the organization. This has resulted in concern that individuals should bring their personal qualities and initiative to their employment. However in terms of an IT intensive organization, a paradox may be discernable in the way in which individuals are enmeshed within the formal rules of the organization whilst at the same time encouraged to use their expertise and initiative on behalf of the business. In achieving a correct balance between the formal rules of an organization and the development of the capabilities of the individual to react in an efficacious manner and so to potentially new work situations, various managerial philosophies have been designed to promote customer care and prevent overreliance upon formal, IT supported, systems of organizational rules. Thus in order to ameliorate the worst excesses of reliance upon computer-generated structured data, Total Quality Management (TQM) and more recently Business Process Reengineering (BPR) has stimulated a process of making employees individually responsible for the quality of customer service both internally and externally to the organization. The ideal in this case being the Hammer and Champy (1993: p. 70) observation that employee `empowerment' consists of `making rules, not following them'. The concept of expanding the capability of the individual to respond in a `correct' manner to new situations, allows for the possibility of decentralisation of organizational control and a tacit acknowledgment by management that information (organizational memory) should be spread around in the organization. Management may now delegate the implementation of process improvement down the organizational hierarchy and allow lower echelon staff to make judgements, allocate resources and call for appropriate action when necessary. Thus it may be argued that the current interest in the use of autonomous teams and decentralized organizational control as proposed in the various TQM and BPR methodologies suggests that organizations are imitating the pattern which is described by the cognitive model of distributed semi-independent neural agents.

Doing the Right Thing: Learning to Learn and Decision-Making

The cognitive model, using the brain as its ideal of an information processing system, allows for the concept of a parallel processing capability consisting of networks of weak processors (neural units) forming together to produce a powerful processor (the brain). Minsky's concept of a society of neural agents and Dennett's pandemonium theory both suggest that the reason that the brain's performance is so impressive is because of its exploitation of massive parallelism where work is divided up and performed by a specialist components of the brain and where the individual outputs are linked together. In organizational development the concept of parallelism may be reflected in the common prescription that redundancy and organizational `slack' are an important source of maintaining system reliability (Galbraith, 1977). Under this perspective organizational strategy is formed from a gradual process of debate among a group of individuals who each possess a capability to influence the final decision outcome. This process of `logical incrementalism' is described by Quinn (1980) and reflects Dennett's concept of the mind forming `multiple drafts' of possible scenarios, which are tested for credibility and then adopted or discarded depending on how much support they gain from the influential agents. The process of

incremental information organization is indicative of the Japanese style management, as described by Aoki (1986), where decisions are reached through a slow process of face-to-face negotiation (*nemawashi* or root binding). Decision-making in Japanese organisations is thus relatively widespread; the on-the-spot knowledge of workers, shops and subcontractors tends to be used and neighbouring units are encouraged to share information. In the West these parallel forms of working have often been explicitly copied from Japanese practice [described by Kenney and Florida (1989) as Fujitsuism, an extensive linkage of the production and innovation processes]. Technological developments which may support the parallel forms of working are now much in evidence in many organizations. The advent of digital technology such as client/server computing, workflow software, computer-telephony integration, broadband multimedia networks, document management systems, satellite communications and electronic data interchange has changed the way information is collected, analyzed and stored. At the same time, these technologies are converging, removing the traditional distinctions between data processing and telecommunications. Consequently the interest in these developments has promoted the concept of a virtual organisation in which employees will rely upon computer networks for communication and information while operating in real time and thus obviate the need for the more traditional organisational structures. In theory, the virtual organisation is a network or loose coalition of manufacturing and administrative services using integrated computer and communications technologies to link differing groups of personnel for a specific business purpose, disassembling when the purpose has been met. These collaborative networks make it possible to draw upon a disparate range of resources as needed, regardless of where they are physically located and, as a result, corporations will increasingly be defined in terms of these collaborative network linkages [for further technical descriptions of the virtual organization see Rheingold (1994) and Bleecker (1994)]. Promoters of such systems suggest that developments such as networked computing coupled with current quality management philosophies may enable decentralised decision-making and autonomy for the individual within the organization. They propose that the coupling of these technologies may overcome the dysfunctional problems of the bureaucratic form of organization through providing the possibility of developing flexible and responsive organizational structures. Thus the vision of parallel working within the networked organization is one of workers as being self-empowered with a set of (IT-based) tools with which they can (working with their colleagues) anticipate, comprehend, correct and improve a complete operational process as opposed to its isolated parts. This IT-supported network of individuals and groups, analogous to the brain's collection of neural units or nerve centres, would combine to allow the organization the possibility of achieving a situation which Argyris and Schon (1978) identify as `double loop' or *reflexive* learning where claims to objectivity and system purpose are questioned and verified through discussion and discourse.

The Problem of Requisite Variety

New thinking about corporate organisation stresses the significance of horizontal communication as opposed to the vertical communications of the classic corporation. Multiple lines of accountability in matrix structures replace the single line of accountability flowing up to a chief executive. However the danger in this approach is the assumption that a matrix structure should be a homogeneous system and that effective organizational communication is entirely dependent on sophisticated technology. In the most successful Japanese practice, the communication structure precedes the implementation of technology: technology is adapted to the existing network forms rather than being imposed in a `big bang' restructuring. The main difficulty resides not so much in physically linking together the processors as in creating meaningful communication within an organization which will enable the production of relevant solutions to relevant problems.

Underpinning many of the concepts of the cognitive model of the organization is the need for each organization to match the complexity of its environment with a range of appropriate responses. The need to maintain this viability within an environment has been identified in socio-cybernetic theory as essential for both the individual and the organization. In this action the organization should ideally achieve the variety which Edelman (1994) suggests is obtained by neuron connectivity in the cerebral cortex (i.e. how they connect up with other neurons to form networks) to create the higher brain functions of speech, thought, complex movement patterns, appreciation of music etc. In the highly automated environment of the modern business organization, the need for variety is reflected in a dichotomy between conception and *monitoring* of the sophisticated technological system. The workers must be vigilant and alert, with enough understanding of the overall system to effectively intervene if the technology malfunctions. In cybernetic terms the variety of possible responses of the individual has to be `amplified' to meet potentially different work situations and to overcome the deleterious effects of IT-induced information attenuation. Daft and Lengel (1984) observe that individuals gain the variety that is requisite for effective working practice in several ways. They propose that the ways in which people receive information provide varying amounts of requisite variety. Information `richness' is highest when people work face-to-face, and informational richness declines steadily as people move from face-to-face interaction to interaction by telephone, written personal communiques (letters and memos), written formal communiques (bulletins, documents), and numeric formal communiques (computer printouts). Effectiveness is postulated to vary as a function of the degree to which informational richness matches

the complexity of organizational phenomena. Rich media provide the multiple cues and quick feedback which are essential for complex issues but less essential for routine problems. Too much richness introduces the inefficiencies of over-complication, too little media richness introduces the inaccuracy of oversimplification. If complex organizations need rich information (e.g. talk) to maintain complexity, then they may find it hard to generate this richness if talk is devalued or if people are unable to find acceptable substitutes for talk (video conferencing and electronic mail may be a substitute). Similarly when environments have more variety than a single individual can comprehend, one of the few ways humans can match this variety is by networks and teams of divergent individuals. A team of divergent individuals has more requisite variety than a team of homogeneous individuals. This observation follows from the fact that individuals have severe perceptual limits on what they can comprehend and a team of similar individuals will do little to offset these limits. In highly complex problem situations the fact that divergence exists may be more crucial than the substance of divergence. Whether team members differ in occupational specialities, past experience, gender, conceptual skills, or personality may be less important than the fact that they do differ and look for different things when they assess a problem. This suggests the importance of informal network structures in promoting flexibility and efficiency, structures that are rarely found when the corporation is seen as a system of hierarchical command-and-control. This argument, however, which suggests that collective diversity increases requisite variety which in turn improves organizational performance, may conflict with the view that in any organization there must be some form of central leadership. The tacit understanding in much of the literature on organizational change is that there has to be some form of centralized decision-making, at least for organizations over a certain size. The continuing success of the hierarchical form may be understood from a system theoretic perspective which suggests that its robustness derives from modular quality and its ability to survive the malfunction or destruction of particular modules (Simon, 1960). This provides the hierarchical form with an evolutionary advantage leading to its dominance in all systems found in nature and society.

Perhaps the main shift in the bureaucratic form of organization to the cognitive model will result from increasing professionalism and a change from physical products to information as an increasing proportion of work performed. Under the cognitive model organizational processes may seem to be run according to the bureaucratic principles first identified by Weber (1947), but the location of knowledge and the need for individual behavioral change (and the difficulty in measuring and initiating this change centrally) ensures that in the networked organization decision processes are distributed rather than centrally controlled. In this subsumption or `web' system, information and authority is transferred laterally and emerges from the `bottom-up'. While authoritarian `top-down' hierarchies will retreat, no distributed system can survive without nested, heterogeneous web systems of lateral bottom-up control. As information and influence flows from peer to peer, it will become coherent as a larger web of slower actions. Over time a multi-level organization will form around the `percolating-up' of control with the capability of a quick response at the bottom levels and a diminishing of this capability at the top of the hierarchy. The central theorem in cybernetics which states that the system regulator must be a model of the regulated system, becomes reflected in the link between IT and TQM/BPR methodologies to provide a capability to control variety within the organizational environment. The socio-cybernetic model suggests that flexible, IT intensive, organizations will remain viable through maintaining an equilibrium between individual autonomy and hierarchial control and that the equilibrium should be dynamic in the sense that the system is constantly adjusting itself in response to changes in its environment, by allowing more autonomy to the satellites or applying more control at the centre as the need arises.

The Managerial Role within the Networked Organization

The concept of distributed organizational control suggests a change in the role of management from being primarily one of decision-maker to one of attempting to personify the organization's `self'. This was recognized by Mintzberg (1973) whose list of managerial roles includes `figurehead', `spokesman', `disturbance handler' and `nerve centre'. It is from this perspective that the aspects of managerial communication and the use of information are the most apparent. In the cognitive model of the organization the most important managerial action becomes the collection and dissemination (communication) of information. The roles of command and control become secondary to this communication activity. The influential role of these actions is identifiable in Dennett's (1991) discussion of how personality forms within the individual. He cites the 19th century pioneer psychologist William James who suggested that a `there is no cell or group of cells of such anatomical or functional preeminence as to appear to be the keystone or centre of gravity of the whole system' (Dennett (1991, p.101). This perspective suggests that there is no `pontifical neuron' or `ghost in the machine' that exist in a command and control position, `either in our brains or *over and above* our brains' (Dennett, 1991, p.413 [emphasis in the original]). Likewise the new role for management in the networked organization is to a the focal point to anchor communication within, and conceptualization about, the organization rather than to maintain directive control of tactical actions. The role of leadership will remain since the idea of communicating with an organization without some form of leadership would seem to be problematic. Within the networked organization however, the concept of the leadership personifying the organization [implying complete knowledge of its activities] will change. Dennett's pandemonium theory provides an

[implying complete knowledge of its activities] will change. Dennett's pandemonium theory provides an insight into what the nature of an organization's `personality' may be. He suggests that consciousness, and consequently the self is `the organization of information that has structured your body's control system', or, more provocatively, `the program that runs on your brain's computer' (Dennett 1991, p.430). Transposing this to an organizational setting, the organization may be perceived in terms of its processes, rather than the entities performing the work. Expressed in recent managerial derivatives such as BPR, the importance of processes is evident in BPR's proposals to develop cross-functional approaches where teams are the norm and the key goal is to refine the industrial processes which produce a service or product that the market perceives to be best. The modern thesis of `excellence through people,' via the formalisation of strategies to encourage innovation, spontaneity, trust and openness, with constraining restrictions on thought temporarily suspended, seems to rest on the mechanism of control variety amplification in compliance with cybernetic theory. In some organisations the move away from formal systems of command and control may be achieved through the development of joint work teams of both expert and non-expert workers supported by socio-technical design methods which will retain and extend worker skill and discretion (Mumford, 1983). As an attempt to escape Weber's `iron cage of bureaucracy' the control mechanism of variety amplification may seem to prevent over-reliance on a hierarchy of IT-based control (variety reduction) in management practice. It may however, also provide an insight into some of the contradictions in cybernetic attempts to develop organizational effectiveness. In observing this system model, caution is required in distinguishing between the activities of variety amplification and variety attenuation. A danger may exist in the tension between the controlling tendency inherent within many organizational IT-supported hierarchical management structures and the attempts to increase workforce decision-making empowerment which are resonant within the TQM/BPR philosophies. Management may simply use the TQM/BPR methodologies to increase surveillance and control and as a means and excuse for the imposition of redundancies among the workforce. Despite experimentation with new concepts of control, more mechanistic and hierarchical notions of control continue to survive within the context of integrating strategies. In many organizations, teams are utilised to provide superficial participation and task diversity remains minimal. In such organisations the `core' workers are rewarded and may participate in decision-making, whereas `peripheral' workers are monitored and controlled and subject to loosely defined contractual terms of employment under the guise of `flexibility'.

Concluding Remarks

The cognitive model outlined above suggests a means of understanding the behaviour of organizations in terms of the recent developments in the understanding of the `mechanics', of the brain. It offers new understanding of the role of hierarchy within a post-bureaucratic, non-hierarchical organization and illustrates the systemic basis of the concepts of autonomous individuals, groups and organizational learning. However, if IT and the quality management methodologies can contribute to employee needs, they must be seen to be doing so in support of the employee role as `nerve centres' of their organisation rather than acting as tools for down-sizing the workforce and limiting their action through systems which increasingly restrict communication and control to a diminishing number of `true' core individuals. In systems terms if managers lose or confuse the true meaning of the dimensions of variety control, as they engage solely in instrumental action through the media of computer-based systems and quality management philosophies, it is likely to lead to distorted understandings and ultimately to a distortion of actions within the organization. It remains the task of the critical observer to identify the many instances of organizational action which are proposed by managerial theorists and practitioners to be acts of variety amplification and to subject these acts to such an analysis that will reveal whether or not they are indeed only variations on the theme of variety attenuation.

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