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Strategic Management Journal, Vol. 17, Special Issue: Knowledge and the Firm (Winter, 1996), 45-62.

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MAKING KNOWLEDGE THE BASIS OF A DYNAMIC THEORY OF THE FIRM

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Knowledge is too problematic a concept to make the task of building a dynamic knowledge-based theory of the firm easy. We must also distinguish the theory from the resource-based and evolutionary views. The paper begins with a multitype epistemology which admits both the pre- and subconscious modes of human knowing and, reframing the concept of the cognizing individual, the collective knowledge of social groups. While both Nelson and Winter, and Nonaka and Takeuchi, successfully sketch theories of the dynamic interactions of these types of organizational knowledge, neither indicates how they are to be contained. Callon and Latour suggest knowledge itself is dynamic and contained within actor networks, so moving us from knowledge as a resource toward knowledge as a process. To simplify this approach, we revisit sociotechnical systems theory, adopt three heuristics from the social constructionist literature, and make a distinction between the systemic and component attributes of the actor network. The result is a very different mode of theorizing, less an objective statement about the nature of firms 'out there' than a tool to help managers discover their place in the firm as a dynamic knowledge-based activity system.

INTRODUCTION

For several years corporate strategy theorists have been paying greater attention to the idea of the firm as a body of knowledge (Nelson and Winter, 1982; Grant, 1995, 1996; Baden-Fuller and Pitt, 1996). Some argue this is simply an academic fad, a reflection of the popular belief that we are moving into a new Information Age, and there may be little need to new theory since decision-making has always been about processing knowledge. But to others it is a significant move toward dealing with the epistemological problems raised by Simon's (1947) critique of economic theory, prompting us to rediscover Penrose's (1959) theory of the growth of the firm, Selznick's (1957) notion of distinctive competence, Chamberlin's (1933) theory of monopolistic competition, Hayek's (1945) theory of markets, or even

Barnard's (1938) definition of executive activity. All were attempts to move the theory of the firm toward the more realistic epistemological basis suggested by Knight (1921) and Machlup (1980). But these earlier treatments lacked the specificity necessary for empirical research, so we also see this trend as part of our field's natural trajectory, given the impact of more rigorous IO and organizational economics, and the emergence of the resource-based and evolutionary views.

We deal later with the resource-based view and its treatment of knowledge as an objective transferable commodity, but on the evolutionary view we can note, as do Barnett and Burgelman (1996: 17), that it is less a distinct theory than a longitudinal perspective on some other underlying cross-sectional or decontextualized theory. Any dynamic theory, with its discussion of reproduction, variation, and selection mechanisms, will offer an evolutionary perspective (Penrose, 1952, 1953). What the evolutionary view tends to overlook is the origin of the firm, or rather, the ways in which the underlying theory of the firm may

Key words: knowledge management; theory of the firm; pluralistic epistemology

or may not explain its origins. The reproduction, variation, and selection mechanisms explain neither the origin nor the underlying nature of the evolving organism or entity, nor the categories in which the evolutionary analysis is couched, though their study is likely to help us with the underlying theory that they are exposing to the test of the firm's internal and external environments (Barnett and Burgelman, 1996: 7). In contrast, the resource-based and knowledge-based views are targeted attempts to deconstruct the black box of the economist's production function into some more elemental components and interactions, and until we identify these we cannot be confident about what is useful to observe over time (Schendel, 1996).

The resource-based approach (Wernerfelt, 1984) was shaped by the suggestion that the strategic actions which reposition the firm require it to possess very specific resources, competencies and capabilities. Those that lead to competitive advantage must, by definition, be scarce, valuable and reasonably durable (Barney, 1991), and are unlikely to be available from others under terms that do not strip them of the net present value of the rent stream they are capable of generating (Rumelt, 1987: 143). So long as we assume markets are reasonably efficient and that competitive advantage is not wholly the consequence of asymmetric information about those markets or the stupidity of others, these rent-yielding capabilities must originate within the firm if they are to be of value. Since the origin of all tangible resources lies outside the firm, it follows that competitive advantage is more likely to arise from the intangible firm-specific knowledge which enables it to add value to the incoming factors of production in a relatively unique manner. Thus it is the firm's knowledge, and its ability to generate knowledge, that lies at the core of a more epistemologically sound theory of the firm.

We can begin to think of the firm as the governance structure, or nexus of contracts (Williamson, 1990: 8), with the incoming factors of production being merged, synthesized and transformed into higher-value products and services, a view that contrasts somewhat with the earlier theories of the firm as a purely homogeneous production function or a bundle of tangible productive resources. We focus on the amplifying effect of the intangible knowledge that the firm's members apply in the firm's value-

adding processes. This is the locus of the all-important wedge that Penrose (1959: 25) uses to distinguish the firm's tangible resources from the services these resources provide. While the former are finite, the latter are mediated by the endlessly extensible body of managerial knowledge (Penrose, 1959: 78) because of its inherently 'public' nature (Arrow, 1962).

This version of the knowledge-based view is becoming conventional (e.g., Conner, 1991; Grant, 1995). We see a flood of literature dealing with theories of innovation and organizational learning, and with the strategic management of the knowledge that it produces. One important effect has been to modify the implicit top-down managerial privilege of the older theories of strategy (Learned *et al.*, 1965; Porter, 1979, 1980) in which management seems privileged simply because they represent the shareholders whose money is invested in the firm's tangible assets. But these theorists actually assume that firms are hierarchical structures dominated not only by shareholder-derived authority but also by the superior knowledge of the entrepreneur or senior management team. As Weber (1968) noted, bureaucracy is organization on the basis of knowledge, rather than on the basis of power alone. Thus the theory of bureaucracy presupposes that all the knowledge necessary to the strategizing and organizational design processes is available at the top of the organization and this underpins its authority base. Whenever this is not true and lower-level employees are able to deal with uncertainties which cannot be resolved by senior management, they have power over the top management.

Much recent work on organizational learning (e.g., Cohen and Sproull, 1996; Moingeon and Edmondson, 1996) adopts an Aristotelian position and presumes a necessary relationship between the learning and the employee's active involvement, moving us towards a more democratic notion of the firm in which different employees undertake different activities and thus learn different things about the process of transforming inputs into outputs. Now there is no reason to think *a priori* that top management's view is privileged. This approach legitimates the knowledge and learning of the rest of the firm's employees and shows that the firm's learning is unlikely to be as effective as it might be if it is managed top down by instructing subordinates

about what and how to invent or observe about the environment. Customers' ideas, and the ideas of those that interact directly with customers, become important (von Hippel, 1988). A diffuse, nonbureaucratic management style seems called for. The implication is that top management would do better to provide a context in which employees at every level become independent agents, take responsibility, experiment and make mistakes and learn as they strive for continuous improvement in every aspect of the firm's total transformation process. The fact that a shift from the resource-based to the knowledge-based view has behavioral and organization design implications merely adds to our awareness of its economic and strategic implications (Leonard-Barton, 1995; Purser and Montuori, 1995). Clearly our field is undergoing a major paradigm shift as it responds to the changes in the economy at large, as the industrial age gives way to the information age. Instead of treating managers as rule-makers and employees as rule-followers, and firms as bundles of tangible resources, we need a different kind of knowledge-based theory in which organizations are enduring alliances between independent knowledge-creating entities, be they individuals, teams or other organizations, and tangible resources are subordinated to the services they provide. This leads to the considerable interest in new forms of organization (e.g., Stacey, 1995; Best, 1990; Nohria and Eccles, 1992; Wheatley, 1994; Nonaka and Takeuchi, 1995: 160).

PROBLEMS

There are many problems with this line of analysis and most are visible in the previous section. What do the terms 'resource', 'service', 'knowledge', 'knowledge-creation' and 'organizational learning' mean? What are the relevant social and economic entities of this analysis, employees or firms, or social institutions, and how are they to be differentiated? And, given our institutional context, how can employees as independent agents be related in ways that benefit the firm's shareholders? A viable knowledge-based theory of the firm should address all these questions in a testable way, and no such theory has yet emerged. The theories we have tend to focus on one question while making gross assumptions about the others. Discussions of organizational

knowledge remain divided over whether we mean individual knowledge shared by all the organization's members, focusing us on the management of the 'sticky' knowledge that must be moved around the firm (von Hippel, 1994) and on the prevention of leakage of information to others, or on the generation of some kind of objectified knowledge that, embedded in the organization's rules and routines, acts as a Hobbesian constraint over its individual members. Likewise, discussions of organizations as bodies of knowledge are not clear about the relevance of the organization's bureaucratic or legal definition, the naysayers arguing that organizations are, more than ever before, boundary-less open systems, not merely taking in factors of production, but in dynamic organic relationships with other knowledge-producing and applying entities.

In the following sections we consider how the concept of knowledge may be made the basis for a theory of the firm. We sketch a system of ideas about organizational knowledge and its relationship to the entities which create it and apply it in the pursuit of economic rents in our evolving institutional context. But our first task is to develop a view of knowledge that makes meaningful discussion about its creation, storage and application possible. Our second task is to relate this epistemology to the firm and show why multiactor organizations are important to the processes of creating, storing and applying knowledge, and how sustained economic rents might arise.

KNOWLEDGE

With few exceptions (e.g., Nelson and Winter, 1982; Spender, 1989; Nonaka and Takeuchi, 1995: 21; Scherer and Dowling, 1995) organizational theorists have constrained their theorizing by adopting a positivist theory of knowledge that takes little account of the millennia of debate about the problematic nature of human knowledge. This naive neo-Kantian view is that all tenable knowledge (justified true belief) is the result of systematic (scientific) analysis of our sensory experience of a knowable external reality. Knowledge is tested by seeing whether it predicts our experience of that reality. Universal knowledge, true at all times and in all places, is the highest grade of knowledge. Though we are con-

fident of some knowledge, especially of the physical universe, we recognize that all our knowledge is tentative and, indeed, must be open to empirical falsification if it is to be other than dogma (Popper, 1969). Learning is the process of experiencing and analyzing, or the process of communicating the knowledge previously generated by others.

This kind of epistemology does much to muddle Platonic ideas about logic and Truth with Aristotelian notions of the results of experience, without grasping either the subtleties of the Kantian synthesis or the essence of the later relativist critiques (Plotkin, 1994: 1). As realists, we assume reality exists and is knowable. As empiricists, we assume that our knowledge corresponds to reality. As rationalists, we assume reality's structure is logical. All these positions neglect the essence of the Kantian critique which is that our knowledge is constructed from sense impressions and cannot, therefore, tell us anything about a reality beyond these impressions. While Kant believed that our experience was shaped by reality, our knowledge of it was based on *a priori* intuitions and consequently delimited by the available categories of human comprehension. Later philosophers, extending the potentially relativist position which Kant opened up, argued that the basis of our interpretation of our experience is as likely to be in the soft structures of subjective perception as it is in the hard reality within which we presume we are contained.

The point here is not to try to resolve these debates, but to observe that knowledge is a highly contentious concept, far too problematic to bear the weight of a useful theory of the firm without a clear statement of the epistemology which gives it meaning. At the same time it is clear that our field's conventional notion of knowledge, derived from positivist philosophy as elaborated by logical positivists such as Ayer and Hempel, and fallibilists such as Popper, is wholly inadequate to our task. First, it is logically impossible to construct meaningful statements about knowledge so long as we have but a homogeneous concept of knowledge unrelated to anything else. Or, put differently, we cannot speak knowledgeably about knowledge so long as our discourse grasps only knowledge and its absence. An epistemology must posit something more complex, such as a correspondence between knowledge and reality, or, should reality be forever unknowable as Kant

believed, between knowledge and something else. Once we construct such a discourse about knowledge, we can seek a theory of the firm that explains the relationship between the firm and knowledge, and explore why the firm's knowledge has economic impact.

The current explosion of writing about organizational knowledge has two somewhat distinct roots. The first, admirably summarized in Nonaka and Takeuchi (1995: 7), and epitomized in the work of Drucker, Quinn and Reich, distinguishes knowledge from the traditional factors of production, labor, land and capital. Knowledge, it seems, has become the most important or 'strategic' factor of production, so managers must now focus on its production, acquisition, movement, retention and application. There is a considerable literature in this tradition both from those considering the economics of knowledge and its production, and from those considering the management of innovation and the organizational design and behavioral consequences of this historical shift.

But it is not easy to make this distinction between knowledge, especially that of the entrepreneur, and the other factors of production stick. Some, following Samuelson (1955) and Arrow (1962), differentiate knowledge by using the notion of 'public good.' While land, labor and capital are private goods, knowledge is often said to be a 'public good', meaning that it is infinitely extensible and its use by one person does not deprive others of its use. But this is scarcely adequate so long as the knowledge relevant to the firm is conceptualized as either labor skills or intellectual capital, thus turning it into a private good which can be accommodated in the conventional analysis. It is obvious that useful labor has always been skillful, and capital has always had to be knowledgeable if it is to cope successfully with the evident risks of doing business, so the public/private distinction does not really explain the modern period's information age label. News of the battles at Marathon, or at Waterloo, may not have been conveyed as quickly as the news about the Gulf War, but knowledge of markets, events and technology has always been crucial to business, and the firm's information-gathering and processing abilities have always been a significant means of strategic competition. Similarly, the discussion of the privatization of knowledge,⁴ as a public good, becomes an analysis of the insti-

tutions, such as patent law, that allow it to be privatized. This avoids a direct discussion of the nature of knowledge and its relationship to the firm's processes. It avoids considering the differences between knowledge and the other factors of production, or between the patent system and the institutions which protect other rights, such as employment title and land use law, and other knowledge such as the norms of the capital market system. To be the basis of a theory of the firm, knowledge must be defined precisely enough to let us see which firm has the more significant knowledge and explain how that leads to competitive advantage.

DIFFERENT TYPES OF KNOWLEDGE

The second discourse has less to do with differentiating knowledge from the other factors of production than with differentiating between alternative types of knowledge. The distinction noted earlier between the Platonist and Aristotelian positions, now part of philosophy as the distinction between rationalism and empiricism, becomes useful once we interpret it to mean that humans might be able to know in two ways, one based on experience, the other based on the exercise of reason. In fact we are used to both types in our research. We employ the first kind of knowledge when we get data, and the second when we analyze it in a logically rigorous manner. We then define science as the process of generating new knowledge by interacting these two types, i.e., science does not comprise either data or hypotheses alone but arises from their interaction. But this method of discovery loses its footing as soon as we stop assuming that data is an unproblematic or unmediated message from reality. A different kind of epistemology is required to move beyond the Kantian synthesis and assume multiple types of knowledge.

There is some irony in the fact that our discipline is increasingly policed by positivistic research methods while most U.S. executives, asked about their philosophy, will claim to be pragmatists. Pragmatism, developed by Peirce, James, and Dewey, is quintessentially American and differs from positivism in part because it has little concern with universal truths, focusing instead on 'cash value' or 'what works', i.e., on a more immediate and less universal concept of

knowledge. Functional criteria replace logical tests, and the positivist presupposition of a logical, seamless and knowable universe is abandoned since no practice engages more than a fraction of the universe. Thus the switch to pragmatism replaces the positivist reality presumed mirrored in our perceptions with the local reality of our experience.

James's (1950: 1221) way of dealing with the relationship between rationalism and empiricism was to argue that human knowledge was indeed of two types: 'knowledge about' and 'knowledge of acquaintance'. Though these terms are clumsy in English, corresponding somewhat to 'in theory' and 'practical common-sense', the distinction is reflected in most Romance languages, e.g. *wissen* vs. *kennen*, *savoir* vs. *connaître*. In the same vein, Ryle is often quoted as distinguishing between 'know-what' and 'know-how'. James argued that the interaction of the two types of knowledge is the pragmatist's notion of the scientific method. While experience provides immediate 'knowledge of acquaintance', 'knowledge about' is the result of the systematic thought that eliminates the subjective and contextual contingencies of experience and extracts the principles that lie behind the 'knowledge of acquaintance'. Science is the process of 'purification' which renders 'knowledge of acquaintance' into 'knowledge about'.

James drew the idea of several types of knowledge from Greek epistemology, which offers a rich array of alternatives. The abstractions of *noesis* (Platonic Truth) and the mathematical purities of *diainoia* contrast with the individual's perceptions and beliefs (*pistis*) and images of concrete objects (*eikasia*) (Ihde, 1993: 21). Likewise abstract generalizations (*episteme*) could be contrasted with knowledge about how to get practical things done (*technē*), an understanding of social activity and politics (*phronesis*), and shrewdness or cunning (*metis*). The problem here is that we have too many alternatives and the relations between the types of knowledge are unclear. To use a multitype or pluralist epistemology as the basis for a dynamic knowledge-based theory of the firm, we need definable relationships between the types of knowledge we posit. Only then can we reframe the firm as that particular mode of governance which fosters the interactions that lead to knowledge growth and so underpin our theory of organizational learning

and competitiveness in the face of environmental change. Thus we search for a theory of the firm as the locus of the production and application of a 'local science', and this is what Penrose (1959) provides.

The multitype epistemology which has had most impact on our field, as well as on Penrose (1959: 53), can be framed in terms of Polanyi's (1962, 1967) distinction between explicit and implicit knowledge. While this reflects James's distinction, Polanyi adds important nuances. Explicit knowledge is like 'knowledge about' in its abstractness, while tacit knowledge is associated with experience. But Polanyi's notion of the tacit is richer than mere knowledge of acquaintance because it brings in a post-Freudian psychological dimension, reaching beyond conscious knowledge into the sub- and preconscious modes of knowing. His intent was to criticize the positivist norm of doing good science, that one should interact only the explicitly rationalist and empiricist traditions by formulating logical hypotheses and doing repeatable tests. He argued that scientific creativity comes primarily from deep immersion in the phenomena to be explained, for that alone gives rise to intuitions about how to begin the interaction. For Polanyi science was a process of explicating the tacit intuitive understanding that was driven by the subconscious learning of the focused scientist.

Polanyi's explicit/tacit distinction was introduced into our literature by Nelson and Winter (1982) in their evolutionary theory of the firm. Their treatment clearly parallels the later analyses of Fuller (1988) and Plotkin (1994) who, as sociologist and psychobiologist respectively, were not aware of Nelson and Winter's earlier work. All argue that social organizations, firms, species and societies evolve by adapting the body of knowledge shared by their members, and that much of the process takes place at the tacit level. Plotkin (1994: 231) argued that all evolved entities are, in some very fundamental sense, true representations of the reality they have experienced. The distinction between the explicit and the tacit is vital because it enables these analysts to posit several different adaptation mechanisms with different characteristics or kinds of knowledge and learning. While the explicit is known to the individual, who can then make reasoned optimizing choices, such 'short-term' rational adaptation is buttressed by a long-term process

at the 'genetic' level which lies beyond the individual's conscious decision-making. While the first may well aspire to positivist science, the second is evolutionary and clearly quite different. Kuhn's (1970) analysis of paradigm change is another version of this same multilevel approach. Filling out the paradigm is short-term 'normal science' and fully explicable. The underemphasized intuitive sense of disciplinary continuity across the paradigms shift, the fact that physicists know, at some level, that relativity theory matters to them, is the locus of long-term evolution or 'critical science.'

Discussing how the evolutionary extrarational modes of adaptation work, Nelson and Winter (1982: 14, 134) refer to organizational routines as the organization's genetic material, some explicit in bureaucratic rules, some implicit in the organization's 'culture'. The interaction between the explicit and the tacit is evolutionary in that the choices made by individuals are selected in or out according to their utility in a specific historical and economic reality, and eventually embedded in organizational routines which then shape and constrain further individual choices. For Nelson and Winter (1982: 166, 400) the firm is a production function made up of decision rules, a set of production rules in the sense that this term is used by expert systems designers, or a script in the sense used by Schank and Abelson (1977). The boundary between the explicit and tacit types of knowledge is both porous and flexible, so there is traffic between the domains. Nelson and Winter move towards a theory of the firm by assuming that the firm provides that special context in which the explicit and implicit bodies of knowledge are both selected by interaction with the external economic reality and then stored in the routines available to future generations of employees. Over time the quality of the interaction of the explicit and evolving implicit types of knowledge may lead to further improvements and, thence, to superior firm performance.

Nonaka and Takeuchi (1995) make the interaction of the explicit and the tacit modes of knowing central to their theory of organizational knowledge creation. Like Polanyi they see the origin of all knowledge in individual intuition. Their theory is precisely focused on the transformation and communication of what is already known tacitly by employees, i.e., on the way other employees learn what an individual has

discovered, rather than on Nelson and Winter's notion of the firm itself learning by acquiring better routines. For Nonaka and Takeuchi (1995: 62, 239), organizational knowledge is the knowledge shared by individuals, albeit transformed and amplified, and the four dimensions of knowledge conversion are the means of communicating the two modes of knowing around the firm. Their theory of the firm, in the sense of explaining (a) how individuals generate tacit knowledge, and (b) how the obvious agency problems are resolved, remains unexplained. The key difference between Nonaka and Takeuchi's treatment, and that of Nelson and Winter, lies in the latter presuming the firm has an ability to know independently of its employees, or at least independently of their conscious reasoning. Nelson and Winter rely more on the employees' pre- or subconscious modes of knowing, though they are less clear about what it is about the firm that facilitates the generation and subsequent application of such extrarational knowledge and learning.

KNOWING ENTITIES

Having adopted a pluralist epistemology to help us move beyond positivist notions of knowledge growth, we must now redefine the firm in ways that move us beyond a mere collection of rational individuals. For Nelson and Winter, the firm is a body of rules, both implicit and explicit, embodied into routines which constrain the firm's members and so begin to address the agency issues. Their theory is about how this set of rules evolves. They fail to discuss the boundaries around this set of rules or otherwise define the firm. What is the minimum set of rules, in the sense that older theory argued that there must be capital, land and labor use before one can have a product? What is the minimum set of genetic material or organizational routines necessary to create life or the viable firm? What is the maximum set? This is the old question about the limits to the size of the viable firm. Indeed, given the participation of customers and external institutions in the formation of the firm's routines, is the concept of a boundary meaningful any more? But as Penrose (1959: 78) notes, as soon as resources cross the boundary and come into the firm the range of services they are capable of yielding starts to change. Thus a theory of the

firm must posit some kind of bounding process or isolation mechanisms, and boundary around that firm.

Nonaka and Takeuchi's (1995: 57) discussion of this topic, which they call the 'ontology' of their theory, is based on earlier work with Hedlund (Hedlund and Nonaka, 1993) and indicated more openness to the notions of nonindividual knowing (Kogut and Zander, 1992: 388). This may be because, unlike the Japanese tradition, the European tradition springs from Durkheim's sociology and notion of '*conscience collective*,' the collective knowing suggested by the term 'organizational culture.' Taking a somewhat similar approach, we have written elsewhere about how the interplay of James's and Durkheim's dichotomies leads to a multitype epistemology (Spender, 1993, 1994a, 1994b, 1995, 1996a, 1996b, forthcoming) with a matrix of knowledge types.

This matrix (Figure 1) clarifies the nonexplicit modes of knowing by separating the psychological individual type of tacit knowledge, on which Polanyi focused, from the sociological or collective type proposed by Durkheim. Sandelands and Stablein (1987) and Weick and Roberts (1993) have carried the second into today's research literature. The matrix's weakness is that it tells us little about how these various types of knowledge interact and thus little about how the firm becomes a context especially favorable to the interaction of knowledge-creation and knowledge-application processes (Spender, 1992, 1996c).

The different types of knowledge are clearly Weberian 'ideal types,' and every real firm will be a mixture of them all. But the modern trend is away from the tacit and towards the explicit, from craft to system. Thus firms increasingly use explicit objectified knowledge, whether that be science or established standards and practices, and become increasingly dependent on the conscious knowledge of their employees, and on their scientific and technical training. But it is also obvious that they remain dependent on their employees' skilled practices, automatic skills, hunches and intuitions (Hirschhorn, 1984; Sternberg and Wagner, 1986; Chi, Glaser, and Farr, 1988; Singley and Anderson, 1989; Healy and Bourne, 1995) or on the judgments captured in the industry's recipe (Spender, 1989). In separate papers, we have argued (a) that the different types of knowledge lead to different types of economic

	<i>Individual</i>	<i>Social</i>
<i>Explicit</i>	Conscious	Objectified
<i>Implicit</i>	Automatic	Collective

Figure 1. Different types of organizational knowledge

rents (Spender, 1994c), and that firms' strategies, as the pursuit of these economic rents, will also differ. While an individual's knowledge is inherently transferable, moving with the person, giving rise to Pareto rents and the resultant agency problems, the social types of knowledge are either publicly available or collective and embedded in the firm's routines, norms and culture. Since the latter are generated internally and remain 'of the firm,' they give rise to the economic rents associated with effective collective practice which we labeled 'Penrose rents' (Spender, 1994c: 365) and different strategies are required for their maximization. Finally, we have argued (b) that the firm's knowledge mix or profile may change over time, being dominated by one type of knowledge at one time and by another type at another time (Spender, 1996a).

It may go further than different types of economic rent and strategic theorizing. Given several different types of knowledge, there may be several different knowledge-based theories of the firm, one for each type of knowledge. A theory based on conscious knowledge depends on solving the agency problem. How can creative R&D personnel, such as Sir James Black, the inventor of Tagamet, be persuaded to contribute their discoveries to the firm's shareholders? This theory could stand on a theory of interpersonal power and charisma, or on a theory of pooled risks, or on a theory of asymmetric information about the true value of the invention. A theory based on automatic knowledge likewise depends on solving the agency problem, but is clearly more psychological. The brilliant intuitive stock-picker must be persuaded to stay with the firm. Likewise competitive advantage derives from the entrepreneur's effectiveness in making deals, in picking creative people and constraining them with agreements such as those scientists in corporate R&D laboratories are habitually asked to sign. A theory based on objectified knowledge depends on effec-

tive use of the institutional mechanisms, such as patents and registered designs, which enable essentially public knowledge to be privatized, albeit temporarily. This leaves open the terms under which intellectual property can be obtained from its individual producers and brings in the strategic factor market argument (Barney, 1986). We might dub this the corporate lawyer's theory of competitive advantage.

On the other hand, a theory based on the inherently immobile collective knowledge produced internally (Penrose, 1959), perhaps the outcome of the firm's evolving methods of team production (Alchian and Demsetz, 1972), focuses more on the processes of knowledge production than on its subsequent ownership and appropriability (Teece, 1987). It becomes a leadership theory of the firm, much like that suggested by Barnard (1938). If, as we have suggested, collectively knowledge is the most secure and strategically significant kind of organizational knowledge, then we should seek an explanation of what it is about firms that enables collective learning to take place, and collective knowledge to be retained and applied better than under other institutional arrangements. Responding to this agenda Nonaka and Takeuchi focus on the way individual creativity contributes to the growth of collective knowledge, while Nelson and Winter focus on the extrarational learning processes that lead the collective to develop routines and so learn as a cognizing entity in its own right.

QUESTIONING THE CONCEPT OF THE INDIVIDUAL

When discussing individual and collective learning it is easy, and common, to assert that only individuals cognize and generate knowledge and so shut down the conversation about whether individuals or organizations are both learning

entities (Huber, 1991). But there is little reason to think the concept of the individual is so unproblematic. Since Simon's (1947) famous critique of rational economic man, there has been wide recognition that the assumption of an atomistic and isolated individual may not serve organizational analysts well. There are significant social, institutional, organizational and economic processes which, we now recognize, can only be explained by going beyond such presuppositions, and cognitive and evolutionary theorists are able to work this ground to good effect. Simon's work, which reflected Knight's (1921) seminal work on risk and uncertainty in economic decision-making, led to the question of what determines or influences the bounds to rationality, and to an interest in organizational culture as evidence of managed value premises.

Thompson's (1967) core of rational process bounded by a region of value-laden boundary spanning posited two modes of decision-making. By extension, there was increased interest in national culture and other institutional influences over individual decision-making. Under this, of course, lies a critique of the presumed freedom of the rational self-interested individual from his or her social, moral and economic context. Given bounded rationality, the individual may become less a principal than an agent of the institutional entity shaping his or her rationality, be that a profession's norms, an organization's or a nation's culture, a union's politics, an industry's recipes, a religion's ethic, etc. Thus individual learning must always be considered in the context of the processes of the social entity that relies on that individual as its active agent—the key to this institutionalist analysis being whether there are mechanisms through which the learning can be communicated or detached from the learning agent and transferred to other individual members, as in Nelson and Winter's theory.

Durkheim argued that every person was, at one and the same time, both an independent psychological decision-making entity and a purely social being. Social entities cognize and learn only to the extent that the individuals who make up that social entity are socially defined beings. The notion of the individual as an asocial rational entity is replaced by a more complex model, matching, of course, the various modes of knowing of which we now presume humans are capable. As soon as we recognize the extent of each

person's tacit knowledge, we can associate the person's conscious knowledge with their sense of individualism, while much of their tacit knowledge can be associated with their social or collective identity. Developmental psychologists, especially those interested in the ways children learn about the world and achieve their sense of self, provide us with some good models. While Piaget argued that children were biologically programmed, acquiring their reasoning facility as their shared genetic code unfolds, another group of developmental psychologists, following Vygotsky, has argued that these abilities are, to a significant extent, internalized from the social context in which the child grows up (Tharp and Gallimore, 1988; Spender, 1996a). Thus to analyze the evolution of the individual's sense of self one has to look at the context of which it is an agent of the social, and so to cover both nature and nurture.

This does not imply social determinism, far from it. The social influence is clearly mediated by an irreducible or random element of individuality. We must argue that organizations learn and have knowledge only to the extent that their members are malleable beings whose sense of self is influenced by the organization's evolving social identity. We argue for an organic or synergistic sense of collective identity quite different from the mechanical sharing of knowledge which treats the organization's identity as a mere classificatory device, a way of identifying which individuals share a particular body of knowledge. While this does not tell us much about the specific social features that influence the individual's sense of self, it does move us towards a 'social constructionist' position in which we focus on the dynamics of the individual's institutional context.

At this point we have argued that both individuals and collectives have knowledge-based identities. It is not easy to determine which is logically or temporally prior. Much of the organizational culture literature is grounded in a distinction between the formal and informal aspects of organizational life. Bring a group of strangers together, even in closely defined roles, and they quickly develop informal relations. In Nelson and Winter's analysis, habitual use of a routine embeds it in the 'taken-for-granted' cultural knowledge of the firm. It becomes traditional in Weber's sense, making the charismatic individual who creates the routine logically prior to the

process of institutionalization that produces the organization (Weber, 1968).

But there is a stronger argument pointing the other way. Individuals cannot be proficient until they are 'socialized' into an organization, until they have acquired much of the collective knowledge that underpins 'the way things are done around here.' Reber (1993) has taken this even further, seeing the tacit knowledge of the social collective as phylogenetically prior to the concept of the individual and therefore to the possibility of individual explicit knowledge. He argues the very sense of self that we take for granted when we use the term 'individual' is a recent evolutionary development. Our explicit knowledge is but the small communicable cap of the iceberg of preconscious collective human knowledge, the vast bulk of which is tacit, unseen, and embedded in our social identity and practice. Thus Reber grounds the progression from preconscious mechanistic solidarity to conscious organic solidarity which Durkheim (1964) observes in evolutionary biology. In less biological terms, collective knowledge becomes the basis of human meaning and communication, what the receiver must know to comprehend the semantic content of the message (Nonaka and Takeuchi, 1995: 58). Physical reality, the positivist's reference point, is here replaced by the evolving body of pluralistic knowledge which comprises our socially constructed reality.

ORGANIZATIONS AS ACTIVITY SYSTEMS

At this point, if we are to move toward a dynamic knowledge-based theory of the firm, we must go beyond the argument so far, that organizational knowledge is of two static types, explicit and tacit or of four static types, conscious, automatic, objectified and collective, and that the dynamics of knowledge production involve interacting these in some disciplined manner. The problem is that we cannot invoke some unchanging external structure or principle such as marginalist equilibrium to contain or bound the knowledge-production process without, with that same move, closing off our theory and making it static. We need to reach behind the process of knowledge creation which leads to competitive advantage and understand that the process itself must be

adaptable. The second loop of the double-loop model (Argyris and Schon, 1978) must be as open to change as the first loop, even though its mode of change might differ.

This threatens to collapse our theory or start an infinite regression. If the learning process is contained only because the firm's managers already know the economic benefit of creating the new knowledge, then these managers' meta-knowledge becomes the static theory of their firm. Alternatively, we might argue that firms are environmentally, institutionally or socially determined, so pushing our analysis toward how those influences change. On the other hand, we might assert the firm's body of knowledge simply evolves. With this move, so long as we know only *a posteriori* which kinds of progress work out well, we become population ecologists and so deny management a significant creative role in the theory. To avoid this drift to stasis, we can focus on the activity of 'loose coupling' as a means of sustaining the dialectic between the four types of knowledge (Orton and Weick, 1990; Spender and Grinyer, 1996: 26) and so seek some sustainable middle ground between the ideas of entrepreneurial creativity and externally determined social or technological change with its concomitant presumption of managerial irrelevance.

With this attention to action we begin to move away from the idea of knowledge as a kind of economic asset or commodity, whether explicit or tacit, individual or collective. We move closer to Penrose's idea of knowledge as the skilled process of leveraging resources, where that knowledge is permanently embedded in the organization and, in the manner of Kant's categories, a reflection of our ability to cognize about our experience of these processes (Spender, 1995). The widespread appeal of Polanyi's distinction between the explicit and the tacit is that it appears to bring human action into the analysis while seeming to leave explicit knowledge in the positively defined domain of abstraction from action. However, Polanyi only includes action obliquely. Instead of suggesting that tacit knowledge is itself 'in action,' implying that tacit knowledge is of the same genus as explicit knowledge, but a form of abstraction that can only be known, evidenced and communicated through action. He puts explicit and implicit knowledge on the same continuum, so that all

knowledge is more or less tacit, denying that the explicit and implicit are alternative modes of knowing. This raises intriguing questions about what it means to know that a practice works (Nelson, 1996) so seeming to conflate the action basis of 'knowing how' with the abstraction and communicability of 'knowing what.'

In the same way that we have to redefine our concept of the individual, sustaining a dialectic between the sense of self and the sense of the social, so we have to modify our notion of explicit knowledge if we are successfully to embed action in knowledge. We can follow a path cleared by those who study the sociology of science and the social construction of technological systems (Bijker, Hughes, and Pinch, 1987; Latour, 1987). Their argument is that science is far from objectified or fully abstracted from the social context of its production. Not only is it closely intertwined with the automatic and collective knowledge of those who do the work of science, it is also incomprehensible when abstracted from the collective practices that give it sustained social meaning (Pickering, 1992).

In the next section, as we begin to envisage the firm as a system of knowing activity rather than as a system of applied abstract knowledge, we draw primarily on the work of Callon and Latour, although Nonaka and Takeuchi (1995: 59), pushing in the same direction, remark that knowledge is essentially related to human action. Callon (1980, 1987: 98; Law and Callon, 1992) introduced the notion of actor networks. Latour (1993, 1996) proposed an epistemology of human activity that we can appropriate to our dynamic knowledge-based theory of the firm. The strength of Latour's approach is that the concept of social action is used to redefine the object of attention, the reality being examined (1993: 51). Reality is neither the abstract notion of physical reality, immutable and beyond our power to change, on which positivist science is grounded, nor the sociologist's abstract notion of social identity, be that of the individual or society, the evolving entities that we take as givens. Nor is it the result of a dialectic or discourse between the two, for neither grasp the nature of existence and experience. Latour takes Callon's and Hughes's (Hughes, 1983, 1992) quasisociological notions of actor networks and gives them additional reach. Callon and Hughes did detailed historical research on particular instances of tech-

nological change and perceived that far from being either socially or technologically determined, the outcomes were reached through their underdetermined co-evolutionary interplay. The actor network is not made up only of individuals. Social entities, people, firms, governments, and social institutions are also involved as identifiable actors. Nor is the actor network purely social. There are human artifacts, pieces of research equipment, embodied knowledge, factories, infrastructure, physical laws and so forth, which constrain and shape its activity, (Latour, 1996).

Latour illustrates this complexity of the real as activity rather than as object with a discussion of the 'ozone hole' over the Antarctic. His point is that such discussion involves chemical reactions, international interests, local elections, Third World poverty, firm profitability, consumer satisfaction, etc., a whole basket of incommensurable discourses about different kinds of reality (Latour, 1993: 1). But explore any one of these and, so long as one does not cut off the analysis with a *ceteris paribus* clause, all the rest inevitably come into sight. The overall dynamic complex is what Latour calls a 'quasi-object,' stressing that while we are all acquainted with them, and develop 'knowledge of acquaintance' about them because we live within them, we are trained to slice them into categories and abstract from their complexity in order to analyze them, thus denying their essential dynamic nature.

One way of clarifying these rather amorphous ideas is to recall the work of the sociotechnical systems theorists (e.g., Trist and Murray, 1993), who sought to integrate theories about the social systems in which individuals are embedded with theories about the physical and technological constraints over their actions. Sociotechnical theory was obviously unsuitable as the basis for a theory of the firm because it adopted too naive a view of social systems and ignored economic interactions. From a modern perspective, it also adopted too naive a notion of technical systems, failing to consider the alternative types of knowledge, most obviously the tacit knowledge which all operators and maintenance personnel display as they keep technical systems functioning (Kusterer, 1978; Hirschhorn, 1984; Harper, 1987). Despite its underlying mechanistic epistemology (Purser and Montuori, 1995: 130), sociotechnical theory goes some way towards explaining the underdetermined interaction of incommensurable systems of

knowledge. We can also detect resonances between Latour's analysis of quasi-objects, Barnard's (1938: 240) discussions of the incommensurability of the organizational system's three subsystems, and Penrose's (1959: 74) discussion of resource heterogeneity, all of which bring collective knowledge as the process of resolving heterogeneity to center stage.

SOME POSSIBLE MANAGERIAL HEURISTICS

If we follow Latour and define the firm as a quasi-object, with its complex heterogeneous internal epistemological processes, what new insights does this offer? First that our mode of analysis needs to be partially holistic rather than purely reductionist. Social entities such as firms must be considered as semi-autonomous organic systems, not just assemblies of interrelated components. The literature on self-regulating systems is still largely based on biology (Buckley, 1968) but, as organization theorists, Purser and Montuori (1995: 133) argue there are four kinds of questions about such systems: scope, approach, optic and modality. Scope corresponds to our previous notion of system identity and boundary. Approach corresponds to the interactions between the system components, in this case the different types of knowledge. Optic refers to the underlying epistemology, in this case the pluralist epistemology that defines the heterogeneity of the components. Modality refers to the shaping of the approach, what constitutes progress toward the objective embedded in the scope. Given these questions, managers can begin to probe for the knowledge processes that underpin the firm's boundary movement and evolutionary trajectory, and for their place in them. Purser and Montuori do not, however, pay adequate attention to the problems presented by a pluralist epistemology. Their notion of knowledge is too wedded to the 'monocular optic' of conventional positivism and too distinct from Latour's appreciation of system activity. The multiple and incommensurate actors compromising the quasi-object being analyzed are unlikely to agree about scope, approach, or modality as a coherent set of ideas or principles. The possibility of resolution must lie in the evolution of a body of practices which convey an integrated sense of scope and modality to those participating, which embrace both the quasi-object's social and artifactual aspects.

There is a related set of social constructionist heuristics or rules of analysis: interpretative flexibility, boundary management or closure, and identification of the relevant actors (Bijker *et al.*, 1987: 4). Given the underdetermined internal heterogeneity within the firm, we can expect considerable 'interpretive flexibility'. Not only is there flexibility in how different individuals and social entities interpret the firm's achievements and processes, so that its history is being constantly rewritten, there is variation and flexibility in the way the actors act and the firm is managed, i.e., there is no single 'best way' or universal prescription that applies. Strategic choices such as product design, organizational structure, methods of production, distribution channels and market engagements could well be otherwise and yet lead to the same results. Hence, in the same way that many economists are attracted to the notion of a technological trajectory (Dosi, 1982), the firm must be considered a dynamic social, technical, economic, political, etc. trajectory (Nelson, 1992) as its underdetermined states are manifest in activity through time. An historical, path-dependent (David, 1985) or novelistic (Latour, 1996) analysis becomes unavoidable if we are to understand why things are as they are, and the case study becomes a necessary methodology (Porter, 1991). Cross-sectional data can never capture the quasi-object we seek, merely its effects, for it leaves the firm's essential dynamic beyond the analysis (Schendel, 1996: 2).

Secondly, we have to consider the mechanisms of a quasi-object's closure, boundary establishment and stability. Social systems continue to evolve, with the managerial interventions designed to deal with old problems unavoidably generating new problems. Likewise technological problems do not go away, they remain not so much solved as seen and treated as solved (Pinch and Bijker, 1987: 44). For instance, even though air travel is clearly the safest mode of transportation, aircraft disasters suggest major problems, while we turn a blind eye to the far greater auto-related deaths because they are an aspect of a quite different activity system with quite different meanings. Closure mechanisms are those aspects of the firm's or industry's internal processes which generate its autonomy and self-regulating facility, define its boundaries and interactions with others, and help attenuate consideration of its endless externalities (Spender, 1989: 213).

Finally, the firm is invariably shaped by parti-

cular social entities who comprise its initial context and sources of identity. The firm is a node in the larger activity system which, abstracted from its sociohistorical context, we call the market. But markets are also quasi-objects which evolve along historical and technological trajectories (e.g., Anderson and Latham, 1986; Galenson, 1989). As a result, at any particular time a market cannot offer us an explanation of its own origin, boundaries, processes or identity (Friedland and Robertson, 1990: 37). A market is a body of activity-based knowledge (Hayek, 1945) about the interaction of entities (quasi-objects) such as individuals, firms, and social institutions. It is subsidiary to the larger socioeconomy, part of a hierarchical set of activity systems (e.g., DiMaggio, 1990) which cannot be completely decomposed or separated (Simon, 1973: 11). For instance, as in Latour's analysis, McCloskey's (1989) detailed historical analysis of medieval strip farming illustrates the complex interaction of social institutions, ideas of individual and household identity and process, agricultural technologies, and the medieval division of labor, all of which need to be considered to understand the behavior of the agricultural markets that existed at that time.

To summarize, Latour's quasi-objects, which embrace physical artifacts, scientific laws, the practices of scientists and technologists, political activity, historically specific social systems and institutions, as well as individuals' dispositions, in an activity system with some autonomy and self-regulating capabilities, provide us with a rich and dynamic sense of the interactions of the many different types of knowledge being created, circulated, stored and applied within the firm. It is clearly a knowledge-based theory, in which knowledge is conceived as competent goal-oriented activity rather than as abstract 'knowledge about'. But it is difficult to imagine how we might operationalize it, or even whether Latour would consider this important or useful. In the following and final section, we step back closer to the more practical and managerial tradition of sociotechnical systems theory.

AN ACTIVITY SYSTEMS APPROACH TO KNOWLEDGE-BASED THEORY

A key concept, implicit in Latour's quasi-objects but explicit in all autonomous self-regulating sys-

tems, is redundancy. It bears some relationship to organizational slack but, bearing in mind Penrose's distinction between resources and services, derives from the incommensurability of the different types of knowledge rather than from the presence of underutilized assets. Redundancy is the source of interpretive flexibility in quasi-objects. Nonaka and Takeuchi (1995: 80) argue redundancy is a precondition for knowledge generation and defined it as the existence of information that goes beyond the immediate operational requirements of the organization's members. Similarly Selznick (1957: 18) defined institutionalization as the process of infusing organizational activity with value beyond the technical requirements of the task at hand. In this sense, institutional identity is 'redundant' to performance, and this remains true so long as the rules and organizational routines are sufficient to the task. It is clearly incorrect as soon as we consider the firm's ability to respond to uncertainty, to the challenges for which there are no existing routines, explicit or implicit. A dynamic theory of the firm must be able to deal with uncertainty by having 'something up its sleeve'.

Nonaka and Takeuchi suggested that redundancy is built in as personnel are rotated around the firm. Intuitively this seems correct even though it is difficult to identify precisely what is produced—perhaps a better sense of how the organization as a whole works, or a sense of the heterogeneity of its processes, or a respect for the skills and resources of others in the firm, and for its culture. The implication, as with Selznick's notion, is that the redundancy-building process puts resources and capabilities into the background rather than the foreground, into 'deep knowledge', a second level of capability where the second of the double loops resides. Organizational slack is a simpler unidimensional idea of underutilized foreground resources. The background knowledge on which Polanyi focused is the fertile reservoir of varied capabilities that can be quickly assembled problemistically to deal with new uncertainties. Czikszenmihalyi's (1988) notion of 'flow,' as the conscious reasoning process 'gets out of the way' of the actor's tacit background knowledge, is one such model.

We can structure this two-level Reber-like model better by noting that systems theory always bridges two levels of analysis: the functioning system and its components (Buckley, 1968). The systemic and componential levels differ because it

is the intercomponent activities, such as feedback, which lead to systemic properties. Hence identical systemic characteristics can often be produced from different types of component. It is immaterial whether a radio uses vacuum tubes or transistors. Simulations and models rest on this idea. It follows that a system's core competencies, which are systemic, do not inhere in its components. Like the system's boundaries, they emerge from its activity. Nor can the systemic attributes be discovered by examining the components without a prior sense of their meaning. We have to know what a clock is and how it is used before we can make sense of the clock's parts. A system's meaning is the 'deep knowledge' which allows us to see its components in the context of the quasi-object of which they are part. As Reber (1993) suggested, the background knowledge is the system's collective knowledge. The activity constituting the background knowledge is the glue that holds the disparate and incommensurate components together as a loosely coupled but bounded system.

The relationship between the systemic and componential types of knowledge is paralleled by the economic relationship between public and private goods. This underlines why, once we move to a dynamic knowledge-based framework, we can no longer think of knowledge simply as an intangible asset, somehow analogous to a tangible asset. The difference between the knowledge-based and resource-based views becomes clearer. Collective knowledge such as culture is embedded as a background practice and is a public good for the activity system that it holds together. It is not consumed by being incorporated into activity—quite the contrary—like trust, it is an outcome of the system's activity, an emergent systemic property. Within its own activity system, it has the properties which Arrow (1962) imagined for knowledge generally. The closure processes define the system's boundaries and emerge from the interplay of its public and private aspects. The core of Penrose's theory is that the wedge between resources and services is infinitely extensible because managerial knowledge is, within the bounded context of their firm, a public good. But outside the firm, this same knowledge is not only not a public good, it is probably without value as a private good.

Thus, in addition to the managerial heuristics suggested above, maintenance of interpretive

flexibility, boundary management and the identification of significant others, the distinction between the systemic and componential aspects of an activity system is the key to operationalizing a knowledge-based theory of the firm. The managerial problem is to know whether, within the firm, particular knowledge processes produce public or private goods, since whether a process is systemic or componential is determined during the emergence of the system itself. As an individual's skills are institutionalized into organizational routines, they become systemic. Contrarily, when new charismatic leadership succeeds in reinventing the firm's sense of itself, culture is privatized into the 'cult of the individual'. At the same time, remembering Latour's quasi-objects, a system's processes are also shaped and delimited by the physical artifacts and objectified knowledge which it has embraced. Technology demands particular types of knowledge of the people who are brought into contact with it, and of the activity systems in which it is embedded. Far from being a tool, technology becomes our master when it shapes the systemic aspects of our systems. When clocks changed from being an expensive bauble to being the centerpiece of a system for coordinating households, factory work, and an entire society's activity (Landes, 1983), clock time became our master, reminding us constantly of its shortage in our just-in-time system of activity.

The evolutionary nature of human activity systems means that we cannot hope to find an *a priori* positivist theory of the firm as a knowledge-based quasi-object. Indeed, the pursuit of such a positivist theory requires the analyst to exclude by assumption the very dynamism that Schumpeter and Penrose sought. Instead, we have to begin our analysis with what is before us, plotting the boundaries of the focal activity system, probing its components, immersing ourselves in its processes in order to discover its systemic aspects. Only then, with this insider's knowledge of its meaning, do we begin to comprehend the dynamics of the system's interactions with other quasi-objects and with the broader environment. Thus our theory is not a theory in the positivist sense, telling us about an immutable reality 'out there'. Instead, it is a diagnostic and explanatory probe, a method of unpacking the complexity of the evolved quasi-objects which constitute 'our world. Its purpose is to help us see how individ-

ual creativity interacts with the background collective knowledge that gives each system its meaning and identity. It is more a theory of executive leadership, as suggested by Barnard or Penrose, than a theory of rational decision-making. The theory itself becomes a quasi-object, in the social world, and the data that it can grasp is delimited by its technical aspects, its interpretations reflecting the particular social interests embodied in its history.

CONCLUSION

A knowledge-based theory of the firm can yield insights beyond the production-function and resource-based theories of the firm. It is a platform for a new view of the firm as a dynamic, evolving, quasi-autonomous system of knowledge production and application. But to build a knowledge-based theory of the firm we have to go well beyond the concepts of knowledge which our positivist training offers us. In this paper we follow a trail from Kant, Polanyi and Durkheim to Callon and Latour. During this journey we redefine human knowledge, the concept of the individual, the nature of social entities, and we have to reconstrue action's relationship with the various types of knowledge. We begin by taking the distinction between explicit and tacit knowledge, widely familiar to our field, and compare the way Nelson and Winter, and Nonaka and Takeuchi, have used it in their theories of the firm. Both leave the task uncompleted because while opening up dynamic processes neither deal with the corollary, that there must be some means of closure. A knowledge-based theory will turn on whether this closure is external or internal, static or dynamic. Our solution, which depends on an emergent internal closure, is a synthesis of sociotechnical systems theory and self-regulating biological systems.

We conclude with the problems of operationalizing this approach. We identify four heuristics which managers might use to help them define the firm as a knowledge-based activity system, and to understand their relationship to it. The heuristics require that organizational knowledge is not defined in a positivist way as a corporate asset. Rather it is a qualitative aspect of the activity system they shape as managers. Ultimately to know is to be able to take part in

the process that makes that knowledge meaningful. Even to feel confident that one could take part is but a representation of that knowledge, not the knowledge itself, for it is the performance, especially in the face of unanticipated uncertainties and challenges, that is the true test of executive knowing.

The four heuristics are (a) interpretive flexibility, (b) boundary management, (c) identification of institutional influences, and (d) the distinction between systemic and component features. If there is no interpretive flexibility the knowledge system is inactive, asocial and purely machine-like. If the system is active and evolving, it follows there must be interpretive flexibility that corresponds, for instance, to the division of labor. Growth may be accelerated by taking steps that increase interpretive flexibility, but this threatens the system's boundaries from within. Boundary management is unnecessary if the system is inactive because the boundaries are no longer dynamic. Just as having a strategy means knowing when to say no to new opportunities, so every activity system requires boundary management. Boundary management, merging, downsizing, outsourcing, acquiring and so forth, in addition to changing the firm's market engagements, can precipitate energizing interpretive flexibility. The firm that is inactive is not threatened from without by external institutional influences. But, for the active firm, every boundary movement affects the significant others beyond the boundary. Unless these external entities and quasi-objects are identified, the boundary management process is uncontrolled. Finally there is the distinction between the firm's systemic and componential characteristics and processes. Effective resource allocation requires careful identification of the internal knowledge processes. But their value cannot be estimated until their meaning is established. Whether they contribute to the firm's private or public resources is crucial. One of the most obvious examples is the firm's information technology process. It is almost certain that this cannot be evaluated within the firm's normal capital investment criteria because its real contribution is to the firm's public features. In contrast, a production machine is essentially private, privatizable and outsourceable. These heuristics push us toward an enriched Penrosian account of the firm, an historically and path-dependent one in which managers are active components of organic

quasi-object/systems, using all modes of human influence to shape the producing and using to the various modes of human knowing. Here strategists are neither the dispassionate designers of machine-like production functions, nor the essentially replaceable computational functions which allocate identifiable resources. They are, instead, nodes of imaginative leadership and influence in the complex of heterogeneous emotionally and politically charged knowledge systems which comprise our socially constructed reality.

ACKNOWLEDGEMENTS

I acknowledge the considerable services rendered by Jay Zimmerman, Anat Lechner and Rob Grant as they read and commented on earlier drafts of this difficult paper.

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