RESOURCE RECOMBINATIONS IN THE FIRM: KNOWLEDGE STRUCTURES AND THE POTENTIAL FOR SCHUMPETERIAN INNOVATION

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Abstract

Schumpeterian innovation rests on the ability to imagine and realize novel combinations of firm resources. Building on the resource-based view of the firm, this paper explores the notion of creative "resource recombinations" within the firm. First, we suggest such recombinations can occur when competencies within the firm (which are interpreted as clusters of firm resources) either combine to synthesize novel competencies (synthesis-based recombinations) or experience a reconfiguration or re-linking with other competencies (reconfiguration-based recombinations). Central to this paper is an examination of the antecedents necessary for such innovation to occur. One important antecedent to such recombinations is the nature of knowledge in the firm. How knowledge is held in the firm is likely to influence both the creative detection of potential new recombinations and the exchange costs associated with implementation. We explore the implications of the general characteristics of knowledge itself and its social organization within competencies. Our paper examines how these characteristics and structures impact the likelihood of firms realizing novel uses of existing resources, developing a model of resource recombination likelihood.

(Keywords: Resource-based view, organizational knowledge, innovation)

I. INTRODUCTION

In recent years, strategy research has been undergoing a shift in emphasis from monopoly and Ricardian (scarcity-based) rents to Schumpeterian (innovation-based) rents (e.g., Amit and Schoemaker 1993; D'Aveni 1994; Henderson 1994; Teece and Dosi 1994; Teece, Pisano and Shuen 1997). Central has been the prescribed role for the firm as the developer of novel resources—that is, firms are encouraged not only to find ways to appropriate value from the deployment of their existing resource stocks but to search out new resources, or new ways of using existing resources, as the basis for future organizational rents. In turn, the development of the "dynamic capabilities" and innovation processes required to generate such novel resources is regarded as a key potential source of sustainable competitive advantage (e.g., D'Aveni 1994; Teece, Pisano and Shuen 1997). In this paper we focus on one type of firm innovation, what we shall call *resource recombinations*, as pointed-to by Penrose (1959:25 emphasis added):

> The services yielded by resources are a function of the way in which they are used—exactly the same resources when used for different purposes or *in different ways and in combination with different types or amounts of other resources* provides a different service or set of services.

Resource recombinations involve *the discovery of previously unenvisaged ways of combining and exploiting firm resources*, potentially producing novel productive resources or novel logics for integrating and using existing resources. Our paper focuses particularly on the knowledge-content of resources and their social properties in examining innovation of this type. Building upon four literature streams: the resource-based view of the firm, organizational knowledge, institutional theory, and organizational capabilities and competencies, we explore this type of innovation and suggest a series of propositions regarding the likelihoods of its occurrence in the firm. In the next section, we first outline the general nature of resource recombinations as an

approach to firm innovation, comparing this approach to other types of innovation. We then specify what we mean by firm resources, honing-in on knowledge-based resources. The main section of the paper then further explicates how these resources may be recombined and develops our model and specific propositions regarding the likelihoods of such innovations. We conclude with some broader implications for strategy research.

II. BACKGROUND

Contemporary strategy research has seen a shift in emphasis from the structure–conduct–performance paradigm which emerged from industrial organization economics and towards theories which focus on the internal resources of individual firms as a key determinant of competitive advantage. Even within the internally-focused, resource-based theories, however, there is a progression from an account of which (and why) resources may be valuable (i.e., scarcity-based or Ricardian rents) to an exploration of how these resources may be generated (e.g., Nelson 1991; Amit and Schoemaker 1993; D'Aveni 1994; Henderson and Cockburn 1994; Iansiti and Clark 1994; Teece and Pisano 1994; Lazonick and O'Sullivan 1995; Winter 1995; Grant 1996; Moran and Ghoshal 1996; Helfat 1997; Teece, Pisano and Shuen 1997). Influential here has been the work of Joseph Schumpeter and his thinking on competitive dynamics (1934; 1942). Schumpeter emphasized that entrepreneurship was the key motive force in the capitalist process, generating the innovations or insights that alter the rules (via "creative destruction") by which an industry or economy operate, his name being associated with such innovation-based rents (i.e., Schumpeterian rents (Rumelt 1987; Mahoney and Pandian 1992)). However, while Schumpeter's particular perspective on firm innovation has been well woven into some recent

work (e.g., Anderson and Tushman 1990; Henderson and Cockburn 1994; Henderson 1994; Grant 1996), much work remains in furthering our understanding of what the Schumpeterian rent creation process may look like viewed from the perspective of the resource-based view of the firm. As Montgomery notes (1995:263):

> "The Schumpeterian view of competition.. ..has taken a distant back seat in the resource-based view of the firm."

Two features of Schumpeter's thinking seem particularly relevant when applied to the firm-level. First, the "entrepreneurial role" Schumpeter often wrote about consisted of recognizing the value in the underlying parts of diverse systems and discerning that these parts could be recombined in a novel fashion. As Schumpeter wrote:

> the defining characteristic [regarding the 'entrepreneurial function'] is simply the doing of new things or the doing of things that are already being done in a new way. (1947:412)

By this, Schumpeter was emphasizing that innovation, as a process, "consists to a substantial extent of a recombination of conceptual and physical materials that were previously in existence" (Nelson and Winter 1982:30). Further interpreting this within the firm, we can distinguish Schumpeterian from incremental innovation. Incremental innovation involves refinements and extensions to firm resources (i.e., products, technology, or processes) without altering their underlying logics or the links between them (cf. Henderson and Clark 1990:11). Schumpeterian innovation, on the other hand, is primarily radical and disruptive in nature. The essence of Schumpeterian innovation is *the reconceptualization of an existing system in order to use the resources from which it is built in novel and potentially rent-generating ways* (cf., Abernathy and Clark 1985; Henderson and Clark 1990; Kogut and Zander 1992; Grant 1996). "Reconceptualizations" includes not only reconfiguring the ways in which resources are

currently integrated, or architectural innovation (e.g., Benetton's and The Limited's reconfiguration of their value-chain (Richardson 1996)) but also developing novel resources from the synthesis of existing ones (e.g., Canon's fusion of its knowledge in electronics with that in its optical division to create major advances in both cameras and copiers). In either scenario, existing resources serve as the platforms from which novelty is generated, emphasizing "strategic insights" in recognizing alternative uses and values from existing resources (Collis 1994:145). Moreover, innovation of this sort is construed more broadly than simply product innovation, occurring instead in a wide variety of areas, including the underlying business processes, market image and strategic positioning of the firm, all of which may be impacted by how the underlying resources of a firm are interpreted, combined and configured (cf. Dougherty and Hardy 1996). This form of innovation is what we term *resource recombination* and is the focus of this paper.

Second, while in much of Schumpeter's writing on competitive dynamics the focus was on the individual, heroic entrepreneur, in his later work (cf. Swedberg 1991:173) Schumpeter noted that the entrepreneur did not have to be a single individual but rather that the "entrepreneurial function" was a social and co-operative process:

> "Every social environment has its own way of filling the entrepreneurial function" (Schumpeter, 1951:255, as cited in Swedberg, 1991)

While we believe creativity to be very much an individual phenomenon, this does not mean that the context in which it occurs is immaterial. It is in the shaping of a creative context amenable to the identification and implementation of novel resource combinations that the firm plays an essential role. In particular, we suggest that the probability of such new connections between resources being discovered and implemented will be contingent upon the nature and dynamics of

knowledge in the firm. For example, in their study of pharmaceutical firms and the product development process, Henderson and Cockburn (1994:72) note that management by committee "appeared to encourage extensive and sometimes unexpected exchanges of information across programs," such structural and social manipulation of knowledge flows receiving significant support as a determinant of innovation. Our analysis therefore incorporates structural and social factors in theorizing about knowledge stocks and flows as the antecedent to resource recombinations.

Below, we continue by defining what we mean by resources in the firm, outlining what we see as two basic types of resource before further explicating resource recombinations. Importantly, our thinking centers on the structure of knowledge within the firm (e.g., Kogut and Zander 1992; Grant 1996; Spender 1996) and how knowledge sets become delineated, institutionalized, and ultimately impact the likelihoods of resource recombinations.

Resources and Knowledge in the Firm

Resources in the RBV have been largely defined by the outcomes that they contribute to rather than their properties. For example, Wernerfelt (1984:172) notes that "by a resource is meant anything that could be thought of as strength or weakness of a given firm". Barney (1991) observes that resources are "all assets" that a firm controls in order to improve its efficiency and effectiveness. When examining the recombination of resources, however, it is useful to first distinguish resources from one another according to some basic properties.

We divide resources into two broad categories: **Input resources** and **Knowledge-based resources** (figure 1).

Figure 1 about here

Input resources are often, though not exclusively, tangible in nature. They include four basic parts: People, Plant & Materials (e.g., all machinery, office equipment, and basic raw materials), Property Rights (e.g., rights to mineral deposits), and Financial Capital (e.g., monetary items)[1]. They are all, to various degrees, required in the transformation processes of firms and form the most basic building blocks of the firm. In order for these resources to be used together productively, a further ingredient is needed which is knowledge. All firms must have some knowledge which enables them to take input resources and manipulate and transform them so as to add value (Teece, Pisano and Shuen 1997:509).[2] How such knowledge (1) may be characterized according to some basic properties and (2) comes to be organized in the firm is central to our thinking on innovation via recombinations.

1. Knowledge: General characteristics.

In recent years, there has been considerable activity surrounding our understanding of knowledge and the firm (Itami 1987; Winter 1987; Henderson and Clark 1990; Kogut and Zander 1992; Leonard-Barton 1992; Conner and Prahalad 1996; Grant 1996; Spender and Grant 1996). From this work, many categorizations of firm knowledge have emerged, often with a fair amount of consistency. In particular, we find three common characterizations to be useful for our purposes: a) tacitness (the extent to which knowledge is or is not codifiable); b) dispersion (the extent to which it is concentrated in the head of an individual or spread out across the minds of many); and c) context specificity (the extent to which knowledge is highly contextualized and codependent on unidentified aspects of the local environment). Each of these general characteristics of firm

knowledge will point to some implications for the ability of firms to recombine their resources.

2. The organization of knowledge in the firm:

Beyond these general characteristics of knowledge, however, knowledge and its complimentary input resources also come to be organized and clustered within the firm. Indeed, one often noted feature of the firm is its integrating role, bringing together diverse basic inputs and specialized areas of knowledge and bundling them to perform a productive task (e.g., Dierickx and Cool 1989; Demsetz 1991; Black and Boal 1994; Grant 1996). Moreover, firms are full of such "clusters" of input and knowledge-based resources. Such clusters include the specialized knowledge surrounding the use and manipulation of constituent parts as well as the architectural knowledge (Abernathy and Clark 1985; Henderson and Clark 1990) or network of relationships (Black and Boal 1994) needed to use them together productively. Moreover, such clusters of resources are consistent with what many have referred to as capabilities or competencies of the firm (e.g., Prahalad 1990; Leonard-Barton 1992; Barney and Zajac 1994; Hamel and Prahalad 1994; McGrath, MacMillan and Venkataraman 1995; Teece, Pisano and Shuen 1997). This literature, however, also reveals some ambiguity over the use of these terms (Collis 1994). Notably, competencies and capabilities are often used interchangeably as well as without precision as to the level of analysis (i.e., sometimes they focus on very specific skills while other times on all strategically relevant behavior and social phenomena). We therefore offer some further interpretation of these constructs, with an eye to how a competence or capability may be defined to help theorize about resource recombinations.

For our purposes, we will reserve the term "capabilities" to refer to the "smallest," relatively

indivisible combination of basic input resources and process knowledge that is needed to accomplish some basic or elemental task (e.g., operation of a certain machine).[3] Here capability is defined principally on technical grounds. Our focus will be more on what we will define as competencies. Adapting Grant (1996), we use the term competencies to describe combinations of input and knowledge-based resources that exist at higher levels in a "hierarchy of integration." At the base are the aforementioned highly specialized capabilities, typically held by individual members of the firm. These are then integrated into some form of higher order systems or clusters of resources, whether technological areas (e.g., printed-circuit board assembly), functional groups (e.g., manufacturing), and so on. Despite the large variety of such boundaries that can be found in firms, we generally define these higher-level resource clusters as competencies (as also used by Teece, Pisano and Shuen 1997:516). Some competencies can be quite wide, involving a number of capabilities and several levels of integration (e.g., functional areas), others may be relatively narrow (e.g., specific technological areas). Some competencies may be linked horizontally to achieve their effect (e.g., cross functional teams) while others may be relatively isolated (e.g., Hewlett-Packard's ink-jet and laser-jet printer technologies). Regardless of the exact form, however, key to our thinking is that competencies will display *social and institutional qualities within the firm* (cf. Collis 1994:145). Human proclivity to grasp for common meaning, to belong to and come to identify with groups, are phenomena which cultivate intra-firm boundaries and bring greater unity to clusters of resources (see Thornton and Tuma 1995). It is these social and institutional, rather than purely technical, properties that are important in our definition of competencies and will give rise to some of the interesting implications for recombinations.

An example of the hierarchical nature of competencies is Canon (see figure 2). Canon describes its competencies as fine optics, precision mechanics, electronics and fine chemicals, each of which encompasses a range of basic inputs and knowledge. As illustrated in figure 2, "fine optics" could be further subdivided into more basic resource combinations, such as lens design, grinding and polishing processes, high performance coating and thin film deposition. Importantly, while each combination is potentially an independent element, within Canon they are typically clustered together into the groups in which they are most commonly deployed, receiving a social quality—that is, their histories become intertwined, common languages and meanings develop, and people come to identify and distinguish themselves as belonging to one competence cluster or another. These social properties of competencies, we will argue, serve as one important source of "stickiness" in combinations of resources, and will therefore be a factor when considering the recombination of resources.

Figure 2 about here

III. RESOURCE RECOMBINATION LIKELIHOODS IN THE FIRM

Forms of resource recombinations.

Viewing resources through the organizing lens of competencies, we can now better explicate "resource recombinations." At the heart of our thinking is that firms are made up of numerous competencies, whose recombination may generate novelty. Specifically, we can envisage resource recombinations occurring in at least two distinct ways. First, novelty may be generated from the *synthesis of existing competencies*. For example, Porter describes the combination of

competencies in musical instruments and consumer electronics that led to the rise of Japanese firms specializing in electronic keyboards (1990). More recently, in their study of a product design firm, Sutton and Hargadon (1996) show how this organization "brokers" knowledge via its central network position between several industries, organizing and merging the different competence domains to which it has access and, through "inventive combinations," creating novel business concepts (Hargadon and Sutton 1996:233). Similarly, Helfat (1997:340) documents how "several sorts of knowledge capital within the firm" (contained in distinct R&D projects) were synthesized by Petroleum firms to generate a novel resource (Coal conversion processes). Common to each work is that the knowledge-based resources in existing competence areas were used to create novel business concepts and processes (see also Nonaka and Takeuchi 1995).

Second, novelty may also be generated through *reconfiguring* the ways in which competencies are linked to jointly achieve some broader purpose (Grant 1996). For example, Richardson (1996) documents how such fashion houses as The Limited have reconfigured their value-chains into new competitive architectures ("quick response" processes), recombining broader functional competencies, such as distribution, design and manufacturing, in novel integrative logics. Of note is that alterations in the way these areas were linked (e.g., use of new information technologies) coincided with changes in the underlying capabilities of the areas themselves (e.g., computerized design capabilities). This process is similar to Henderson and Clark's discussion of radical innovation, involving both the reconfiguration of components and alterations to the components themselves (1990). Moreover, Richardson's work also helps to distinguish our level and unit of analysis from Henderson and Clark's study. While Henderson and Clark's study was

more concerned with product development processes and the reconfiguration of *physical* components, we are concerned more with broader "strategic innovations" which reconfigure broadly-held knowledge-based resources into new approaches to competing (Grant 1996:382). Furthermore, while architectural innovation emphasized just the re-assembly of component parts (i.e., without altering the parts), a focus on reconfiguring broader and more abstract resource clusters we believe *must* have implications for the knowledge organized in these clusters as well as how they are linked (as Richardson found). In other words, we envisage reconfiguration-based recombinations to be more radical in nature than simply architectural.

To summarize, resource recombination (whether synthesis-based or reconfiguration-based) concerns itself with how the knowledge embedded within a competence may have to be untangled, altered, and integrated with other knowledge bases to create novel business concepts and/or competencies. A focus on such higher-level recombinations seemingly offers the firm the highest potential payoffs (given their focus on generating radical breakthroughs at the broader, strategic level) although they also confront the firm with its greatest challenges (since greater disruption is likely when altering or integrating systems with wider, more encompassing umbrellas). Because of the more radical nature of such innovations, we will term these *Schumpeterian* resource recombinations.[4]

A model of Schumpeterian resource recombination likelihood.

We now turn to our propositions regarding the likelihood of such recombinations. As noted, our model (figure 3) is based upon an exploration of the characteristics and social construction of knowledge in the firm. In general terms, we hold that recombinations depend upon competency-

related knowledge flows in the firm. By knowledge flows, we mean all the various ways in which information, know-how, understandings, histories, etc., may be exchanged in the firm regarding competencies.[5] In the case of synthesis-based recombinations, such knowledge flows may have to be created; exchanges between relatively isolated competence areas may have to be constructed where they do not exist. For example, such *de novo* sharing and exchange of knowledge was emphasized in Nonaka and Takeuchi's description of the creation of the home bread maker (1995), interacting diversely-based (and otherwise in seldom contact) individuals from within and outside Matsushita as the first step in each of the three "cycles" of discovery in the innovation process. Even in the case of reconfiguration-based recombinations, where some stable interactions (by definition) already exist, new information and insights on neighboring competencies may be important to generating alterations in the linkages themselves. For example, Henderson and Cockburn's work on pharmaceutical firms (1994:67) suggests that "rethinking" and "deepening the flow" of information across normally interacting competence areas is an important precursor to generating novel architectures between these competencies (see also Clark and Fujimoto 1991). In both cases, therefore, the realization of resource recombinations depends upon the flow of competency-related knowledge between competence areas. Importantly, we hold that these knowledge flows will themselves depend upon the basic characteristics of knowledge and its social construction in competencies in the firm (see also Chi 1994). Below we present propositions for the likelihood of resource recombinations which rest upon the five principal themes arising from the properties and organization of knowledge introduced earlier: 1) the *tacitness* of knowledge, 2) its *context specificity*, 3) its *dispersion*, 4) the *delineation of competencies,* and 5) *competencies as sources of identity.*

Figure 3 about here

Finally, Figure 3 also shows the role of two mediating constructs through which these five themes operate on knowledge flows: the *detection likelihood* of novel uses for existing resources and the *exchange costs* associated with implementation (cf. Iansiti and Clark 1994). Detection likelihood focuses on the *ex ante* knowledge flows that may be required to conceptualize novel recombinations. For example, knowledge regarding competencies, exchanged between individuals in the firm prior to the discovery of resources recombination opportunity (i.e., *ex ante*), may raise the probabilities for detecting novel uses of resources or alterations in linkages between competencies. The nature and organization of some knowledge may make novel arrangements of resources more difficult to conceive. Exchange costs captures the notion that even while some novel uses may be detected, for such insights to be implemented knowledge may have to be transferred across competence boundaries (i.e., *ex post*). Given that the transmission of knowledge is not costless (Arrow 1969; Teece 1977; Teece 1981), exchange costs may also influence recombination likelihoods. Again, certain characteristics of knowledge in the firm may raise exchange costs.

Basic Knowledge Characteristics

1. Tacitness of knowledge.

Knowledge can be distinguished according to its tacitness. Tacitness is now a familiar category for knowledge in organization theory (see Polanyi 1966; Itami 1987) and generally describes the extent to which knowledge is or is not codifiable. Literally, tacit means "understood, implied or existing without being stated" (Shorter Oxford Dictionary). Note that we do not require the more

severe claim that tacit knowledge is never codifiable. The codifiability of knowledge is a continuum, rather than a step-function. Codifiability may change depending on what is available to assist in the codification. For example, processes involving the mechanics of motion of the human body were probably long thought non-codifiable until scientific techniques (e.g., video and computer analyses of motion, and other tools of Kinesiology) were brought to bear and some explication made possible. Within the firm it is also likely that no means currently exist to codify certain knowledge, or where such technology might exist, it may be too expensive compared either to the expected returns from its transfer or from those returns anticipated were transfer achievable without codification. So, for our purposes, it will be enough that some knowledge cannot be easily codified.

Knowledge that is difficult to codify may be difficult to detect. Because it is not prone to easy articulation and documentation, it is more difficult for someone to identify this potential resource and imagine how it may be used in novel ways or new contexts. This will be particularly true across competencies, where people are less likely to spend appreciable time interacting with one another, and thus less likely to have the time and experience to be able to detect the novel use of some (highly tacit) resource.

An alternative means of transferring tacit knowledge involves moving the people possessing the tacit knowledge to different areas in the firm and allowing socialization to inspire new combinations. Because this should ensure greater effectiveness of knowledge transfer (Nonaka and Takeuchi 1995), it should raise probabilities of detecting new combinations. However, transferring knowledge through socialization is costly, involving the prolonged, if not permanent, interaction of individuals with whom tacit knowledge resides. This is particularly problematic

across broad and disparate competence areas. For firms reluctant to invest in a costly exchange of people, given the uncertainty of consequent innovation and associated returns, knowledge exchanges will diminish and the likelihood of detection of new combinatory opportunities will fall as a consequence.

Finally, even if a recombination opportunity were to be roughly identified, knowledge that is difficult to codify will be difficult to transfer for it to be combined with other knowledge in the firm (Teece 1981). The effectiveness of documentation as a method for making knowledge available across competencies will decline quite rapidly the greater is the tacit component and, as was described above, socialization as a means of transfer is costly. In general,

Proposition 1 The likelihood of Schumpeterian resource recombinations will be diminished the more inherently tacit the knowledge base, both due to lower detection probability and higher costs of resource exchange.

2. Context specificity and the routinization of knowledge.

The context in which knowledge is developed is also important to its flow. This is mainly because knowledge is often highly contextualized (Rorty 1991). Take for example the tight co-ordination of an aircraft carrier flight-deck crew, as Weick and Roberts describe (1993). This valuable resource (i.e., its 'group mind') to the US navy is likely to be of little use outside of the relatively narrow context for which it was developed. It would be far less effective a resource at New York's JFK airport even if it were given the same basic set of tasks—the differences in technology, physical layout, time pressures, task interaction effects and social atmosphere may all serve to reduce the usefulness of the carrier crew's "collective mind" when deployed in a different context. This is not to suggest that knowledge could not have multiple uses (cf.

Wernerfelt 1984; Prahalad 1990). However, because of the advantages of specialization, knowledge may be heavily customized to one particular use, increasing the context specificity and lowering its chances of flowing elsewhere. While this is desirable at the inter-firm level, a factor in the creation of imperfect mobility of resources (Peteraf 1993:183), it may be detrimental at the intra-firm level, for purposes of recombinations.

One particular way in which this operates is through routinization. Routinization here refers to the development of a sequence of individual or organizational actions that require relatively little attention (Nelson and Winter 1982:125), so that the execution of the task becomes reliable, easily reproducible, and efficient (Meyer and Rowan 1977; Hannan and Freeman 1989). Furthermore, as Nelson and Winter point out, organization routines are often context dependent in various ways (1982:87). That is, routines are often built over time and in such ways so as to hone-in the specific actions to the local context within which they are embedded. In this sense routinization, in general, may represent an obstacle to Schumpeterian innovation (Nelson and Winter 1982:131).

Routinization, however, may be further unpacked to reveal other implications for recombinations. First, we suggest that routines can often consist of both tacit and explicit knowledge. Using Nelson and Winter's (1982) example of the routine of driving to work, knowledge which began in documented form (say a map) becomes tacit with repetition and the map is often discarded. The routine may be re-codified, i.e., documented, at some later date, perhaps in a set of detailed instructions to a colleague (e.g., by noting where exactly to turn, the best time of day to travel, hazards to avoid, etc.) only some of which may be captured by the map. This routine can therefore come in the form of documented instructions to be followed

verbatim (as in a standard operating procedure), where it is primarily explicit, or auxiliary learning as one goes through the process and develops habits, where it is primarily tacit. Just as in the case of tacit knowledge described above, however, knowledge held in tacit routines will make detection problematic and may be a burden to codify. The more organizations run on tacit routines the less likely it will be that they will be able to realize novel resource recombinations. In general,

Proposition 2(a) The likelihood of Schumpeterian resource recombinations will be diminished the more organizational activities depend on tacitly-held routines.

There are also implications, however, stemming from the knowledge retained in highly explicit routines, that is sequences of codified activities. The portion of a routine held in codified form is likely to have two, opposing influences on resource recombinations. First, codification will improve detection probability. A routine that appears in a manual or a database somewhere in the firm is more likely to be identified as a potentially useful resource by another area of competence than one that is not documented (for example, this is part of the rationale behind Andersen Consulting's internal database on case histories and consultant experiences (Economist 1996)). The more routines an area documents, the greater the probability that the embedded knowledge will be detected elsewhere in the firm. Therefore,

Proposition 2(b) The likelihood of Schumpeterian resource recombinations may be enhanced where routines are held in explicit forms due to an increase in detection probability.

Codification of routines, however, may also present problems for recombinations in the presence context specificity. Because the documentation of tacit routines into standard operating procedures typically strips away the rich detail in which may be embedded the understanding of

why a routine functions as it does in that context (Chakravarthy and Doz 1995), application to new contexts will be difficult. That is, while codification may possibly make "know-how" explicit (a causal chain for "knowing how to do something" (Kogut and Zander 1992)) it will usually do a poor job in explicating the "know-why" (theorizing about the know-how, that is understanding how the context mediates links in the causal chain (Bohn 1991)). In general, such detrimental aspects of context specificity of knowledge may be due to the fact that the codependency of the know-how with the local environment is not understood. Where re-deployment is across competence boundaries, meaning that knowledge be used in new contexts, such context specificity reduces its utility for recombination. For example, while departments may document tacit routines for internal use, they seldom go far enough in mapping processes so as to make them useful to an outside observer (who would be without the benefits of being able to go through the same process in the same context). Although codification may very well increase the likelihood of exchange, the loss of this understanding will work in an opposing direction diminishing its impact in a new setting. A more thorough documentation of the routine and its context, with more analytical work being put into developing a deeply nuanced understanding of the underlying reasons for the routine's effectiveness, may enhance its applicability in new contexts. However, doing such unpacking increases the cost of transfer and may well diminish an organization's willingness to undertake the task on a speculative basis.

Proposition 2(c) The likelihood of Schumpeterian resource recombinations may be reduced where routines are held in explicit form but are highly context specific, increasing the cost of transfer of the underlying "understanding."

3. Dispersion of knowledge.

Knowledge can also be distinguished according to its dispersion. It can be tightly held when self-contained and residing in the minds of individuals. It can also be widely dispersed, residing in the collective organizational mind, for example in patterns of heedful interactions between individuals within a competence area (Weick and Roberts 1993). Dispersion does not mean information that is widely distributed. A picture on a jigsaw puzzle is *distributed* when each person receives a photocopy of the picture from the lid of the box. The same image would only be *dispersed* when each of the pieces is given to a different person.

The dispersion of knowledge will influence its detection and movement. In general, concentrated knowledge may be detected and moved much more easily than dispersed knowledge. The first difficulty is in tracking down and identifying all the necessary 'parts of the puzzle'—because accurate views of complex systems are difficult (i.e., trying to determining the picture on the puzzle box by sampling potential owners of individual pieces) detecting dispersed knowledge may be problematic. Moving dispersed knowledge is also difficult. For example when knowledge resides in systems of interactions (e.g., Weick and Roberts 1993), moving such knowledge cannot simply be achieved by transplanting an individual into the new setting where the knowledge is to be applied. The transplanted individual will likely bring with them too small a part of the total system of heedful interactions. In other words, knowledge that is widely dispersed will be "lumpy". Moving this type of systems-embedded knowledge may require the wholesale uprooting of the system and its transplanting in the new context. This may not be realistic as current operating commitments and priorities may preclude the removal of the team with whom the knowledge resides. Moreover, since competence areas are likely to consist of

relatively more dispersed knowledge, issues of lumpiness will be particularly problematic for recombinations of this form.

Proposition 3 The likelihood of Schumpeterian resource recombinations will be diminished the more widely dispersed the knowledge, both because of higher costs of exchange and lower detection probabilities.

Social Characteristics of Knowledge

Having considered how some general characteristics of knowledge impact across-competence recombinations, we now turn our attention to how the organization and social interpretation of competence areas impacts the same. While we build upon the concepts developed above, our discussion will be more focused on the dynamic construction and interpretation of competencies.

As noted, implicit in our thinking is that firms possess several competencies. Some of these will be explicitly identified and named in the firm (more likely today as managers and consultants are encouraged to exploit their competencies). However, competencies need not be explicitly identified by the firm in order to exist and have influence. It is likely that competence boundaries evolve naturally and gradually: some may become explicitly defined, others may not. In either case, the construction and interpretation of these boundaries will impact the firm's ability to transfer knowledge from one competence to another. Below, we first look at how competence boundaries may come to be delineated and impact recombinations, arguing this occurs through the divergence in knowledge and language over time. We then consider the effect of the development of shared mental models and institutionalization processes on personal identities in the firm, also noting the impacts on recombination likelihood.

4. Delineation of competencies.

Boundaries between competencies are likely to arise around groups of individuals who interact frequently and come to share a common meaning or interpretive system (e.g., Neisser 1976; Daft and Weick 1984; Walsh and Ungson 1991; Kogut and Zander 1992). As individuals interact (say around a new technology or an emergent process within a young firm) a particular body of language and symbols (both social and technical) develop over time, facilitating information exchange. The use of a common (often unique) language improves the efficiency of knowledge exchange first by allowing exchanges to take place more quickly and second by avoiding the necessity for ideas to be translated into a higher-level language for exchange (Cohen and Levinthal 1990; Kogut and Zander 1992; White 1992). Such an esoteric language itself represents a store of tacit knowledge since it often contains words with highly specific associations and meanings which are seldom (if ever) documented. More generally, this process suggests the construction and solidification of perceived reality through the imparting of common *meaning* to repeated exchanges and patterns of action (Berger and Luckmann 1967; Rorty 1991). These "externalized" actions and routines (see Zucker 1977) create mental models by which actors are guided in subsequent interactions. Sapienza's study of speech communities is useful here (1994:4):

> "'culturally produced' language emerges in every speech community. Within research and development functions, for example, managers and scientists constitute a unique speech community, in which people 'talk together, and come to share the same verbal categories and explanations' (Bloomfield 1961; Sproull 1981:207). Their shared language therefore results in collective (i.e., shared) cognitive structures..."

Furthermore, as the stock of within-competence knowledge and meaning grows, and becomes more complex, relative to the stock of knowledge about other competencies, i.e., a deepening

rather than a broadening of knowledge held in that competence, people's absorptive capacity for within-competence knowledge will rise compared to their inter-competence absorptive capacity, (Cohen and Levinthal 1990). This reinforcing process will further deepen the knowledge within the competence but impede cross competence knowledge flow (important to synthesis-based recombinations). Or where such linkages already exist, there may be a tendency to keep these links relatively simple and standardized, offering greater freedom and flexibility for the development of complex individual areas (see Sanchez and Mahoney 1994; Sanchez 1995). However, while such loose linkages may improve the chances of *modular* innovation, it is also likely (given the logic of modular innovation) that attention will be focused predominantly on further developments within a competence area and thus draw attention away from the linkages *per se* (important to reconfiguration-based recombinations).[6] In other words, while simple linkages may encourage changes in competencies, their ensuing development and complexity may not be amenable to alterations in the linkages or standards. In general, the delineation process will build momentum within a competence area, conditioning the future trajectories that a particular resource set within the firm may take and lessening the potential for spontaneous influence from other competencies and/or radical considerations of changes in linkages. Penrose points to as much when she wrote (1959:113 emphasis added):

> "[A firm's] opportunities are largely determined by its existing resources. Its entrepreneurial and managerial personnel work within the framework provided by these resources and their *interests and abilities are conditioned by them.*"

Although Penrose intended this as an explanation of why entire firms chose to grow and diversify in the directions that they do, we note that the same mechanisms can operate within the firm to explain why delineated resource bundles, once set on different and distinct trajectories

(implicit in the delineation process), may fail to adequately interact, reducing the probabilities of resource recombinations.

The difference between mental models of one competence and another will reduce the detection probabilities of potential useful knowledge. Moreover, differing language systems are likely both to reduce the likelihood of detection and result in exchange costs between competencies being higher than those within a competence. The likelihood of any knowledge recombinations across competence areas will fall. In other words, innovative search and knowledge flow will be local and the likelihood of Schumpeterian innovation diminished (cf. Cyert and March 1963). A self-perpetuating cycle is likely—long histories of independent action or linkages with other competencies that are seldom reconsidered lead to more distinct meaning sets, which make interaction or alteration more difficult and boundaries thicker, and so on. In general,

Proposition 4 The likelihood of Schumpeterian resource recombinations will be diminished the more delineated the competency area (i.e., having distinct and idiosyncratic mental models and histories), because of both lower detection probabilities and the higher costs of exchange with other competence areas.

It is also worth noting that competence boundaries do not necessarily always align themselves with a firm's internal/functional boundaries, nor do they need to be contained entirely within a single firm. A firm with competence in a certain type of basic research may well find that the competence boundary encompassing this type of work extends outside the firm: scientists may interact more easily with other scientists at conferences and through journals than with non-scientists within the firm, since they share the same language, knowledge bases and mental models, a phenomenon observed by Allen, Tushman and Lee (1979). These "communities of practice" will cross firm borders and very probably country borders as well (Van Maanen and

Barley 1984). The general point is that mental models within resource clusters will often become solidified in the minds of individuals in the firm - competencies become delineated and, in this sense, institutionalized (Scott 1987).

5. Competencies as sources of identity.

Competencies can be institutionalized in a slightly different sense as well (cf. Scott 1987). The fact that competencies have histories will have implications beyond their ability to create esoteric modes of communication. Sharing the same world-view will tend to strengthen ties and build a feeling of association with those who share that view. In turn, competencies may also develop a life of their own, a taken-for-granted quality that imparts to them a *social value* beyond their usefulness in communication and exchange (Selznick 1957; Leonard-Barton 1992). Such structures tend to be identified by individuals as distinct, "living" entities, with certain anthropomorphic qualities; individuals therefore tend to identify themselves with particular competencies, taking pride in their membership (e.g., members of GM's Saturn unit were nationally advertised as proud of their distinct presence in the firm—we can speculate how other division's felt about Saturn). This may make competence areas within a firm less susceptible to alteration, both to the extent that they are seen as value-laden entities and thus worthy of preservation and to the extent that personal identities are wrapped-up within them. As Scott (1987) points out, institutionalization of this sort tends to promote stability in the structure being institutionalized. Moreover, not only do the competence areas themselves become institutionalized over time but so do their *interrelationships* with other competencies in the firm—institutionalization, in essence, is about stability of ones *relative* role or status, thus linkages may also become more rigid.

In general, where such institutionalization of a competence area is strong, and the absorption of individual identities deep, resource recombinations are less likely. At least two routes to this consequence are plausible, the first cognitive in nature (and emphasized in the previous proposition), the second motivational. As noted, having shared mental models may simply direct peoples' attention to the methods and interests of their own competence, leaving little time and energy for things "outside." While incentives could be created and formal structures built to integrate knowledge across competence boundaries, encouraging individuals to keep abreast of knowledge produced in other competence domains, the mental models of the recipient will still heavily filter the inflow of information, increasing the tendency to perceive data congruent with one's own mental models and unconsciously ignoring information that might not fit (cf. Vallone, Ross and Lepper 1985). This 'distorted perception' reduces the identification and retention of knowledge that might seed a significant change to existing knowledge structures (Neisser 1976; Dutton and Jackson 1987; Rumelt 1995). The probability of a 'frame-breaking' innovation through the recombination of two distinct sets of organizational knowledge is thereby reduced.

Second, strong identification with a competence domain may also see members viewing their competencies as being of greater value than knowledge residing in neighboring competencies. This inability to properly value the resources residing outside of one's competence regime is the 'not-invented-here' syndrome operating within the firm. Hubris (e.g., an overestimation of the value of one's competence regime (Rumelt 1995)) and general defensive behavior (e.g., perceiving competencies outside of ones immediate association as threats (Argyris and Schon 1978)) also contribute to reduce the probability that novel recombinations of knowledge will be discovered or transferred without significant social friction (Szulanski 1995).

Proposition 5 The likelihood of Schumpeterian resource recombinations will be diminished the more personal identities become bound up in and associated with a competency area, both because of the lower probabilities of detecting novel uses for existing resources and cost of overcoming frictions in their subsequent transfer.

IV. CONCLUSION

Focusing on competency-related knowledge flows in the firm, we have suggested a number of propositions relating to the potential for discovering novel resource combinations within firms. First, we believe that rents may be created if existing stocks of knowledge are combined in new ways, either to synthesize new knowledge or use existing clusters of knowledge in new combinations. To enable such recombination to take place requires first that knowledge is detected across competencies. Second, once detected, it must be relatively easy to transfer to the new place of use. Both these factors involve knowledge flows.

Where knowledge is tacit or dispersed, flows of knowledge between competencies will be inhibited and the probability of recombination will be low. Routinization will also reduce the potential for innovation; where routines exist mainly in the form of individual habit, tacitness will make transfer problematic. Where knowledge resides in organizational routines which are documented in operating procedures, detection likelihood is enhanced. However, where such knowledge is also highly context specific, its context specificity will interact with the low level of understanding that codification can capture to increase the cost of applying it in new settings. Furthermore, whenever competencies become institutionalized within the firm, that is develop an esoteric language and interpretative systems or logics and become linked to individuals sense of identity, the likelihood of radical recombination is also predicted to be low. While these points

summarize our theoretical model, their intention is also normative. They seek to guide management in what we believe to be key impediments or issues to consider if novelty through resource recombinations is desired. They should also help strategic management scholars to build better frameworks for implementing or further operationalizing recombinations. For us, however, the focus has been more on the prior issue of what is it about the way firm resources are organized that may or may not allow such a phenomena to occur. Below we consider some specific implications.

Implications for Strategic Management

Ricardian vs. Schumpeterian rents. Much prior work in the RBV tradition has focused on the implications of the difficulty of transferring knowledge across firm boundaries as factor that contributes to the protection of a firm's inimitable competencies (Peteraf 1993). Where the goal is to protect the longevity of useful knowledge associated with a firm competence, low imitability and mobility are advantageous. Moreover, wherever firms are emphasizing the exploitation of their current competencies, routinization has considerable efficiency benefits. The increasing use of specialist esoteric language within a competence will not only aid efficiency bit promote identification and the institutionalization of competencies, which may have very positive motivational results.

However, the price of increased routinization and efficiency and higher motivation from strong localized identification may be an overall reduction in frame-breaking innovation. Actions that promote exploitation may come at a cost to exploration (cf. March 1991). Firms thus face a choice between potentially lowering the barriers to imitation and thus reducing the longer term

appropriability of its competencies and increasing the probability of new discoveries. The choice is perhaps best made on the basis of industry conditions (Collis 1994; Argyres 1996). For example, in more dynamic environments, where long-term exploitation of competencies may be less important than continual on-going innovation (Doz and Lehmann 1986; Guth and Ginsberg 1990), a greater emphasis on creating novel business concepts and competencies will be required, even where this potentially comes at the expense of longer-term inimitability. In other words, Schumpeterian resources recombinations, as one form of dynamic capability, may not be equally necessary in all environments (Collis 1994).

Corporate diversification.[7] Creating a new resource combination could increase the diversity of a firms product market portfolio, as in the case of Canon. Since this combination is based entirely on existing resources, it may be more likely to be related diversification. In other words, firms seeking to innovate by looking for recombination opportunities may be more likely to diversify in related directions, at least compared to those firms who diversify largely through acquisitions. Indeed, our theory may suggest a predictor of diversification mode: diversification through acquisitions may be more likely within firms where the structure of knowledge and the processes of institutionalization are not conducive to resource recombinations. Moreover, once diversification by acquisitions has been started—where arguably there is a higher potential for unrelated expansion—the ensuing lower likelihood for resource recombinations could cause this mode of diversification to become self-perpetuating. On the other hand, where firms have amassed experience with resource recombinations, generating novel and related competency areas from which to build future novelty, this process may also become a self-perpetuating mode of expansion.

Defining competencies in the firm. We noted earlier that many firms are now striving to explicitly identify their competencies. Unfortunately, this could well accentuate institutionalization processes, sharpening the delineation between competencies and making interaction and transfer of knowledge more difficult. By overtly classifying a particular skill as a part of one competence set it is implicitly separated from possibly related skills in another competence set. The greater the degree to which competencies are clearly defined, the more rigid and entrenched they become. Firms which have leapt onto the core competence band-wagon and have tried to incorporate competence development explicitly into the strategic planning of the firm, have sometimes found themselves with core rigidities (Leonard-Barton 1992). The very act of articulation reinforces the natural tendency towards institutionalization, and with it, impediments to recombination. Paradoxically, the very process of attempting to identify knowledge that is worthy of moving to other competencies to support potential recombination, may reduce the likelihood of knowledge transfer and thus of discovering new resource combinations.

Finally, in this paper we have considered the properties of knowledge as given. However, the knowledge a firm develops is not only a determinant of innovation and thus of future strategy but also an *outcome* of past strategy (Itami and Numagami 1992). Thus mangers have the potential not simply to accept the typology of knowledge as starting point for the determination of strategy but to shape the properties of the stocks of knowledge the firm accumulates. Managerial intervention is essential to shape the structure of knowledge stocks in the firm and guide the process of institutionalization to raise the probability of knowledge recombinations. Indeed, what Schumpeter long ago noted about Western capitalism "that there may be an imbalance brewing

between bureaucratization and the rationalization of work (i.e., the seeking of efficiencies) and the entrepreneurial spirit" is largely still relevant to today's firms (Schumpeter 1942).

> "The profits to be made by rationalizing the organization of production and especially by cheapening the tortuous way of commodities from the factory to the ultimate consumer are more than the mind of the typical businessman can resist. (p140)
>
> The perfectly bureaucratized giant industrial unit not only ousts the small or medium-sized firm and 'expropriates' its owners, but in the end it also ousts the entrepreneur" (p134)

This may also be why Schumpeter regarded new combinations as largely the work of new firms and not existing ones (1934:66), perhaps a chilling thought to the wave of academics attempting to help understand how existing firms may generate *Schumpeterian* rents. Perhaps our propositions expand upon why existing firms may in fact find such novelty difficult to achieve. Our aim, however, is not to encourage pessimism regarding resource recombinations within firms but to encourage such innovation by offering a view as to the obstacles that management must overcome in order to make such novelty possible. We hope that by thinking of resources and their recombination through the twin lenses of knowledge characteristics and its institutionalization, some progress might be made to improving the chances of discovering new ways of using existing resources to create new sources of value for the firm.

V. ENDNOTES

[1] We can also include under capital less tangible things like firm reputation and brand image. These are distinct, however, from knowledge-based resources in that they are typically an outcome, over time, of the interaction of various other resources (see Hall 1992). Yet, once accumulated, they do operate as a basic input for the firm and can be included under capital.

[2] We can call this knowledge *process knowledge* (Teece, Pisano and Shuen 1997). However, knowledge may also itself be an input on which some manipulation is carried out before being sold as an output (and an instance of an intangible input resource). Investment bank reports on companies are an example; the bank collects information about firms, summarizes, analyzes, and provides opinion, and then resells it in a more valuable form (e.g., Chakravarthy and Rodan 1994). For our purposes, however, when we refer to knowledge-based resources we will mean the *process knowledge* that is necessary for the understanding and manipulation of input resources—whether those input resources are themselves some form of knowledge or not.

[3] By claiming capabilities to be "relatively indivisible," we acknowledge that any capability can be reduced to finer and finer constituent parts. "Indivisibility" is merely a simplifying constraint with the property that some capabilities will not be easily and/or normally reducible within the confines of a single firm or individual. For example, most firms purchase personal computers which they can combine and organize in various ways. While they might swap disks and add memory, most firms cannot make changes to these systems below the level of the individual sub-assemblies of the PC.

[4] While a typology of innovation regarding competencies is beyond the scope of our paper, we can distinguish Schumpeterian resource recombinations from a few other forms of innovation involving competencies. First, a competence may simply be developed in isolation, for example by improving the efficiency of an underlying capability, without consideration of other competencies in the firm. Second, a competence may also be exploited through alternative application, for example when a single core competence is leveraged into alternative product-market areas , as described by Penrose (1959:130): "..the competitive advantage in the new field can often be traced to the fact that the firm has developed productive services in its existing productive activities which are especially valuable in the new activity." Empirical studies have shown some performance benefits to applying corporate-wide distinctive competencies to different business areas (e.g., Hitt and Ireland 1985). Although closer to our notion of recombinations than the former, this form of innovation differs in as far as it emphasizes just the "bulk" reapplication of existing knowledge, without consideration of how the knowledge embedded within a competence may have to be untangled and integrated with other knowledge bases to create new knowledge.

[5] We envisage this needing to occur largely between individuals in different competencies. However, we do not exclude such creative connections occurring inside the mind of a third-party, such as senior managers, as well.

[6] A few notes on Sanchez's work on modularity may be useful. Modularity in organizational design (Sanchez and Mahoney 1994) argues for keeping linkages between areas simple and maintaining independence or modularity. This should allow the greatest flexibility to areas, since alterations *within* areas may mean few changes *between* areas. However, given that some logic, or constraints, in interaction must exist, and the desire is for the radical alterations in the <u>logic of the linkages themselves</u> (regardless how simple they may be), modularity seemingly focuses too much attention on the development of the quasi-independent parts, to the potential detriment of architectural reconfigurations of resources.

[7] We are grateful to one anonymous reviewer for the Academy of Management Meetings for raising the interesting issue of the implications of resource recombination on diversification.

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Figure 1:
Basic Structure of Resources and Knowledge

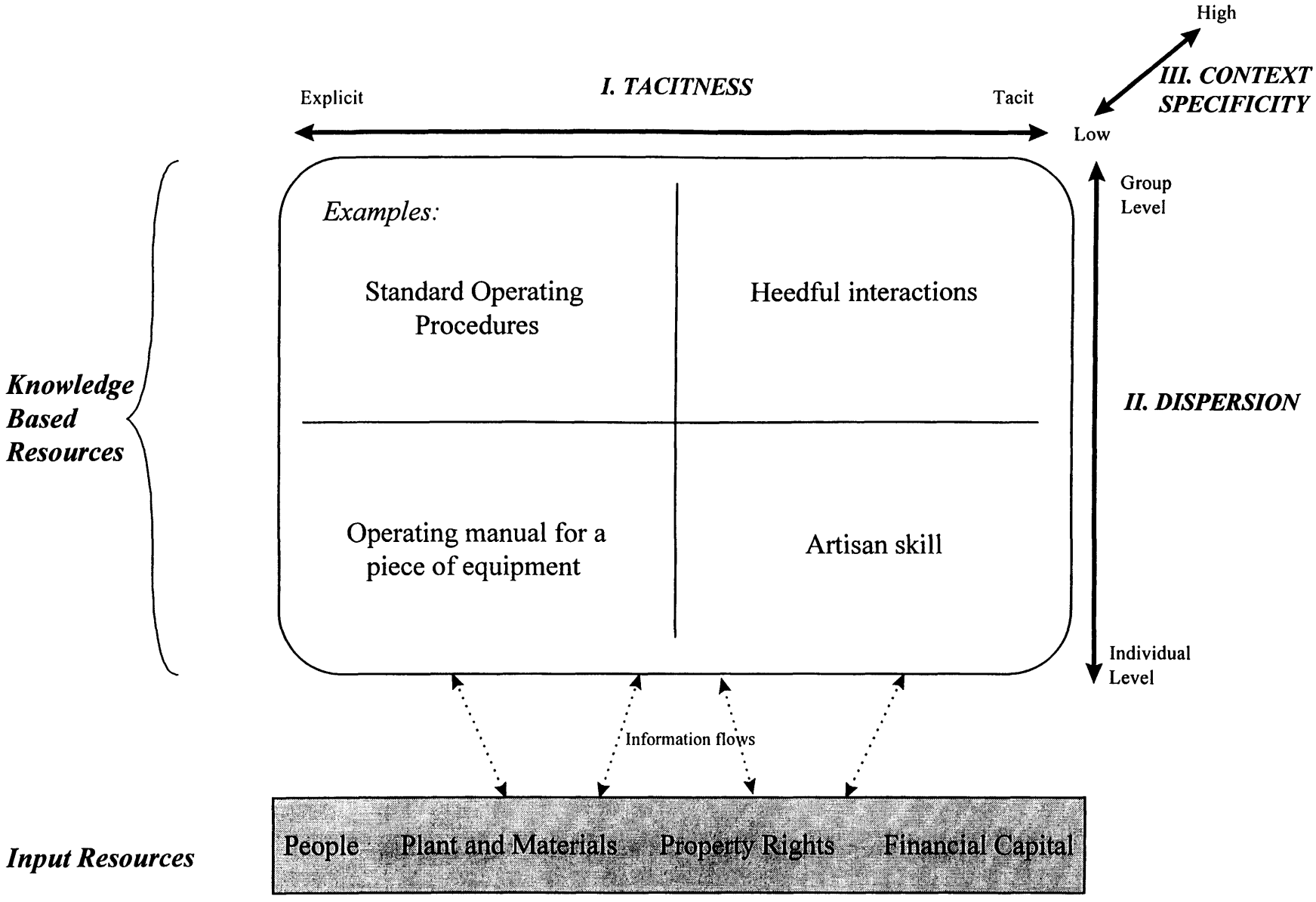

Figure 2:
The Sub-Structure of Competencies—Example of Canon

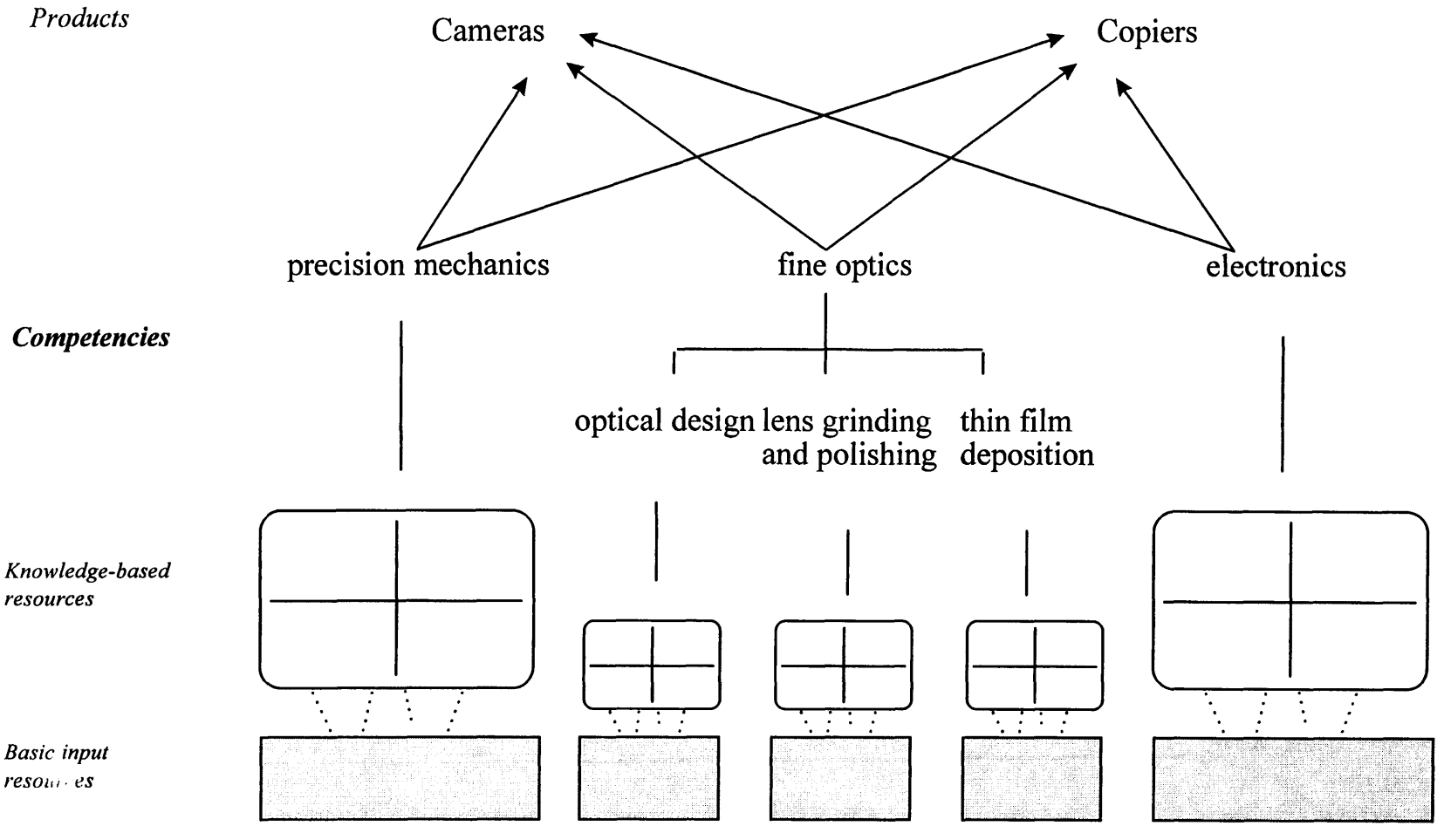

Figure 3:
A Model of Resource Recombination Likelihood