FROM ORGANIZATIONAL ROUTINES TO DYNAMIC CAPABILITIES

Maurizio Zollo
Department of Strategy & Management
INSEAD
77305 Fontainebleau, France.
Tel: (33-1) 60 72 44 74
Fax: (33-1) 60 74 55 43
zollo@insead.fr

Sidney G. Winter
The Wharton School
Department of Management
University of Pennsylvania
Philadelphia, PA 19104.
(215) 898-4140
winter@wharton.upenn.edu

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Abstract:
This paper investigates the mechanisms through which organizations develop capabilities in a dynamic sense (Teece, Pisano & Shuen, 1997) and reflects upon the role of (1) experience accumulation, (2) knowledge articulation and (3) knowledge codification processes in creating and constantly reshaping organizational routines. The argument is made that dynamic capabilities originate from the co-evolution of these three mechanisms. At any point in time firms adopt a mix of learning behaviors constituted by a semi-automatic accumulation of experience and by increasingly deliberate investments in knowledge articulation and codification activities. Further, the relative effectiveness of these capability-building mechanisms is analyzed here in their interaction with selected features of the task to be learned, such as its frequency, homogeneity and degree of causal ambiguity. Testable hypotheses are developed in the context of a theoretical model of dynamic capability building, and some preliminary empirical evidence in support of the arguments made is reviewed. Finally, implications of the analysis for evolutionary economics and for the emerging knowledge-based view of the firms are discussed and an agenda for future research efforts on these issues is advanced.

INTRODUCTION

Explaining the variation in the degree of success of business organizations by reference to different degrees and qualities of organizational knowledge and competence has been a major focus of recent theorizing in both strategic management and organizational theory. Concepts and labels coined to characterize the phenomenon abound. From pioneering efforts, such as Selznick's (1957) "distinctive competence", to the more recent and refined notions of organizational routines (Nelson & Winter, 1982), core competencies (Hamel & Prahalad, 1990), absorptive capacity (Cohen & Levinthal, 1990), architectural knowledge (Henderson & Clark, 1990), combinative capabilities (Kogut & Zander, 1992) and, finally, dynamic capabilities (Teece, Pisano & Shuen, 1997) there are decades of investment in sorting out the traits and the boundaries of the phenomena. Recent contributions (Teece, Pisano & Shuen, 1997; Dosi, Nelson & Winter, 1999) aimed at providing definitions for and clarify distinctions among the various constructs offer some hope that the problem of proliferating and overlapping terminologies is being alleviated and real progress is being made.

As the field progresses in the definition of the phenomenon, though, it becomes correspondingly apparent that we are still missing a solid account of how organizational capabilities come into existence and of how they evolve over time. What accounts for the fact that one organization exhibits "competence" in some sense, while another does not? And how do we explain the growth and decay of that particular competence, other than the simple repetition, or lack thereof, of behavior? Building on Nelson & Winter's view of the organization as a set of interdependent operational and administrative routines

which slowly evolve on the basis of performance feedbacks, Teece, Pisano and Shuen (1997) define the concept of "dynamic capabilities" as "the firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments". While this suggests something of what dynamic capabilities are for and how they work, there is a troublesome near-tautology in defining a capability as ability. Also, the definition essentially "kicks" the learning problem one level up, from single-loop to double-loop learning in Argyris and Schon's (1978) terms, and leaves us with the same problem: how are dynamic capabilities formed? How do they evolve?

This paper attempts to provide a theoretical account of the genesis and evolution of dynamic capabilities within the firm and of the role that organizational routines play in the process. It does so by first presenting a model of cyclical evolution of organizational knowledge, and then focusing on selected knowledge-based mechanisms that might be responsible for at least part of its functioning. Section 3 then presents a simple model describing the interactions among the capability-building mechanisms that underlie the evolution of operational routines. Next comes a proposed account of how the dynamic capability- building process can be affected by the variation in the fundamental characteristics of the task at hand, from which we derive a set of propositions about the relative effectiveness of the identified mechanisms within different learning contexts. Section 5 will then review recent empirical evidence relevant to an initial test of the propositions offered, and Section 6 concludes with a reflection on some implications of our analysis for managers as well as scholars interested in pursuing a similar agenda.

1. THE CYCLICAL EVOLUTION OF ORGANIZATIONAL KNOWLEDGE

Before we tackle the question of the creation and evolution of dynamic capabilities, it is both necessary and useful to put our discourse within a more general view of how collective knowledge evolves within organizations. This clarifies the origin of some of the knowledge-related concepts that we utilize, and it is useful in grounding our analysis in the received literature on organizational learning and evolutionary economics.

Fig. 1 offers a graphical view of what we term a "knowledge evolution cycle". It is a simple account of the development of collective understanding regarding the execution of a given organizational task. We have adapted for our purposes the classic evolutionary paradigm of variation-selection retention[1].

FIGURE 1 ABOUT HERE

Organizational knowledge is here described as evolving through a series of consecutive processes, chained in a recursive cycle. The logical point of departure for each cycle lies in the variation stage, where individuals or groups of them generate a set of ideas on how to approach old problems in novel ways or to tackle relatively new challenges. This happens on the basis of a combination of external stimuli (competitors' initiatives, normative changes, scientific discoveries, etc.) with internally generated information

[1] This model has significantly benefitted from many discussions had during the "Knowledge and Organization" workshop held at Warwick University. The authors would like to thank for and acknowledge the contributions of Arie Lewin, Anna Grandori, Bart Nooteboom, among many other participants. The model is also closely related to Max Boisot's notion of Social Learnig Cycle (Boisot, 1998) which has influenced our own thinking and has spurred on many of the intuitions which follow.

derived from the organization's existing routines. These sets of ideas, initially in embryonic and partly tacit form, are then subject to internal selection pressures aimed at the evaluation of their potential for enhancing the effectiveness of existing routines or the opportunity to form new ones. These pressures arise as new ideas are considered in relation to the understanding of the organization's prior experience derived from its knowledge articulation and codification processes. There are multiple implications, both positive and negative, for the organization's ability to adapt to dynamic environments. Suffice to say, for now, that these processes facilitate the evaluation and screening of new initiatives in two ways: (1) by reducing the number of dimensions of the problem considered and therefore its cognitive complexity (Gavetti & Levinthal, 1998), and (2) by providing the opportunity to clarify causal links between action patterns and outcomes (Weick, 1995; Boisot, 1998). These significant advantages come at a price in terms of reduced variety and increased inertia in the system. Cognitive efforts contribute to the rigidity of the system even as they guide the selection and approval of the most promising creative initiatives for replication and diffusion throughout the organization.

It is generally agreed that articulated and codified knowledge diffuses more rapidly and efficiently (Kogut & Zander, 1992, Nonaka, 1994; Zander & Kogut, 1995) and that this is one of the main reasons why organizations engage in knowledge articulation and codification activities. Replication of new or improved routines in time and space reflects the organization's strategic intention to leverage the newly found wisdom in different competitive contexts (see Szulanski & Winter, 1999). Less familiar however, is the notion that the diffusion of knowledge through replication processes contributes new (raw) information that can provide the diversity needed to start a variation phase of a new

knowledge cycle. By replicating routines in diverse contexts and accumulating experience with the new approach, organizations can simultaneously achieve a number of objectives. On the one hand, they complete the adaptation process, renewing the set of procedures followed before the current knowledge cycle began. More importantly for our current purposes, the application of the routines in diverse contexts generates new information as to the performance implications of the routines employed. The hypotheses constructed through the cognitive efforts of the selection phase can be now potentially tested with empirical evidence. This evidence if properly collected, can further illuminate the context-dependent, cause-effect linkages between actions taken and performance outcomes generated. It can thereby prime the initiation of a new knowledge cycle. However, the retention phase also poses an implicit challenge to the dynamic functioning of the knowledge cycle, in that collective knowledge tends to evolve toward a more tacit form as it becomes highly embedded in the behavior of the individuals involved in the multiple executions of the task. Repetition leads to automaticity in the execution of a given task, and to a corresponding reduction in individual awareness and collective understanding of the action-performance linkages, as well as of the purpose of the execution criteria followed. The abundance of raw information potentially available thanks to the repeated execution of tasks is, in fact, typically unusable without significant cognitive efforts aimed at evaluating, classifying, analyzing and finally distilling the results into new initiatives to create new routines or modify existing ones.

Incidentally, it is important to note that the external environment plays two distinct roles in the process. It supplies diverse stimuli and substance for internal reflections on possible applications to the improvement of existing routines. Of course,

it also functions as a selection mechanism in the classic evolutionary sense as it provides the feedback on the value and viability of the organization's current behaviors. While we fully recognize the fundamental relevance of both these roles, the focus of this paper is on the set of internal processes located, from a temporal standpoint, between the two.

A few more observations can be made by entering some additional elements in the basic framework. Figure 2 shows the basic activities that underlie the different evolutionary processes described, and provides the opportunity to link our discussion to the received literature on organizational learning processes.

FIGURE 2 ABOUT HERE

First, the knowledge cycle proceeds, in March's (1991) terms, from an exploration phase to an exploitation one, potentially feeding back into a new exploration phase. Whereas exploration activities are primarily carried out through cognitive efforts aimed at generating the necessary range of new intuitions and ideas (variation) as well as selecting the most appropriate ones through knowledge articulation and codification processes, exploitation activities rely more on behavioral mechanisms encompassing the replication of the new approaches in diverse contexts and their absorption into the existing sets of routines for the execution of that particular task. We suggest that exploitation can prime exploration, and that this is more likely when it addressed diverse contexts (Adner, 1999). Thus, we propose that, in addition to the familiar tradeoff, there can be a recursive and co-evolutionary relationship between them. This may indicate a way to conceptualize the managerial challenge of handling both processes simultaneously (Nooteboom, 1999). The

second observation is that the nature of organizational knowledge is assumed to change during the various phases of the cycle. At the start, explicit efforts to modify existing routines emerge from articulation and codification processes and a variety of other stimuli, both internal and external. Through the replication and retention phases, knowledge becomes embedded in human behavior, and likely gains in effectiveness while declining in abstraction (as it is applied to a wider variety of local situations) and in articulation (as even the people involved in its application have difficulty in explaining what they are doing and why). We suppose that situations vary tremendously in terms of the significance of the various activities in the knowledge cycle – and in fact, the impact of variation in the effort devoted to knowledge articulation and codification is a focal concern of this paper.

Having sketched this picture of the evolution of organizational knowledge, we are now ready to address the key questions in more detail. We will begin by proposing a definition of dynamic capabilities that is consistent with our evolutionary framework, and then move on to analyze the role of the key mechanisms in the development of such capabilities.

2. DYNAMIC CAPABILITY BUILDING

In the emergence of dynamic capabilities, the entire process described above through which firms create and refine the ways they execute a given task becomes the subject of the collective learning (Dosi, Nelson & Winter, 1999). Mindful of the above-mentioned limitations of the existing definition of dynamic capabilities (Teece, Pisano & Shuen, 1997), and in the spirit of bridging the behavioral and cognitive approaches to the

organizational learning phenomenon (Glynn, Lant & Milliken, 1994), we propose the following:

Definition. *A dynamic capability is a learned pattern of collective activity through which the organization systematically generates and modifies its operational routines in pursuit of improved effectiveness.*

In addition to avoiding the near-tautology of defining a capability as an ability (Teece, Pisano & Shuen, 1997), this definition has the advantage of specifically identifying operational routines, as opposed to the more generic "competencies", as the object on which dynamic capabilities operate. Also, it begins to flesh out some of the characteristics of this construct. The words "learned pattern" and "systematically", highlight the point that dynamic capabilities are structured and persistent; an organization that adapts in a creative but disjointed way to a succession of crises is not exercising a dynamic capability. Dynamic capability is exemplified by an organization that brings out generation after generation of innovative products through a relatively stable and replicable product development process. Another example is given by an organization that develops from its initial experiences with acquisitions or joint ventures a process to manage such projects in a systematic and relatively predictable fashion.

What mechanisms are involved in the creation and evolution of dynamic capabilities? What features distinguish an organization capable of systematically developing new and enhanced understanding of the causal linkages between the actions it takes and the performance outcomes it obtains?

We argue that part of the answer to these fundamental questions lies in the cognitive and behavioral activities that underlie the functioning of the knowledge

evolution cycle presented above. In particular, we focus the attention on the routinization process, which supports the retention and (as we argued above) at least part of the variation mechanisms, and on the knowledge articulation and codification processes, which constitute the internal selection mechanism. Of course, this is not to say that the environmental scanning activities, also part of the variation mechanism are less important. They are viewed here as inputs to the dynamic capability building process, rather than parts of the process itself. For example, a sound understanding of what competitors do and customers desire represents a crucial element of any firm's competitive strategy, but, in and of itself, does not make it any more capable of creating and modifying its own set of operational routines. Also, an inherently tacit form of collective knowledge such as the one under study is highly unlikely to be developed or shaped simply by the observation of competitors, suppliers, customers or other external constituencies. It will have to be developed "in-house" through a set of activities and cognitive processes focused on the organization's own routines.

Finally, the replication process – the set of activities that enable an organization to replicate its own routines in novel contexts without excessive losses in performance -- are outside the scope of the present study, though they are certainly an important part of the dynamic capability picture. (Szulanski & Winter, 1999). The three mechanisms focal to this analysis are introduced separately below. The notion of a learning investment function is then introduced to provide a conceptual integration and point the way toward a synthesis of the dualities described above (exploration and exploitation; behavioral and cognitive learning). The organizational challenge suggested by our account of the knowledge evolution cycle and definition of dynamic capabilities offered above lies is the

question of how simultaneously to explore and exploit new knowledge, and how *simultaneously* to learn through action and through cognition (Nooteboom, 1999). Causal links among the three mechanisms will be underemphasized here to keep attention focused on how the mechanisms jointly influence the creation and evolution of collective competence.

Organizational Routines. Routines are stable patterns of behavior that characterize organizational reactions to variegated, internal or external, stimuli. Every time an order is received from a customer, or a decision is made to upgrade a production process, for instance, a host of predictable and interrelated (sequential and/or simultaneous) actions are initiated, which will eventually conclude with the shipping of the ordered goods (and receipt of corresponding payment) or with the launch of the new production system. In spite of the superficial similarity between these two examples, though, the two patterns of behavior present a theoretically relevant distinction. The first type of routine involves the execution of known procedures, while the second seeks to identify the necessary changes to an existing set of (in this case) production routines. Given the objectives of the present work, it will be necessary to distinguish the first type, which can be labeled *operational* routines, from the second type, usually known as *learning*, or *search*, routines (Nelson and Winter, 1982). Routines of the latter type are a central constituent of dynamic capability.

It is also important to recognize that routines, both operational and learning ones, have different effects on the generation and appropriation of rents depending on the pace of change in the environment. Of course, effective operational routines are always a

necessity, and superior operational routines are always a source of advantage. In a relatively static environment, a single learning episode may suffice to endow an organization with operational routines that are adequate, or even a source of advantage, for an extended period. Incremental improvements are accomplished through the tacit accumulation of experience and sporadic acts of creativity. Learning routines are unnecessary, and if developed may prove too costly to maintain. But in a context where technological, regulatory and competitive conditions are subject to rapid change, persistence in the same operational routines quickly becomes hazardous. Systematic efforts at learning are needed to track the environmental change; both superiority and viability will prove transient for an organization that has no learning routines (Senge, 1990). If change is not only rapid but also unpredictable in direction, learning routines themselves will need to be updated repeatedly. Failure to do so turns core competencies into core rigidities (Henderson & Clark, 1990; Leonard Burton, 1992; March & Levinthal, 1993). It seems clear, therefore, that a theory of the development and evolution of dynamic capabilities, must invoke mechanisms that go beyond semi-automatic stimulus-response processes in operations and experience-driven.

Knowledge Articulation. One of the recognized limitations of the behavioral tradition in the study of organizational learning consists in the lack of appreciation of the deliberative process through which individuals and groups figure out what works and what doesn't in the execution of a certain organizational task (Cangelosi & Dill, 1965, p 196; Levinthal & March 1981, p. 208). Important collective learning happens when individuals express their opinions and beliefs, engage in constructive confrontations and challenge each

other's viewpoints (Argyris & Schon, 1978; Duncan & Weiss, 1979). Organizational competence improves as members of an organization become more aware of the overall performance implications of their actions, and is the direct consequence of a cognitive effort more or less explicitly directed at enhancing their awareness of these causal links. We therefore direct attention to the process through which implicit knowledge is articulated through collective discussions, brainstorming sessions and performance evaluation processes as a second mechanism at the basis of the development of collective competence. By sharing their individual experiences and comparing their opinions with those of their colleagues, organizational members can achieve an improved level of understanding of the causal mechanisms intervening between the actions required to execute a certain task and the performance outcomes produced. In rapidly changing environmental contexts, organizational processes are subject to significant causal ambiguity with respect to their performance implications (Lippman & Rumelt, 1982). Higher-level cognitive efforts and a more deliberate, collective, focus on the learning challenge help to penetrate the ambiguity – although some part of it always persists. It is important to note that only a small fraction of articulable knowledge is actually articulated, and that organizations differ substantially on the degree to which they transform potentially articulable knowledge into articulated statements (Winter, 1987; Kogut & Zander, 1992). While potentially requiring significant efforts and commitment on the part of the members of the organization, such articulation efforts can produce an improved understanding of the new and changing action- performance links and therefore result in adaptive adjustments to the existing sets of routines or in recognition of the need for more fundamental change.

Knowledge Codification. An even higher level of cognitive effort is produced when individuals codify their understanding of the performance implications of internal routines in written tools, such as memos, manuals, blueprints, spreadsheets, decision support systems etc.. It is to be noted that, while some of these tools are deliberately aimed at uncovering the linkages between actions and performance outcomes (such as performance appraisals, post-mortem audits etc.) most of them are intended to simply provide guidelines as to the execution of future tasks. Whatever the intentions motivating the codification effort, the point we emphasize is that the process through which these tools are created and consistently updated implies an effort to understand the causal links between the decisions to be made and the performance outcomes to be expected, even though the learning process might not be the deliberate goal of the codification effort. To exemplify, both the readers and the authors of this article have certainly experienced the significant increase in the clarity of their ideas consequent to the act of writing the first draft of a research paper. Through the writing process, one is forced to expose the logical steps of one's arguments, to unearth the hidden assumptions and to make the causal linkages explicit. Similarly, a group of individuals who are in the process of writing a manual or a set of written guidelines to improve the execution of a certain task (think of the development of a new product, or the management of the post-acquisition integration process) will most likely reach a significantly higher degree of understanding of what makes a certain process succeed or fail, compared to simply telling "war stories" or [SW1]discussing it in a brainstorming session.

Knowledge codification is, in our view, an important and relatively under-emphasized element in the capability building picture. It has typically been seen in the

literature as benefiting the learning firm in facilitating the diffusion of knowledge (Winter, 1987; Zander and Kogut, 1992; Nonaka, 1994), and in facilitating the coordination and implementation of complex activities[2]. In the language of the knowledge evolution cycle presented above, knowledge codification has been typically understood as a mechanism in support of the routine replication process. Having identified the new or improved routine to be established, the organization would be better served from the creation of a manual or of a tool to facilitate its replication and diffusion. While this is clearly true, this appraisal overlooks the cognitive implications of all the activities necessary for the creation and development of these tools. To develop a manual for the execution of a complex task, the individuals involved in the process need to form a mental model of what actions are to be selected under what conditions. By going through that effort, they will most likely emerge with a crisper definition of what works and what doesn't and why. Codification, therefore, can be viewed as an important element of the internal selection process, as it can facilitate the identification of the strengths and the weaknesses in the proposed variations to the current set of routines. The cognitive simplification inherent in the act of synthesizing on paper (or on a computer program) the logic behind a set of instructions can therefore represent both an economizing on data processing requirements (Boisot, 1998) and a more-or-less deliberate form of retrospective sense-making with respect to the performance implications of a given set of repeated activities (Weick, 1979; Weick, 1995).

To be sure, though, these advantages do not come for free. There are specific costs attached to the knowledge codification process. Direct costs include the time, the

[2] See the strategic planning literature, and Mintzberg (1994) for a critique

resources and the managerial attention to be invested in the development and updating of task-specific tools, while indirect costs refer to the increase in organizational inertia consequent to the formalization and structuration of the task execution. A long debate, dating back to Weber's work, has engaged organizational theorists with respect to the advantages and disadvantages of formalization, a kindred phenomenon to knowledge codification. For [SW2]a long time, the skeptics seemed to have the upper hand. Most recently, though, there seems to be an increasing willingness to see the formalization of operational routines as capable of producing both an "enabling" as well as a "coercive" bureaucracy (Adler & Borys, 1996). This is consistent with the thrust of the current analysis: instead of rejecting knowledge codification processes tout-court as producers of inertial forces, our objective is to determine the conditions under which the costs attached to codification will be more than offset by its learning and diffusion advantages. We acknowledge, of course, that this is not likely to be true in all cases – and that codification, like many other things, is likely to produce bad results when done badly.

3. THE CREATION AND EVOLUTION OF DYNAMIC CAPABILITIES

Having provided a working definition of dynamic capabilities and identified the mechanisms by which organizations develop them, we now concentrate our analysis on the complex interplay of these mechanisms.

The following proposition describes our view of the dynamic capability building process:

Proposition. D*ynamic capabilities emerge from the co-evolution of tacit experience accumulation processes with explicit knowledge articulation and codification activities.*

The co-evolutionary formulation signifies the importance of viewing the influence of the three mechanisms as longitudinal, simultaneous and inter-related antecedents of the dynamic capability construct. Our emphasis is not on the causal links between the three capability building mechanisms, but on the way their interaction generates insights as to how to improve the existing set of operational routines. In other words, firms learn how to create and adjust their own routines by adopting an "opportune" mix of behavioral and cognitive processes, by learning how to articulate and codify knowledge while at the same time they facilitate its diffusion and retention in different geographical or competitive contexts.

In the present section, we suggest one way in which cognitive and behavioral learning activities can be simultaneously considered in order to evaluate the inputs dedicated to the capability development process. We then attempt to identify the requirements for the three knowledge mechanisms to produce their learning effects. Finally, in section 4, some of the boundary conditions for the effectiveness of these mechanisms will be studied, so that a clearer sense of what an "opportune" mix of learning processes really means.

Learning Investments. As we saw above, both the behavioral and the cognitive approaches to organizational learning processes are important in highlighting specific aspects of the capability-building problem, but neither, alone, is likely to suffice. The knowledge evolution cycle presented in Section 1 shows that firms improve their processes through a variety of learning mechanisms. A similar pattern is likely to apply to the capability defined upon the management of the knowledge evolution cycle itself.

In order to study the simultaneous effect of the three mechanisms identified as possible precursors of dynamic capabilities, we advance the notion of a learning investment function, defined upon the level of resources (financial, temporal and cognitive) committed by the firm to the purpose of improving the collective understanding of the action-performance linkages.

Figure 3 shows the proposed ordering of the three mechanisms along this investment continuum.

FIGURE 3 ABOUT HERE

The level of investment in developing dynamic capabilities will be the lowest when the firm counts on the routinization process, as the learning happens in an essentially semi-automatic fashion on the basis of the individual adaptations to unsatisfactory performance. The effectiveness of this learning mechanism requires "*only*" the stability of personnel exposed to the experienced events, good performance monitoring systems and sufficiently powerful incentives to ensure that individuals will initiate the search routines when performance levels decay.

The "learning investment" is likely to be higher in the case of the knowledge articulation process. In addition to the requirements typical of the routinization process, the organization will have to incur costs due to the time and energy required for people to meet and discuss their respective experiences and beliefs (Ocasio, 1997). A brainstorming session organized to de-brief the lessons learned from a complex project can be expensive in terms of both the direct costs and, most importantly, the opportunity costs deriving from the sacrifice of time dedicated to active projects. Paradoxically, the higher the activity levels in the execution of a certain task, the higher the opportunity costs for the learning investments dedicated to that specific task, and therefore the lower the likelihood that the hyper-active team will afford the time to de-brief, despite the obvious advantages from the potential identification of process improvements.

The investment of time, efforts and resources will be the highest in the case of knowledge codification processes. Here, the team involved in the execution of the task not only has to meet and discuss, but also has to actually develop a document or a tool aimed at the distillation of the insights achieved during the oral discussion(s). If a tool (a manual or a piece of software) already exists, the team has to decide whether and how to update it, and then to proceed with the implementation of its own decisions.

Consider, by way of example, the approaches taken by Hewlett Packard and Corning in developing their internal competence in the management of strategic alliances[3]. Both companies are considered to be among the most experienced and sophisticated players in the strategic alliance arena. The way they managed their

capability development process, though, was at the opposite extremes of our learning investment continuum. Whereas Corning made a point to specifically avoid the codification of its alliance practices, preferring to rely on experience-based learning and apprenticeship systems, HP decided to invest in a large variety of collective learning mechanisms to both identify and diffuse best practices in this particular task. They started with the creation of a database of all their past alliances, for each of which they requested a written post-mortem analysis. They then proceeded to create what became a 400-page binder with the distilled wisdom on the criteria to follow and the pitfalls to avoid in each phase of the alliance process. Further, the expert team in charge of the alliance practice initiated a series of internal workshops/seminars open to any HP manager, to ensure the diffusion of their alliance management practices. In the language of our model, HP adopted a mix of behavioral learning mechanisms (the construction of a stable team of alliance experts) with explicit cognitive investments in knowledge articulation (regular de-briefing sessions) and codification (written post-mortem analysis and updating of alliance manual). In terms of learning investments, HP's commitment of managerial resources is much higher than Corning's. But was the investment worthwhile? What kind of returns can organizations reap from higher levels of commitment to cognitive learning processes? And, most importantly, what factors influence those returns? What weight should be given to the fact that the Corning approach, relying heavily on tacit accumulation, is more vulnerable to personnel turnover? *Ex-post*, both approaches seem successful, suggesting some degree of

[3] For those interested in this specific empirical context, please refer to an article entitled "Two grandmasters at the extremes" appeared on the Alliance Analyst on Nov. 25 1995.

equifinality, but which one is preferable, ex-ante, for a firm that is trying to develop a similar competence?

To start answering these questions, we need to identify the contingencies under which higher degrees of cognitive efforts are justified. Three broad categories of factors should influence the shape of the returns to learning investments:

1. Environmental conditions, such as the speed of technological development or the time-to-market lags required by customers. One might tentatively infer that, *ceteris paribus*, HP's model might facilitate dynamic capability development in high-speed contexts. The cognitive simplification afforded by knowledge codification has been argued to be preferable to behavioral adaptations in these types of industries (Eisenhardt and Brown, 1997). In others, learning processes based on craftsmanship appear to be superior, as in Seely Brown (1991)'s notion of communities of practice.
2. Organizational features, such as its own cultural predisposition towards secrecy in protecting knowledge assets. Boisot (1998)'s distinction between "neo-classical" (based on a knowledge "hoarding" attitude") and "Schumpeterian" (relying on open knowledge flows and constant production of new creative insights) approach to learning speaks to this point. Another important aspect might be related to the firm's position along the exploration/exploitation continuum (March, 1991), where the closer the firm is to the exploitation extreme, the greater the tendency to select a behavioral learning approach. Learning investments will clearly be higher in organizations with a more exploratory attitude.
3. Task features. Returns to investments in cognitive learning mechanisms might finally be influenced by a number of dimensions characterizing the task that the organization is trying to master. Highly frequent and

relatively homogeneous tasks, for example, might require lower degrees of learning investments, as behavioral adaptations might suffice to produce adjustments to existing routines. Striking the right balance to enhance the dynamic capability development process is in this case a question of comparing the relative effectiveness of the behavioral and the cognitive learning mechanisms along these dimensions. In the following section, we examine in more detail this last class of determinants of the returns to learning investments. We see substantial potential in the study of how knowledge accumulation, articulation and codification processes interact with task features. First, the analysis is at a level amenable to strategic action on the part of the firm (there is relatively little the firm can do in order to operate on its own cultural features, as well as change its environmental context). Second, this emphasis tends to correct a bias that has arguably distorted the organizational learning literature: the organization is engaged in highly frequent, relatively homogeneous types of tasks, reasonably well defined in their decisional alternatives and sometimes even in their action/performance linkages. This is the case of the vast majority of the learning studies conducted so far in organizational settings, where the task typically observed is manufacturing

4. TASK FEATURES AND DYNAMIC CAPABILITY BUILDING

The central tenet of the present section is that the relative effectiveness of the various mechanisms introduced above to explain the creation and evolution of dynamic capabilities depends, among other factors, on the characteristics of the tasks that the organization is attempting to learn and of the operational routines that it is interested in adjusting or radically redesigning. Depending on the features of the task or of the operational routines, tacit learning mechanisms based on simple experience accumulation

might be more or less effective than more explicit investments of managerial and, more broadly, organizational resources in knowledge articulation and codification processes.

We will focus our attention on three specific dimensions of the task or operational routines at hand. The first has to do with its frequency, or how often it gets triggered and executed within a specific unit of time. The second is its degree of heterogeneity, or how unfamiliar the task appears to the unit that has to execute it, given the stock of prior experiences. It is, in essence, a measure of dispersion in the defining traits of the task across multiple occurrences. The third dimension relates to the degree of causal ambiguity in the action-performance links, or how clear the "Dos" and "Don'ts" in the execution of the task are to the responsible unit. We will elaborate on each of them in turn.

Frequency. It is very clear that organizational processes vary immensely on this dimension. In principle, all of them, from extremely high frequencies, such as check-processing in a bank or manufacturing operations in a typical high-volume production firm, to rare events such as a reorganization or a CEO search process, are subject to learning mechanisms. The question of what mechanism(s) work better at different frequency levels has been substantially neglected, though (but see March, Sproull & Tamuz, 1991). Based on the model presented above, we argue that at increasing frequency levels, the capability-building mechanism based on tacit accumulation of experiences in the minds of "expert" personnel becomes increasingly more effective relative to the more explicit investments in knowledge articulation and, even more so, in knowledge codification processes. At lower frequency levels, while both types of mechanisms will suffer significant losses in their capability-building power, we argue that

the signs of the disequation expressing the relative effectiveness of the various mechanisms inverts, and knowledge codification becomes increasingly more effective than knowledge articulation, which, in turn, becomes more effective than tacit experience accumulation. Fig. 4 below reflects these propositions.

FIGURE 4 ABOUT HERE

The reasons why we maintain this is a fair representation of the interaction between the capability-building processes and task frequency are as follows.

1. Individual memory. As the mechanism based on tacit accumulation relies on the memory of individuals exposed to previous occurrences, it follows that the more frequent the event is, the higher the likelihood that individuals will have retained their impressions as to what worked and what didn't in the previous experiences. Indeed, the success of codification efforts may be limited because the results of tacit learning are too entrenched.[4]
2. Coordination costs. The knowledge articulation and codification processes become increasingly complex to coordinate, as the frequency of the event increases. Individuals need to meet in order to brainstorm, and typically need face-to-face contact in order to coordinate the completion or upgrading of a manual or a decision-support system.
3. Opportunity costs. Brainstorming and updating tools after the completion of the task cannot be done too often without diverting attention away from day-to-day operations.

> A balance between explicit learning activities and execution activities, between thinking and doing is essential (March, 1991; Mukherjee, Lapre'. & Van Wassenhove, 1999).

In their seminal piece on this issue, March, Sproull and Tamuz (1991) argue that with highly infrequent events, organizations can learn from quasi-histories (i.e. "nearly happened" events) or from scenario analysis. Both mechanisms entail a substantial amount of investment in cognitive efforts and, most likely, rely on the creation of written output or on the use of electronic support systems in order to identify and make all the assumptions explicit. Our objective here is to tease out the benefits of the explicit learning activities from the less deliberate ones and to generalize them to different types of tasks, according to their frequency.

These arguments can be expressed in a slightly more formal way by advancing the following hypothesis.

H1 *The lower the frequency of experiences, the higher the likelihood that explicit articulation and codification mechanisms will exhibit stronger effectiveness in developing dynamic capabilities, as compared with tacit accumulation of past experiences.*

Heterogeneity. The variance in the characteristics of the task as it presents itself in different occurrences presents a different, albeit related, type of challenge with respect to the frequency problem. The issue here is that individuals have to make inferences as to the applicability of lessons learned in the context of past experiences to the task presently at hand. At increasing degrees of task heterogeneity, inferences become more difficult to

[4] There is a potential paradox here, because high frequency arguably implies ample justification of the one-time costs of a codification effort – that is, if people actually follow the codified procedures!

make and, when made, they are likely to generate inappropriate generalizations and, consequently, poorer performance (Cormier & Hagman, 1987; Haleblian & Finkelstein, 1999). What is the relative effectiveness of the capability-building mechanisms at different degrees of task heterogeneity? We submit that the more explicit mechanisms based on knowledge articulation and codification processes will be relatively more effective in developing dynamic capabilities, compared to tacit experience accumulation, at higher degrees of task heterogeneity. The rationale is that the hazards of inappropriate generalization can only be attenuated via an explicit cognitive effort aimed at uncovering the interdependence between the dimension(s) of heterogeneity and the action-performance relationships. For example, a firm that has made several acquisitions in a wide variety of sectors will probably find it more difficult to extrapolate rules of conduct in managing acquisition processes, compared to another one that has consistently acquired in its own domain. The former might find it comparatively more useful to invest in brainstorming sessions and in detailed post-mortem analyses as opposed to simply relying on its group of M&A experts. The necessity of understanding what works and what doesn't in the different contexts requires an explicit investment in building specific capabilities to modify existing routines and create new ones for the different contexts in which acquisitions might be completed in the future.

These arguments suggest the following hypothesis for future empirical work.

H2 *The higher the heterogeneity of task experiences, the higher the likelihood that explicit articulation and codification mechanisms will exhibit stronger effectiveness in developing dynamic capabilities, as compared with tacit accumulation.*

Causal Ambiguity. The third task dimension that we take into consideration for our study of the relative effectiveness of capability building mechanisms is the level of causal ambiguity, or (conversely) the degree of clarity in the causal relationships between the decisions or actions taken and the performance outcomes obtained (Lippman & Rumelt, 1982). Irrespective of the degree of expertise developed in handling a certain task, there are a number of factors that obscure these cause-effect linkages. The number and the degree of interdependence of sub-tasks are obviously responsible for increasing the uncertainty as to the performance implications of the executing unit's actions. Another important factor is the degree of simultaneity among the sub-tasks. If the sub-tasks can be managed in a consequential fashion, it will be easier to pinpoint the consequences of each part for the performance of the entire process.

Again, the costs related to the "learning investments" described above will be justified and justifiable in the presence of high causal ambiguity, as the higher degrees of cognitive effort implicit in the articulation and codification of the lessons learned in previous experiences should help penetrate the veil of ambiguity and facilitate the adjustment of current routines to rapid environmental changes.

We therefore submit this final hypothesis for formal testing in future empirical work.

H3 *The higher the degree of causal ambiguity between the actions and the performance outcomes of the task, the higher the likelihood that explicit articulation and codification mechanisms will exhibit stronger effectiveness in developing dynamic capabilities, as compared with tacit accumulation of past experiences.*

5. PRELIMINARY EVIDENCE

A limited amount of empirical evidence has been recently gathered in the study of the consequences of these capability building mechanisms for the performance of relatively infrequent, heterogeneous and causally ambiguous tasks. In a study of post-acquisition integration processes in the US banking industry, Singh & Zollo (1999) found that acquirers that devoted more effort to codifying their integration processes significantly improved their ROA (with respect to competitors), particularly in high integration contexts, whereas acquisition experience curves do not have a significant impact. Similarly, Walston's (1998) study of re-engineering processes in about 1,000 US hospitals show that their ability to cut costs was influenced by the extent to which they had developed codified guidelines and coordination tools for the management of the restructuring process, and not by the fact of having gone through another re-engineering effort in the past.

At slightly higher frequency levels, the relative effectiveness of the tacit and more deliberated learning mechanisms might be roughly equivalent. Kale (1999) studied the antecedents of the development of an organizational capability specific to the management of joint venture processes in a variety of industries. His work is unique in the sense that he gathered measures for both knowledge codification and knowledge articulation processes, together with more standard alliance experience trajectories (see also Anand & Khanna, 1998). Results show that codification and articulation are equally important in explaining higher success rates and that experience does not affect the odds of success with comparable explanatory power. Finally, in the manufacturing context, the study by Mukherjee, Lapre' & Van Wassenhove (1999) on quality improvement projects

show that both "learning-by-thinking" (analogous to the articulation concept proposed above) and learning-by-doing are equally important in affecting the likelihood that quality improvement initiatives will be actually implemented and that this significantly reduces waste rates in production processes.

With respect to the heterogeneity construct, Haleblian & Finkelstein (1999) show an U-shaped relationship between acquisition experience and performance, which they attribute to the higher likelihood of inappropriate generalizations when experience is scarce and heterogeneous. In a similar vein Zollo & Leshchinskii (1999) find a U-shaped relationship for the effectiveness of the tacit knowledge accumulation mechanism on M&A performance, but also an *inverted* U-shape curve for the effectiveness of knowledge codification in improving performance. Consistent with Adler & Borys's (1996) theory of the enabling and coercive bureaucracy, knowledge codification can then be both a positive and a negative antecedent to capability development. Given the characteristics of the task to be mastered, there might very well be an optimal degree of formalization through knowledge codification, after which the positive effects of higher cognitive efforts are overcome by increasing coordination and opportunity costs.

6. CONCLUSIONS

This paper is an initial attempt to provide a coherent structure to the study of the formation and evolution of dynamic capabilities within organizations. It does so by drawing on arguments derived from both the behavioral and cognitive traditions in organizational learning studies. Starting from a definition of dynamic capabilities that highlights the role of systematic patterns of organizational activity aimed at the

generation of new, and the adaptation of existing, operational routines, we have proposed that they are likely to emerge from the co-evolution of three mechanisms: tacit accumulation of past experience, knowledge articulation and knowledge codification processes.

One of the most intriguing implications of the analysis, for theoretists and practitioners alike, is the somewhat counterintuitive notion that knowledge codification (and, to a lesser extent knowledge articulation) activities become superior mechanisms with respect to the accumulation of expertise as the frequency and the homogeneity of the tasks are reduced. The result is in fact quite the opposite of what organizations typically do. A bank would copiously codify its branch operations (how to open an account, execute a wire transfer etc.), a manufacturer would do the same with its standard operating procedures, but neither would typically be prepared to do the same when it comes to managing a re-engineering process or the acquisition of a company. This is the result of a natural tendency to think that the costs of codification activities are justified by their outputs rather than by the cognitive implications of the codification process itself. In our relatively unfamiliar process perspective, the creation of a manual or a decision support tool aimed at the facilitation of a relatively infrequent and heterogeneous task may be more valid (or at least as valid) as a capability building exercise, than for the benefit derived from the actual use of the tool. Codification efforts force the drawing of explicit conclusions about the action implications of experience, something that articulation alone (much less experience alone) does not do.

In our view, this is just one example of the potential benefits for theory building and management development purposes that may be derived from an inquiry into how

competence is generated and evolves within an organization. This inquiry is, however, still in its infancy. We know little, for example, of how the characteristics of the organizational structure and culture interact with the features of the task to be mastered in determining the relative effectiveness of the various learning behaviors. Why is it that certain firms, with comparable levels of expertise, codify a set of activities more than others do? And under what conditions does that enable, as opposed to inhibit, performance? To what extent is intentionality necessary to produce adaptive adjustments in existing routines? The complexity of these questions, compounded by the fact that we have only recently started to converge on a parsimonious vocabulary for these concepts, is only comparable to the magnitude of the expected returns from the advancement of our knowledge on these issues.

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Fig. 1 - The Knowledge Evolution Cycle

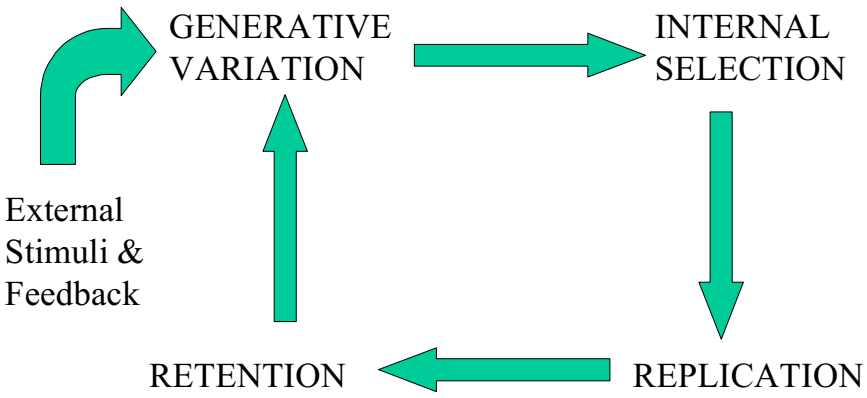

Fig. 2 - Knowledge Evolution Mechanisms

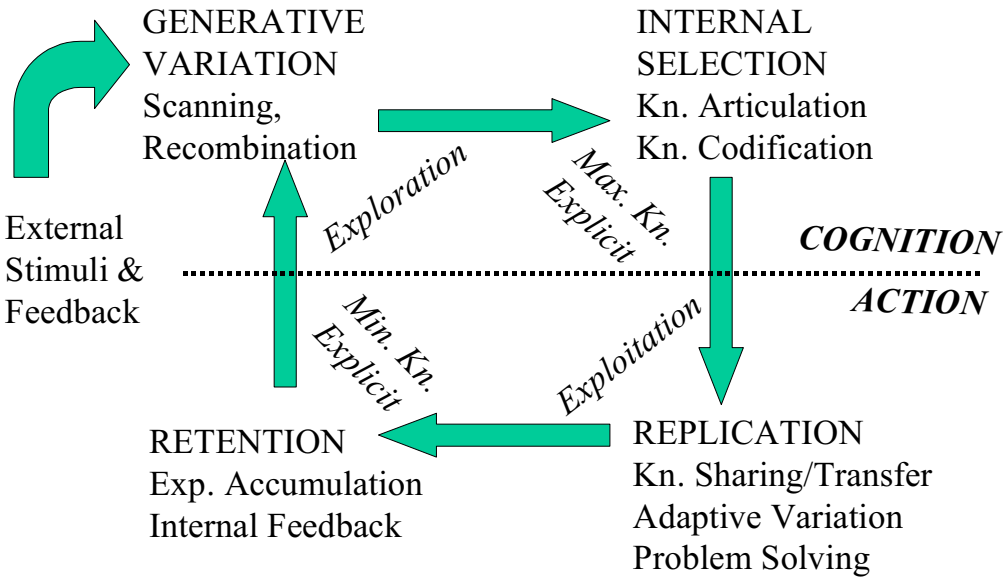

Fig. 3 - Capability-building and Cognitive Investments

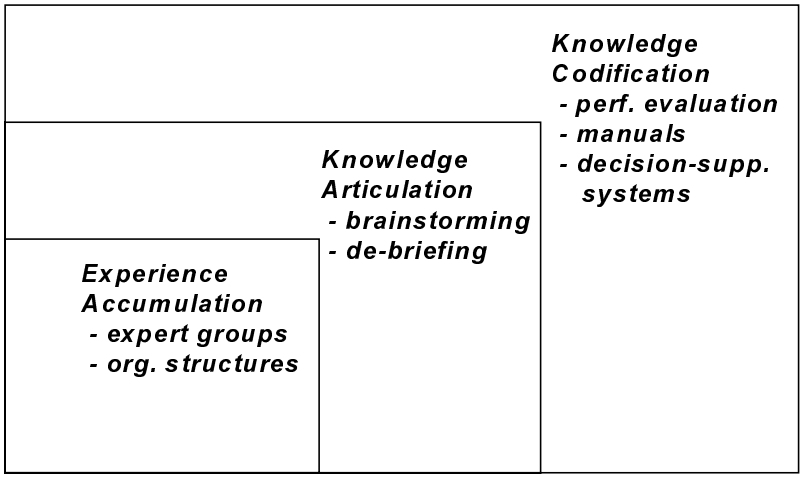

Fig. 4 Task Frequency and Capability-building Mechanisms