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Organizational Capabilities, Patterns of Knowledge Accumulation and Governance Structures in Business Firms

An Introduction

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AN INTRODUCTION

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We would like to dedicate this work to the memory of our friend and mentor Keith Pavitt, whom we met for the last time at that conference.

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1 INTRODUCTION

Business organizations are *behavioral entities*[1] characterized by seemingly quite different arrangements in terms of operational and cognitive division of labour, as well as equally different hierarchical set-ups, pattern of access to information, and incentive and control structure.

Correspondingly, economic organizations embody also specific and rather inertial compromises between different functions.

They perform, namely (i) resource allocation; (ii) information processing; (iii) efforts elicitation; (iv) coordination (largely through non-price devices) among multiple cognitive and 'physical' tasks; (v) governance of competing claims upon the total generated surplus; (vi) experimentation and learning[2]. Finally these different organizational 'functions' yield also multiple co-existing levels of interaction amongst organizational members.

Clearly, a thorough understanding of what organization are and how they operate ought to take on board the analysis of all the foregoing mechanisms of interaction. One still falls well short of such an objective. However, over the last four decades one has witnessed multiple endeavours enriching our understanding of the nature of economic organizations.

As one discusses at greater length in Dosi, Levinthal and Marengo (2001), quite diverse interpretative efforts range between two extreme archetypes.

At one hand, the dominant strand of contemporary analysis starts with 'primitives' of the interpretation of the nature of organizations based on sophisticated, self-seeking, agents. Together, the behaviors of these self-interested actors are viewed as typically directed by market forces. Only in those settings in which, due to failures of information and contract incompleteness, market are less effective in this task, then organizations are called for to surrogate such imperfections. It is a story too familiar to be repeated here[3].

Conversely, a small - but not negligible and growing - minority of the economic profession has placed his "primitives" of the analysis of the nature of economic organizations, in their *problem-solving features*, in turn nested in ubiquitous forms of human "bounded rationality", grossly imperfect processes of learning and diverse mechanisms of social distribution of "cognitive labour". The root of this approach can be found in the

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[1] We borrow this expression from Kreps (1990)
[2] This categorisation refines upon a similar one suggested in Coriat and Dosi (1998)
[3] A few more detailed epistemological remarks are provided in Dosi (1995) and Coriat and Dosi (1998)

works of Herbert Simon, Alfred Chandler, James March, Richard Nelson and Sidney Winter.

Table 1 offers a comparison between the two approaches along some significant dimensions and theoretical building blocks.

Table 1
Pure incentive view vs. pure problem-solving view of organizations (Dosi and Marengo 2000)

Dimension of analysis and theoretical building block	*Pure incentive view*	*Pure problem-solving view*
1.Problem solving/cognition/knowledge	No	Yes (central dimension of analysis)
2. Incentive governance	Yes (central dimension of analysis) via equilibrium contracting	Not so far (but see Coriat and Dosi, 1998 and Dosi , Levinthal and Marengo, 2002)
3. Behavioral microfoundations	Perfect, far-sighted, rationality	Bounded rationality (usually with 'myopic' attributes)
4. Organizational behavior	Strategic (in the game-theoretic sense)	Driven by routines, heuristics, rules etc.
5. Learning	No	Yes (central dimension of analysis)
6. Unit(s) of Analysis	- transactions - Strategies - Allocation of information - Allocation of property rights	- Elementary 'bits' of knowledge - Routines and other elementary behavioral traits.
7. Non- economic dimensions of organizations	Not as 'primitive' dimensions	Power, trust, identity building etc.

Clearly there are elements of truth in both the *incentive view* and the *problem solving view*, and bridging them ought to be part of the research ahead.

In any case, the starting point for such a bridge-building has important consequences for the sort of bridge one creates. The starting point embodies a commitment to some assumption on first order vs. second order effects. Forced to such a choice here we pick the second *weltanschauung* as a provisional point of departure (which also happens to be the least explored one).

We do need to assume *weak incentive compatibility* to begin with (see Dosi and Marengo (1995)) in the sense that there exists some selection pressure which, in turn, generates some (albeit possibly loose) connection between performance and rewards. However, having that, one precisely focuses (as a first theoretical approximation) on the diverse problem solving characteristics of different organizations, and only in the second instance one tackles the ways in which incentive structures interact with problem-solving knowledge.

Putting it in another way, the archetype "incentive view" fully censors any competence issue associated with what organizations do and how well they do it –except for issues of misrepresentations of "intrinsic" individual abilities and adverse selection, or incentive misalignment in effort elicitation. As an extreme characterization, given the "right" incentives any firm can make microprocessors as well as Intel, or bioengineering as well as Genetech.

The second, "problem-solving", archetype, on the contrary, censors precisely the incentive-alignment issue. In a sense, all agents are "angels" as their motives are concerned. Conversely, it focuses on the problem-solving efficacy of what they do, especially in so far as what they do does not stem from any differential "ontological" ability but rather from the social division of tasks and their combinatorics.

So, in the first approximation of this latter view, the basic units of analysis are *elementary physical acts*, such as moving a piece of iron from one place to another, and *elementary cognitive acts*, such as applying inference rules. Problem-solving can be straightforwardly understood as combinations of elementary acts, within a procedure, leading to a feasible outcome (e.g. an engine, a chemical compound, etc.)[4].

At this level of analysis, an organization embodies problem solving in at least three senses. *First*, it displays the operational competencies associated with its actual problem solving procedures (much in accordance with the routines discussed in Nelson and Winter (1982); see also M. Cohen, R. Burkhart et al (1996). *Second*, the organizational structure –both the formal and informal ones - determines the distribution of informational inputs of the processing tasks and of the "allowable acts" (i.e. "who can do what to whom") and, as such, it determines all the decompositions of problem-solving procedures that are, so to speak, "legal". Third, it shapes the search heuristics for yet-unsolved problems –e.g. a new engine, a new chemical compound, etc.- , that is, broadly speaking, the heuristics of innovative search.

One can also describe it the other way round. Given all the problem-solving procedures leading to a given "outcome" (e.g. an engine, etc. or, for that matter, a theorem, a statement about the purported structure of the observed world) - which might well be an infinite set - one may decompose them in sub-sequences of elementary acts of varying length that may

[4] See Marengo et al. (2000) for further discussion of this point

be eventually performed according to various execution architectures (e.g. sequential, parallel, hierarchical…).

In the following we shall spell out the basic structure of such "capability "- or "knowledge"- based view of the firm(section 2) and offer an interpretation of the processes of organizational knowledge accumulation, which may indeed be extended to integrate incentive and power issues (section 3). Section 4 is dedicated to empirical predictions, concerning, among others, the vertical and horizontal boundaries of the firm, the relationships between learning processes and organizational structures and the determinants of firm performances. (The extensive referencing in this work is meant also as a guide to the reader in this wide and expanding field)

2 NATURE AND DYNAMICS OF FIRMS COMPETENCIES AND CAPABILITIES[5]

It is familiar enough that business firms and other organizations "know how to do things" – things like building automobiles or computers, or flying us from one continent to another. On second thoughts, what does this mean? Is there not a sense in which only a human mind can possess knowledge? If so, can this proposition somehow be squared with the idea that organizations know how to do things? And if organizational knowledge is a real phenomenon, what are the principles that govern how it is acquired, maintained, extended, and sometimes lost?

Our focus here is on the particular forms of organizational knowledge that account for the organization's ability to perform and extend its characteristic "output" actions – particularly, the creation of a tangible product or the provision of a service, and the development of new products and services.

Pending a more thorough discussion of terminology, we identify the term "organization competencies or capabilities" with the know-how that enables organizations to perform these sorts of activities.

In a first instance, let us just build on the idea that o*rganizational knowledge* is a fundamental link between some *collective pool of knowledge/ skills/ incentives opportunities, on the one hand, and*

[5] This section largely builds upon the Introduction to Dosi, Nelson and Winter (2000)

the rates, directions and economic effectiveness of this exploration/ development/ exploitation, on the other.

In turn, distinctive organizational competencies / capabilities bear their importance insofar as they can be shown to persistently shape the destiny of individual firms - in terms of e.g. profitability, growth, probability of survival-, and, at least equally important, the patterns of change of broader aggregates such as particular sectors and whole countries.

2.1 ORGANIZATIONAL COMPETENCIES AND CAPABILITIES

A general equivalence between "competencies" and "capabilities" is often assumed within the literature.

As discussed in Dosi, Nelson and Winter (2000), it should be clear that we think of "capability" as a fairly large-scale unit of analysis, one that has a recognizable purpose expressed in terms of the significant outcomes it is supposed to enable, and that is significantly shaped by conscious decision both in its development and deployment. However, intentions and conscious purposes may be remote from capability's instances such as observed activities and outcomes, which often are automatic and habitual.

These features distinguish "capability" from "organizational routines" as that term is used in organization theory and evolutionary economics – subject to the qualification that *some* organizational routines might equally well be called capabilities. In general, however, the notion of a routine involves no commitment regarding size (large routines are typically structured sets of medium-sized ones, and so on). It involves no presumption regarding evident purpose: one of the interesting things about routines is indeed that they are often found in contexts where nobody can explain what they are for except in the vague terms of "the way things are done around here". And there is no presumption of deliberation or conscious choice; a flight crew probably does not choose its response to unexpected turbulence any more than a football player 'deliberates' on how to kick a penalty.

In a very broad sense the concept of routines refers to simple decision rules which require low levels of information processing (rules of thumb), but also to complex, automatic behaviors which involve high levels of repetitive information processing (Cohen et al., 1996).

Cohen, Burkhart et al (1996) suggest a synthesis of different points of view, defining an organizational routine as "an executable *capability* for repeated performance in some *context*

that have been learned by an organization in response to *selective pressure*" (Cohen et. al 1996). Thus, the capacity to generate a specific action (the capability) is conceived as possible only in some context, seen as a kind of "external memory" and as a source of inputs to actions. The fact that routines are learned implies the possibility of tacitness and automaticity, stressed so far. The concept of selective pressure represent a broad term that indicate a wide variety of forces which operate on actions sequences.

To conclude, capabilities involve organized activity and the exercise of capability is typically repetitious in substantial parts. Routines, as defined above, are the building blocks of capabilities with a repetitive and context-dependent nature – although they are not the *only* building blocks of capabilities. A marketing capability, for example, might require a customer database, for example, which is neither a routine itself nor does it resemble a routine in the way that the working of complex equipment sometimes does. The database is, instead, a contextual requisite of some of the organizational routines supporting the capability.

Individual skills, in turn, are among the building blocks of organizational routines. What we commonly think of as individual skills are quasi-modular components of routines; their names are useful in expressing, for example, the idea that the role played by one skilled machine operator might well be played by another. But "knowing the job" involves knowing things that are relational – involving other participants – and organization-specific (Nelson and Winter, 1982) That is why the skilled operator still needs to learn the job when joining an unfamiliar organization to operate a familiar machine – and why someone who is a perfectly adequate machine operator might nevertheless fail to learn the job. Some of the non-modular knowledge required is skill-like, regardless of what it is called – but these are skills that can be learned only through experience in the specific organization.

Following Dosi, Nelson and Winter (2000), clarity would be served by reserving the term "skills" to the individual level and "routines" to the organizational level.

Turning to the concept of competence, a few works have addressed similar ideas but making use of some notion of *competence*.

An influential article by Prahalad and Hamel (1990) popularized the term "core competence". Only a brief encounter with the article is required to note four points: (i) that large corporations have multiple core competencies (five or six at a maximum, they

suggest, not twenty or thirty – but not one, either); (ii) that competencies are fundamental to the dynamics of the firm's competitive strength, lending strategic coherence to a string of new and improved products appearing over an extended period; (iii) that the competencies referred to are all areas of "hard technology"; (iv) that while the relationship of competencies to large-scale structural features of the organization is a featured issue, the organizational aspects of the competencies themselves do not capture the authors' attention.

As discussed in Dosi, Nelson and Winter (2000) the last two points are much at odds with the concept of organizational capabilities, which need not to relate to technology and certainly have significant internal organization. However the first two could be considered coherent with the concept of capabilities.

We then arrive at the idea that a successful large corporation derives competitive strength from its excellence in a small number of capabilities clusters where it can sustain a leadership position over time. This comes very close to the concept of "dynamic capabilities" advanced by Teece et al. (1997) wherein one defines dynamic capabilities as the "firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (see also below). In areas of "hard" technology, the dynamic capabilities of a firm depend heavily on its R&D resources. However they cannot be built simply by spending on R&D or making analogous investments. On the contrary – and to an increasing extent as the competitive pace quickens – coordination between R&D and other functions, and often with suppliers or alliance partners, is of the essence. Such coordination is needed, among other things, for effective identification and linking of technological options and market opportunities, and for identifying the strengths and weaknesses of existing resources relative to the requirements of a new product or process.

Thus the concepts of "core competence" and "dynamic capabilities" point in the same direction, being broadly concerned with the firm's ability to carry off the balancing act between continuity and change in its capabilities, and to do so in a competitively effective fashion.

Another important idea in this general area is referred to a 'combinative capabilities' by Kogut and Zander (1992). Here again the emphasis is on the firm's availability to handle change by transforming old capabilities into new ones. Two points about the nature of this

transformation are emphasized: (i) that firms produce new capabilities by *recombining* existing capabilities and other knowledge, (ii) that the ability of the firm to do this is affected by the organizing principles guiding its operations-principles that include matters of formal structure but, more importantly, internal social relations shaped in part by differences in the knowledge bases of individuals and groups within the firm. Pursuing these ideas the authors develop a view of the firm and the make-or-buy decision quite different from that put forward in transaction cost economics.

The character of decision-making in this realm, and in contexts in which both competence (or vision) and capabilities play an important role, has been explored by Fransman (1994*a*, 1994*b*). The question of the value that top management competence brings to the firm, and its relation to managerial compensation, has also been studied by Castanias and Helfat (1991), although both the orientation and language is different (see also section c, below).

This discussion of terminology would certainly be incomplete without reference to what was (at least to our knowledge) the original use of the term 'capabilities', in a sense closely akin, if not identical, to our own. George B. Richardson, in his article 'The Organization of Industry' (Richardson 1972) made the fundamental point that 'organizations will tend to specialize in activities for which their capabilities offer some comparative advantage', and that the pursuit of activities that are similar in the sense of drawing upon the same capabilities may lead a firm 'into a variety of markets and a variety of product lines' (ibid.).

After all this definitional *tour de force*, let us also propose, for the time being, a narrower interpretation of the notion of competencies which gives the latter a distinct meaning confined to a scale of observation intermediate between single routines and overall firm wide capabilities (as defined above), capturing "chunks" of *organizational abilities* identified in terms of performed tasks and knowledge-bases upon which they draw.

So, one might talk of *mechanical competencies* to capture, together, ensembles of skills of individual members of the organization and, at the same time, directly organization-embodied elements of knowledge, routines, etc. - all aimed at the design production improvement of, say, machine tools. Note that, in this example, mechanical competencies are not likely to fulfil the overall *organizational capability* of producing and effectively selling the machine tools themselves. Other *complementary competencies* will be required to that effect, concerning e.g. electronic technologies, marketing activities, etc.

If one accepts this interpretation of *competencies stricto sensu*, some important consequences follow.

First, in line with Patel and Pavitt (2000) one may begin to distinguish different but complementary types of competencies concurring to determine the overall capabilities of an organization. Patel and Pavitt, in this respect, single out some *distinctive* functional features discriminating between background, *core* and *niche* competencies of an organization, emphasizing at the same time their interdependencies.

Second, in this context, one is always referring to organizational competencies bearing that the "competence of company *x* in technology *y*" is something different from "the ensemble of the individual skills in technology y of all the members of company *x*".

Having said that, it is useful to distinguish between what we shall call *technological* and *organizational competencies* [similar distinctions are made in Dosi and Teece (1998), Coriat and Weinstein (2002)].

The two types of competencies are clearly overlapping in the empirical world. However, the distinction rests in that *technological competencies* refer to shared pieces of scientific and technological knowledge concerning essentially "the structure of nature" and routines concerning "how to handle it".

Conversely, we shall call *organizational competencies* those shared pieces of knowledge and routines concerning the governance of coordination and social interactions within the organization and with outside entities (customers, suppliers, etc.), i.e. "how to handle people"

So, while it is straightforward that a technological competence requires some organizational arrangements in order to be put to work, it is also true that fundamentally similar bodies of technological knowledge might be nested in and exploited by diverse organizational arrangements and coordination modes.

Indeed a number of works have addressed a) the exploration of the patterns in such diversities (even when holding strictly knowledge bases constant); b) the impact of organizational competence upon corporate performances; c) the role of organizational

innovations; and d) the co-evolutionary dynamics between organizational and technological competencies[6].

2.1.1 Technology and Organization

Following the foregoing interpretation, mapping knowledge dynamics into organizational and industrial dynamics has become a priority research task.

For sake of illustration, consider the response of an industry to the appearance of a technology that provides a new way of performing functions of central importance to the industry's activities. Such episodes can be identified on a very large scale - such as the replacement of mechanical and electro-mechanical devices by electronic devices in a wide range of types of equipment, and - on a quite smaller scale - such as the successive generations of displacement of larger disk drives by smaller disk drives in computers (Christensen and Rosenblom, 1995; Christensen and Bower, 1996; Christensen, 1997, Rosenblom 2000).

A common pattern in such episodes is that the leading firms in an industry often seem to react slowly to the challenge, with the result that leadership passes to some of the pioneers of the new technology. Sometimes a previously leading firm even fails to survive, or has a very close call.

One problem is to understand why this happens. Another problem is to understand why it *doesn't* happen - the pattern described is not universal, and the intuitive expectation that a 'bigger' technological change ought to make it more likely is not always confirmed. Among a number of explanations that are complementary and hence difficult to untangle, considerations related to the nature of the adjustment of firm capabilities needed to cope

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[6] See, for example Coriat (2000) and Florida and Kenney (2000).

The capability/competence-based view of the firm bear large overlapping with the *resource-based view*: see Barney (1991), (2001), a few of the contributions in Montgomery (1995) and Foss and Mahnke (2000). Part of the difference rests in the terminology. However, terminology as such is not void of importance: a "resource centered" language risks to convey a 'reified' view of capabilities as 'object-like' entities, while – we hope – the explicit capability/competence language make it easier to conserve the underlying process story. Capabilities are not "things" but "ways of doing", collective fuzzy algorithms, properties of collective knowledge essentially revealed through its implementation.

A critique of Barney 's (1991) version of the resource-based view and a comparison with the evolutionary (and capability/competence-based) approach are provided by Bromiley and Fleming (2002).

For an inquire on the behavioural roots of the two approaches see also Pierce et al. (2002).and Rumelt (1995)

with the challenge have received increasing attention. [For different perspectives, cf. Tushman and Anderson (1986), Henderson and Clark (1990), Pavitt (1999)].

Certainly, technology-specific modes of knowledge-accumulation are likely to shape and constrain the ways "particular firms do particular things". Relatedly, the combinatorics amongst different competencies are likely to be product-specific and possibly sector-specific.[7]

2.1.2 Individual Skills and Collective Competencies/Capabilities

Fundamental questions in the interpretation of the nature of organizational competencies/capabilities concern - as already mentioned - first the *loci* where they reside, and, second, the extent to which they are *additive* in the skills and knowledge of organizational members

In order to highlight some major underlying issues let us dramatize two alternative views. The first archetype, which shall call the *modular view,* holds that "organizational knowledge" is primarily a shorthand for the knowledge of the individuals belonging to the organization. By the same token, in this perspective, strong warnings come - as H. Simon puts it - against "reifying the organization and talking about it as 'knowing' something or learning' something. [Rather], it is usually important to specify where in the organization particular knowledge is stored and who has learned it" Simon, 1991).

Here, one of course is far from denying the importance of individual skills as constituents of the broader organizational competencies /capabilities.

However, largely in tune with an alternative *collective view* of organizational knowledge, let us suggest that competencies have indeed a dimension which is not easily reducible to those of the individual organizational number: "it is firms, not people that work in firms, that know how to make gasoline, automobiles and computers" (Winter, 1982); and, dynamically, organizational learning is a social phenomena and cannot be reduced to individual learning processes of the members of the organization (more in Marengo, 1996).

Let us suggest here that organizational knowledge is not only incorporated into the heads of organizational members but also into a) a set of routines, other organizational practices and shared representations, and, b) a set of material artifacts which shape intra-organizational relations and individual behaviors (a germane discussion is in Cohen, Burkhart et al., 1996).

3 PATTERNS OF LEARNING AND COMPETENCE ACCUMULATION

In acquiring and adapting their competencies/capabilities over a period of time, organizations are doing something that can reasonably be called *organizational* learning. Here again there is a large literature embracing a wide range of specific intellectual ambitions, methodologies, and techniques. There are a few works that seek to speak directly to managers (a notable and influential example being Senge, 1990). Facilitating certain types of organizational learning is a major objective of quality management, and indeed the large literature on such topics provides another port of entry into the subject of organizational learning and hence to organizational capabilities. Classics in the area include Deming (1982), and Juran (1989); for a recent assessment of the quality movement see Cole (1999). More recently, consultants and corporate executives have evinced great interest in "Knowledge Management", a rubric that seems to span a substantial number of distinguishable concerns - but some of these concerns clearly relate to the effort to improve capabilities through learning.[6] In particular, the quest of improved performance through "benchmarking" and the identification and transfer of "best practices" is an activity that is widely and systematically pursued. Careful studies of the microprocesses of organizational learning have been conducted both in the field as in Hutchins (1991), Adler (1993), and Von Hippel and Tyre (1995), Narduzzo et al. (2000) and in the laboratory [see Cohen and Bacdayan (1994) and Egidi (1995), among others].

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[7] A contribution to the analysis of the co-evolution of products and firms, i.e. how the firm's skills are influenced by the flow of products, is the recent paper by Padgett et al. (2003). Using a chemistry analogy the authors conceive the firm as an organism which contains products, which, like chemicals are transformed by skill, that, like reactions, are rules that transform products into other products. Trade, like food, allows the passage of transformed products among firms. The composition of firm's skills evolves through learning by doing, thus the more a skill is used the more it is reinforced. The question the paper wants to answer is how a coherent and self-organized transformation network can emerge from randomly distributed skills across firms. The models developed are based on the chemistry concept of hypercycles.

[6] On this valuable reference is the special issue on 'Knowledge and the Firm' (R.E. Cole, Ed.) of the *California Management Review* (v. 40, Spring 1998).

Let us thus introduce some notions of organizational learning.

3.1 ORGANIZATIONAL LEARNING

The two alternative archetypes of organizational knowledge, which we called the *modular* and *collective* views, find a mirror image in the representation of organizational *learning*.

So, well in tune with the former, Simon (1991) emphasizes that strictly speaking "organizational learning" is only a metaphor since "all learning takes place inside human heads": thus, "an organization learns in only two ways, (a) by the learning of its members, or (b) by injecting new members who have knowledge the organization did not previously have".

Conversely, while not denying at all the importance of the foregoing learning modes a number of authors have attempted to disentangle – both in theory and from organizational evidence - the patterns of change of some sort of *collective intelligence* which organization embody: see, in particular, Levinthal (2000), and Marengo et al. (2000) on the theory side; Narduzzo et al (2000), Fujimoto (2000), Coriat (2000), Dosi, Hobday and Marengo (2000) for empirical investigations, Warglien (1999) on both.

Of course, both caricatures (the "modular" and the "collective" one) should not have difficulties in acknowledging that diverse organizational structures:

- foster learning by individual members of the organization in certain *directions* and hinder it in others;
- affect the rates at which individual learn;
- shape the efficacy by which individual skills are exploited and contribute to the overall performance of the organization;
- affect the rates at which individual skills and broader competencies are diffused throughout the organization.

Given all that, the "collective view" also adds dynamic aspects to the idea that there is an intrinsically organizational dimension of organizational knowledge embodied in the routines, hierarchical structures, culture of an organization. Hence:

- organizational learning of whatever origin goes together with changes in routines and possibly organizational structures; and
- "in order to become organizational, the learning that results from organizational inquiry

[and, we would like to add, also that absorbed from the environment] must be embedded in the images of organization held in its members' mind and/or in the epistemological artifacts (the map, memories and programs) embedded in the organizational environment" (Argyris and Schön, 1996)[8].

Organizational learning is obviously linked with the change of individual skills – sometimes indeed with the loss of some of them -, but also with changes of collective representations, rules, and even of hierarchical set-ups [cf. Narduzzo et al (2000)].

In essence, organizational knowledge and organizational learning ought to be partly considered – in the "collective view" – as an *emergent property*, shaped by the interaction amongst multiple learning/ adjustment processes occurring within the organization itself – ranging from the levels of the individual, to teams, departments, plants, etc.

Some important implications are also worth emphasizing:

I. *the organizational nature of learning* is also *reflected* by its being linked with *changes in organizational practices which might not display* any evident *correlation with what individual "know"*;

II. all forms of long-lasting *organizational learning imply* some mechanisms of *codification of knowledge and interaction procedures.*

Despite a fundamental incompleteness of codification mechanisms themselves, *codification* - also in the form of archives, documents, training practices, etc. – (*imperfectly*) *deals with the persistence organizational knowledge well beyond the mobility of organizational members*. [For discussions on such a vexed debate cf. Dosi, Marengo and Fagiolo (2003), Pavitt (1987) and *Industrial and Corporate Change*, 2, Special Issue, (2000)].

Relatedly, the very codification of individual skills is a fundamental aspect of the establishment of an *organizational memory*.

III. *Organizational learning is never a purely cognitive process*: Rather it finds a *crucial ingredient* in processes of *social adaptation, learning and modification of organizational rules, development of*

[8] Kieser and Koch (2002) propose an alternative view of organizational learning based on the idea of "transactive memory". Members of the organization can hold a very specialized knowledge but at the same time they can simulate a joint memory through which it is possible to identify the relevant knowledge and to localize it without the need for sharing it. Routines and formal organizational rules provide the basis for the

shared interaction patterns, etc.

In many respects, the point mirrors dynamically the relation between technological and organizational competencies we made earlier. Changes in the collective "knowledge of nature" and the procedures to master it – being it related to the design and production of a new machine tool, a new drug, a new type of airplane, etc. – usually go together with changes in skills distributions, information flows, action patterns and sometimes even "cultures" within the organization. But the converse does not necessarily hold: one may indeed observe even significant changes in the social division of labour, in action patterns, etc. without any dramatic change in the technical competencies the organization holds. In fact, this lack of one-to-one correspondence between technological and organizational innovation is also a necessary premise for the comparison of the performances of diverse organizational set-ups, while holding strictly technological knowledge roughly constant. In turn, this bears far-reaching implications in terms of comparative assessment of different organizational archetypes (e.g. "the Japanese firm" vs. "the American firm", etc.)

IV. Organizational learning is ridden with path-dependencies whereby incumbent competencies shape and constrain the patterns of future exploitation.

One might not be prepared to subscribe Weick and Westley (1996) extreme view that "organizing and learning are essentially antithetical processes…to learning is to disorganize and increase variety". Still it should come relatively easy to acknowledge the widespread occurrence of competence traps, and lock-ins into history-reinforced specializations, "way of doing things", hierarchical arrangements, action patterns [cf. Levitt and March (1996), Cohen and Sprull (1996) Levinthal (2000), Cantwell (2000)].

In the broadest definition, some form of organizational innovation (whether successful or not is a different matter) occurs whenever an organization changes its protocols for the coordination of the information and knowledge distributed across its individual members; for the monitoring and governance of its conflicts of interest across organizational members; and for the distribution of authority assignments. All this, to repeat, might or *might not* go together with changes in technological competencies and organizational knowledge. Having said that, a crucial but still largely unexplored question *is how*

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recombination of the knowledge of specialized members and mechanism like prototyping can represent the means through which they can contribute without extending their cognitive capabilities.

organizational innovations occur. More specifically,

V. one may distinguish two "ideal types" of learning processes, namely, first, internal learning processes vs., second, acquisition of external competencies and organizational models.

Let us begin with internal learning and notice that, as far as organizational competencies are concerned, one hardly finds any equivalent to R&D search concerning technological innovation. There is no functionally specialized locus invested with "organizational search". Rather, experimentation and adjustments are diffused throughout the organization. But with that come delicate problems of interpretation of experience, opaqueness in the relations between actions and outcomes, ambiguities in "credit assignments" of successes and failures to sub-units of the organization [Argyris and Schön (1996), Sproull (1981) and Levinthal (2000)].

Path-dependence looms large throughout.

The problem associated with the acquisition of external practices and competencies are those more generally stemming from forms of indirect experience. First, learning tends to concern primarily codified forms of knowledge. Second, issues of interpretation of "external models" and local adaptation remain fundamental, and with that also the question of the degrees to which one can maintain that there are identifiable, relatively invariant, organizational models that undergo inter-organizational diffusion.

Moreover, both "internal" and "external" forms of organizational learning entail subtle links with organizational structures. So, for example, as Marengo (1992) emphasizes there is an intrinsic tension between knowledge decentralization – as such a fundamental source of variety and experimentation -, and centralization which guarantees coherence in the exploitation of these diverse forms of learning. So it might well be that higher degrees of decentralized learning are not necessarily conducive to higher degrees of *organizational* learning: they are so, only in so far as the former can be 'pulled together' and made coherent with the overall organizational learning process (Marengo 1992).

VI. Routines and other organizational practices do not only represent problem-solving procedures, but represent at the same time specific control and governance devices.

The suggestion that organizational routines entail also "truce" amongst potentially conflicting interests goes back to Nelson and Winter(1982). However, it is also true that, until recently, the "governance" side of organizational practices has been largely neglected

within knowledge-centered views of the firm (needless to say, exactly the opposite applies to "incentive-centered" perspectives, including agency theories and to a good extent also transaction costs economics, with their neglect of most knowledge issues).

Coriat and Dosi (1998) attempt to investigate the emergence of specific organizational forms as a co-evolutionary outcome of organizational innovation affecting both the problem-solving and governance/control roles of corporate practices and structures. In order to do that they analyze the origins and the properties of some set of routines from two organizational archetypes, namely the American "Tayloristic" firm and the Japanese "Toyotist" one.

Let us consider the Tayloristic example. The Time and Motion studies, at the core of the Tayloristic revolution, have been the prerequisite for the codification of previously tacit productive knowledge in a set of elementary procedures. But at the same time, this codification was a precondition for a new design of control mechanisms upon effort elicitation (new pay and control systems). In fact, one of the major obstacle to productivity growth in the nineteenth century was the abilities of skilled workers to bargain on the condition of the use of the knowledge embodied in their experience because of employer ignorance about "the way to do things". Rather than attempting to refine upon the incentive structure, the general Tayloristic programme involved a major redefinition of the nature of productive knowledge". With that came a major reshuffling of the distribution of knowledge within the organization (from the shopfloor up to the Departments of Planning, Design, etc.) and lead to involve broader changes in the general structure of the labour market (including new rules for labour mobility, hiring and firing). At the same time, such an organizational revolution opened the way to the development of new organizational capabilities conducive to efficient manufacturing of high volume, standardized, low cost products.

Indeed the investigation of the "governance side" of problem-solving procedures, while still at an early stage promises to finally take on board issues of incentives, control and power distribution as co-determinants of organizational arrangements and behaviors.

4 INTERPRETATIVE IMPLICATIONS AND EMPIRICAL PREDICTIONS

To begin with note that the whole foregoing discussion suggests that the interpretation of observed corporate structures and performances ought to concern primarily the relationships between the *internal working* of firms themselves and the interactive environment in which they operate.

Indeed , one of the fundamental propositions shared by evolutionary economics and the "capability view " of business organizations is that firms have ways of doing things that show strong elements of continuity. A related and equally fundamental proposition is that firms have distinctive ways of doing things: firms are generally heterogeneous even in the ways they accomplish functionally similar tasks, to say nothing of the large-scale differences that separate the chemical firm, the automobile manufacturer, the mass retailer, etc.. Taken together, these propositions set the stage for the dynamic interplay of the evolutionary triumvirate of variation, selection, and retention. Variety in the form of heterogeneous firm behaviour patterns gives the market selection process something to work on; because the pattern persist, the market's selection and promotion of successful ones ought to bear significant systemic consequences over time.

Early roots of the idea go back to Edith Penrose's notion (1959) that the profitability and the growth of a firm should be understood in terms of its possession and development of unique and idiosyncratic resources. It is nowadays shared albeit with different interpretation by "resource-based" and "capability-" or "knowledge-based" views of the firm.

Scholars who identify themselves with the "resource-based view" examine the question of what sorts of resources confer lasting competitive advantages, how these advantages can be extended "leveraged", and what considerations prevent the elimination of the gap between the cost of the resources and the market value of the output produced.

Many discussions in this vein seem to imply that firm resources are "idiosyncratic" in only a weak sense; they are relatively discrete and separable from the context of the firm and are the sorts of things that would naturally carry a market price. On this interpretation, the resource rubric does not subsume capabilities. Some authors, notably Dierickx and Cool (1989), offer a sharply contrasting view, suggesting that competitively significant resources are gradually accumulated and shaped within the firm, and are generally non-tradable. Unique, difficult-to-imitate capabilities acquired in a protracted process of organizational learning are example of the sorts of resources they see as sources of competitive advantage. Needless to say, an implication of the "capability view" discussed above is that strong

idiosyncratic differences across firms ought to be widespread, notwithstanding the powerful influence that specific types of problem-solving activities exert upon the structure and boundaries of business organization. Moreover , another fundamental implication is that idiosyncratic capabilities persistently shape corporate performances.

Let us first consider the idea that the nature of problem-solving activities is central to the explanation of organizational forms. If this is so, taxonomic exercises on "types of problems" ought to map into corresponding taxonomies of organizational forms .

4.1 ORGANIZATIONAL PROBLEM SOLVING AND THE COMPLEXITY OF TASK

Consider as a sort of extreme reference the Taylorist/Fordist organizational archetype. In the foregoing terminology, the decomposition of the overall design/production/distribution problem is, so to speak, solved "top-down" and "once-and-for-all", involving a first "cut" of broad sub problems (e.g. production) attributed to the various divisions and a much finer decomposition at operational level into minute tasks to be tackled in highly routinized fashions.

At the opposite extreme, however, a much less studied archetype is that whereby organizational design problems cannot be solved once-and-for-all and relatedly the distribution of problem-solving knowledge is bound to be much more fluid.

Indeed, Dosi, Hobday and Marengo (2000) consider six ideal types of organizational forms, ranging from the pure functional form, with separated functional departments, to the project-based form, where the entire organization is dedicated to one or more complex projects and there are no clear-cut functional boundaries.

Within such a taxonomy, Dosi, Hobday and Marengo (2000) present an analysis of the co-evolution of problem-solving knowledge and organizational design in complex, non-routinized and non-stable tasks. In particular, they focus on the so called *complex product systems* (CoPs), broadly including complex capital goods, consisting in many interconnected and customized elements, which sometimes exhibit even emergent properties during their production- i.e. unpredictable properties which reveal themselves only at the stage of system engineering and integration, or later during their actual use.

CoPs include relatively traditional goods, such as train engines, but also mobile communication systems, military systems, corporate information technology networks,

aircrafts, air traffic control systems, tailored software packages, and many others. Their complexity is also due to the number of components and inputs required, the presence of many design choices, the degree of customization and the breadth and depth of knowledge involved in design and production.

The project-based form, one argues, seems to be well suited to the problem-complexity and fuzzy decomposition tasks characteristics of CoPs. A good illustration of how the nature of technical/organizational problems and of the related knowledge bases shape organizational arrangements stems from the comparison of the role of the project manager under "project-based" form, on the other hand, ad under traditional "functional" patterns of division of labour, oh the other. In the former mode, "decompositions" tend to be rather loose and "credit assignments"/incentive schemes rather ill-defined. This, however, demands a core role for the project manager, who represents the main channel of communication and is pivotal in the coordination and integration of specialist functions and would-be solutions to sub-problems. Indeed, the evidence discussed in Dosi, Hobday, Marengo and Prencipe (2002) suggests that the overall project management be undertaken by distinct firms which perform as *system integrators* (cf. Brusoni, Prencipe and Pavitt (2001)).

At the other end of the spectrum, on finds integrated organizations which may well produce complex products but do so under rather precisely defined decompositions, lines of command and incentive schemes (think of the "classic" Fordist automobile industry). In these circumstances "project management" is nothing but one of the many functions within the firm.[9]

4.2 THE HORIZONTAL AND VERTICAL BOUNDARIES OF THE FIRM

Another promising domain to which the "capability view" can be fruitfully applied regards the proximate 'boundaries' of the firm.

It is well known that almost all large firms and a good deal of small ones are multiproduct, both in a 'vertical' sense – i.e. firms produce some of their own inputs - , and in a 'horizontal' sense – i.e. firms produce more than one output - . Moreover , as Rumelt (1974 and 1982) has shown, after World War II , at least in the U.S., the largest corporations have increasingly diversified their production. Between 1949 and 1974 "the proportion of

the largest 500 industrial firms that were substantially diversified more then doubled, rising from 30 to 63 per cent" (Rumelt 1982). Using a sample of 100 firms and the definition of categories of firms ranging from single business to unrelated business, based upon Rumelt (1974), he observes a steady decline of the number of single product firms and a rapid growth of diversified ones. A similar pattern is described by Montgomery (1994) for the period 1985-1992. She also cites evidence about other countries (Japan and UK) which are in line with this conclusion.

There are of course different theoretical candidates for the explanation of such empirical patterns , including these broadly deriving from "agency" theories (cf. the discussion in Holmstrom and Roberts (1998), transaction cost considerations - limitedly to *vertical* integration - (Williamson (1975), (1985) and (1999) , and again Holmstrom and Roberts (1998)), and the (partly overlapping) 'resource' and 'capabilities' views. Here , let us focus on the achievement of the latter (see Montgomery (1994), Rumelt (1982), Markides and Williamson (1994), Bettis (1981), Palepu (1985), Zollo and Reuer (2001), Teece et al (1994)).

In particular, Teece et al. (1994) stress three fundamental characteristics of modern corporations , namely, (i) their multi-product scope; (ii) the non-random distribution of product portfolios of firms conditional on their principal activities; (iii) the stability in the composition of firms' portfolios over time.

The work suggests that firms are 'coherent ' in their portfolios in so far as they diversify by adding activities which share with the existing ones some market or technological characteristics: they build on the capabilities which they already have .

Teece et al (1994) make use of two measures of "coherence". The first one indicates the degree to which an activity *i* is related to all the other activities of the firm. Relatedness is defined by the comparison between the observed number of corporations which are active in any combination of industries with the number of them that would be expected under the hypothesis that diversification is random . The second measure of coherence refers to the strength of association between activity *i* and his closest neighbors.

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[9] In the literature one begins to find also exploratory attempts to identify, so to speak "bottom-up", the seemingly viable combinatorics amongst multiple inter-related organizational traits: see, on automobile manufacturing, McCarthy et al. (1997) and the formalization in Allen (forthcoming)

The empirical analysis, based on the 1987 TRINET tape , largely corroborates the notion of 'coherent diversification' .The suggested interpretation is that the boundaries of the firm - and thus the predicted degrees of diversification and coherence - can be understood in terms of characteristics of (i) learning, (ii) path-dependencies, (iii) technological opportunities, (iii) selection environments, and in terms of (v) firms endowments of complementary assets (page 274). Thus, for example, rapid learning, rich technological opportunities and tight path-dependencies will correspond to (nearly) single product, fast-growing, firms. Conversely, within a context of rapid learning, converging technological trajectories and thigh selection one can expect to see coherent diversifiers. Moreover , the interpretation suggests that unrelated diversification is likely to be viable only under conditions of weak market selection.

A complementary analysis is by Chang (1996) who studies both diversification and divestment decisions through the examination of the entry-exit patterns, triggered by 'satisfying ' criteria of performance and driven by the human resource profiles which the organization embody. The evidence, from the TRINET and COMPUSTAT databases, with some caveats, supports the behavioral, knowledge-driven, model of diversification.

So far we have discussed the capability-centered views with an emphasis on the determinants of the *horizontal* boundaries of the firm. Let us now focus on the *vertical* ones.

A well-known interpretation of the latter is in terms of relative costs of governing market-mediated vs. hierarchically governed transactions (Williamson (1975), (1985), (2000)). However, while not denying the importance of transaction cost considerations, a few studies have begun to explore resource-/capability-based explanations of the choices between market and other forms of governance of input/output flows (see, among others, Argyres (1996), Jacobides (2000), Jacobides and Hitts (2001), and Delmas (1999)). The central conjecture here – as well as in the earlier discussion of the governance of CoPs – is that the degrees of vertical integration and the selection of governance forms is shaped by the nature and distribution of problem-solving knowledge. Consider for example Delmas study (1999) on the waste industry – as such characterized by high technological and regulatory uncertainty -. Her evidence corroborates the idea that a major determinant of the vertical boundaries of the fir rests in the distribution of capabilities across segments of activities and across firms: "firms will rely on alliances for tacit technologies in highly

uncertain environments. Although incurring high transaction costs, collaborations are perceived as possessing the flexibility and the adaptability necessary to build competencies and to gain a competitive advantage" (p. 664)

4.3 DETERMINANTS OF CORPORATE PERFORMANCES

Some of the most robust stylized facts in industrial are that firms persistently differ, even within the same lines of activities, in their innovativeness productivity and profitability.

Concerning the patterns of innovation, plenty of evidence confirms (a) systematic differences in the propensity to introduce innovation and adopt them (Dosi (1988), Freeman and Soete (1997), Freeman (1994)). Moreover (b) probabilities of success and failures in innovative activities appear to be influenced by underlying differences in organizational arrangements and behaviours – as such circumstantial evidence of different 'capabilities'. (A pioneering study is the SAPPHO project from the '70s – described in Freeman and Soete (1997) – attempting to identify systematic differences between successful and failing innovators).

With regards to various indicators of efficiency (*in primis*, labour productivity) as Jensen and McGuckin (1997) note, an increasing number of studies highlights a pervasive heterogeneity in firms' and plants' characteristics both cross-sectionally and over time[10].

The crucial question here is whether one can identify robust relations between (non-tautological) proxies of capabilities, on the one hand, and the various dimensions of performances, on the other.

We have no difficulty in admitting that the quest for the foregoing proxies is far from over. However, in addition to counts of discrete innovations and patents (i.e. measures of innovative output) one is painstakingly identifying an increasing number of (often sector-specific) proxies for capabilities: see, for example, Baldwin and Johnson (1995) Argote and Darr (2000), Pisano (2000) and Henderson and Cockburn (2000).

Can as it may, the litmus test over which a capability theory of industrial performances stand or fall concerns its ability to account for inter-firm differences in profitability and growth patterns.

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[10] Cf. among others Rumelt (1991), Davis, Haltiwanger and Schuh (1996), Baldwin (1995), Haltiwanger (2000), Nelson (1981), Dosi (1988), Bartelsman and Doms (2000), Foster, Haltiwanger and Krizan ((2001) Noda and Collins (2001)

Consider, first, the relation between innovativeness and profitability. In this vein, Geroski et al. (1993) in the case of a sample of large UK firms does identify a positive relation between innovativeness and profitability. Next, they ask whether the correlation reflects transitory (innovation-specific) effects or, conversely reflect long-term differences between innovating and non-innovating firms. The conclusion is that both phenomena are present. In particular, we would argue permanent differences reflect more general underlying differences in corporate capabilities. Further, the analysis shows that profit margins of the innovating firms seems to be less sensitive to cyclical downturn than are those of non-innovating.

Cefis (1999) uses data on UK firms throughout the period 1978-1991 and investigates the persistence in firms' profits as a function of the persistence in innovation (patent applications). First, the separate analysis of the distribution of profit and innovation shows a significant persistence in both variables. Second, a similar pattern emerges from the analysis of the joint distributions of profits and innovations: "firms which are systematic innovators and earn profits above the average have a high probability to keep innovating and earning profits above the average, as well as firms which are occasional innovators and earn profit below the average have a high probability to remain in the initial situation"(p. 4). It is also worth noting that changes in the relative position of a firm with respect to the average profitability are not correlated with the relative position in the innovation dimension in the short run, but it is correlated with it in the long run.

The evidence on the relationships between capabilities and corporate growth is much more controversial. On the pessimistic side, Geroski (2000) concludes his discussion of the statistical evidence by saying that "corporate growth rates differ between firms in temporary and unpredictable ways, and it is hard to reconcile the inimitability and durability of organizational capabilities with these data" (p. 181). Since that survey, however, some investigations have detected much more structure in the growth process. In particular the findings by Bottazzi et al. (2001), in the case of the international pharmaceutical industry, include a significant autocorrelation in growth dynamics and a 'fat tailed' distribution of growth shocks which may be quantitatively mapped into the arrival of major innovations. [11]

As we see it, this remains indeed a priority area of research, and bails down to the question: what are the statistical properties of the growth profiles of different firms in the

[11] The later 'fat-tailedness' property is confirmed also by different pieces of evidence from the Italian industry: however the former is not (Botazzi, Cefis and Dosi (2002), and Bottazzi and Secchi (2003))

markets where they compete with each other (i.e. by line of business) and as a whole corporate entities when one properly condition upon proxies for "capabilities"?

5 SOME IMPLICATIONS FOR STRATEGIC MANAGEMENT, BY WAY OF A CONCLUSION

So far we have mentioned *some* of the interpretative implication of a "knowledge centered" theory of the firm and the related empirical predictions. But what are the implications of such a theory for strategic management? That is if the theory holds, what does it predict that manager do? And at which variables and processes *should* they look in order to improve organizational performance?

Let us conclude with some remarks on these issues.

Indeed, an important theme in the recent strategy literature is the idea that the most distinctive role of the business firms in general and of strategic management in particular is the way they bring knowledge to bear on productive effort. This and related ideas have been discussed under the heading of the "knowledge-based" theory of the firm [Grant (1996), Kogut and Zander (1992), and Dosi and Marengo (1994)]. As with the notion of resources, this discussion converges with the capabilities discussion in proportion as the knowledge is conceived as know-how embedded in the organization's activities, as opposed to passive, library-like stocks in the heads of participants[12].

In this perspective, as forcefully argued by Teece, Pisano and Shuen (2000), strategic management has a key role in shaping

(i) *organizational processes*, by the establishment of specific organizational structures and, equally important, by introducing *and by breaking* particular organizational routines (cf. Rumelt 1995);

(ii) the *position* of the firm (broadly defined to cover their specific assets, their locations along the value chain and their relationship with suppliers and customers); and,

(iii) *paths* (i.e. the patterns of change in the former two sets of characteristics).

[12]For broader discussion of the recent emphasis on capabilities in the strategic management literature, see Rumelt et al. (1991), Teece et al. (1997), and Stalk et al, (1992). The discussion in Robert Grant's excellent textbook illustrates the appearance of these ideas in the business school curriculum (Grant 1996, ch 5.)

These activities are indeed at the core of what Teece et at (2000) call the *dynamic capabilities* of the firm.

Moreover , managerial tasks involve

(iv) presiding over the *replication* within the organization of well-performing bundles of routines (Szulanski (2000), Winter (2000));

(v) defining the *cognitive frames* and the *aspiration levels* of the organization (that is also the shared "representations" and perceived "fitness landscapes" discussed earlier)[13], and

(vi) mastering the persistent and tricky dilemmas *between exploitation and exploration*, as March (1991) put it, that is between the improvement of what the organization "is already good at", on the one hand, and the search for more radical innovative opportunities , on the other.

These tasks, in turn, involve the "rethinking of traditional management tools – such as team staffing and mobility, incentive policies and information storage and retrieval – conceptualizing them as tools for setting the parameters of intra-firm [exploitation/exploration] dynamics" (Warglien (1999)).

In such a context, the management of a *variety of exploration trajectories* implies a view of an organization as an "artificial ecology" (Levinthal (2000)) wherein managers look somewhat like contemporary bioengineers trying to "fine tune" ex ante the discovery of new traits/biochemical properties, etc. and ex post test and select among them (indeed the analogy is chilling, were one to extrapolate the rate of managerial success to the biological domain!).

It is important to notice that this perspective on organization, organizational learning and their management clearly shifts the focus of analysis from "clever strategizing" against market rivals to the process of problem-solving and organizational governance and, dynamically to capability-enhancing strategies (Tidd, Bessant and Pavitt (1997) is an insightful and thorough management text in this perspective).

And it sets also in a different light the relationship between capabilities and (managerial) decision.

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[13] For some impressionistic cf. Massini, Lewin, Numagami and Pettigrew (2002)

As a useful contrast, notice how in economics and other disciplines that employ the theoretical tools of decision theory, key assumptions about skills and capabilities often remain implicit. Consider, for example, the simple and basic tool called 'pay-off matrix': an array with choice alternatives on one side, 'states of the world' (or opponent choices) on the other, and the outcome utility values in the cells. Typically, the choices are actions or entail actions. While in some cases the choices listed are everyday action that are familiar and perhaps available to the typical reader of the analysis ('carry umbrella'), in other cases they emphatically are not ('conduct seismic tests', 'shut down nuclear reactor').

In these latter cases, the availability of the actions is apparently presumed to inhere in the identity of the decision maker, and this presumption goes unremarked. Arguably, the development of the menu of future choices would be a candidate for the first exercise introducing the topic of sequential decision analysis. In fact, the question of where the menu comes from is generally ignored.

Further, choices available to the decision maker are, in decision theory, feasible by definition –any uncertainty attached to the consequences of *trying* to take specific action (the sort of choice that is in fact readily available) is subsumed in the uncertainty attached to states of the world. This is in principle an inconsequential formal convention, but in practice significant questions of feasibility tend to get swept under the rug in the process of abstracting an analyzable problem from a real situation. The rich sequences of unfolding events that often follow a failed attempt-sequences that may involve wholly unanticipated outcomes and learning, among other things- could be represented in a sufficiently elaborate decision-theoretic formalism, but generally are not.

These habits of decision-theoretic thought contribute to the obscurity in which capabilities issues have long resided in economic analysis. The entries in the menu of choices are specified and promptly taken for granted, one situation at a time- even when choices involve complex actions. Little is seen of the costly and protracted learning process that place alternatives on the menu. The consequences for future menus of the choices made today- for example, the likely strengthening of the capabilities that are exercised and the likely withering of those are not- are generally abstracted away. These practices may well represent sound, in largely tacit, judgement about the domain where decision theory is useful. They nevertheless leave a major gap in the understanding of behavior- a gap best filled, perhaps, by the use of other tools.

Just as the market system accomplishes remarkable feats of coordination without the aid of a central plan, organizational learning produces the coordinated performances of organizational capabilities without the aid of a recipe- alternatively, without the aid of a comprehensive plan, optimized or not. According to the mainstream tradition in economics, economic actors do not have to understand the price system for it to work. Similarly, an organization produces coordinated activity without anyone knowing how it works- although participants may well aware of managerial intentions to achieve coordination. There are far more of these details than any amount of observation will uncover or any imaginable set of manuals will ever record. Tentative choices that are actually incompatible or substantially subversive of the overall performance get rooted out in the course of learning- not in response to the imperative "follow the recipe" but in response to "try something different!". Choices compatible with the overall performance are allowed to stabilize and become habitual, without either the choices or the habits necessarily being recognized as such along way. Finally, in the well-established capability, the activity in progress is its own best (and only) operating manual.

In all that one role of strategic management is to painstaking steer the process at the level discussed above while both recognizing the weight of the path-dependencies in knowledge and organizational practices inherited from the past and trying to detect the "windows of opportunities" ahead.

Certainly, there is no general recipe for the managerial success (and there *cannot* be). Simply, consider the foregoing remarks as pointing at *managerial heuristics* and *diagnostic tools* which, in our view, are at the core of the dynamic capabilities of business organizations.

REFERENCES

Adler, P. (1993). 'The Learning Bureaucracy: New United Motor Manufacturing, Inc', *Research on Organization Behavior.*, 15:111-194.

Allen P.R. (forthcoming), 'The Complexity of Structure, Strategy and Decision-Making', forthcoming in *Frontiers of Evolutionary Economics II*, Aldershot, Edward Elgar

Aoki, M. (1988). *Information, Incentives and Bargaining in the Japanese Economy*, Cambridge,Cambridge University Press.

Aoki, M. (2001). *Toward a Comparative Institutional Analysis*, Cambridge, Mass.: MIT Press.

Argote L. and Darr E.(2000), "Repositories of Knowledge in Franchise Organizations" in Dosi, Nelson and Winter (eds.) *The Nature and Dynamics of Organizational Capabilities*, Oxford U.P.

Argyres N.S. (1996). 'Evidence on the role of firm capabilities in vertical integration decisions', *Strategic Management Journal.* 17(2): 129-150

Argyris, C. and Schön, D. A. (1996). *Organizational Learning II. Theory, Method, and practice,* Addison-Wesley Publishing Company.

Augier, M. and March J.G. (eds.) (2002) *The Economics of Choice, Change and Organization: Essays in Memory of Richard M. Cyert.* Cheltenham UK and Northampton, MA, USA, Edward Elgar.

Baldwin, J. R. (1995). *The Dynamics of Industrial Competition*, Cambridge University Press.

Baldwin, J.R. and J. Johnson (1995). 'Business Strategies in Innovative and Non-Innovative Firms in Canada' Analytical Studies Branch Research Paper, N. 73, Ottawa: Statistics Canada.

Baldwin, J.R. and David Sabourin (2002) 'Advanced technology use and firm performance in Canadian manufacturing in the 1990s' *Industrial and Corporate Change* , 11: 761-789

Bartelsman E.J. and Doms M., (2000). 'Understanding Productivity: Lessons from Longitudinal Microdata', *Journal of Economic Literature*, 38(3): 569-594.

Barney J.B. (1991). 'Firm Resources and Sustained Competitive Advantage', *Journal of Management*, 17: 99-120.

Barney, J.B. (2001). 'Is the Resources-Based View a Useful Perspective for Strategic Management Research? Yes', *Academy of Management Review,* 26:41-46.

Barney, J.B. (2001a). 'Resource-based *theories* of competitive advantage: A ten-year retrospective on the resource-based view', *Journal of Management, 27(6): 643-650.*

Bettis, R.A. (1981). 'Performance Differences in Related and Unrelated Diversified Firms', *Strategic Management Journal*, 2(4), pp. 379-393.

Bottazzi, G., Dosi, G., Lippi, M, Pammolli F. Riccaboni M. (2001). 'Innovation and Corporate Growth in the Evolution of the Drug Industry', *International Journal of Industrial Organization*, 19(7) :1161-1187.

Bottazzi G., Cefis E. and Dosi G. (2002) "Corporate growth and industrial structures: some evidence from the Italian manufacturing industry" *Industrial and Corporate Change*, 2002 11:705-723

Bottazzi G. and Secchi A. (2003), "A Stochastic Model of Firm Growth" forthcoming in *Physica A*.

Bromiley, P. and Fleming, L. (2002) 'The resource-based view of strategy: a behaviorist critique' in Augier and March (2002).

Brusoni, S,. Prencipe, A., and Pavitt, K. (2001). 'Knowledge Specialization and the Boudaries of the Firm :Why Firms Know more than they Make ?' *Adiministrative Science Quarterly,* 46: 597-621.

Cantwell, J. (2000). 'Technological lock-in of large firms, since the interwar period', *European Review of Economic Histor*y, 4: 147-174.

Cefis, E. (1999). 'Persistence in profitability and in innovative activities', *Quaderni del dipartimento di Scienze Economiche*, N. 6, University of Bergamo, Italy.

Chandler, A. (1977). *The Visible Hand: the Managerial Revolution in American Business,* Cambridge, Mass., Harvard University Press.

Chandler, A. (1990). *Scale and Scope: the Dynamics of Industrial Competition*, Cambridge, Mass., Harvard University Press.

Chandler, A. (1992). 'Organizational Capabilities and the Economic History of the Industrial Enterprise' *Journal of Economic Perspectives,*6(3): 79-100.

Chandler, A., Hagström, P. and Sölvell, Ö. (eds.) (1998). *The Dynamic Firm*, Oxford/New York, Oxford University Press.

Chang S.J. (1996). 'An evolutionary perspective on diversification and corporate restructuring. entry, exit, and economic performance during 1981-1989', *Strategic Management Journal,* 17(8): 587-611.

Christensen, C. M. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fa*il, Boston, Harvard Business School Press.

Christensen, C. M. and Rosenblom, R. (1995). 'Explaining the attacker's advantage: technological paradigms, organizational dynamics, and the Value Networ*k', Research Polic*y, 23: 233-257.

Christensen, C. M and Bower, J. L. (1996). 'Customer power, strategic investment and the failure of leading firms', *Strategic Management Journal* 17: 197-218.

Cohen, M., and Bacdayan, P. (1994). 'Organizational routines are stored as procedural memory', *Organization Science*, 5: 554-68.

Cohen, M. , Burkhart R., Dosi G., Egidi M., Marengo L., Warglien M, Winter S. (1996). 'Routines and Other Recurring Action Patterns of Organizations: Contemporary Research Issue' *Industrial and Corporate Change*,, 5 (3): 653-699.

Cohen, M. D. and Sprull, L. S. (Eds.)(1996). *Organizational Learnin*g, Organization Science, Sage Publications.

Cohen, W. M. and Levinthal, D. A. (1989). 'Innovation and Learning: the Two Faces of R and D', *The Economic Journa*l, 99: 569-596.

Cohendet P., Llerena P. and Marengo L. (2000) "Is there a Pilot in the Evolutionary Firms?", in Foss and Mahnke eds., *Competence, Governance and Entrepreneurship* Oxford U.P.

Cole, R. E. (1999). *Managing Quality Fads: How American Business Learned to lay the Quality Game,* New York, Oxford University Press.

Coriat, B. (2000). 'Organisational innovation in European firms: A critical overview of the survey evidence', Sant'Anna School of Advanced Studies LEM, Pisa, Italy: *Dynacom working paper series.*

Coriat, B. (2000a). 'The "Abominable Ohno Production System". Competences, Monitoring, and Routines in Japanese Production Systems', in Dosi,, Nelson and Winter (2000).

Coriat, B. and Dosi, G. (1998). 'Learning How to Govern and Learning How to Solve Problems: On the Co-Evolution of Competences, Conflicts and Organizational Routines', in Chandler et al. (1998).

Coriat, B. and Weinstein O. (2002). 'Organization and Institution in the generation of innovations', *Research Policy,* 31(2): 273-290.

Cyert, R.M. and March J.G. (1963). *A Behavioral Theory of the Firm*, Cambridge: Blackwell.

Davis, S.J., Haltiwanger J. C. and Schuh, S. (1996) *Job Creation and Destruction.* Cambridge, Mass: MIT Press.

Delmas, M. (1999) 'Explosing Strategic Assets to Create New Competencies: The Case of Technological Acquisition in the Waste Management Industry in Europe and North America', *Industrial and Corporate Change,* 8:635-671.

Deming, W. E. (1982). *Out of the Crisi*s, Cambridge, Mass.: MIT Center for Advanced Engineering Study.

Dierickx, I. and Cool, K. (1989). 'Asset stock accumulation and sustainability of competitive advantage', *Management Science* 35: 1504-1511.

Dopfer K. (eds.) (2003) *Principles of Evolutionary Economics,* Cambridge, Cambridge University Press

Dosi G. (1988). 'Source, Procedures and Microeconomic Effects of Innovation', *Journal of Economic Literature* 26: 1120-1171.

Dosi, G. (1995). 'Hierarchies, Markets and Power: Some Foundational Issues on the Nature of Contemporary Economic Organization ', *Industrial and Corporate Change,* 4(1): 1-19.

Dosi, G. and L. Marengo (1995). 'Some Elements of an Evolutionary Theory of Organizational Competences', in R. W. England (Ed.), *Evolutionary Concepts in Contemporary Economics,* Ann Arbor: University of Michigan Press.

Dosi, G., Marengo, L.. and Fagiolo, G. (2003). 'Learning in Evolutionary Environments' forthcoming in Dopfer K. (eds.) *Principles of Evolutionary Economics,* Cambridge, Cambridge University Press (2003).

Dosi, G. and Teece, D.J. (1998). 'Organizational competences and the Boundaries of the firms', in R. Arena and C. Longhi (Eds.), *Markets and Organization*s, Berlin/Heidelberg, New York, Springer-Verlag.

Dosi G., Coriat B., Pavitt K. (2000). *Competence, Capabilities and Corporate Performances*, Sant'Anna School of Advanced Studies, LEM, Pisa, Italy: Dynacom working paper series.

Dosi, G., Hobday, M. and Marengo, L. (2000). 'Problem-Solving Behaviours, Organisational Forms and the Complexity of Tasks', *Sant'Anna School of Advanced Studies,* Pisa, *LEM Working Papers,* forthcoming in Helfat (2003).

Dosi, G., Hobday, M. , Marengo, L. and Principe A. (2002) 'The Economics of System Integrators: Toward an Evolutionary Approach', Sant'Anna School of Advanced Studies, Pisa, Italy *LEM Working Papers.*

Dosi G. and Marengo L. (2000). 'On the Tangled Discourse between Transaction Cost Economics and Competence-Based Views of the Firm' in in Foss and Mahnke eds., *Competence, Governance and Entrepreneurship* Oxford U.P.

Dosi G., Levinthal D. and Marengo L. (2001). 'Bridging Contested Terrain. Linking Incentive-Based and Learning Perspectives on Organizational Evolution'", Sant'Anna School of Advanced Studies, Pisa, Italy *LEM Working Papers,* forthcoming in *Industrial and Corporate Change*, 2003.

Dosi, G., Levinthal, D. and Marengo, L. (2002) 'The Uneasy Organizational Matching Between Distribution of Knowledge, Division of Labor and Incentive Governance', Sant'Anna School of Advanced Studies, Pisa, *LEM Working Papers.*

Dosi, G., Nelson R. and Winter S.G.(eds.) (2000). *The Nature and Dynamic of Organizational Capabilities.* Oxford/New York, Oxford University Press.

Egidi, M. (1995). 'Routines, hierarchies of problems, procedural behavior; some evidence from experiments', in K. J. Arrow (Ed.*), The Rational Foundations of Economic Behavio*r, London: Mac Millan.

Florida, R. and Kenney, M. (2000) 'Transfer and Replication of Organizational Capabilities', in Dosi et al. (eds.)(2000).

Foss, N. and Mahnke V. (eds.)(2000). *Competence, Governance and Entrepreneurship*, Oxford, Oxford University Press.

Foss K. and Foss N. (2000). 'The Knowledge-Based Approach and Organizational Economics: How much do they really differ? And how does it matter?' in in Foss and Mahnke eds., *Competence, Governance and Entrepreneurship* Oxford U.P.

Foster, L., Haltiwanger ,J. C. and Krizan C.J. (2001) 'Aggregate Productivity Growth: Lessons from Microeconomics Evidence' in Hulten C.R., Dean, E. and Harper, M. J. *New Developments in Porductivity Analysis*, University of Chicago Press

Freeman C. and Soete L. (1997). *The Economics of Industrial Innovation* (3th edition), London, Pinter.

Fujimoto T. (2000). 'Evolution of Manufacturing Systems and Ex Post Dynamic Capabilities', in Dosi et al. (Eds.)(2000).

Gavetti, G., and Levinthal, D.E. (2000), "Looking Forward and Looking Backward: Cognitive and Experiential Search." *Administrative Science Quarterly,* 45 :113-137.

Geroski P.A. (2000), "The growth of Firms in Theory and Practice", in Foss and Mahnke eds., *Competence, Governance and Entrepreneurship* Oxford U.P.

Geroski, P.A., Machin, S. Ad Van Reenen J. (1993). 'The profitability of Innovating Firms', *RAND Journal of Economics,* 24:198-21.

Ghoshal S., Hahn M. and Moran P. (2000), 'Organizing for Firm Growth: the Interaction between Resource-Accumulating and Organizing Processes' in Foss and Mahnke eds., *Competence, Governance and Entrepreneurship* Oxford U.P.

Grant, R.M. (1996). 'Toward a knowledge-based theory of the firm', *Strategic Management Journal* 17 (Winter special issue): 109-122.

Griliches, Z. (1986). ' Productivity, R&D and Basic Research at Firm Level in 1970's ', *American Economic Review,* 76: 141-154.

Haltiwanger, J. C. (2000) 'Aggregate Growth: What We Have Learned From Microeconomic Evidence' *OECD Economic Department Working Paper n. 267*

Hart O. and Moore J. (1999). 'On the design of Hierarchies: coordination versus specialization', *Harvard Institute for Economic, Research Discussion Paper.*

Helfat, C. (ed.) (2003). *Evolution of Capabilities: Emergence, Development and Change*, London, Routledge.

Henderson, R. and Clark, K. (1990). 'Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms' *Administrative Science Quarterly*, 35: 9-30.

Henderson, R. and Cockburn, I (2000). 'Measuring Competence? Exploring Firm Effect in Drug Discovery' in Dosi, Nelson and Winter (eds.) *The Nature and Dynamics of Organizational Capabilities*, Oxford U.P.

Holland, J.H. (1975), *Adaptation in Natural and Artificial Systems*, Ann Arbor, University of Michigan Press.

Holland, J.H., Holyoak, K.J., Nisbett, R.E. and Thagard, P.R. (1986), *Induction: Processes of Inference, Learning and Discovery*, Cambridge Mass., MIT Press.

Holstrom, B. and Roberts J. (1998) 'The Boundaries of the Firm Revisited', *Journal of Economic Perspectives,* 12(4): 73 – 94.

Hutchins, E. (1991). 'Organizing work by adaptation', *Organization Scienc*e, 2: 14-39.

Key N. (2000) "The Growth of Firms", in Foss and Mahnke eds., *Competence, Governance and Entrepreneurship* Oxford U.P.

Jacobides, M.G., (2000), 'Capabilities, Transaction Costs and Limits to Growth: A formal Model of Scope and Profitability in Mortgage Banking'. *Working Paper, Wharton Financial Institutions Center*, The Wharton School

Jacobides M.G. and Hitt L.M. (2001) 'Vertical Scope Revised: Transaction Costs Vs Capabilities & Profit Opportunities in Mortgage Banking' *Working Paper, Wharton Financial Institutions Center*, The Wharton School

Jensen J.B and McGuckin R.H. (1997) ' Firm Performance and Evolution: Empirical Regularities in the US microdata', *Industrial and Corporate Change,* 6(1): 25-47.

Juran, J. M. (1989). *Juran on Leadership for Quality. An Executive Handboo*k, New York: Free Press.

Kauffman, S.A. (1988). 'Adaptation on Rugged Fitness Landscapes' In *Lectures in the Sciences of Complexity, Volume I, Santa Fe Institute Studies in the Sciences of Complexity*. D.L. Stein, Ed., Addison Wesley.

Kauffman, S.A. (1993). *The Origins of Order*, Oxford: Oxford University Press.

Kieser A. and Koch U. (2002) 'Organizational Learning through rule adaptation: from the behavioral theory to transactive organizational learning' in Augier and March (2002).

Kogut, B. (1992). 'National Organizing Principles at Work and the Erstwhile Dominance of the American Multinational Corporation', *Industrial and Corporate Change*, 1: 285-317.

Kogut, B. and U. Zander (1992). 'Knowledge of the firm, combinative capabilities, and the replication of technology', *Organizations Scienc*e, 3: 383-97.

Kogut, B. and Zander V. (1996). 'What Firms Do? Coordination, Identity and Learning', *Organizational Science,* 7:502-18.

Kreps, D.M. (1990). 'Corporate culture and economic theory' in Alt, J.E., Sheplsle K.A.(eds.) (1990) *Perspectives on Positive Political Economy*, Cambridge University Press.

Lazonik (1990). *Competitive Advantage on the Shopfloor*, Cambridge, Mass., Harvard University Press.

Leonard – Barton, D (1995). *Wellsprings of Knowledge*, Boston, Harvard Business School Press.

Levinthal, D. (2000). 'Organizational Capabilities in Complex Worlds', in Dosi., Nelson and Winter (2000).

Levinthal, D. (2002) 'Cognition and Models of Adaptive Learning' in Augier and March (2002).

Levitt, B. and March J.G. (1996). 'Organizational Learning', in M. D. Cohen and L. S. Sproull (Eds.)(1996) *Organizational Learnin*g, Organization Science, Sage Publications.

Loasby B.J. (2002), 'The organizational basis of cognition and the cognitive basis of organization' in Augier and March (2002)

March, J.G. (1991), 'Exploration and Exploitation in Organizational Learning', *Organization Science*, 2: 71-87.

March, J.G. and Simon H.A. (1993), *Organizations*, New York, Wiley, 2nd Edition.

Marengo, L. (1992). 'Coordination and Organizational Learning in the Firm', *Journal of Evolutionary Economic*s, 2: 313-326.

Marengo, L. (1996). 'Structure, Competence and Learning in an Adaptive Model of the Firm', in G. Dosi and F. Malerba (Eds.), *Organization and Strategy in the Evolution of the Enterprise,* London, Macmillan.

Marengo, L., Dosi, G., Legrenzi, P. and Pasquali, C. (2000). 'The Structure of Problem-solving Knowledge and the Structure of Organizations', *Industrial and Corporate Chang*e, 9: 757-788.

Marengo, L. Pasquali C. and Valente M. (2002). 'Decomposability and Modularit of Economic Interactions' in Callebaut, W. and Rasskin-Gutman, D. (eds) *Modularity: Understanding the development and evolution of complex natural systems*, Cambridge MA, MIT Press.

Markides C.C. and Williamson P.J. (1994). 'Related Diversification, Core Competencies and Corporate Performance', *Strategic Management Journal,* 15: 149 165.

Marsili O. (2001). *The Anatomy and Evolution of Industries. Technological Change and Industrial Dynamics,* Elgar.

Massini S., Lewin A.Y., Numagami T. and Petigrew A.m. "The evolution of organizational routines among large Western and Japanese firms", *Research Policy* 31 (2002) 1333-1348

McCarthy I., Leseure M., Ridgeway K. And Fielles N. (1997), 'Building a Manufacturing Cladogram', *International Journal of Technology Management*, 13, 2269-96

Montgomery C.A. (1994). 'Corporate Diversification', *The Journal of Economic Perspectives,* 8(3) pp. 163-178.

Montgomery C.A. (1995)(ed.). *Resource-Based and Evolutionary Theories of the Firm : Towards a Synthesis,* Boston : Kluwer Academic Publishers

Narduzzo, A., Rocco, E and Warglien, M. (2000) 'Talking about Routines in the Field', in Dosi, Nelson and Winter (2000).

Nelson, R.R. (1991). 'Why do Firms Differ, and how does it matter?' *Strategic Management Journal*, 12: 61-74.

Nelson, R.R. and Winter, S.G. (1982). *An Evolutionary Theory of Economic Chang*e, Cambridge Mass., Harvard University Press.

Noda T, and Collis D.J. (2001) 'The evolution of intraindustry firm heterogeneity: Insights from a process study', *Academy of Management Journal,* 44(4): 897-925

Nystrom P.C and. Starbuck W. H (Eds.) (1981), *Handbook of Organizational Desig*n. Oxford, UK: Oxford University Press

Padgett, J.F., Doowan L, and Collier N. (2003) 'Economic Production as Chemistry' MIMEO

Page, S. E. (1996). 'Two measures of difficulty', *Economic Theory*, 8: 321–346.

Palepu K. (1985). 'Diversification Strategy, Profit Performance and the Entropy Measure' , *Strategic Management Journal,* 6(3): 239-255.

Patel, P. and Pavitt K.(1991). 'Europe's Technological Performance' in Freeman et al. (eds.) *Tecnology and the Future of Europe: Global Competition And The Environment in 1990s,* London: Pinter Publisher,

Patel, P. and Pavitt K. (2000). 'How Technological Competencies Help Define the Core of the Firm', in Dosi et al. (Eds.)(2000).

Pavitt, K. (1987). 'The Objectives of Technology Policy', *Science and Public Policy,* 14:.192-198.

Pavitt, K. (1999), *Technology, Management and Systems of Innovatio*n, Edward Elgar.

Penrose, E. (1959). *The Theory of the Growth of the Firm,* New York: Wiley.

Pierce, J. L., Boerner S. Ad Teece D.J. (2002) 'Dynamic capabilities, competence and the behavioral theory of the firm' in Augier and March (2002).

Pisano G.P. "In Search of Dynamic Capabilities" in Dosi, Nelson and Winter (eds.) *The Nature and Dynamics of Organizational Capabilities*, Oxford U.P.

Prahalad, C. K. and Hamel, G. (1990). 'The Core Competence of the Corporation', *Harvard Business Review,* May-June: 79-91.

Richardson G.B. (1972), 'The organization of industry', *Economic Journal*, 82,883-96, reprinted in G.B. Richardson, *The Economic of Imperfect Knowledge*, Cheltenham, UK and Northampton, USA, Edward Elgar, 1998

Rosenbloom R.S. (2000).'Leadership, Capabilities, and Technological Change: The Transformation of NCR in the Electronic Era', *Strategic Management Journal 21: 1083-1103.*

Rumelt R.P. (1974). *Strategy, Structure and Economic Performance,* Division of Research. Harvard Business School, Boston.

Rumelt R.P. (1982). 'Diversification Strategy and Profitability' , *Strategic Management Journal,* 3, pp. 359-369.

Rumelt, R.P. (1991) 'How Much Does Industry Matter?', *Strategic Management Journal*, 12 (3): 167-185.

Rumelt R.P. (1995) 'Inertia and Tranformation' in Montgomery (1995)

Rumelt, R. D. Schendel and D. Teece. (1991). 'Strategic management and economics', *Strategic Management Journa*l, 12: 5-29.

Senge, P. M. (1990). *The Fifth Discipline: the Art and Practice of the Learning Organizatio*n, New York: Doubleday.

Simon, H.A. (1962). 'The Architecture of Complexity', *Proceedings of American Philosophical Association.*

Simon, H.A. (1962). 'The Architecture of Complexity'. *Proceedings of the American Philosophical Society* 106, 467-482.

Simon, H. A. (1981). *The Sciences of the Artificial*, Cambridge Mass., MIT Press.

Simon, H.A. (1991). 'Bounded Rationality and Organization Learning', *Organization Science*, 2: 125-134.

Simon, H.A and Newell, A.(1972). *Human Problem Solving*. Englewood Cliffs: Prentice-Hall.

Sproull, L. S. (1981). 'Beliefs in Organizations', in Nystrom and Starbuck (1981), *Handbook of Organizational Design*. Oxford, UK: Oxford University Press.

Stalk, G., P. Evans and L. E. Shulman (1992). 'Competing on Capabilities : the New Rules of Corporate Strategy', *Harvard Business Review,* March-April : 57-69.

Szulanski G. and Winter S. (2002) 'Getting it Right the Second Time', *Harvard Business Review,* January: 63-69.

Teece, D.J. (1986). 'Profiting from Technological Innovation', *Research Policy*, 15: 285-305.

Teece, D.J., Rumelt R., Dosi, G., Winter S. (1994) 'Understanding corporate coherence. Theory and Evidence", *Journal of Economic Behavior and Organization* 23:1-30.

Teece, D.J., Pisano G. and Shuen, A. (1997). 'Dynamic capabilities and strategic management', *Strategic Management Journal*, 18: 509-33; a revised version is published in Dosi, Nelson and Winter (2000).

Teece, D. J., G. Pisano and A. Shuen (2000). 'Dynamic Capabilities and Strategic Management', in Dosi et al. (Eds.)(2000).

Tidd, J., Bessant J., Pavitt, K. (1997). *Managing Innovation,* New York, Wiley.

Tirole J. (2001). 'Corporate Governance' *Econometria* 69:1-35.

Tushman, M., and Anderson, P. (1986). 'Technological discontinuities and organization environments', *Administrative Science Quarterly*, 31: 439-65.

Von Hippel, E., and Tyre, M.J. (1995). 'How learning by doing is done. Problem identification in novel process equipment', *Research Polic*y, 24: 1-12.

Warglien M. (1999). 'The evolution of competencies in a population of projects: a case study', Sant'Anna School of Advanced Studies, LEM, Pisa, Italy: *Dynacom working paper series.*

Weick, K. E. and Westley, F. (1996). 'Organizational Learning: Affirming an Oxymoron', in S. R. Clegg, C. Hardy and W. R. North (Eds.), *Managing Organization*s, Sage Publications, London.

Williamson O.E. (1975) *Markets and Hierarchies: Analysis and Antitrust Implications*, New York, Free Press

Williamson O.E. (1985) *Economic Institutions of Capitalism*, New York, The Free Press

Williamson O.E. (1999) 'Strategy Research: Governance and Competence Perspective' *Strategic Management Journal,* 20: 1087-1108; now in Foss and Mahnke (eds.) (2000) *Competence, Governance, and Entrepreneurship*, Oxford U.P.

Winter, S.G. (1982). 'An Essay on the Theory of Production', in H. Hymans (Ed.), *Economics and the World around It*, Ann Arbor, University of Michigan Press, pp. 55-93.

Winter, S.G. (1987). 'Knowledge and Competencies as Strategic Assets' in Teece, D. (ed.) *The Competitive Challenge*, Cambridge, Mass., Ballinger.

Winter, S.G (1986), 'The Research Program of the behavioral theory of the Firm: orthodox critique and evolutionary perspective' in B. Gilad and S. Kaish (eds.) *Handbook of Behavioral Economics*, Greenwich, CT, JAI Press

Winter, S.G. (1995) 'For Rs of Profitability: Rents, Resources, Routines, and Replication' in Montgomery (1995).

Winter, S.G. (2000) 'Toward and Evolutionary Theory of Production' *Sant'Anna School of Advanced Studies,* Pisa, *LEM Working Papers*, forthcoming in Dopfer (2003).

Zollo, M. and Reuer, J.J. (2001) 'Experience Spillovers across Corporate Development Activities', Wharton School Center for Financial Institutions, University of Pennsylvania, *Center for Financial Institutions Working Papers*