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TIME, SPACE AND CONSTRUCTIVE CAPABILITIES.
TRANSLATING PARADOXICAL INNOVATION
REQUIREMENTS INTO COMPREHENSIVE
ORGANIZATIONAL ARRANGEMENTS: A SOCIO-
COGNITIVE PERSPECTIVE
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Time, Space and Constructive Capabilities.

Translating paradoxical innovation requirements into comprehensive organizational arrangements: a socio-cognitive perspective.

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Abstract

When innovating, interaction is beneficial for (1) exploring problem definition spaces and (2) exploiting them. The social processes in which both activities unfold, display paradoxical characteristics which can be addressed by introducing space and time as (organizational) design variables. Complementary arrangements that connect space and time are needed in order for such organizational forms to be sustainable. Propositions in this respect, which build directly on the specific nature of knowledge creation processes, are elaborated.

Introduction

"Innovation is not the isolated entreprise of a single entrepreneur. It is a collective enterprise that centers on a network of relationships that bind together people and their organizations in order to transfom an abstract concept into reality. Thus, the management of innovation involves developing and maintaining a variety of cooperative relationships from inside and outside an organization." Ring, P. and Van de Ven A. (1989).

Within the extant literature on organizing and managing innovation activities, the multiple roles of communication and interaction have been focal points of attention. The seminal study of Pelz and Andrews on scientists and engineers concluded in the late 1960s with respect to communication: 'the more the better' (Pelz and Andrews, 1967, p 52). Likewise, the influential work of Thomas Allen underscored the importance of communication in relation to effectiveness within innovative environments. Interaction turns out to be of major importance when designing and implementing suitable problem definition and problem solving strategies. Those findings have been further corroborated and refined by numerous studies addressing the importance and the role of communication within R&D and innovation settings. Important contributions include – amongst others – the work of Allen (1966, 1977), Tushman (1977, 1978), Tushman and Katz (1980), Katz and Allen (1986), Ring and Van de Ven (1989), Angle (1989) and Ancona and Caldwell (1992a,b). The influential work of Nonaka, and Takeuchi (Nonaka 1990; Nonaka 1994; Nonaka and Takeuchi 1995) again underscores the crucial and central role interaction and collaboration play in the context of knowledge creation processes. Likewise, the overview on new product development processes developed by Brown and Eisenhardt (1996) assigns a central role to communication and interaction, irrespective of the research perspective considered.

However, some of the findings originating from this research indicate that the role and impact of communication and interaction is not without its particularities. Allen (1977) advanced the notion of gatekeepers in order to explain why more communication with external partners did not always translate into better performance. Dougherty (1992) argued that the presence of 'interpretive barriers' can be seen as one of the main difficulties cross-functional R&D teams face. Sub-optimal performance results from not being able to transcend such differences. Ancona and Caldwell (1992a) were confronted with puzzling relationships between communication patterns, team composition and the performance of R&D teams. Likewise Fiol (1994) and more recently Keller (2001), have pointed out that functional diversity is beneficial for technical quality but is at the same time associated with diminishing levels of group cohesiveness.

In this paper, we will argue that these puzzling findings can be better understood by acknowledging the dual role interaction can – and should – play in relation to knowledge creation, a phenomenon present – by definition - in any innovative trajectory. This dual role can be related to the distinction made by March (1991) between exploitation and exploration. Whereas exploitation refers to activities such as 'refinement, efficiency, selection and implementation', exploration is best captured by notions like 'search, variation, experimentation and discovery' (March, o.c.,p.102). Strong similarities can be noticed with the notions of divergent and convergent

behaviour as outlined by Van de Ven, Polley, Garud and Venkatraman (1999). We argue that the social dynamics in which both types of activities are embedded not only expose characteristics of a different, but even of a paradoxical nature. In order to arrive at this conclusion, we first elaborate on the dual role of interaction within innovation settings by adopting a socio-cognitive perspective. A detailed scrutiny of the social dynamics in which both types of activities[1] (i.e. exploration and exploitation) unfold, allows us to outline their paradoxical nature. This paradoxical nature will be used as a starting point to develop specific propositions on how to organise R&D activities that allow both exploration and exploitation to occur. Those organizational arrangements are seen as a condition sine qua non to arrive at the creation of dynamic capabilities (Eisenhardt and Martin, 2000) which bear the potential of resulting in a continuous stream of innovations (Tushman, Anderson and O'Reilly, 1997).

THE DUAL ROLE OF INTERACTION

The observation that the relational processes in which professional activities are embedded affects directly the scope and the nature of the knowledge creation processes taking place in the organization, can be traced to the seminal work of Argyris and Schön (Argyris and Schön, 1974; for an overview, see also Argyris, 1992). The differences in variables that guide and govern interaction between people within organisations - described as model I and model II – have a direct influence on the nature of the learning processes that occur. This relational emphasis as to the processes of knowledge creation has since then been a recurring theme in the work of scholars who adopt a situated activity or community perspective (see for instance Engeström, 1987; Chaiklin and Lave, 1993; Lave and Wenger, 1991; Brown and Duguid, 1991, 2000; Wenger, 1998; Blackler et al, 1999; 2000) as well as within the emerging domain of knowledge management (see for instance Nonaka, 1990, Nonaka and Takeuchi, 1995). Several of these authors have advanced the idea of interaction fulfilling a dual role (e.g. starting with Pelz and Andrews, 1967) which can be understood by introducing the notions of exploration and exploitation as developed by March (1991). In the next section, we will first elaborate on this dual view on interaction. Then, we highlight more in depth the social dynamics in which both activities unfold. To this end, we introduce insights originating from developmental psychology. We argue that both activities imply social processes that have characteristics of a different and even paradoxical nature[2]. As a consequence, both types of activity differ in terms of proximity effects and the time span needed for the preparatory and execution phases that occur throughout each of them. The paradoxical nature of both activities, i.e. exploration and exploitation, directly points to the need to better understand as to how to organize innovation including both the exploratory and the exploitative dimension. In the final section, we will advance several propositions related to the implications for organizing innovation that build on the nature of the knowledge creation processes outlined and in which the use of time and space figure explicitly as organizational design variables.

The Dual Role of Interaction: Exploitation and Exploration.

Exploitation. Joint and integrated efforts are needed in order to fill in the 'missing bits, bytes and links' of information during processes of knowledge creation. As Pelz and Andrews already remarked; 'frequent contacts and interaction are beneficial when it comes to solving problems by adding pieces to the puzzle or by detecting errors one overlooks because of being too engrossed with the problem at hand'. (o.c. p.52). Faced with (difficult) problems, people start to work and to discuss with one another. This behaviour generates an inherently social process that results in and benefits from interaction.

In a more technical sense, one might state that interaction is instrumental in handling uncertainty. In line with the work of Schrader, Riggs and Smith (1993), we use a definition of uncertainty as "a characteristic of a situation in which the problem solver considers the structure of the problem (including the set of relevant variables) as given but is dissatisfied with his or her knowledge of the values of these variables" (Schrader, Riggs and Smith, 1993). As R&D professionals and their teams are continuously confronted with situations characterised by high levels of uncertainty, the ability to involve knowledgeable colleagues in this endeavour is beneficial for the NPD process. This has been illustrated abundantly by numerous scholars (see for instance Allen (1977); Tushman and Katz (1980); Tushman (1978); Van de Ven et al. (1989); Brown and Eisenhardt (1996) Orr, 1996; Brown and Duguid, 1991, 2000).).

Exploration. However, joint activity does not limit itself to filling in 'missing bits, bytes and links'. New product development processes are aimed at creating novel products, processes and/or services. Here too, interaction plays a major role. As pointed out by Pelz and Andrews, contacts can be useful to provide intellectual stimulation and hence to generate new ideas: "jostling a man out of his old ways of thinking about things" (o.c., p. 52 & 53).

Schön (1963) drew our attention to the fact that novel solutions and insights stem from problem-defining and problem-solving interaction sequences, whereby multiple opinions and viewpoints become integrated into a new synthesis or artifact. Underlying this 'displacement' of concepts and experiences, social processes figure prominently. Likewise, work within the domain of sociology of science and technology points to the social dynamics in which the developmental processes of new scientific knowledge and/or technological artifacts are embedded, including their conflicting or 'revolutionary' nature. Fleck's early work (1934) inspired Thomas Kuhn (1962), who identified the role of social networks in which paradigms originate and flourish, including their sometimes conflict-ridden and revolutionary character. These insights were further extended and refined by Mulkay (1968) by examining the work of Pasteur and the emergence of new medical disciplines. Ben-David and Collins (1966) point to similar dynamics when documenting the genesis of psychology as a scientific discipline. More recently, the analyses by Constant (1980) on the development of the turbojet, by Thomson on the development of mechanized shoe production (1988), or by Burgelman

(1994) on Intel's exit from the DRAM-industry, all point to technological paths and directions taken or to be taken as the result of interactions between different communities of theory and practice. Along similar lines, Bijker's social-constructivist approach (1995) to decision-making in technology development and technological evolution highlights a process where the confrontation of beliefs, routines and artifacts characteristic of and held by various communities is continuously re-evaluated, renegotiated and finally fused into a synthesis on which a new community coalesces.

Interaction during new product development processes thus implies generating and addressing the differences in opinion and interpretation between the actors involved and their translation into a novel synthesis. Stated otherwise, interaction is not only instrumental for reducing uncertainty; though, for handling ambiguity as well. Ambiguity implies an unclear situation with respect to the problem-definition and hence problem-solving space considered as relevant by the actors involved. In more formal terms, ambiguity relates to "the need for determination at the level of the relationships between the variables and the problem-solving algorithm (level one) or even at the level of the relevant variables (level two)" (Schrader, Riggs and Smith, 1993). Dealing with ambiguity ideally results in the genesis of a novel synthesis whereby the variety of ideas that prevail among a variety of involved actors are re-interpreted, re-negotiated and finally fused into the new synthesis. In other words, handling ambiguity implies acknowledging and addressing differences in opinion about what might hold true or what might be relevant to consider or to integrate during certain development trajectories. As a consequence, ambiguity extends beyond the idea of information exchange in order to fill in gaps present in an existing framework; it relates directly to the creation of new frameworks or knowledge. Whereas the relationship between information, information exchange, and uncertainty has received widespread attention and as a consequence, has been much better articulated, it can be observed that handling uncertainty, or addressing 'information asymmetries', is only one side of the coin. One needs to address 'interpretation asymmetries' as well (Van Looy, Debackere and Bouwen, 2001). These relate directly to the presence of ambiguity within the innovation process; actors belonging to different communities are confronted with finding ways to handle a variety of beliefs, evaluation routines and enabling artifacts. In March's terms, exploration as well as exploitation is – or should – be an intrinsic part of any truly innovative effort and is needed for any system in order to survive (March 1991, 1996). In the next section, we argue that the complexity[3] of interaction during innovation trajectories stems directly from this duality.

A closer Look at the Social Processes in which Exploitation and Exploration unfold: Unraveling a Paradox.
"If social interaction is of particular importance in development, it is to the degree that conflict arises..." (Doise and Mugny, 1986, p. 101)

As (inter-)action and structure imply each other recursively (Giddens, 1986), a better understanding of the social dynamics characteristic of both modes of knowledge creation (i.e. explorative versus exploitative knowledge creation), will allow to assess in more detail the relevance of organizational arrangements and routines that will either favor or constrain them. Within the next section, we argue that whether interaction is

oriented towards exploitation or exploration does make a difference in terms of the characteristics of the social processes in which these activities are being embedded. Exploitation benefits from homogeneity or similarity, whereas exploration requires heterogeneity or dissimilarity. Consensus and hence the confirmation of identities are intrinsically linked to exploitation, while conflict and redefining identities are the essence of exploration. We will develop these insights in detail in the next sections. As a consequence, we will develop the proposition that the relational field in which both activities are rooted have characteristics of a paradoxical nature: what is beneficial for the one hampers the other and vice versa. To clarify this point, and as an introduction to this section, we have a brief look at the N.I.H. syndrome as documented and described by Katz and Allen (1982).

The social dynamics underlying exploitation: The Not Invented Here syndrome revisited. Katz and Allen (1982) examined the relationship between average project member tenure and performance of 51 R&D projects. The results of this classical study are well known: an initial increase in performance is followed by a strong decline after a period of three years during which project members have worked together. While the initial growth in performance can be related to an improvement in cohesive working relationships and team building, the sharp decline is more puzzling. Katz and Allen clearly demonstrated that lack of communication is a key ingredient in explaining the NIH phenomenon: communication with the most relevant outside actors declines significantly over time. The introduction of other control and moderating variables, relating to the tenure within the organization, age or even competence levels of the team members, does not alter this fundamental observation. These findings suggest that teams that develop certain routines in terms of cooperation and communication tend to orient themselves less and less towards relevant parties outside the project team. Such an inward orientation results in a reduction in effectiveness. Additional research (Moenaert et al., 1996) has further pointed to the increased likelihood of information from outside the team being ignored as the newness of the information is higher. As Katz and Allen (1982) further noticed: "While the regression relationship between project performance and mean team tenure is an inverted U-shaped curve, its two major component shapes are very different. The first component rises rapidly with mean tenure showing the positive effects of 'team building'. Team members develop better understanding of one another's capabilities, better understanding of the relevant technologies, better working relationships, etc. and such improvements are reflected in rapidly increasing performances." However, this 'team-building effect' gradually tapers off, and as a result, its gradient performance diminishes. The authors relate this performance decline to a reduction in communication: "At the same time, the exponential decay has set in, resulting in part from reduced communication. Between these two component curves lies the area for potentially influencing project performance. As we gain additional understanding of the reasons underlying this exponential decay, policies can be implemented to counter such effects in order to have the relationship between mean project tenure and performance approximate more closely to the team-building curve" (Katz and Allen, p. 305-306).

However, one could argue that the same phenomenon that creates the observed positive performance effects underlies the subsequent performance decline. Developing

better or more cohesive working relationships – based on a better appreciation of skills and capabilities – results in patterns and routines that 'exhaust' diversity over time. This phenomenon was raised by Festinger almost half a century ago: "The more cohesive the group, that is the more friendship ties there are within the group and the more active the process of communication which goes on in the group, the greater will be the effect of the process of communication in producing uniformity of attitudes, opinions and behavior" (Festinger et al., 1960; p. 175). Katz (1997) pointed out that groups working together over longer time frames might evolve from healthy levels of self-reliance towards problematic levels of closed-mindedness whereby novel situations and approached are either ignored or forced into known categories. A pattern of increasing isolation sets in characterized by selective exposure; group members tend to communicate only with those whose ideas and outlooks are in accord with own interests, needs and attitudes.

Similar phenomena have been amply documented within the innovation literature (see for instance, Stork, 1991; Moenaert & Souder, 1996; Moenaert & Caldries, 1996) as well as the literature focusing on team effectiveness (for an overview based on team formation and effectiveness, see Bouwen and Fry (1996) and Wheelan and Hochberger (1996)). Likewise contributions related to the notion of trust as a necessary ingredient of collaborative relationships (e.g., MacAllister (1995), Lewicki and Bunker (1996)) arrive at similar conclusions. Homogeneity and similarity are found to be crucial antecedents for developing trustworthy relationships. As for innovation projects, this introduces a paradoxical challenge. On the one hand, collaborative relationships are essential for addressing the uncertainty involved in a smooth and efficient way. On the other hand, the homogeneity implied is in sharp contrast with the variety needed to arrive at novel solutions. Stated otherwise, divergent opinions and the conflicts they entail are crucial for development teams in order to arrive at the creation of *novel* products and/or services. To clarify this point, let us look in more detail at the social process underlying exploration.

Conflict as an Inherent Dimension of Exploration. It can be observed that the majority of scholars within the field of organizational behavior and management, while emphasizing the social nature of knowledge, limit themselves to processes of knowledge diffusion. Less attention tends to be paid to the social origins of knowledge creation. This becomes clear when one takes a closer look at the seminal work of Nonaka and Takeuchi. For Nonaka and Takeuchi, the essence of human knowledge creation is situated at the level of knowledge conversion[4]. This emphasis on conversion - from tacit to explicit and vice versa - tends to shift our attention away from the initial genesis of new knowledge[5]. While this suits a model of knowledge creation at the *organizational* level, it contributes less to an understanding of the nature of knowledge creation processes at the micro-level; i.e., the inter-individual dynamics that result in the creation of new knowledge. In the next paragraphs we discuss some contributions from the field of educational psychology, in which interaction processes that are at the origin of (knowledge) development have been focal points of attention and whereby knowledge creation, including the development of higher mental functions, is inherently seen as a socio-cognitive process.

Within this field, a range of scholars has been advancing the idea that knowledge creation is intrinsically a socio-cognitive, situated, process. Important contributions stem from Vygotsky (1978, 1986) and Luria (1971), while the work of Doise, Mugny and colleagues (1984; 1998) empirically demonstrated the central role of socio-cognitive conflict. Vygotsky was among the first to highlight the social nature of development processes by pointing to the precedence of language over thought: "The specifically human capacity for language enables children to provide auxiliary tools in the solution of difficult tasks, to overcome impulsive action, to plan a solution to a problem prior to its execution, and to master their own behavior. Signs and words serve children first and foremost as a means of social contact with other people. The cognitive and communicative functions of language then become the basis of a new and superior form of activity[6] in children" (Vygotsky, 1978, p. 27-28). While it was Luria (1971) who demonstrated the relevance of these processes for any form of knowledge creation process, Doise and Mugny (1984) demonstrated the central role of socio-cognitive conflict in an empirical way.

Doise and Mugny start from a social definition of intelligence that incorporates but goes beyond a Piagetian notion of development: "While Piaget describes intellectual activity as coordination, we believe that this coordination is not only individual but to an equal extent social in nature. It is in the very coordination of his actions with those of others that the individual acquires mastery of systems of coordination, which are later individualized and internalized. ... Co-ordinations[7] between individuals are the source of individual co-ordinations and the former precede and produce the latter" (Doise and Mugny, op. cit., p. 23). By setting up a series of rigorous experiments, Doise and Mugny succeed in demonstrating the central role of conflict for knowledge creation. (for a detailed discussion of the experiments conducted, see Doise and Mugny, 1984; 1998). Prominent findings relate to the absence of superior models in order for development to happen while at the same time conflict, i.e. the presence and hence the confrontation of different approaches turns out to be essential to arrive at the integration into a new synthesis. When exposed to such conflicts, the majority of participants acquired insights that resulted in a novel synthesis, which resolved the conflict. This was not only the case when an expert introduced correct models. When no such correct models were advanced, the presence of conflict was in itself a sufficient condition for arriving at novel insights: "The novel contribution demonstrated by the present experiment is that a similar model[8] leads to substantial progress, and to generalization equivalent to that with a correct model. Thus restructuring can result from two 'centrations' at a 'lower' level. Such a restructuring results directly from the subject's attempt to resolve the conflict between him and the collaborator.... If social interaction is of particular importance in cognitive development, it is to the degree that socio-cognitive conflict arises. It is not necessary to demonstrate the appropriate response[9] explicitly, s/he constructs it in the interaction..." (Doise and Mugny, 1984, p. 101).

Hence, in order to arrive at novel insights and knowledge, coordination or interaction between individuals is needed and should be characterized by conflict. Such conflict builds on opposing viewpoints and hence presupposes some heterogeneity[10]. The recent work of Doise and Mugny (1999) even implies that this divergence in

opinions needs to be made explicit, a process labelled 'social marking', in order for development to happen.

Besides social marking, knowledge creation processes of this nature are path-dependent and require extended time frames. The idea of 'path-dependency' has been elaborated extensively by Vygotsky who advanced in this respect the notion of 'zone of proximal development' (Vygotsky, Mind in Society, p.86). With this notion he refers to the relationship between existing knowledge and the extent to which new knowledge can originate and become internalized. What is achievable in terms of mastering new knowledge depends on the level of prior development. As a consequence, a picture emerges of situated, specific, trajectories (Piaget, 1968; Breuer, 1994; Brown and Campione, 1994) of a path dependent nature[11] (Garud and Karnoe, 2001): "If we think of learning as a trajectory, certain points on that path, whose coordinates are concepts and skills, must be traversed successfully before other can reached. Thus, what people can readily learn depends to a great extent on what they already know; prior knowledge enables or impedes future learning" (Breuer, 1994, p.274). As such, this notion of 'proximal development' should be understood in conjunction with the difference between learning and development as outlined by Vygotsky. Learning and development are seen by Vygtosky as closely interlinked, but not identical. Learning, situated in the interaction depicted above, results in (mental) development and hence sets in motion a variety of developmental processes. Therefore, the development process can be seen as 'lagging' behind the learning process; the unity of learning and development implies that learning processes are converted into development processes, not that they coincide. Such processes characterize the transformation of an interpersonal process into an intra-personal one[12]; spanning both activities implies a considerable amount of development activity[13] and hence time. Those development activities take longer the more novel the idea.

Respecting the role of time during those processes becomes even more prevailing and at the same time hazardous since one has to deal with the presence of 'older truths'. During those incubation and development activities, one needs to find ways to relate 'old to new' (Fry and Bouwen, 1986, Dougherty, 1996). A complex matter[14] as observed by William James (1907) almost a century ago, when discussing the processes related to the introduction of novelty, called 'new truths': "An outrée explanation, violating all our preconceptions, would never pass a true account of novelty... The most violent revolutions in an individual's belief leave most of his old order standing. Time and space, cause and effect, nature and history, one's own biography, remain untouched. New truth is always a go-between, a smoother-over of transitions. It marries old opinion to new fact so as ever to show a minimum of jolt, a maximum of continuity. We hold a theory true just in proportion to its success in solving this problem of maxima and minima. ... The point I now urge you to observe particularly is the part played by the older truths. Their influence is absolutely controlling. Loyalty to them is the first principle - in most cases it is the only principle; for by far the most usual way of handling phenomena so novel that they would make for a serious rearrangement of our preconceptions is to ignore them altogether, or to abuse those who bear witness for them" (W. James, 1907, p. 25).

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These dynamics make it understandable why bringing in new perspectives is often a hazardous enterprise, and in any case, a time consuming one. James' account made clear that incorporating novel ideas touches upon the notion of identity; persons 'as a whole' are involved in such processes. As pointed out by scholars like Brown and Duguid (1991), Schein (1996), Orr (1996), and Wenger (2000), knowledge creation processes imply identity formation, and hence transformation. Rethinking one's own premises and preconceptions of what holds true introduces additional levels of profoundness in R&D activities. Recently, Brown and Starkey (2000) convincingly argued that learning indeed implies anxiety-provoking identity changes and hence gives rise to individual – and collective – defensive actions aimed at maintaining present levels of self-esteem. The likelihood of occurrence of such phenomena is directly related to the extent that knowledge creation processes are of a more exploratory nature On top of that, it can be noted that both the activities connected to incubation and to fusing novel ideas with older 'truths' – including dealing with the accompanying tensions and resistance - tend to coincide during the early days (which may last for a long time period stretched over several years) of the conception of a novel synthesis. Not devoting enough time to this issue increases the risks of ending up favoring de facto exploitation over exploration.

In Figure 1 we now summarize the main characteristics of the dual, paradoxical, forces at work. Exploitation benefits from homogeneity, whereas exploration presupposes heterogeneity; exploration implies conflict and a redefinition of identities, while exploitation thrives on consensus and can be seen as identity confirming.

Insert Figure 1 about here

Hence, innovation activities, by their very nature, display dual and paradoxical requirements in terms of interaction. The polarities outlined, pertaining to the social dynamics in which exploitation versus exploration unfold, can be seen as one of the root causes of the paradoxical nature of innovation strategies firms are being confronted with. In line with the notion of creative destruction, advanced by Schumpeter in the mid '30s, several scholars have pointed to the tensions organizations encounter during innovation journeys: tensions experienced especially by 'incumbent firms' as they have put in place multiple resources and capabilities aimed at exploitation. Abernathy (1991) argued that it was almost impossible for an organization to be simultaneously creative and productive. In addition, both activities do differ in terms of their contribution to the competitive advantage of a firm, depending on the stage a technology and/or industry is finding itself in: whereas creativity can be seen as highly relevant during the pre-dominant design – exploration oriented - phase; productivity dominates during post-dominant design - exploitation oriented - phases (Abernathy and Utterback, 1978; Anderson and Tushman, 1991). In line, Ghemawat (1991), adopting a game-theoretic perspective, pointed to the irreconcilable nature of "flexibility" on the one hand and "commitment" on the other hand. As long as exploration is a priority, one needs to remain flexible from an organizational point of view as well as to the objectives pursued. Once committed, i.e. once a firm has adopted a determined exploitation trajectory, flexibility is at odds with the dominant mode of organization required for exploitative purposes. Ghemawat argues that this duality "flexibility" versus

"commitment" is extremely difficult to handle and to maintain simultaneously within an organization. More recently, Benner and Tushman (2003) reminded us of these tensions when comparing the dominance of process management activities with the prerequisites of combining exploitation and exploration.

Hence, when designing and implementing innovation strategies, organizations need to find ways to handle those paradoxical requirements. At least this is, if they want to achieve objectives in line with exploration and exploitation simultaneously rather than sequentially. In the next paragraphs we will develop relevant propositions in this respect. These propositions build directly on the nature of the polarities outlined above while at the same time acknowledging their paradoxical nature. It is obvious that insights on how to handle paradoxes turn out to be highly relevant here.

HANDLING PARADOXES

As became clear, interaction during innovation trajectories contains paradoxical ingredients. Paradoxes can be seen as situations in which contradictory elements operate simultaneously. This simultaneity results in situations in which choosing one side occurs at the expense of the other and vice versa (Hampden-Turner, 1990); Quinn and Cameron (1988); Janssens and Steyaert (1999); Lewis (2000)).

With respect to coping with paradoxical requirements, several strategies have been proposed. Poole and Van de Ven (1988) advance four generic strategies to handle paradoxical situations. A first approach consists of accepting the paradox and using it constructively, whenever scrutinizing the polarities can result in refinements and additional insights. The next approach attempts to clarify the levels of analysis and, by introducing different levels (e.g., micro/macro), paradoxical situations can be resolved. As such, this approach can be seen as a form of 'spatial' separation. A third approach consists of introducing time: temporally separating the two levels can also lead to resolving the existing tensions. Finally, new terms can be introduced to resolve the paradox.

Steyaert and Janssens (1999), basing their work on an exhaustive overview of relevant literature, arrive at six different strategies. The first three, 'sequencing', 'layering' and 'helix type' approaches, acknowledge and 'accept' the dualities present. The other three strategies, consisting of introducing 'interpenetration' concepts, 'reframing' and the use of 'third parties', aim at going beyond the polarity. To clarify the latter three strategies first, it should be pointed out that they all imply the introduction of a third element; either a new concept which facilitates a reconciliation of the duality (interpenetration), a new frame of reference (reframing) or a new person who in turn can lead the way to cognitive and or relational restructuring. In practice, one often observes the simultaneous presence of all three different elements (concept, frame, party).

Sequencing can be seen as an approach whereby attention shifts over time and hence resembles the idea of temporal separation advanced by Poole and Van de Ven. Sequencing can take on the form of extreme shifts from one pole towards the opposite pole (often accompanied by 'crisis' situations) or can imply more planned, gradual

transition paths. The layering strategy involves developing new capabilities while at the same time reinforcing past strengths. Hence, dualities are managed by building new complementary capabilities on top of the existing, opposite capabilities. Finally, helix type approaches imply a combination of sequencing and layering, combining the use of both time and space in order to design managerial solutions for handling paradoxical requirements.

At first sight, resolving paradoxes by arriving at a new encompassing concept or view might be looked upon as a 'Holy Grail'. The inherent nature of innovation activities however leads us to conclude that limiting managerial design efforts to this option is too narrow a view. The specific nature of knowledge creation processes, encompassing exploration and exploitation, limits the applicability of this 'paradox resolving' strategy given the extended timeframes exploration inevitably entails. This does not imply that we advocate discarding this strategy for managing innovation; in many cases conflict management implying the introduction of a third element, turns out to be instrumental in achieving progress. The effectiveness of which can even be enhanced by adopting blends of different styles which reflect the paradoxical forces at work as illustrated by Lewis et al. (2002).

However, it should be noted that this strategy implies proximity in terms of time and space, favoring exploitation over exploration. By adopting systematically a 'here and now' (problem-solving) approach, organizations will achieve only partially the multiple objectives any innovation strategy entails. This is the first argument we develop in the next section. By looking in more detail at the recent debate on speeding up the new product development process, combined with the arguments developed before, we conclude that speeding up development processes might result in a price tag, labeled novelty. In order to arrive at more encompassing or comprehensive strategies, covering both exploitation and exploration, time and space need to be taken into account explicitly as design variables. This is the second argument we develop in the next section. As a consequence of the introduction of time and space as design variables, organizing R&D activities will lead to the introduction of a variety of organizational forms. This brings us to the specific points of attention those forms of organizing entail. As they imply extended investment efforts and introduce higher levels of organizational complexity, we will argue that additional value creation needs to be realized in order for these modes of organizing to become sustainable. Hence, capabilities oriented towards such additional value creation become a necessity. In this respect, we will advance specific arguments and propositions that directly build on the nature of the knowledge creation dynamics outlined above and indicate how handling these processes can become translated into relevant organizational practices aimed at creating such additional value creation.

IMPLICATIONS FOR ORGANIZING R&D ACTIVITIES: TIME, SPACE AND CONSTRUCTIVE CAPABILITIES.

Acknowledging Implied Trade Offs. Recently, a host of scholars has stressed the importance of speed in relation to new product development processes. Important contributions in this respect are to be found in the writings of Iansiti (1995, 1997),

Iansiti and MacCormack (1997), Verganti, MacCormack and Iansiti (1998), MacCormack A, Verganti R, Iansiti M. (2001) Brown and Eisenhardt (1997) and Eisenhardt and Tabrizi (1995). Major ingredients of the models developed include 'learn-adapt cycles' or 'iterative' approaches (Verganti, MacCormack and Iansiti, MacCormack 1998) and 'experiential' ways of working' (Eisenhardt and Tabrizi, 1995). These imply high levels of customer involvement, frequent cycles of concept (re)design and development, consisting of multiple iterations and extensive testing. The central assumption behind these adaptive models is best described as a reliance on a 'philosophy of fast learning' (Iansiti, 1997) or 'fast organizational processes' while at the same time, there still is little "understanding in the organizational literature of how and why processes are fast" (Eisenhardt and Tabrizi, 1995, p. 107).

While we agree on the importance these authors attach to 'speed' for many of today's organizations, we wish to present some caveats with respect to the nature of and hence the implications of what constitutes fast processes, based on how and when they are more likely to be achievable. Given the arguments developed in the previous section, it will come as no surprise that we advance the idea of 'homogeneity' as a crucial enabler for achieving fast progress. The concepts and findings advanced by the authors mentioned above seem to confirm this interpretation. Verganti, MacCormack and Iansiti (1997) point to the relevancy of devoting considerable resources to the development of a "product architecture which allows the information generated during the process to be easily integrated into the design as development proceeds" (op. cit. p. 1064). The authors suspect that speed can only be achieved if such a shared view on the product architecture is present. Stated otherwise, and framed within the distinction coined earlier, the dynamics reported in this study seem to relate foremost to situations in which exploitation prevails[15].

Similarly, the propositions advanced by Thomke and Fujimoto (1997, 2000) with respect to the role of 'front-loading' and its impact on shortening product-development time, point in the same direction. The explicit 'problem-solving' approach adopted by these authors implies a consensus with respect to problem-definition activities: "... we view problem-solving as an iterative process, driven by trial-and-error experiments *that are guided by knowledge of underlying relationships between cause and effect*" (op. cit., 2000, p. 130, italics added). Likewise, the approaches advanced to achieve effective front-loading presupposes similarity at the level of problem-solving algorithms. Both the idea of project-to-project knowledge transfer and the introduction of rapid problem-solving approaches, in which advanced design and development tools and technologies figure prominently, assume a commonality at the level of the underlying problem-solving approach. Relevant variables and the relationships among them are known, indicating again that such organizational arrangements are highly relevant for addressing knowledge creation of an 'exploitation' nature rather than of an 'exploration' one.

Acknowledging the underlying knowledge creation dynamics and their constituting relational field immediately reveals what tends to become neglected when adopting those practices on a large scale. When extended to all R&D activities, no room is left for activities of a more exploratory nature. The creative process implies, based on its 'conflictual conception', preparatory and incubation activities characterized by an unpredictable timeframe. The occurrence of those 'digestive' time periods as an inherent

part of exploration needs to be taken into account explicitly in order to arrive effectively at maturation. As Shapero (1985) and Utterback et al. (1992) have pointed out, valuable new ideas and artifacts do not fall from heaven; they come into being only after intensive preparation activities and after a period of incubation. Crawford (1992) reminded us of the hidden costs to be encountered in this respect[16]; these can be directly related to attempts to compress exploration processes, which simply tend to disappear under such compression as pointed out recently by Benner and Tushman (2003). Likewise, March (1991) demonstrated how this compression approach jeopardizes the medium and long term survival of any organization; an issue that becomes all the more precious, the more company relevant technologies are in flux and transformation as illustrated in detail by Christensen and Oversdorf more recently (Christensen and Oversdorf, 2000, Christensen, 1997).
Based on these reflections, we develop the following propositions:

- The effectiveness of innovation strategies directly depends on the extent to which they encompass both exploration and exploitation.
- The paradoxical characteristics of the relational field (rooted in the need for conflict versus consensus) in which both exploration and exploitation unfold, imply that when organizing in order to achieve both objectives, trade-offs are being encountered: speed and efficiency come at the expense of novelty and vice versa.
- The effectiveness of innovation strategies will depend on how these trade-offs are being matched by comprehensive organizational arrangements.

Time and Space as Critical Design Parameters in Innovation Settings. In order to organize innovation activities in a comprehensive way - i.e. encompassing both exploration and exploitation - 'design variables', allowing for a variety of practices, need to be introduced. The work on paradoxes as outlined above is illuminating and illustrative in this respect. Both time and space figure prominently in the action strategies that can be deployed; an issue implicitly addressed by authors like Brown and Eisenhardt (1997), Tushman, Anderson and O'Reilly (1997) as well as Christensen and Overdorf (2000)).

Using time and (social) space will allow addressing exploration and exploitation within (partly) different social configurations and/or at different moments in time. Examples of structured attempts at combining time and space are found in the systematic use of project portfolios and roadmaps, a direction pointed to by Brown and Eisenhardt (1997). Roadmaps allow for the creation of "links in time; organizational practices that address past, present and future time horizons and the transitions between them" (Brown and Eisenhardt, op. cit. p. 29; see also Goodman et al., 2001). Extending insights beyond the project level in this manner, presents a fruitful way to transcend the paradoxical requirements faced at the project level itself. Likewise, project portfolios, in as far as they mediate between both types of activities, can support the design of more inclusive arrangements.

Approaches that combine both - in a moderate, or even discrete, way - are to be found in the notions of funnels on the one hand and bootlegging on the other. The concept of the innovation funnel with its fuzzy front-end and the ensuing aggregate project plan, tries to reconcile explicitly both exploration and the exploitation aspects by

placing them within a longitudinal process (Zirger & Maidique, 1990, Wheelwright & Clark, 1992). By combining "filtering" and "tunneling" innovation opportunities, management practice explicitly recognizes the need for reconciling a more open, exploratory mode of action with a more closed, planned mode of exploitation.

In addition, R&D management has since long recognized the need to allow its researchers to 'bootleg', giving them the opportunity to pursue ideas and experiments outside the normal lines of "planned" research within the organization. Bootlegging indeed has become one of the main informal mechanisms managers can deploy in order to shield and stimulate the time-consuming, highly ambiguous and unpredictable processes of creative, inventive activity from detailed budgetary and progress scrutiny. Such approaches are of particular relevance during the early stages of technology or R&D trajectories. Hence, bootlegging as an organizational process to cope with the exploratory, ambiguous nature of emerging technological programs should be fully taken into account when dealing with the paradoxical nature of exploration versus exploitation. (Rappa and Debackere, 1994; Debackere et al. 1996; Danneels, 2002). This "bootlegging" phenomenon is also reflected in the so-called "blue sky research time" allocated and institutionalized in quite some R&D labs.

Finally, introducing considerable amounts of distance both in time and social space can be appropriate, resulting in arrangements that cross organizational boundaries. According to Christensen and Overdorf, an external organizational form like a spin-off, is seen as the mechanism "par excellence" companies can rely on to achieve their more disruptive innovation activity at certain points in time (e.g. Christensen, 2000). Likewise, Eisenhardt and Martin (2000) point out the role external alliances might play in order to install dynamic capabilities. As outlined by Roberts and Berry (1986), the extent of familiarity with the knowledge involved is guiding in this respect: the relevance of adopting this approach increases as R&D activities are of a more exploratory nature, compared to the existing stock of knowledge, competencies and routines. Stated otherwise, the greater the distance between new R&D activities and the existing knowledge or competence base, the more explicit time and space become as organizational design variables. Hence, R&D strategies aimed at achieving both exploitation and exploration require 'playing' with time and space. In Figure 2 we show the different strategies discussed, within a time/space framework as well as their counterparts at the level of organisational practices.

Figure 2 about here

Ambidextrous organizational forms. Introducing time and space however pushes into the direction of hybrid organizational forms, whereby different parts of the (R&D) organization, embrace arrangements of a very different nature, reflecting the distinction between exploration and exploitation. In this respect, Eisenhardt and Tabrizi (1995) made a clear distinction between 'compression strategies' on the one hand and 'experiential strategies' on the other hand. In line with the arguments outlined above, the analysis of Eisenhardt and Tabrizi reveals that there is in fact no single way to be effective. The efficacy of one approach over the other is seen as dependent on the type of task. Compression tactics seem to be more effective in certain environments and

circumstances, while more experiential approaches suit situations characterized by high levels of volatility and fuzziness. Stated otherwise, organizational arrangements that effectively support exploration differ from the ones that are beneficial to exploitation. Brown and Eisenhardt (1997) have extended these findings into the direction of 'hybrid' structures that simultaneously and separately but in combination with each other reflect characteristics of organic and mechanic structures (Burns and Stalker, 1961)[17]. Christensen and Overdorf (2000) advance the idea of complementing 'traditional' organisational practices, via the creation of new organizational structures, spinouts and acquisitions in order to achieve the exploration oriented objectives of an innovation strategy. To the extent that companies pursue at the same time objectives of a more exploitative nature, hybrid organisational forms will therefore become a necessity. This argument has been advanced explicitly and convincingly by Nadler and Tushman (1997) and Tushman, Anderson and O'Reilly (1997) when elaborating on the idea of ambidextrous organisations. When facing the challenge of embracing incremental, architectural and radical innovation, the authors point to the relevance of designing organizations that are inherently unstable as the adequate organisational arrangements required for the different objectives are of an opposite nature. At the same time, handling those tensions requires the presence of a clear common vision within which they make sense. The presence of overarching concepts allows spanning a variety of perspectives and technical competencies, while at the same time having sufficient 'mobilising' power to result in joint action. This vision needs to be coupled to capabilities – at the senior management level - that allow balancing the tensions presented[18]. These reflections lead to the following propositions on how to handle the exploration-exploitation polarity by introducing time and space as organizational design variables:

- Comprehensive organizational arrangements imply the introduction of time and space as design variables.
- Introducing time and space as design variables results in the presence of a portfolio of practices including matrix structures complemented by paradoxical conflict management styles; portfolios and roadmaps; funnels and bootlegging, as well as inter-organisational alliances and spin out arrangements.
- Organizing R&D activities in an comprehensive way hence implies a portfolio of organizational arrangements or formats whereby different parts of the organization adopt organizational configurations of a different nature as a function of the type of activity at hand, leading to organizational forms of a hybrid nature.

Towards Constructive Capabilities: Connecting Space and time

In the final paragraphs of this paper, we outline that introducing hybrid or ambidextrous organizational forms implies specific points of attention in terms of value creation, given the presence of extended time frames and the increase in organizational complexity. In the final propositions that we advance, we argue that in order to achieve additional value creation organizations have to introduce organizing practices that build on the dynamics that characterize the dual nature of the knowledge creation process; namely social marking and designing transition paths of a stepwise nature.

The necessity of additional value creation. *'A system – any system, economic or other – that at every given point of time fully utilizes its possibilities to the best*

advantage may yet in the long run be inferior to a system that does so at no given point of time, because the latter's failure to do so may be a condition for the level or speed of long-run performance' (J. Schumpeter, The process of Creative Destruction, p.83).

Given that hybrid organizations imply the simultaneous presence of different activities - coinciding with differences in technology and market maturation - financial returns inevitably will reflect this diversified resource allocation pattern. Compared to organizations that focus (within a given time period) on the – at that moment – most lucrative part of the portfolio, hybrid organizations may tend to be inferior in terms of financial performance (see in this respect the findings of Wernerfelt and Montgomery, 1988). In addition, the idea of semi-structures or ambidextrous organizations (Tushman, Anderson & O'Reilly, 1997; Benner and Tushman, 2003), is diametrically opposed to the notion of internal consistency that has dominated the literature on organizational design over the last decades (Mintzberg, 1979; Miller & Friezen, 1986). Given such tendencies towards internal consistency, as higher levels of managerial and organizational complexity are being introduced, this will imply the need for additional resources.

Stated otherwise, hybrid or ambidextrous organizations face the risk, at least in the short term, to become outperformed by organizations with more focus, both in terms of time and space[19]. Faced with such short term performance considerations, investors and management will need good reasons not to comply with them. Such reasons can – and should - be found in creating additional value which allows compensating for adopting extended (investment) time frames and for the increase in complexity encountered. Ceteris paribus, it can be argued that such additional value creation can only stem from the resources present and the diversity they imply, shifting our attention to finding ways on how to generate returns from this diversity. In this respect, we will argue that the nature of the knowledge creation dynamics outlined above, can be informative in terms of designing *comprehensive organizational* practices.

Connecting space and time in a sustainable manner: the relevance of social marking and path specific transition trajectories for value creation. As outlined above, social marking denotes the necessity of making differences explicit in order for development to happen. Transposed to the organizational level, it implies that some forms of 'tight' coupling will become inevitable at a certain moment in time. Indeed, to the extent that different activities – related to the variety of innovative outcomes (incremental, radical, and architectural) – are being loosely coupled within an organizational architecture, the potential for cross-fertilisation within the organization becomes jeopardised. This cross-fertilisation potential is however crucial to arrive at a 'continuous' stream of innovations including innovations of a more radical nature. In addition, the absence of cross-fertilisation opportunities within the organisation will sharpen the tensions between 'old' and 'new', as one of the dynamics to be found frequently within organizations relates to older, more traditional units sabotaging the entrepreneurial units: 'today's efficiency (and incremental innovation) kills tomorrow's architectural and/or discontinuous innovation' (Tushman et al, o.c., 1997, p.6). Hence, such a loosely coupled approach might result in the perception of the overarching vision as being confusing, or even hypocrite, rather than compelling and mobilizing, at least by

those parts of the organization working on technology platforms that enter the final stages of their (technology) life cycle. Social marking, i.e. being explicit about the differences present at the organizational level, serves both ends: creating necessary conditions for knowledge creation to flourish while countering the centrifugal forces at work.

Being explicit, however, might not be sufficient. As pointed out by Tushman and colleagues (1997), the very notion of ambidextrous organizations brings along the importance of capabilities aimed at managing organizational change and transformation (Tushman et al., o.c., p.18). Such organizational change process will – periodically – be of a radical and discontinuous nature. As Schein reminded us the last decades, processes underlying organizational change of a transformational nature are complex and profound, often implying time periods that span several years, even generations (Schein, 2002), while at the same time, effects in terms of additional value creation often remain modest[20]. In this respect, the idea of knowledge creation processes as situated or path dependent – stemming directly from the notion of 'proximal development' – deserves our attention. Crucial in this respect is finding ways to relate old with new (Schein, 1996). Translating this notion towards the organizational level implies transitory trajectories whereby present capabilities become combined or integrated with novel elements. As such, ambidextrous organizations should aim their efforts primarily at creating new products or services which imply ingredients or capabilities of a *hybrid* nature, combining both existing and novel competencies and routines. When adopting such an approach, a picture emerges that starts to include both necessary and sufficient conditions for achieving additional value creation. Indeed, when striving for the development of product platforms and ranges that combine competencies in such a way, one might achieve sustainable value creation while at the same time attenuating the profoundness of the organizational transformation processes implied. Stated otherwise, such inclusive orientation might counteract potential centrifugal forces ambidextrous organizations face as transformational processes of a more stepwise nature are being envisaged In this respect, the work of Tripsas (1997) on complementary assets, the work of Galunic and Rodan (1998) regarding conditions affecting the likelihood of resource combinations of a 'Schumpeterian' nature as well as the notion of symbiosis advanced by Pistorius and Utterback (1997) provides us with indications of the relevance of such practices.

Finally, given the importance of connecting space and time, gatekeeping activities (Allen, 1997) of a constructive nature come to the forefront. As radical innovations find their roots in cross-fertilization processes in which a diversity of ideas and insights is becoming fused into a novel synthesis, pro-active gatekeeping, directed towards spanning boundaries, becomes a strategic role within ambidextrous organizations. Not only is infusing new ideas essential; ensuring effectiveness in terms of cross-fertilization -with established lines of activity- will require an active orientation from senior management over longer time periods, aimed at realizing the potential promises that the diversity of hybrid organizations contains. 'Play' or enacting 'potential spaces' (Winnicott, 1971) is necessary in this respect, however not enough. Persistence at the organizational level is needed in order to arrive at effective value creation (March, 1996, p. 435). As such gatekeeping activities do not limit themselves to infusing and

connecting new scientific or technological insights; they pertain to change and transformation processes of the organization as a whole. Enacting such processes is however, as argued, a profound[21] and often exhaustive process, requiring persistence in order to arrive at effective realization. Hence, managerial responsibility does not limit itself to creating an overarching and compelling vision, persistence and pro-activity in order for cross-fertilisation actually to happen is as needed.

Insert Figure 3 about here

Combining the notions of enacting the present diversity, designing stepwise transition paths, including hybrid products, and finally gatekeeping activities oriented towards effective realisation and implementation, all point out the necessity of installing and even institutionalizing interface management at an organizational level. In this respect managerial practice will imply both spinning out companies and re-integrating them; centralizing certain R&D activities in order to decentralize them latter and vice versa (Argyres, 1996). In the wake of the arguments put forward by Galbraith (1973), specific liaison or even transition units might be created so as to move from one state to a newly desired innovation state. Management should extend the notion of interface management from merely setting up structures and teams that manage across functions to setting up structures and teams that manage across time and space; re-inventing interface management might be a solution to the transition needs that have been articulated. As a consequence, the transitory organizational forms require and necessitate much more managerial activity and responsibility at the interfaces than has been the case up till now. Interface management (including time and space as interface design variables) thus becomes an explicit managerial responsibility within ambidextrous organizations. Moreover, such interface, change oriented, processes will be more effective, the more they are of an explicit, stepwise and at the same time persistent nature. Hence, to summarize this last section, the following propositions:

- Organizational forms of an ambidextrous nature constantly face the risk of being outperformed by more focused competitors. Increased levels of organizational and managerial complexity further add to additional value creation requirements. Hence, such organizational forms will only be sustainable to the extent that they are able to create surplus value in a recurrent way.
- Additional value creation can only stem from the diversity ambidextrous organizational forms imply. As such, a profound understanding of the social dynamics in which knowledge creation process unfolds, becomes highly informative for designing and implementing organizational arrangements aimed at harvesting the innovation potential ambidextrous organizations entail.
- Transposing insights - stemming directly from the knowledge creation dynamics outlined at the micro-level - towards the level of the organization as a whole, results in the following hypothesises:
  Ambidextrous organizations will only be sustainable to the extent that they :
    o Install interface management practices aimed at enacting the present diversity
    o Adopt organizational transformation processes of a stepwise nature
    o Complement managerial roles, pertaining to creating an overarching and mobilising vision, with gatekeeping activities of a constructive nature that pertain to and imply the organization as a whole.

20

Conclusion. Within this paper we have argued that the characteristics of the different forms under which knowledge creation manifests itself - more specifically the nature of the relational field in which both are embedded – push into the direction of adopting organizational practices of a hybrid nature. Whereas exploitation refers to activities like refinement, implementation and execution, exploration denotes search, variation and discovery oriented activities. We argued that organizing interaction aimed at exploitation will not only be of a nature different from organizing in order to accomplish exploration; both activities display characteristics of a paradoxical nature. In a next step, time and space have been introduced as design variables to handle the paradoxical requirements involved. By introducing time and space, one is, at least in the short term, able to relieve the tensions encountered. However, this might not turn out to be a sustainable approach in the long run, unless one is able to create additional value that compensates for the complexity that is being introduced this way.

This additional value creation in turn can only originate from the resources that are available. In the case of ambidextrous organizations, these resources are of a diversified nature. Hence the dynamics relating to the knowledge creation processes of an explorative nature outlined above become relevant for designing organizational arrangements aimed at achieving this additional value creation. More specifically, the notion of social marking, the path dependent nature of knowledge creation processes, and finally the dynamics of identity redefinition, have been introduced as concepts that deserve our foremost attention. Rather than treating such micro-processes as a 'black box', we have demonstrated that scrutinizing constituting parts of the –complex – processes entailed, might be highly informative for organisational practice. Hence stressing interface management practices aimed at enacting diversity in a stepwise manner, while at the same time devoting sufficient levels of managerial attention and efforts to the change processes implied.

As such, the propositions developed here might be helpful to further substantiate the notion of dynamic capabilities as outlined by Teece and Pisano (1997) (see also Helfat (1997), Eisenhardt and Martin (2000), Helfat and Raubitschek, 2000) and direct our attention further to crucial strategic functions within the firm, including operational effectuation (Porter, 1996; Sarasvathy, 2001). We are aware that we focused within this article heavily on the micro-dynamics of interaction; at the same time we strongly believe that such a socio-cognitive perspective can add to our understanding of the organizational dynamics ambidextrous organizations entail and hence might inspire organizational and managerial practice. Of course, given the focus of the article, the views and propositions outlined within this paper are by definition partial and offer but one way to approach the complex phenomena at hand. Empirical testing of the propositions outlined becomes in this respect a crucial point of attention to further reveal their relevance and push their development. By elaborating in such detail on the micro processes in which exploration and exploitation activities unfold, such empirical testing becomes feasible. Moreover, we hope to have inspired colleagues to participate in such efforts.

References

- Abernathy W. (1991) *The productivity dilemma*. Baltimore, John Hopkins University Press.
- Abernathy W. and Utterback, J. (1978) Patterns of industrial innovation. *Technology Review*, 7, 40-47.
- Allen, T. (1966) 'Studies Of The Problem-Solving Process In Engineering Design' *IEEE Transactions On Engineering Management*, 13, 386-397.
- Allen, T. (1977) *Managing The Flow Of Technology*. MIT Press.
- Allen, T., Lee, D. and Tushman, M. (1980) 'R&D Performance as a function of internal Communication, Project Management and the nature of the Work.' *IEEE Transactions On Engineering Management*, 27, 1, 2-12.
- Ancona, D. and Caldwell, D. (1992a) 'Demography And Design: Predictors Of New Product Team Performance.' *Organization Science*, 3, 3, 321.
- Ancona, D. and Caldwell, D. (1992b) 'Bridging The Boundary: External Activity And Performance In Organizational Teams.' *Administrative Science Quarterly*, 37, 634-665.
- Anderson, P. and Tushman M. (1991) Managing through cycles of Technological Change. *Research/Technology Management*, May/June, 26-31.
- Angle, H. (1989) 'Psychology and Organizational Innovation.' In: Van de Ven, A., Angle, H. (1989) and Poole, M.S. (Eds.) Research On The Management Of Innovation: The Minnesota Studies. Edited, Harper & Row Publishers.
- Argyris and Schön (1974) *Organisational learning; A theory of action perspective*. Addison Wesley.
- Argyris C. (1992) *On organizational Learning*. Blackwell Publishers.
- Argyres N. (1996) Capabilities, Technological Diversification and Divisionalization. *Strategic Management Journal*, 17, 395-410.
- Ben-David, J. and Collins, R. (1966) Social factors in the origins of a new science: the case of psychology, *American Sociological Review*, 31, 451-465.
- Benner M.J. & Tushman M.L. (2003) Exploitation, exploration, and process management: The productivity dilemma revisited. *The Academy of Management Review*; 28 (2): 238-256
- Bijker W. (1995) *Of bicycles, Bakelites and bulbs*. towards a theory of socio-technical change. MIT Press.
- Bijker, W. and Law, J. (Eds.) (1992) *Shaping Technology/Building Society*. MIT Press.
- Bijker, W., Hughes, T. and Pinch, T. (1987) (Eds.).*The Social Construction Of Technology*. MIT Press.
- Blackler F. Crump N. and McDonald S. (1999) Managing experts and competing through innovation: An activity theoretical analysis. *Organization*, 6, 1, 5-31.
- Blackler F, Crump N, McDonald S. (2000) Organizing processes in complex activity networks. *Organization* , 7 (2): 277-300
- Bouwen, R. and Fry, R. (1988) 'An Agenda For Managing Organizational Innovation And Development.' In: Lambrecht, M. (ed.) *Corporate Revival*. Leuven University Press.
- Bouwen, R. and Fry, R. (1991) 'Organisational Innovation And Learning: Four Patterns Of Dialogue Between The Dominant Logic And The New Logic.' *International Studies Of Management And Organisation*, 21, 37-51.
- Bouwen R. and Fry R. (1996) Facilitating group development: interventions for a relational and contextual construction. In: West M. (ed.) *Handbook of Work Group Psychology*. Wiley and sons.
- Bower J. and Christensen C. (1994) Disruptive technologies: catching the wave. *Harvard Business Review*, January-February.
- Breuer J.T. (1994) Classroom problems, School Culture, and cognitive research. In: McGilly K. (ed.) *Classroom lessons: integrating Cognitive Theory and Classroom Practice*. MIT Press.
- Brown, A. and Starkey K. (2000) Organizational identity and learning: a psychodynamic perspective. *The Academy of Management Review*, 25, 1, 102-121.
- Brown A. and Campione J. (1994) Guided discovery in a community of learners. In: McGilly K. (Ed.) *Classroom Lessons: Integrating Cognitive Theory and classroom Practice*. MIT Press.

- Brown, J.S. and Duguid, P. (1991) 'Organisational Learning And Communities Of Practice: Towards A Unified View Of Working, Learning And Innovation.' *Organisation Science*, 2, 40-57.
- Brown, J. S. and Duguid P. (2000) *The social life of Information*. Harvard Business School Press
- Brown, J.S., Collins, A. and Duguid, P. (1989) 'Situated Cognition And The Culture Of Learning.' *Educational Researcher*. January–February, 32-42.
- Brown, S. and Eisenhardt, K. (1997) The art of continuous change: linking complexity Theory and Time-paced Evolution in Relentlessly Shifting Organizations. *Administrative Science Quarterly*, 42, 1-37.
- Brown, S. and Eisenhardt, K. (1996) Product Development: Past Research, Present Findings, And Future Directions.' *The Academy Of Management Review*, 20, 2, 343-378.
- Burgelman R. and Sayles L. (1986) *Inside corporate venturing*. New York Free Press.
- Burns T. and Stalker G. (1962) *The management of innovation*. Tavistock, London.
- Chaiklin S. & Lave , J. (eds. 1993) Understanding Practice: Perspectives on Activity and Context. Cambridge University Press.
- Christensen C. and Overdorf M. (2000) 'Meeting the challenge of disruptive change'. *Harvard Business Review*, March-April 2000.
- Christensen C. (1997) *The innovator's dilemma: When new technologies cause great firms to fail*. Harvard Business Press.
- Clark, K.B., Wheelwright, S.C. (1993) *Managing New Product and Process Development*. Text and Cases, The Free Press, New York.
- Cohen, W. & Levinthal, D. (1990) 'Absorptive Capacity: A New Perspective On Learning And Innovation.' *Administrative Science Quarterly*, 35, 128-152.
- Constant, E. (1980) The origins of the turbojet revolution. Baltimore: The Johns Hopkins University Press.
- Cooper, R. & Kleinschmidt, E. (1987) 'New Products: What Separates Winners From Losers?' *Journal Of Product Innovation Management*, 4, 169-184.
- Cooper, R.G. (1979) 'The Dimensions Of Industrial New Product Successes And Failure.' *Journal Of Marketing*, 43, 93-103.
- Crawford C.(1992) The hidden costs of accelerated product development. *Journal of Product Innovation Management*, 9, 188-199.
- Danneels E. (2002) The dynamics of product innovation and Firm Competences. *Strategic Management Journal*, 12, 1095-1121.
- Debackere K. , Clarysse B., Wijnberg N. and Rappa M. (1994) Science and Indusry: A theory of networks and Paradigms. Technology Analysis and Strategic Management, 6, 1, 21 – 37.
- Doise, W. and Mugny G. (1984) *The social development of the intellect*. Pergamon Pres. Oxford.
- Doise, W., Mugny G. and Pérez J. (1998) *The social construction of knowledge: social marking and socio-cognitive conflict*. In Fleck U. (ed.) The Psychology of the Social. Cambridge University Press.
- Dougherty (1996) '*Organizing for Innovation*.' In: Clegg, S. and Hardy, C. (Eds.) Handbook of Organisation Studies.
- Dougherty, D. (1992) 'Interpretive Barriers to Successful Product Innovation in Large Firms.' *Organization Science*, 3, 2, 179-201.
- Eisenhardt, K. M. and Tabrizi, B.N. (1995) 'Accelerating Adaptive Processes: Product Innovation In The Global Computer Industry.' *Administrative Science Quarterly*, 40.
- Eisenhardt K. and Martin J. (2000) Dynamic Capabilities: what are they? Strategic Management Journal, 21, 1105-1121.
- Engeström, Y.(1987) *Learning By Expanding*. Helsinki: Orienta-Konsultit Oy.
- Festinger, L. , Schachter, S. and Back, K. (1960) *Social Pressures In Informal Groups*. Stanford University Press, California.
- Fiol, M. (1994) 'Consensus, Diversity and Learning in Organizations.' *Organization Science*, 5, 3, 403-420.
- Fleck L. (1979, original text appeared in 1935) *Genesis and development of a scientific fact*. The university of Chicago Press.

- Galbraith (1973) *Designing Complex Organizations*. Addison Wesley Publishing Company.
- Galunic C. and Rodan S. (1998) Resource recombinations in the firm: knowledge structures and the potential for Schumpeterian Innovation. *Strategic Management Journal*, 19; 1193-1201.
- Garud R. and Karnoe P. (2001) *Path Dependency and Creation*. LEA Publishers.
- Garud R. and Rappa, M.A. (1994) A socio-cognitive model of technology evolution: the case of cochlear implants, *Organization Science*, 4.
- Ghemawat (1991). Flexibility and Commitment: The Dynamics of Strategy, New York: Free Press.
- Giddens, A. (1986) *The Constitution of Society*. Polity Press.
- Goodman, P.S., Lawrence, B.S., Ancona, D.G., Tushman, M.L., (2001), Special Topic Forum on Time and Organizational Research. *Academy of Management Review,* Vol. 26, No. 4
- Hampden-Turner, C. (1990) *Charting The Corporate Mind*. Free Press, Oxford, UK.
- Helfat C. (1997) Know-how and asset complementarity and dynamic capability accumulation: The case of R&D. *Strategic Management Journal*, 18, 5: 339-360
- Helfat C. & Raubitschek R. (2000) Product sequencing: Co-evolution of knowledge, capabilities and products. *Strategic Management Journal* 21, 10-11, 961-979.
- Iansiti, M. and McCormack, A. (1997) 'Developing Products On Internet Time', *Harvard Business Review*, September-October.
- Iansiti, M. (1995) 'Shooting The Rapids: Managing Product Development In Turbulent Environments.' *California Management Review*, 38, 1, 37-58.
- Iansiti, M. (1998) *Technology Integration*, Harvard Business School Press.
- Imai, K., Nonaka, I.& Takeuchi, (1985) 'Managing The New Product Development Process.' In: Hayes, R., Clark, K. & Lorenze, (Eds.) *The Uneasy Alliance: Managing The Productivity Dilemma.*
- Nonaka I., Toyama R. and Konno N. (2000) SECI, Ba and leadership: a unified model of dynamic knowledge creation. *Long Range Planning*, 33.
- James W. (1907) *Pragmatism*. Reprinted Dover Publications.
- Karpov Y.V. and Haywood H.C. (1998) 'Two Ways To Elaborate Vygotsky's Concept Of Mediation: Implications For Instruction.' *American Psychologist*, January, 27-36.
- Katz R. (1997) How a team at Digital Equipment designed the 'Alpha' chip. In: *The Human Side of Managing Technological Innovation*. Ed. By R. Katz. Oxford University Press.
- Katz, R., ed. (1997) *The Human Side of Managing Technological Innovation*. Oxford University Press.
- Katz R. and Allen T. (1982) Investigating the Not Invented Here Syndrome: A look at the performance, tenure and communication patterns of 50 R&D project groups. R&D Management, 12,1, 9-17.
- Keller, R. (2001) Cross-functional project groups in Research and New Product Development; Diversity, Communications, Job Stress and Outcomes. *The Academy of Management Journal*, 3, 547-55.
- Kramer, R. and Tyler, T. *Trust In Organizations; Frontiers Of Theory And Research*. Sage, Thousand Oaks California.
- Kuhn, T.S. (1962) *The Structure Of Scientific Revolutions*. University of Chicago Press.
- Lave J. and Wenger E. (1991) *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press.
- Levine J.M. and Moreland, R.L. (1990) 'Progress In Small Group Research.' *Ann. Rev. Psychology*, 585-634.
- Lewicki, R.J. and Bunker, B. (1996) 'Developing And Maintaining Trust In Work Relationships.' In: Kramer, R. and Tyler, T. *Trust In Organisations; Frontiers Of Theory And Research*. Sage, Thousand Oaks California.
- Lewis M. (2002) Exploring Paradox: Towards a more Comprehensive Guide. *The Academy of Management Review,* 5, 760-776.
- Lewis, M., Welsh M., Dehler G. and Green S. (2002) Product development tensions: exploring contrasting styles of project management. *Academy of Management Journal*, 45, 3, 546-564.
- Luria A. (1971) Towards the problem of the historical nature of psychological processes. *International journal of Psychology*, 6, 4, 259-272.

- MacCormack A, Verganti R, Iansiti M. (2001) Developing products on "Internet time": The anatomy of a flexible development process. .*Management Science* 47 , 1, 133-150.
- March J. (1991) Exploration and exploitation in organizational learning. *Organization Science*, 2, 1.
- March J. (1996) The Future, Disposable Organizations and the Rigidities of Imagination. *Organization*, 2, 427-440.
- Markides C. and Williamson P. (1994) Related diversification, core competencies and corporate performance. *Strategic Management Journal*, 15, 149-165.
- Marquis, D. M. (1969) 'The Anatomy Of Successful Innovations, Innovation, 1969'. <u>Reprinted in</u>: Tushman, M.L. and Moore, W.L. (Eds.) *Readings In The Management Of Innovation*, Harper Business.
- McAllister, D. (1995) 'Affect-And Cognition-Based Trust As Foundations For Interpersonal Co-Operation In Organisations.' *Academy of Management Journal*, 38, 1, 24-59.
- Miller, P. and Friesen, D. (1984) *Organisations: A Quantum View*. Prentice-Hall.
- Mintberg H. (1979*). The structuring of organizations: a synthesis of the research*. Prentice Hall
- Moenaert R. & Souder W. (1996) Context and antecedents of Information Utility at the R&D/Marketing interface. *Management Science*, 42, 11, 1592 – 1610.
- Moenaert R. & Caeldries F. (1996) Architectural Redesign, Interpersonal Communication and Learning in R&D. *Journal of Product Innovation Management*, 13, 296-310.
- Mulkay (1968) *The Social Process Of Innovation. A Study In The Sociology Of Science*. MacMillan Press.
- Nadler, D.A. and Tushman, M.L. (1997) *Competing by design*. The Power of Organizational Architecture. Oxford University Press.
- Nonaka, I and Kenney, M. (1991) 'Towards A New Theory Of Innovation Management: A Case Study Comparing Canon Inc. And Apple Computer Inc.' *Journal Of Engineering And Technology Management*, 8, 67-83.
- Nonaka, I. (1990) 'Redundant, Overlapping Organization; A Japanese Approach To Managing The Innovation Process.' *California Management Review*, Spring 1990, 27-38.
- Nonaka, I. (1994) 'A Dynamic Theory Of Organizational Knowledge Creation.' *Organization Science*, 5, 1, 14-36.
- Nonaka, I. and Takeuchi, H. (1995). *The Knowledge Creating Company*. Oxford University Press.
- Orr, J.(1996) *Talking About Machines: An Ethnography Of A Modern Job*. Ithaca, NY, Cornell University Press.
- Piaget J.(1967) *Six psychological studies* Random House, New York.
- Pinch T. and Bijker W. (1987) *The social construction of facts and artefacts: or how the sociology of science and technology might benefit each other*. In: Bijker W., Hughes T. and Pinch T. (Eds.) The Social Construction of Technology. MIT Press.
- Pistorius C. and Utterback J. (1997) Multi-mode interaction among technologies. *Research Policy*, 26, 67-84.
- Poole M.S. and Van de Ven A. (1989) Using paradox to build management and organization theories. *Academy of Management Review*, 14, 4, 562-578.
- Porter M. (1996) What is strategy? *Harvard Business Review*, Nov-Dec., 61-78.
- Quinn R. and Cameron K; (eds.) *Paradox and transformation. Toward a theory of change in organisation and management*. Cambridge, Ballinger Publishing.
- Rappa M. and Debackere K. (1992) Technological Communities and the diffusion of knowledge. *R&D Management*, 22, 209-220.
- Ring, P. & Van de Ven, A. *Formal And Informal Dimensions Of Transactions*. Chapter 6, In: Van de Ven et al. (1989).
- Roberts E. and Berry C. (1986) Entering new business: selecting strategies for success. *Sloan Management Review*, 26, 3
- Shapero A. (1985) *Managing creative professionals*. Research-Technology Management. March-April. Reprinted in Katz R. (1997)

- Sarasvathy S. (2001) Causation and Effectuation: toward a theoretical shift from economic inevitability to Entrepreneurial Contingency. *The Academy of Management Review*, 26, 2, 243-263.
- Schein E. (1996) Kurt Lewin's change theory in the Field and in the Classroom: Notes toward a model of Managed Learning. *Systems Practice*, 9, 1, 27-47.
- Schein, E. (2002) The anxiety of learning . HBR interview by Coutu, D. *Harvard Business Review*, March, 100-106.
- Schön D. (1963) *Invention and the evolution of ideas – The displacement of concepts.* Tavistock Publications
- Schoonhoven Bird, C. and Jellinek M. (1990) Dynamic tension in innovative, high technology firms: managing rapid technological change through organizational culture. Reprinted in: *Managing strategic innovation and change.* Ed. By Tushman M. and Anderson P. (1997). Oxford University Press.
- Schrader, S., Riggs, W.M. & Smith, R.P. (1993). 'Choice Over Uncertainty And Ambiguity In Technical Problem Solving.' *Journal Of Engineering And Technology Management*, 10.
- Schumpeter J. (1934) *The Theory of Economic Development.* Harvard University Press. Cambridge, Mass.
- Sheremata W. (2000) Centrifugal and Centripetal Forces in Radical New Product Development under Time Pressure. *The Academy of Management Review*, 25, 2, 389-408.
- Steyaert C. and Janssens M. (1999) The world in two and a third way out. *Scandinavian Journal of Management*, 15, 121-139.
- Stork, D. (1991). 'A Longitudinal Study Of Communication Networks: Emergence And Evolution In A New Research Organisation.' *Journal Of Engineering And Technology Management*, 7, 177-196.
- Teece D., Pisano G. & Shuen A. (1997) Dynamic capabilities and strategic management *Strategic Management Journal*, 18 (7): 509-533
- Thomke S. and Fujimoto T. (2000) The effect of 'front-loading' problem solving on Product Development Performance. *Journal of Product Innovation Management*, 17, 128-142.
- Thomke S. and Fujimoto T. (1997) Shortening Product Development time through 'front-loading' problem solving. Proceedings 5th International Product Development Management Conference, Como, Italy, 25 – 26 May.
- Thomson, R. (1988) *The path to mechanised shoe production in the U.S.* University of North Carolina Press, Chapel Hill.
- Tripsas M. (1997) Unravelling the process of creative destruction: complementary assests and incumbent survival in the typesetter industry. *Strategic Management Journal*, 18, 119-142.
- Tripsas M. and Gavetti G. (2000) Capabilities, cognition, and inertia: evidence form digital imaging. *Strategic Management Journal*, 21, 1147-1161.
- Tushman, M. and Katz, R. (1980) 'External Communication and Project Performance: An Investigation into the Role of Gatekeepers.' *Management Science*, 26, 11, 1071-1085.
- Tushman, M. (1977) 'Special Boundary Roles in the Innovation Process.' *Administrative Science Quarterly*, 22, 587-605.
- Tushman, M. (1978) 'Impacts Of Perceived Environmental Variability On Patterns Of Work Related Communication.' *Academy Of Management Journal*, 22, 3, 482-500.
- Tushman, M. (1978) 'Technical Communication In R&D Laboratories: The Impact Of Project Work Characteristics.' *Academy Of Management Journal*, 21, 4, 624-645.
- Tushman, M.L. and Nadler, D.A. (1978) 'Information Processing As An Integrating Concept In Organisational Design.' *Academy Of Management Journal*, 21, 613-625.
- Tushman M.L., Anderson P.C. and O'Reilly C. (1997) Technology cycles, Innovation streams, and Ambidextrous Organizations: Organization renewal through Innovation Streams and Strategic Change. In: Managing Strategic Innovation and Change. A collection of Readings. Edited by Tushman M. and Anderson P. Oxford University Press.
- Utterback, J. , Meyer M. , Tuff, T. and Richardson L. (1992) When speeding concepts to market can be a mistake. *Interfaces*, 22, 24-37.
- Van de Ven, A., Angle, H. (1989) and Poole, M.S. (Eds.) *Research On The* Management Of Innovation: The Minnesota Studies. Harper & Row Publishers

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- Van de Ven, A. Polley, D., Garud, R and Venkatraman S.(1999) *The Innovation Journey*. Oxford University Press.
- Van Dongen H., de Laat H. and Maas A. (1996) Een kwestie van verschil (A matter of difference) Eburon, Delft.
- Van Looy B., Debackere K. and Bouwen R. (2001) Innovation as a community spanning process: looking for interaction strategies to handle path dependency. In: Raghu G. and Karnoe P. (eds.) *Path Dependence and Creation*. LEA Publishers.
- Verganti, R., MacCormack A. and Iansiti M. (1998) *Rapid learning and adaptation in product development: an empirical study of the internet software industry*. Proceedings 5th International Product Development Management Conference, Como, Italy, 25 – 26 May.
- Vygotsky L. (1986) *Thought and Language*. MIT Press.
- Vygotsky, L. (1978) *Mind in Society*. The development of higher psychological processes. Harvard University Press.
- Weick, K.E. (1979) *The Social Psychology Of Organising* (second edition) Random House, New York.
- Weick, K.E. (1995) *Sensemaking in Organizations*. Sage Publications, Thousand Oaks, California.
- Wenger, E. (1998) *Communities Of Practice: Learning, Meaning And Identity*. Cambridge University Press.
- Wernerfelt B. and Montgomery C. (1988) Tobin's q and the Importance of Focus in Firm Performance. *The American Economic Review*, 246-250.
- Winnicott, D.W. (1971) *Playing and reality*. London, Tavistock/Routledge.
- Wheelan S. and Hochberger J. (1996) Validation studies of the group development questionnaire. *Small Group Research*, 27, 1, 143-170.
- Wheelwright and Clark (1992) *Revolutionizing Product Development*. Free Press, New York.
- Zirger B. and Maidique M. (1990) A model of product development – An empirical test. *Management Science*, 36, 7, 867-883.

Figure 1: The Dual and Paradoxical Nature of Interaction

The Dual Nature of interaction in relation to Knowledge Creation Processes	
Exploitation: selection-execution-adaptation in an efficient manner	Exploration : search –discovery-experimentation-variation in an effective manner
Addressing Uncertainty; problem structure is given/shared but precise knowledge with respect to the (magnitude of) the variables and their inter-relationships is searched for.	Addressing Ambiguity: multiple/unclear viewpoints with respect to problem structure and its constituting variables
Handling Information Asymmetries	Coping with Interpretation Asymmetries
Predominant Characteristics of the relational field in which both activities are being embedded	
Homogeneity as facilitating/enabling with respect to (fast/efficient) information sharing	Heterogeneity as necessary/enabling in order to arrive at a novel analysis and synthesis (social marking)
Consensus and Cohesiveness	Conflict and tension
Confirming Identity	Redefining Identity (in a path dependent manner)
Implications in terms of effects and predictability	
Temporal and spatial proximity of effects.	Temporal and spatial distance of effects
Selection and execution activities characterized by a predictable time frame	Variation and incubation activities characterized by an unpredictable time frame

Figure 2: Handling Paradoxical Requirements by using Time and Space
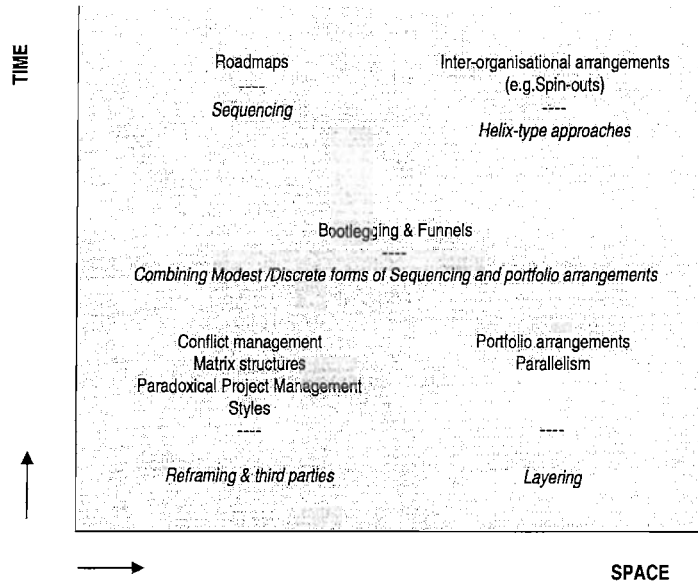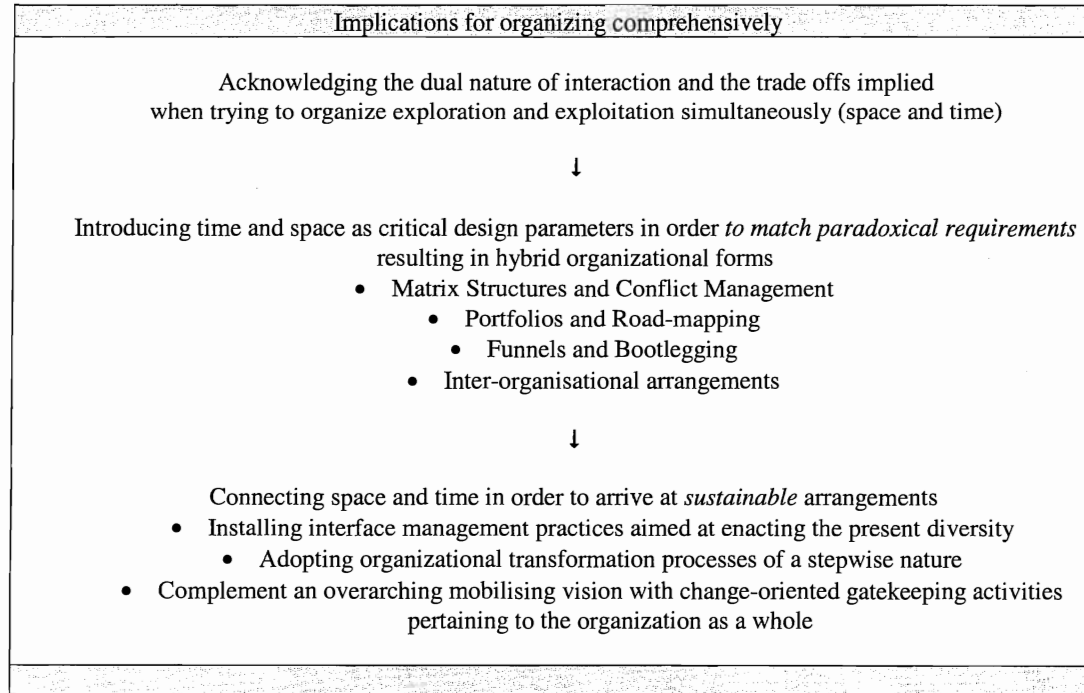

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Figure 3: Towards Constructive Capabilities

Implications for organizing comprehensively

Acknowledging the dual nature of interaction and the trade offs implied
when trying to organize exploration and exploitation simultaneously (space and time)

↓

Introducing time and space as critical design parameters in order *to match paradoxical requirements*
resulting in hybrid organizational forms
- Matrix Structures and Conflict Management
  - Portfolios and Road-mapping
  - Funnels and Bootlegging
- Inter-organisational arrangements

↓

Connecting space and time in order to arrive at *sustainable* arrangements
- Installing interface management practices aimed at enacting the present diversity
  - Adopting organizational transformation processes of a stepwise nature
- Complement an overarching mobilising vision with change-oriented gatekeeping activities
pertaining to the organization as a whole

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[1] 'Activities' as a term are used within this paper to denote the actions related to exploration and exploitation and should not be confused with the broader notion of 'activity' or 'activity system' and its connotations with the cultural infrastructure of knowledge as used by scholars working in the field of activity theory (see Blackler et al. 1999).

[2] The arguments developed here are different from approaches whereby both activities are suggested to be intrinsically similar (e.g. Brown and Duguid, 1991) or whereby less attention is paid to the distinctive differences between exploitation and exploration (e.g. Nonaka et al., 2000). In this paper we elaborate on the thesis that unravelling the distinction between both modes of acting - and hence of interacting – is relevant as they do expose characteristics of a distinct nature that directly affect the relevance for customized underlying organizing principles. At the same time, it should be observed that this distinction should not be understood as a dichotomous one. Both types of knowledge creation processes show, at least temporarily, similar dynamics as the work of Lave and Wenger (1991) on exploitative learning has made clear. Hence, the distinction is used to indicate the predominance of the 'unique' social dynamics involved.

[3] We prefer the notion of complexity, as concepts such as 'barriers' suggest avoidable phenomena. From the perspective developed here, barriers, as far as they originated from differences or heterogeneity, are necessary in order to arrive at novelty and hence they should be considered as a 'natural' ingredient of any innovative effort.

[4] Whereby the interaction between tacit and explicit knowledge results in four modes of knowledge conversion including socialization, externalization, combination and internalization.

[5] Indeed, many examples provided by the authors relate to the transfer and diffusion of knowledge, rather than its genesis. As such, the authors are acknowledging this viewpoint themselves and seem to adhere to a rather individual stance when it comes down to knowledge creation: "An organization cannot create knowledge without individuals. The organization supports creative individuals or provides contexts for them to create knowledge. Organizational knowledge creation, therefore, should be understood as a process that 'organizationally' amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge network of the organization." (Nonaka, Toyama and Konno, 2002)

[6] Here the notion of activity does not refer to the notions exploitation/exploration and should be understood as in line with the definitions and approaches used within Activity Theory.

[7] This term is being used in the sense Piaget proposed it to denote intellectual activity.

[8] In which the subject is confronted with centrations that are certainly opposed but also as incorrect as its own centrations.

[9] It can be noted that if appropriate models were a necessary condition for progress, novelty in itself would become impossible.

[10] An observation which can be related directly to the relevancy of composing R&D teams in a cross-functional or multidisciplinary manner as advanced repeatedly by scholars in the field (Cooper, 1979, Imai et al., 1985, Cooper & Kleinschmidt, 1987; Brown and Eisenhardt, 1996; Keller, 2001). In this respect, it - can observed that our arguments imply a rather direct relation between interaction on the one hand, and the occurrence of ambiguity on the other, whereby the first clearly can precede the other. This implies an extension of a reciprocal nature with respect to the relationship between ambiguity or equivocality and 'cycles of interlocked behavior' as advanced by Weick (1979). For an elaboration on this argument, see Van Dongen et al. (1996).

[11] See in this respect also the notion of 'absorptive capacity' as advanced by Cohen and Levinthal (1990).

[12] Such a transformation is seen as the result of a long series of developmental events in which psychological processes, as they appeared before, actually cease to exist: "They are incorporated into the system of behavior and are culturally reconstituted and developed to form a new psychological entity." This internalization of socially rooted and historically developed activities is for Vygotsky the distinguishing feature of human psychology.

[13] Activity in which, for instance, 'play' fulfills an important role. These 'getting acquainted' activities are seen as essential for mastering the implications of certain insights or even higher mental functions. For more details on this aspect, we refer to Vygotsky, op. cit., chapter 7.

[14] Another clear example is implied in the well-known quote of M. Planck in relation to the creation of new scientific insights: 'A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents die, and a new generation grows up that is familiar with it".

[15] This interpretation is confirmed upon examination of the average percentage of changes after the first beta release that could be labeled as new features. For the 22 internet development projects, this percentage amounts to less than 20%.

[16] These hidden costs as advanced by Crawford relate to a) driving out more profitable breakthrough types of innovation by low-profit, trivial innovation; b) increasing the amount of mistakes when skipping steps; c) negative and disruptive effects on the motivation of R&D people; d) unexpected inefficiencies resulting from pressure which tends to be applied evenly on different steps, while various steps don't respond evenly to reductions in the 'time budget' and finally e) chewing up a firm's complex set of resources by the pressure from players on speeded-up teams.

[17] See in this respect as well the notion of 'quasi-structures' advanced by Schoonhoven and Jellinek (1991).

[18] Sheremata (2000) outlined the various organisational dimensions which can be instrumental for finding an equilibrium between the 'centrifugal' and 'centripetal' forces at work in those situations; including Decentralization, Reach, Free Flow of Information, Connectedness, Project Management influence, Cross-functional team influence and Temporal pacing.

[19] While modular organizational architectures might ease the pain in this respect - for a recent overview see Garud (2003), - the question on how to benefit from the diversity present remains a pertinent one.

[20] The more distance between existing and novel capabilities, the more hazardous transformation trajectories tend to become, see in this respect also Markides and Williamson (1994)

[21] Recall the notion of identity outlined above; for an illustration of such profoundness in action, see Tripsas and Gavetti's account on the Polaroid Corporation (Tripsas & Gavetti, 2000).