

Innovation in interaction

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Abstract

Managing innovations has to do with the interactions of two very different processes – one highly uncertain, creative and full of surprises, and the other systematically relating economic entities to each other. The reason for this duality can be found in the characteristics of the interfaces between commercial innovations and their business landscapes. In this article we suggest that a rain forest metaphor may be a useful starting point for a new way to conceptualize these interfaces in order to advance our understanding of what innovation management is about.

Any innovation may be seen as an entity within a multidimensional and interdependent business landscape where relatedness, motion and variety are three key dimensions. The innovation has to be positioned within some partly visible, partly invisible location in some already existing business landscape. This includes (1) to activate and maintain a complex set of relationships between activities, resources and actors, (2) to systematically handle reactions to friction forces across these productive entities and (3) to maintain and advance the necessary framing needed to coordinate interactions across the development, production and using contexts of commercial innovations across all their interfaces to already existing business resources, activities and actors, who represent their own framings.

A general conclusion is that systematic managerial action appears to be the main driving force enacting and coordinating these complex interactions. In order for innovations to materialize, there is a critical need for some type of multi-functional interrelated managerial network that is capable of constantly recreating simplified and conceptual unity and sense of direction while simultaneously managing the complexity, extendedness, ambiguity and multi-contextual challenges associated with the shaping and adjusting of these many complex interfaces. Hence, extended innovation management is argued to constitute the most critical function in actual innovation processes.

Introduction

Studies of innovations and of innovation management are being and should be done in many different ways (Van de Ven & Poole, 2005). In this article we aim at outlining and exploring an analytical conceptualization at a relatively general level of analysis, on the basis of an extended number of detailed business case studies and theory contributions over the years. These studies have explored problems of business interactions from a grounded, ethnographic research perspective, gradually contributing to an understanding of the actual functioning of market economies and business operations as quite different from and – in particular - much more networked and interacted than what the economic market theory generally portrays. Our ambition in this paper is to advance from these theories of interacted business networks to explicitly consider the innovation phenomenon. What is an innovation process in the context of an economy that is generally perceived of as interacted, material and complex? And, what is actually the role of management in all of this? Is it possible to characterize, in some unified way, what innovation management is about from this bottom up, localized and detailed perspective on business activities and market economies?

To us, innovation processes have an interesting duality – almost like a Janus-face. On the one side they are the results of new ideas for instance about new uses of materials, new combinations of resources, new ways to solve complex problems and so forth. They are the results of multifaceted creative processes containing substantial elements of exploration into the unknown, into the unexpected and quite often also into the impossible, the irrational and the apparently unlimited imaginativeness of creative entrepreneurs. On the other side, they must also be the results of material and social interactions with numerous elements of their environments that are actually there doing whatever they do. These second kind of processes are obviously constrained by whatever is actually given in the real world. In order to be economically viable, new innovations have to be systematically combined with already existing resources, activities and actors. In order to reach some kind of positive economic result, they even have to be systematically “built into” existing economic systems through numerous such interactions.

This duality may be seen as representing the fundamental sub-processes of economic creation. The interactions of the two represent the creative evolution of economies; the interactions of the imaginative processes of human minds with the dynamic processes of real life economies

as represented by their already existing resources, activities and actors. We take this duality as our point of departure to suggest a conceptual framing for analyzing the *interfaces* between innovations and their immediate economic environments. The ambition is to portrait how this duality affects how these interfaces may be conceptualized from an economic point o view. From there we will discuss the role of the management function in relation to innovations and how their interfaces are developing within the business landscape.

The interfaces between innovations and their business landscapes

We assume that a realistic understanding of commercial innovations requires an understanding of their processes of emergence within their actual contexts. This necessitates an analytical conceptualization that takes into account that interactions between a new economic entity and economic entities already existing, is core to the understanding of what constitutes economically valuable innovations. Therefore, we are looking for a theory that fundamentally acknowledges the importance of combining resources and linking activities as core features of what constitutes economic sources and value creation in the innovation process.

We base the following analytical suggestions on extractions from a large body of detailed case studies that has aimed at understanding business economics from an anthropological research perspective. This work has envisioned business in practice as a world of highly interrelated and mutually interdependent activities (Håkansson et al, 2009, Wilkinson 2008, Ford et al, 2003). The business landscape they describe truly looks much more like complex rain forests with a huge variety of interdependent actors, activities and resources than a jungle with species fighting each other (Håkansson et al 2009). A general conclusion is that the survival and economic prosperity of any particular firm or business activity to a considerable extent depends on its relations to others. Similarly, innovations emerge through extended interactions. They become as a function of their growing relations to, interactions with and dependency on others. Their essence and economic value is somehow given by these emerging interdependencies. Innovations – as economic entities – appear largely to be relational, internally and externally interacted, emergent phenomena.

In these interactions actors, activities and resources are related to each other in multifarious ways. Resources are combinations of natural and social, activities are linked and

interdependent, and actors engage with one another to form collaborative structures. Resources are systematically related to activities and actors. Activities are using as well as producing resources and are performed by actors. Actors control resources and perform activities in order to reach economic goals. All of this is taking place within as well as across company borders (Håkansson & Johanson 1992). Businesses tend to interact in multiple ways forming commercially viable cross-functional business networks.ⁱ Neither of these entities can be assessed without reference to the roles of the others. In this way, we may perceive of economic phenomena as the outcomes of historical innovations that have managed to expand their material and social relations to others – to include sufficient interactive capacities to provide for their existence.

In such a world, an innovation will have to develop and establish a large number of interfaces towards a variety of existing resources, activities and actors. It will have to find its place and its functionalities in between whatever is already there to the extent that it appears impossible to develop, produce or use an innovation without having established proper interfaces to entities that are possibly already crowding the areas addressed. It will have to relate to the communicative reality of these arenas, to various kinds of expertise, to whatever has become influential ways of thinking and behaving, to institutional arrangements of numerous kinds, and so forth. Most of these are outcomes of historical creations established through efforts by many over considerable periods of time. Thus, an innovation and its interfaces will be developed, produced and used by actors that to a substantial degree are already related to each other, are influencing one another and are engaged in a variety of activities that constantly evolve the business landscape into new layers of economic activities and configurations. The business landscape that will interact with the innovation is itself a complex interrelated and dynamic phenomenon.

Earlier attempts at characterizing the contextual dependencies of innovations

One early, simple but powerful representation of the importance of innovation interfaces was presented in the 70s by Utterback and Abernathy (1975). They used the notion “investments in place” to underline that an innovation may severely disturb an existing economic order and that the costs of such disturbances are typically extensive if and when already existing production systems have to adjust in substantial ways to the new innovation. Or in their

words: “Unfortunately, the pay-off required to justify the cost of change is large while the potential benefits are often marginal” (Utterback & Abernathy, 1975, p. 644). The significance of the relationship between innovations and already existing activities and resources affected by them, becomes evident when focus is moved from the innovation itself to the wider system dynamics of the innovation setting.

A similar phenomenon can also be seen at the core of the “lead user” concept (von Hippel et al). The argument is that advanced users know more about the interfaces to other resources and activities in the using situation and thereby of how it should be formatted than do others. Users should therefore be deeply involved in the innovation process. An innovation can never successfully be a stand alone entity. It must fit to its immediate environments in order to convey its possible net benefits to others - by enrolling those others in the shaping of the innovations’ interfaces. The process of becoming a commercial success can not be separated from such translational interactivity between the innovation entity and those others that need to be included into its actual exploitation. To remain a stand alone entity corresponds to not becoming anything to anybody.

Another important attempt to address this issue has been done through applying the visual image of a “rugged landscape” (Kauffman 1989, Bruderer & Singh 1995, Poole & Van de Ven 1995, Levienthal 1997, Van de Ven et al 1999: 86-88). Based also on detailed case studies, these researchers discussed the interfaces between the innovation activities and the business landscapes surrounding them as a highly demanding managerial challenge. They used the image of a “rugged” landscape to describe innovation journeys – in particular in their early explorative phases – as analogous to journeys to reach across dark valleys to some peak on the other side. Innovators need to explore such valleys to learn what routes could be possible. They need to send out scouts to discover what is actually there, to study particular challenges in great detail, to create routes through open areas and dense forests and across caves and canyons. In order to succeed they need to explore a variety of possible paths, thereby building complex repertoires of action experiences, outcome preferences, contextual practices and creative connections between means and ends (Van de Ven et al 1999:88). Hence, the complexities and difficulties represented by the innovation to business landscape interactions necessitate highly demanding managerial capacities and skills. Without such managerial capabilities, the innovation will not only be costly. It is unlikely to reach the other side.

Another research area also identifying interfaces as the important place for economic development is service science. (Gummesson et al 2010). Research in service science and the Service dominant logic are based on the assumption that the customers always are co-creating the services together with the supplier and where operant resources become critical as an explanatory factor. One consequence is that all economic actors become resource integrators. (Vargo & Lusch 2007, Barile & Polese 2010)

The above examples indicate that there is a similar type of interface between an innovation and its business context as has been identified between the production of knowledge and the research context (Latour 1986, Collins & Pinch 1993, Galison 1997). The main argument has been that scientific knowledge is not something absolute and neutral but very much a consequence of its “production” processes including the tools and machines used to produce it. Thus, knowledge is something highly context dependent and is therefore always relational. In a similar way an innovation will be the outcome of its own production process within the context of its own development. This will have incorporated certain features into it that precisely reflects the processes of developmental interactions. But, an interesting difference is that the innovation then moves to the context of production where it needs to be fitted to other activities and resources as well. These might be so different that the earlier incorporated functional elements come in direct conflict with what is appropriate in the latter context. Next, the innovation also needs to adapt to various contexts of use. All together, the innovation typically needs to interact with things that are really not present in the immediate development and production contexts but are rather located in more distant contexts such as with the customers’ customer or the suppliers’ supplier or in international trade regulations, in safety and quality control regulations, in customs declaration systems, in industry standardization agreements, and in anti-terrorist security systems. The number of such contexts a given innovation may have to adapt to may obviously be high – with a corresponding number of interfaces to be established and adjusted.

Business landscape as a “rain forests”

If you view a rain forest from an airplane, it looks rather homogeneous; just green, dense forest. If you experience it from a car travelling through it on a road built through dense wooded areas, it shows a much more dramatic variation of trees, flowers, animals and typography. But still, it is rather easy to grasp. If you look at it while trying to walk through a

not yet explored part of it, you may discover an incredible variety of plants, animals and modes of life. Finally, if you do the same during nighttime, you will experience other animals and activities. You will probably also react quite differently to all of this in darkness when things are hard to see and situations are harder to judge. We would like to claim that a similar type of variety and partial invisibility can be found when looking at innovations in the business world.

One implication from this analogy is that visibility is not an absolute but a relative factor. It varies with who is the viewer as well as with the landscape, the light and the means of observation. The experienced, the engaged and the professionally equipped see more than the un-experienced and disengaged amateur. Some see a lot. Some hardly discover anything interesting. Furthermore, visibility varies over time. At certain times some items appear as highly visible while becoming less visible and even invisible during other periods. Visibility is also dependent on the location of the viewer and on his/her movements relatively to the landscape. Normally invisible activities may be interrupted so that they start coming out of their shaded spots - to mark their territories, to secure food supplies, defend offspring or whatever. Movements and changes cause attention, tension, action, flight, and new noises caused by these reactions may trigger reactions quite distant from the original incident. To exploit advantages from mastering the variable visibility of business landscapes and innovation activities seems also to be an essential part of what innovation management and innovation strategy includes.

A second implication is that nobody will have a complete picture or anything close to it. Thus, actors with highly different images will engage with one another while continuously contesting the others' image representations as well as their argued consequences by continuously offering upgraded images, beliefs, theories and suggestions to the others. The ability to relate, to interact and thereby to materialize an innovation is closely connected to this kind of abstract knowledge exchanges and the eventual alignments of images of the relevant reality, interpretations of their consequences and so forth. Because so much is hidden and so hard to interpret, the strength of an innovation to a considerable degree is reflected in the extension and quality of its observatory and interpretative capabilities; the extensions and alignments of its managerial interactions.

Applying the rain forests metaphor to the world of innovations suggests that typically the environment is complex, multifunctional and interdependent. This gives profound advantages to those who know the environment, to those with some overview and insight, those with multiplicity of connections and lasting experiences and to those with a capacity to discover, involve and influence others. To the newcomer, only part of the landscape will be visible, while much of what really goes on will appear as in shaded spots - remaining inaccessible to them. Innovators in such a world need to discover, relate to and interact with many of those entities and activities, and the processes of discovery will typically be marked by surprises. The world does not turn out to be as expected. This implies that there is an important discrepancy between the involved actor's perception and understanding of the business landscape and what may actually be important features. Whatever immediately visible will typically tend to dominate perception and interpretation, while the invisible parts will be underestimated if not completely ignored.

In such a world an innovation has to interact with entities that are typically quite visible, such as firms, entrepreneurs, financial investors, technology labs, accounting firms, stock prices, machines, and prototypes. But, apart from these, there are all those entities and activities that are much less visible that also will affect the process. Some of them might be discovered over time and may also be possible to react to in one way or another. Others might only be recognized in terms of unexplainable negative or positive effects. Much of what will be relevant discoveries, contain highly specialized activities, resources and actors, and much of what those actually know and do will remain blurred or invisible to everybody else. They do things that you cannot easily interpret, replicate or avoid – even if you have some clue about who they are and what they actually do. Particular experiences, techniques and potential solutions to problems are often hidden and interlinked. They pull resources and feed activities without really showing what is going on. They are hiding among entities that we may denote “networks of interaction”, “patterns of collaboration”, “path dependent connections”, “experiences”, “mental maps”, etc.ⁱⁱ

Three key factors; interdependency, motion and variety

In these complex business landscapes of a rain forest type it is still possible to identify some key factors defining or typifying economic entities such as innovations, and affecting their

economic outcomes. The first has to do with the role of interdependency in constituting what economic entities are. All the species in a rain forest are dependent on others in complex patterns which define their ability to survive and prosper. A similar pattern is a striking feature observed in empirical studies of economic activities in their business landscapes to the degree that it seems to constitute all economically significant phenomena as internally and externally relational and interdependent entities. This has been observed in the industrial network studies (Håkansson et al 2009) as well as in the service science area (Barile & Polese 2010). This way of characterizing the business landscape is very much in line with a tradition of thought that can be typified by Penrose (1959), Richardson (1972), Arthur (1989, 2009), Freeman (1982, 1991) and Powell et al (1996).

A second factor has to do with the role of motion in shaping the conditions and mechanisms for adaptation and co-emergence across these multiple interfaces. There is always motion that in a number of ways both undermines the stability of established economic relations, and supports the ability of economic entities to expand, to interact closer and to move resources, activities and actors around in relation to emerging opportunities. As in the rain forest there is birth, growth, death, but also entities moving in relation to each other - in space and time as well as in purely mental representations – to re-connect in new ways. Without motions, there can hardly be any innovations. If there is one common result from numerous innovation process studies, it is that “history matters”. This is expressed in different ways, but the most common is that some type of path dependency (trajectory, reverse salient, etc) is at work (Hughes 1983, 2004, Rosenberg 1982, 1994, David 1986, and Arthur 2009).ⁱⁱⁱ Hence, the relevant motions are those in the interactions between the established and the new.

Finally, the third factor has to do with the role of variety in constituting variable economic value. The variety is partly given by nature as in the rain forest, partly an outcome of the creative interactions in all kinds of processes of becoming of entities in society. This evolving variety constantly supplies new opportunities for actors to imagine and create additional unique combinations. The economic value of some created entity in this type of world obviously depends on which specific items it is being combined with. Thus, there are possibilities to increase the value of a given entity through finding other items to combine with that enhances their collective economic value. This is the essence of what constitutes a

commercial innovation. Here our work is very much in accordance with Cyert & March 1963, Alchian & Demsetz, 1972, Weick 1979, Economides 1996, and Uzzi & Spiro (2005).

These three factors represent the analytical starting point for a more extended framework for analysis of how the interfaces between the innovation and the environment influence economic outcomes. In the next three sections we will look closer at each of these and we will try to answer three questions; (1) in what way can these become a positive economic source, (2) in what way do they affect the innovation and the innovation project, and 3) in what way do they appear in relation to major management issues. In the following we will discuss each of these factors in relation to these three questions and we will for each suggest a proposition, before we conclude by focusing more specifically on the role of management in relation to innovations in business landscapes.

Table 1 in here

Interdependency as the key factor

If interdependency is a significant attribute of economic activities and business landscapes, it will also be an attribute of innovation and innovation processes. The emergence of an innovation can be described as the process of expanding, aligning and including more relationships to other entities and networks; to actors, artifacts like technology, symbols, things, texts, organizations, regulations, natural resources, money, contracts and partnerships, etc. There is no way that it may become without engaging in these many interactivities across multiple contexts. Numerous studies of innovations are full of descriptions of these many efforts to resolve what is needed to establish stable and effective interactions with others. In fact, innovations seem to emerge as a function of their increased relatedness with these many heterogeneous entities in their different contexts.

The essence of this understanding is that the emergence of economically valuable entities like commercially successful innovations is a direct function of their internal and external interdependencies. It is through increased interdependencies that innovations emerge. And it is through these interdependencies that the innovation becomes connected to and may be exploited by others. Interaction is more or less constantly relating each and every item in the total innovation structure to some other items in systematic ways. Thus, a first basic

proposition *is that relatedness is a core dimension of what constitutes an innovation* . The more extended its relatedness to others, the more valuable it becomes.

As interdependencies in no way are evenly distributed and developed, this results in an important variation in how each item is related to others, i.e. how well these relations are developed. Some interfaces become much more developed than others as a result of more extended interactions, adjustments and mobilizations. Some are much harder to align than others. Some will resist being engaged and adapted. Existing resources, activities and actors will obviously affect the ability to interact with new innovations simply by representing their already established interdependencies between specific resources, activities or actors. That is; existing resources, activities and actors propose interfaces to new innovations that are outcomes of their own historical emergences as interacted entities. This regards interfaces between activities mobilized and used to develop, produce and use the innovation, interfaces between the needed and utilized resources and interfaces between involved actors. The success of the innovation will depend on its ability to engage in these propositional interfaces to align the interface it proposes with those on the other side, its ability to manage, utilize and compensate for the adjustments and the efforts involved.

The importance of the development in the interfaces means that we have to acknowledge the economic effects of qualitatively variable mutual interdependencies between involved activities, resources and actors. Changes in one of them will trigger responses in the others – and vice versa, while still leaving it open exactly how any of these responses may be. Sometimes the material substances of the things involved will offer particular responses themselves – in terms of output failures, decreased lead times, etc. At other times creative responses by involved actors may solve the problem by adjusting items affected by the troubled interface. But the particular solution to this may cause other challenges to some other part of the world it interacts with. To include the degree of interface development characterizing the particular business landscape triggers a focus on the implicit demands a business landscape represents towards whatever aims at establishing itself within it. And it emphasizes that these demands are not located in some general conceptions such as “culture” or “knowledge”, but are represented by the degree of development in numerous established interfaces across the particular business area.

, This implies, and this is our second proposition, *that one of the most critical features of an innovation must be contained in the specificity of its relatedness to other entities in the particular business landscape*. The more developed are the interdependencies, the more specialized and precise must be the functional offers represented by the proposed innovation, for it to expand and materialize.

From a managerial point of view the importance of the specificity of the innovation in relation to whatever it needs to associate with in order to emerge as a commercial success, highlights all the work that is needed to actually enroll and activate others. To acknowledge the importance of interdependency, emerging relatedness, and need for relational specificity, turns innovation management away from a focus on independent strategic decision-making and turns it into a necessary focus on advancing specific solutions and offerings in order to connect to, engage with and influence others. As many of the interfaces are with other actors or with resources and activities controlled or performed by others, these become central to the outcome. In this way it is others who determine or at least influence the outcome of the innovation as well as how it will be produced and used. Through its interfaces the innovation is also influencing all these others. The specificity of the interface is always affected from both sides. In this perspective, and this is our third proposition, *a dominant dimension of innovation management is to deal with “the importance of others”*. The creative capabilities of experienced and extended management appears to be what is needed to actually orchestrate these complex tasks, to engage in relating the innovation to others, in mobilizing interests, in adjusting propositional interfaces, in alignments of interests, in operations, routines, and market planning. Without substantial creative capabilities and energy represented by process management, there seems to be no way that an innovation can be able to actually establish itself within an existing business landscape – in between all the other business activities that are already engaged in one another. Innovation management is to manage the processes of interaction between the two processes that constitutes each side of the Janus-face; the creative and the alignment.

Motion as a key factor

If motion is a typical feature of the business landscape that the innovation becomes part of, then there will be movements also in the relational interfaces between an innovation and its

many interdependent counterparts. One could perhaps perceive of these movements as similar to what happens during the performance of a musical concert where the various players interact to perform a complex but perfectly harmonious collective outcome. To some degree, this captures the essence of what we may observe when innovations have become stabilized as normal business. However, this is the outcome of tremendous rehearsals and interplays over long periods of time, and observing innovations as they seek to establish themselves and get their interfaces to others ordered, is more about trial and error and rehearsing than concert performing. Actors may come and go. Resources may be turned to other objectives. Unified activities may divert into different trajectories. Everything may seem to move in disharmonious patterns. Multiple concerts and rehearsals may go on at the same time. At each and every moment the innovation may threaten to collide or dissolve.

In this perspective, innovations seem to become and emerge as a function of their increased ability to establish some degree of harmonious, stabilized, collective unity across the many interfaces to heterogeneous entities. Harmonious interactions in dynamic rain forests are never given to you. But they may result from hard efforts at multiple frontiers over time.

When an innovation is incorporated into the existing business world, it is creating change for all others. As these others already at least partly have invested into each other through developing their existing interfaces, any such innovation will be a challenge to these existing investments. The friction caused by the imposing of an innovation into a given business world is what generates the need for hard efforts to further develop and adjust the innovation – to make it fit to all these others. Hence, our forth proposition is that *friction forces caused by imposing an innovation onto a given business world represent sources of economic value creation* (Harre 1993, Nowotny 1993, Håkansson & Waluszewski 2002).

A consequence of continuous innovation efforts is that all interfaces between different elements are constantly put under two opposing kinds of pressures. They are firstly under the pressures of existing investments to keep whatever is established together in their already established positions and roles. The existing structures have developed over years through the efforts by many. Hence, there are substantial investments into all the interfaces keeping them together. Secondly, there are the pressures from all suggested changes coming both from changes suggested by different actors but also changes due to existing discrepancies in the existing solutions that cause further pressures on the existing interfaces – pulling them apart,

forcing them in different directions or transforming their internal positions, roles and patterns of interaction.

The combination of these two forces is “friction” - reactionary effects within each of the entities involved. Friction leads to the mobilization of efforts that is caused by disharmonious movements. This causes a struggle between forces moving the relationship back into its previous order and forces escalating it towards some other end or shape. Friction will obviously slow down some changes but might also, surprisingly, accelerate others. If a suggested change is in accordance with a set of other changes they might in combination with the existing resources together create a joint “moving mass” that may mobilize efforts to redirect, to reshape and to improve the quality of the interactions. In the opposite situation, friction forces will mobilize to move back to the previous order. Usually, however, interpretations are ambiguous, causing conflicts and additional trial and error excursions. An important aspect of this is that friction triggers the mobilization of creativity – of additional entrepreneurial and problem solving processes represented by the interactions of mental creative processes with the disruptive processes represented by the material and social interactions initiated by motion.

As such, friction is a basic economic source that is needed for effective, efficient and stabilized harmonious economic phenomena to become and to improve their performance capacities over time. Friction is a concept that helps us to discuss “economizing” as creative efforts to utilize motions – which in turn makes it easier to explain and predict economizing trajectories. It is a way to understand how the development of existing and potential relationships create positive and negative effects for the suggested innovation and how these effects feed additional creative responses.

The economic function of friction is to make all types of reactions important as triggers of diverse mobilization processes. Because friction contains controversy, it leads to mobilization of elements on both sides of the interface that are aimed at persuading interdependent entities to move, to re-stabilize or to change. Through these mobilizations, additional elements are being enrolled and aligned on all sides of the controversy, leading to more intensified, more sophisticated and more mobilized business activities.

Our fifth proposition is that *friction forces the innovation to advance the adaptability of the interfaces it offers to those other entities*. The more mobilized the business landscape, the more it will influence and shape those innovation projects that aim at establishing themselves within it. Hence, innovators constantly face the dilemma that if they move into the more advanced and mobilized business areas to become part of more advanced and economically rewarding business activities, they may also have to accept being moved by others into roles and positions orchestrated by them. If they move towards a less mobilized business area, they may become more influential, but the business area may be less rewarding. At the same time, the less adaptive the innovation, the less mobilized business area it needs to address in order to enroll others.

This implies that there can be no other way for an innovation to become than by upgrading its level of development and level of mobilization across its interfaces to other entities through historical time in real world contexts. We accordingly need to include the time and space dimensions in the conceptualization of the interfaces between the innovations and their business landscapes. Innovations can neither be understood nor managed as separated from their historical circumstances. The innovation will be embedded in its own history – extended to the history of the related elements in its relevant business landscape. The actual interfaces can – in this perspective – be seen as the actual representations of these historical features as they are present in actual business activities. History will leave its imprints on the relationships and thereby on all interfaces.

Our sixth proposition is: *The consequence of friction can in the innovation managerial perspective, be formulated as the importance of handling reactions*. Motion causes friction, which causes a constant managerial occupation with adjusting to responses from whatever needs to be connected to the innovation, towards mobilizing resources, activities and actors to move activities towards more rewarding states, and to resolving their tensions, conflicts and disruptions. Hence, any stabilized, harmonious order across multiple interfaces is constantly threatened by new frictions in the various interfaces.

Due to the existence of many items and multiple interdependencies between them, there are so many sources and so many ways that innovation management will have to encounter these disharmonious events. There will also be multiple ways to react to these challenges – leading

to substantial efforts to increase coordination capacities and capabilities within the management function itself. Thus, management is usually fighting with too many possible interpretations and too many possible ways to react to too many friction forces in a situation that calls for an extended management function with a capacity to overview and interact in a large number of interfaces to others.

On the other hand, frictions and mobilizations cannot be avoided, only partially managed. A completely stabilized innovation will quickly be torn apart as a result of motions in their landscapes. Accordingly, innovation management is about establishing entities capable of moving in some harmony with the motions of others. The need for stabilization is not absolute, but relative to whatever it interacts with, reflecting the need for a widely extended managerial network. Friction necessitates managerial overview and ability to mobilize efforts towards shifting interfaces over time, which requires participation in extended networks with observatory positions reaching quite far away from the core of a particular innovation project. One needs to interpret such things as business cycles, consumer trends, political conflicts, new breakthrough inventions or discoveries in science as well as the effects of all these aspects on the direct interactions between involved units.

Variety as a key factor

If variety is a typical feature of the business landscape, this will also affect the interfaces between the innovation and its business landscape. The variety in terms of relevant options presenting themselves in a given commercial setting can have at least two very different sources. One is the social-natural variety in the world of already existing entities. The other is the variety represented by human ideas or propositions more or less independently from whatever of actual existence. The interactions of these two sources in relation to commercial use represent the world of actual creativity from where innovations and economic developments emerge. Variety follows from the vast number of possible combinations of all these entities. Hence, the number of possible propositional combinations is virtually unlimited, and as a result there is a constant flow of such imaginative suggestions all of the time. This says nothing about the economic value of any of these propositions. However, it tells us that the economic value must vary across different compositions, and as such they represent potential additive economic value to a given economic activity.

Our seventh proposition is *that the unique combinations that define the innovation will affect the economic value of the innovation both directly and indirectly*. In the direct sense, this represents a third kind of economic source closely related to the existence of heterogeneous resources. The value of a resource is dependent on with which other resources it is combined with.^{iv} Specific and mutual adaptations to directly related entities will generate specialized variations of the entities as well as of the whole. It will in this way create a specific value related to how it takes advantage of the existing heterogeneity represented by the interacted resources. Only a very few out of the many propositional combinations will generate additional economic value, as compared to combinations already in place producing economic outputs every day. Most represent potential economic losses. However, unique combinations is the essential economic source of value creation, and hence the point of departure for all commercial innovations.

Consequently, due to these combinations they carry variable economic values, different abilities to convince others and potentially some ability to engage in new relations in the sense that others would want to relate to them in order to somehow take advantage of their properties. The two fundamental sources of variety and their interactions create a landscape where most entities evolve into highly specialized and complicated commercial connections – very similar to our perceptions of the complex interplays existing in a rain forest. In such an economic world, the challenge is to find yet another position where an innovation can make a living on the basis of sophisticated specialization by which to exploit the particular specializations represented by others. Such a world will grow by including more and more specialized variety. This, we believe, is in fact a core characteristic of what we associate with an innovation driven economy.

However, the innovation may also be affected by changes in entities to which it only indirectly is related through other entities. This is what we usually associate with network effects, causing complex patterns of change and adaptations that result in alterations in value creation by means of adjusting combinations of already paired resources in unique ways. Hence, variety generating impulses may roll back and forth in heterogeneous structures causing adaptations and re-combinations that will have economic effects. For instance, demand for product variation on the user side causes propositional variations to roll back and

forth through a development and production system leading to adjustments to enable such variation in output.

The variety of unique combinations within a particular business landscape leads to a “multiplicity” of optional entities surrounding established interfaces. Hence, variety represents an important dimension of business landscapes. Each interface is not simply between two items but is indirectly constituted in relation to the other potential interfaces presenting themselves as commercially exploitable options. This availability of multiple options with different potential economic values represents a particular dimension of business landscape interfaces which causes substantial challenges to innovation management.

The consequence of this for the innovation to business landscape interfaces is that the degree of variety represented by the particular business area, the more demanding will be the innovation’s ability to engage in more rewarding combinations than whatever is actually already present. Thus, our eighth proposition *is that the innovation has to build on and combine previously incompatible interfaces in unique ways*. On the one hand, the innovation has to offer opportunities that are distinctly unique and attractive as compared to other alternatives, and on the other hand it needs to enhance its ability to connect to a multiplicity of combinations of others. Over time, these highly complex landscapes tend to emerge into unmanageable levels of diversity, which causes friction forces that mobilizes towards standardization of interfaces. Hence changing demands for combinability functions is a challenging dimension of innovation to business landscape interaction.

The managerial issue that follows from the observed variation factor is essentially the difficult continuous striving to avoid chaos represented by a multiplicity of combinatory options; the striving to create and maintain some simplified conceptual unity and sense of direction on the side of the innovation collectivity. It is to develop, adjust, upgrade, communicate and enforce particular conceptualizations that link the major elements together in such a way as to present a route to economic rewards. They are communicative conceptions of value creating models and processes that serve as ordering systems to coordinate and mobilize resources, activities and actors to reach perceived objectives and goals. These conceptions are typically mobilized entities at the frontiers of enrollment and interacting activities. For instance, we observe a lot of ideology production built on simplified belief systems along with production of persuasive

arguments to discredit alternatives and maintain commitments. In the managerial perspective the challenge is to manage an overwhelming complexity in the face of limited ability to actually evaluate the value of the various options without engaging in additional costly and time consuming trial, error and rehearsing processes into the shaded spots of the rain forest where nobody knows what problems may appear. The capacity to manage, investigate and develop is always tiny compared to what is needed to assess what is represented by the variation that presents itself to the innovation. Hence, and this is our ninth and final proposition, *in the face of substantial variation, framing of value creation processes becomes a core innovation management activity.*

The role of managerial actions

The application of a rain forest metaphor to understand the business landscapes of innovation activities brings to the foreground the importance of managerial actions. Apparently, managerial activities are involved in the mediations of all the needed interfaces. Managerial actions direct the processes towards rewarding economic outcomes. Some of these actions deal specifically with the variable visibility problems out there in the rain forest. Others concern the characteristics of the interfaces that are relating resources, activities and actors in the many projects and processes that characterizes the becoming of an innovation..

The visibility – invisibility attribute of business landscapes implies that discovery and learning are unavoidable ingredients in innovation processes. Surprise in the context of innovation management, is by no means limited to the discovery of business opportunities. It is about everything and anything. Good and bad. Market possibilities, partners, competitors, technological failures, financial disruption, customer attitudes, production requirements, other inventions, consumer hypes, patents, etc. keep coming out of “the rain forest” to affect the innovation project. Some of these are feedbacks from the project’s own activities, such as attempted interactions with partners, contract negotiations, market tests, and quality tests that keep changing the innovation project as they appear. But most are the outcomes of actions taken by others.

The visibility-invisibility aspect highlights the need for active and conscious minds. It necessitates continuous mental interactions to interpret, discuss, propose, associate and decide – quite often at a level of high intensity and speed. There is particular need for managers with

deep and extended familiarity with the complexities of the business landscape in order to be capable of maneuvering the project, of protecting it from potentially chaotic or otherwise destructive influences, of finding alternative solutions, of including additional resources and actors. Managing innovations in rain forest like business landscapes requires expertise based on extended experience in interaction with others.

We have identified three important dimensions of management activities; the activation of others, the handling of reactions and the framing of value creation.

The primary managerial consequence of interface interdependency is to acknowledge the innovation project's dependency on others. Success depends on others that are never fully controlled and adapted to fit to the innovation. Innovation management accordingly necessitates a lot of creative interactions with others in order to enroll, mutually align and maintain those others in their roles. Every new enrollment will force some frictions within the interconnected system, some adjustments, some disturbances to whatever is already in place. Over time, the reactions to these, forces innovation managers to upgrade the specificity of their relationships to those others - to upgrade the functionality and robustness of the interfaces involved.

Hence, the second managerial consequence is to deal with those reactions. The implication of interface motions for innovation management is the acknowledgment of friction forces across particular interfaces which cause reactions and counter-reactions through out the interconnected innovation venture. Management of the flows of variable forces that result from these frictions is a major part of what innovation managers have to do in order to maintain relative stability and sense of collective unity and direction. All the disturbances, oppositions, misfit problems, stresses, and noises that keep flooding the innovation processes cause substantial managerial efforts to resolve them, to create robustness or to reformat parts of the interfaces. A lot of these frictions are indicators of improvement potential. In that sense, efficient innovation management is not to prevent friction forces, but to address them adequately to further stabilize and improve the productive capacity of the innovation venture in relation to all those at the other sides.

To utilize frictions requires conceptual and communicative framing activities. Eventually, most of the frictions caused by all kinds of movements and changes, need to be managed by many across multiple interfaces. In order to create a specific coherence, individual framing of meaning, objectives, targets and methods have to come together in such a way as to shape a collective expectancy and discipline for what in the end can only be executed through a distributed trouble resolving managerial structure.

In our discussion, we have attempted to pull Schumpeter's "innovations as re-combinations" argument further by focusing on the characteristics of the interfaces between the heterogeneous entities combined, which force particular kinds of managerial activities. What we discover then, is that creative management is obviously the single most critical resource needed for these processes to succeed. To manage these interfaces, is what innovation management really does.

Finally the third managerial consequence is the constant need for framing and re-framing when dealing with innovation. Framing requires sense-making and abstract conceptualization needed for communication and mediation in multiple relations. Conceptualization is essentially a mental, intellectual activity by which something is isolated from the regular flow of everyday events, and turned into focused, structured and argued entities that may be meaningfully and powerfully communicated, mobilized and used for constructive ends. It defines the meaning of any discovery or new combination in the innovation context. It defines what is to be included as well as what is to be excluded; what should be interacted and what should not. Because of the extendedness of the networks interacted, the overflows into what has been framed, the need for analytical conceptualizations can only be adequately dealt with through extended rehearsing, practice and communicative interaction to the point where a major share of these conceptualizations are automated and taken for granted. They become blackboxed and partly invisible.

Through these processes, management itself emerges into an extended interrelated network with interfaces shaped by these conceptualizations. It forms a network of "shared understanding" and "automated communication channels". Without these, there is no way that innovation processes can be managed at the level needed to become as actual economic successes. Through these mechanisms innovation managers stabilize their activations of others, their ways to deal with reactions and their framing of the value generating activities. On this basis the creative side of the Janus face gradually transform into the disciplined

structures of its other side in which all the involved entities interact in some harmonious order.

In advanced economies, effective conceptualization of discoveries typically requires specific and variable expertise. Hence, relevant discoveries regularly occur in parts of “the rain forest” that are hardly visible or understandable to other parts of the networks and contexts affected. From discovery to re-conceptualization to communication to adequate re-construction of network and context interfaces, may accordingly represent quite lengthy and heavy processes involving many managerial actions. The less interconnected these entities are, the more difficult it will be to reach the other end. Feedback from such locally situated discoveries may accordingly be blurred and hard to interpret. Quite often it will simply result in “the sound of silence”, as the discovery will not circulate out of the area of expertise at all, in which case the learning output to the innovators will probably be low, while interactions may successively die out for reasons they do not adequately understand.

Interface multiplicity causes a substantial complexity challenge to innovation management. There are usually multiple options for connecting across a given interface. Different types of resources and actors, variable qualities, different quality/price mixes, different degrees of specialization requirements, and different knowledge bases have to be connected. Such complexity forces simplification as an important and distinct managerial activity. Hence, simplification is a necessary part of managerial framing activities. Simplification is in itself also a creative activity, typically associated with such notions as mental holistic conceptualization, selection, focus, unity, strategy, and goal targeting. However, simplification is an activity at the epistemological and constructional level. It fundamentally underpins our ability to communicate and to act in productive ways. In a business landscape marked by relatedness, motion and variety, simplifications are always like attempts at “freezing” particular images of rational meaning to the entities in order to permit for more focused and deliberate interactions in more stable and constrained contexts mentally, communicatively and operationally - by excluding complexity. But, because the reality is still complex, interrelated, dynamic and variable, it typically keeps challenging the proposed simplifications. Simplifications are accordingly always propositional and need a lot of managerial work in order to stabilize and materialize among others.

This kind of work is a major part of what contributes to friction across new interfaces. It is often important to each side of an interface to maintain their own simplifications, their own unity, sense of focus and ability to operate effectively and efficiently in a semi-autonomous way. They tend to immediately fend off against anything that does not fit in – anything that looks like “overflow”. By the part that proposed to interact, this corresponds to “a negative feedback” discovery which forces new rounds of conceptualization, creative learning, simplification and coordination in order to re-format the interface, to move on to another opportunity or to adapt to the conditions set by the other.

The central role of interfaces represents a particularly dominant dimension of what innovation management actually is. It always includes actors outside direct hierarchical control. Organizing and re-organizing is about building an innovation context and a management apparatus needed to deal with all these specialized interfaces. It is a management task that gradually leads to a more and more stabilized and specialized judicial, managerial and business economic governance and control system that are enforced by the adding of more or less standardized formats and technologies. It is about growing a business context with multiple highly specialized interfaces in such a way as to stabilize the business activity and grow its value creation qualities in interaction with all those others out there in the rain forest.

At the same time, managing processes behind an innovation is obviously an extremely complex task. Resources, activities and actors have to be directed based on propositional simplifications and conceptualizations that are constantly being contested. Creative learning processes have to be orchestrated that keep producing rival propositions as to what the project actually is and where it ought to go. New events, opportunities and negative feedbacks keep flowing into the project at any node of its activities which has to be evaluated and decided upon. The rugged and only partially visible rain forest around the innovation keeps changing what is visible and accessible. A focused and holistic unity must be kept together while attention is being diverted into a variety of quite extended activities needed to manage distant, but influential activities containing multiple holistic conceptions where the project may have some role to play. If the rain forest is a compelling metaphor for the business landscape of innovations in interaction, managing innovations obviously requires a broad set of complementary managerial roles (Van de Ven et al 1999; 112-116). “The manager” would

then be a pluralistic, multifunctional, multi-specialized networked entity: An innovation in interaction of its own – each and every time. It somehow needs to be a collective entity.

Conclusions

Somewhat similar to the two sides of a Janus-face, an innovation emerges as a unity of two different processes. One of these two kinds is very open, creative and full of uncertainties and fluctuations - essentially associated with mental processes of mind. The other kind appears almost the opposite – a systematic process of combining, adapting and linking in order to fit the “creative new” into already existing activities and resources in an economically efficient way. This is a process constrained by whatever is already there in the social-material world. Both “creative newness” and “real world economizing” are needed for an innovation to actually materialize and succeed. Based on this argument, we have in this article explored into a more thorough conceptual understanding of the world of innovations in their surrounding business landscapes. Using a rain forest metaphor gives us a basic image of how complex and multidimensional this relationship is. We argue that an innovation needs a whole set of very different interfaces relating it to specific other resources and activities. We see each and every such interface as the outcome of Janus-face like innovation processes. Hence, the overall unified process may be seen as a conglomeration of a large number of linked micro-processes. To manage these, is what innovation management is about.

We have identified three important factors dominating innovation management challenges in business landscapes; interdependency, motion and variety. Each of these is associated with a particular source of economic value creation. The importance of interdependency follows because economic entities are constituted by their relations to others. The importance of motion follows because motion causes friction which causes mobilization of creative micro-processes. The importance of variety follows because the value of a given resource, activity or actor depends on its combining with particular others. Hence, interdependency, friction and combinatory uniqueness are conceptual building-blocks in an economic theory that takes interaction as a fundamental feature of real economies.

Based on these, we argue that management of innovations requires a set of particular qualities that are needed to transform these economic sources into specialized semi-stabilized innovation entities linked to other entities in their business landscapes through a large number

of particular interfaces. The three factors and their associated economic sources are represented within the interfaces. From there we have identified three important dimensions of these interfaces that need to be managed in order to secure the effective transformation of the economic sources into some kind of simplified collective unity with a sense of direction and a capacity for disciplined interactions. These are the specificity dimension, the adaptability dimension and the combinability dimension of the interfaces.

It follows from this that the ambition to succeed in bringing a radical innovation from idea to success will require some kind of multi-functional interrelated managerial network that is capable of constantly recreating simplified and conceptual unity, sense of direction and collective coordination, while at the same time managing the extendedness of the operation, the many changeable, moving and complex interfaces in their different contexts, as for instance represented by the context of development, the context of production and the context of the using of the innovation by others. Given these challenges, management and management action must be the most critical function in any innovation process – almost like an innovation in itself.

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Table 1: Innovation in interaction: Three fundamental factors and their three analytical dimensions

Fundamental factors observed:	<i>Economic source</i>	<i>Innovation dimension</i>	<i>Managerial issue</i>
<i>Interdependency</i>	Relatedness of economic entities	Specificity	Activating others
<i>Motion</i>	Friction across interfaces	Adaptability	Handling reactions
<i>Variety</i>	Value combinations	Combinability	Framing value creation

ⁱ This has been formulated by Swedberg (1994) noting that the market mechanism put forward has made the description of what is going on in the market very “thin”.

ⁱⁱ Studies of “complex systems” within areas such as management, physical and technological systems and innovation have applied complexity theory to study how these complex worlds coordinate and generate particular outcomes at the overall level of analysis (Amaral & Uzzi, 2007). This approach is complementary to the more micro-oriented perspective we apply in this paper

ⁱⁱⁱ Path dependency defined broadly implies that the next step depends on the previous steps. Whatever becomes is dependent on things already existing. In economic theory, the notion of path dependency is used to argue that existing technologies have increasing returns in relation to new competing technologies, because they are already adapted by users and are baked into the competencies of companies. In addition to their internal superior capabilities, new technologies will have to overcome the costs of adaptation. Over time this is said to cause a potential problem of technological lock-in of suboptimal solutions. (Arthur; 1989, David; 1986, David & Bunn; 1987).

^{iv} This is in accordance to the definition of heterogeneous resources in Alchian & Demsetz 1972