Designing a Strategy Formulation Process for New, Technology-Based Firms: a Knowledge-based Approach

Antonios Livieratos
Université Paris 11 Sud, France and BIC of Attika, Athens, Greece
alivieratos@bicofattika.gr

Abstract: In the knowledge-based economy the nature of what is strategic has been modified along with the importance of knowledge and its management. One of the most important implications of these changes is the expansion of resources and products that are globally tradable, highlighting the importance of knowledge as the key economic resource of lasting competitive advantage. As a consequence of this shift in the economy, an increasing number of industries are moving from the closed innovation model to the open innovation model that created porous boundaries between the innovative company and its surrounding environment, changing the inter- and intra-organizational modes of coordination. In an environment where knowledge is the key economic resource and the open innovation model is applied in more and more industries, we are experiencing the increasing importance of the New Technology-Based Firm (NTBF). NTBFs face a number of difficulties mainly associated with a lack of resources and entrepreneurial skills and in order overcome the difficulties NTBFs strive towards flexibility while accelerating the development and commercialization processes by creating and/or entering business networks. By adopting a knowledge-based view for NTBFs and consequently placing knowledge in the centre of a systemic innovation model, knowledge networks constitute an asset for NTBFs. As this new form of cooperation takes multiple and often unpredictable forms it is thus essential to develop strategy formulation tools and processes that can help NTBFs to face their challenges. Until now little attention has been given to the development of strategy tools and processes tailored for the requirements of NTBFs. The present paper presents a concept to cope with NTBFs' by developing a generic process for strategy formulation. In this respect, an action research project was initiated. The proposed concept was initially designed, although not exclusively, for a Greek NTBF, Astrofos Ltd. The author, who is coordinator of the incubator where Astrofos is sited, is acting as a strategy consultant for the firm and has taken part in all its major decisions since summer 2007. In order to build the strategy formulation process, this paper proposes a mapping technique that attempts to depict a NTBF's tangible and intangible transactions as well as the strength of ties between the focal NTBF and its partners and the complexity of the knowledge. In developing the mapping technique, we have used a combination of the concept of weak ties, derived from social network analysis, with the notion of complex knowledge, as this combination was initially proposed by Hansen (1999). Additionally, a set of questions is proposed that have to be answered in order to pass from knowledge identification to knowledge transfer, from a strategic point of view. In this regard, the presented methodology constitutes an effort, on the one hand, to study the emergent patterns in what is considered to be a chaotic or disordered system and, on the other, to stimulate the creation of new patterns in the system that would be consistent with the NTBF's strategy.

Keywords: new technology-based firm (NTBF), innovation, strategy formulation process, value network, mapping technique, social network analysis, knowledge complexity

1. Knowledge-based economy and the open innovation model

In the rapidly changing environment of the knowledge-based economy we are experiencing "structural changes … in the economies of advanced developed countries", modifying the nature of what is strategic and highlighting the importance of knowledge and its management (Teece 1998). One of the most important implications of the changes posed by the knowledge-based economy is the expansion of resources and products that are globally tradable, highlighting the importance of knowledge as the key economic resource of lasting competitive advantage (Teece 1998; Nonaka and Takeushi 1995; Drucker 1985).

Since the mid-80s a new systemic model of technological innovation has emerged, incorporating a number of factors (e.g. externalities, transferability, modularity, network structure, etc.) not included in the previously dominant linear model (Autio, 1997). In this regard, innovation is viewed as a systemic, irreversible (Pavitt, 1990) and knowledge-centric (Nonaka and Takeushi 1995; Drucker 1985) process influenced by the institutional environment (Braczyk et al. 1998).

As a consequence of this shift in the economy (and theory), an increasing number of industries are moving from the closed innovation model, in which companies generate, develop and commercialize their own ideas, to the open innovation model, in which companies commercialize both their own ideas as well as innovations from other firms (Chesbrough 2003). According to the open innovation model, i) the innovation process becomes more complex and fragmented, ii) the actors are

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increasingly heterogeneous, as well as being more interdependent, and iii) the period from conceptualization to commercialization is shorter. This model has created porous boundaries between the innovative company and its surrounding environment, changing the inter- and intra-organizational modes of coordination and triggering new answers to Coase's question as to "what determines the boundaries of the organization" (1937). Networks of heterogeneous players with non-common interests (and often non-rational in the neoclassical sense) are no surprise in the modern innovation process. Bazaar governance (Demil and Lecocq 2005), the "private-collective" innovation model (von Hippel and von Krogh 2003), communities of practice (Wenger 1998) and "co-opetition" (Brandenburger and Nalebuff 1996) are some of the concepts which have been developed to describe the changing modes of coordination.

With knowledge being the centre of this non-linear innovation model, knowledge networks constitute a new asset for the company. This new form of cooperation, which has succeeded the technology networks, takes multiple and often unpredictable forms (Lengrand and Chatrie 2001) in the open innovation model. While technology networks seem "frontierless" from a technoglobalism perspective (Archibugi et Michie 1995) this may not be the case for knowledge networks. Evolutionary economists, who emphasize the importance of tacitness and cumulativeness of knowledge, localized learning, and externalities associated with proximity and the importance of national and/or regional systems of innovation, claim that geography and proximity still matters for innovation (Cassiolato and Lasters 1999). As discussed below, this latter position seems to serve well as a theoretical base for New, Technology-Based Firms.

2. Research question

In the knowledge-based economy, where the open innovation model is being applied in more and more industries, a great deal of attention is being given to New, Technology-Based Firms (NTBF), which have gained an increasing role in the innovation process.

From an entrepreneur's point of view, innovation constitutes a high-potential entrepreneurial effort (Schumpeter, 1996) and an NTBF can definitely be viewed as such. Additionally, the emergence of a new environment that has served to increase the potential return of NTBFs has expanded the interest for this type of organization. A great number of business intermediaries such as technology brokers, technology transfer institutions, high-tech marketers, liaison offices, incubators, etc., that support NTBFs and their networking requirements have been multiplied in the recent years. Furthermore, due to perception that NTBFs contribute to the technological renewal of economies, develop the national technology base and contribute to growth and new jobs (Autio and Yli-Renko, 1998, Wennekers and Thurik, 1999, DG, 2002), the interest in NTBFs is also reflected in most of the related public policies of the developed countries. As explicitly illustrated by Acs and Audretsch (2001), most public policies have progressively shifted from the question on "Should we break up, regulate, or simply take over General Motors, IBM, and US Steel?" to that of "How can we grow the next Silicon Valley?"

NTBFs have also attracted the attention of an increasing number of scholars who have implicitly or explicitly highlighted the importance of knowledge in their creation, formation and development. However, apart from a few exceptions (Luggen, 2004), since the first appearance of the term NTBF (Little, 1977) there has been relatively little research on the development of tools that would support the business strategy formulation of NTBFs following a knowledge-based approach. The present paper presents a concept to cope with the challenges of NTBFs by developing a generic knowledge-based process for strategy formulation. The development of the process is part of a greater action research project that aims to develop and implement the process with the collaboration of a Greek NTBF, Astrofos Ltd. The author, who is coordinator of an incubator where Astrofos is sited, is acting as a strategy consultant for the firm and is taking part in all the major decisions made since summer 2007. The proposed strategy formulation process has been developed on the basis of bibliographical research, a significant number of interviews and informal discussions with entrepreneurs and people involved in the business incubation industry in Greece, France, Finland, Spain, Germany and United States as well as interviews and informal discussions with Astrofos members. Both the methodological approach of the research and the empirical findings from a longitudinal application of the methodology are the subject of forthcoming papers.

The paper is primarily addressed to NTBFs managers and consultants who support NTBF. It is also addressed to policymakers who design and implement programs, measures and support organizations that are aimed at helping NTBFs.

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3. Defining new, technology-based firms

According to the classification proposed by Rickne and Jacobsson (1996), apart from the age of the company, there are three ways to distinguish NTBFs from other firms: the nature of the firm's product and/or services, the patenting intensity and the level of employee education/competence. However, none of the above criteria are universal. This paper adapts Laranja and Fonte's definition (1998) of NTBFs as "young small companies founded by an entrepreneur or a team of entrepreneurs with a strong educational or professional background which are involved in the development, application and commercial exploitation of an innovative idea based on technological know-how". Adopting this definition it is worth mentioning a few relevant points. The first is that we are referring here to firms that are relatively new and small and do not have strongly institutionalized internal processes. Consequently, such organizations are not as path dependent as bigger and older structures and are thus much more adaptable. The second point is that it is more frequent to find NTBFs in fast-moving industries in which short product cycles are likely to drive the establishment of network partnerships in order to reposition products rapidly and respond quickly to changing market conditions and technological developments (Powell, 1990). The third point is that not all NTBFs are aggressively growth oriented and this is often related to the size of the niche they are serving (Autio 1997) and the personal ambition of entrepreneurs to retain control over the firm (Jones-Evans 1998). The fourth point is that NTBFs may be characterised by small windows of opportunity, such that all may be lost if investments are not made at the appropriate time (Luggen, 2004). The final point is the recognition that social capital density has a positive impact on the creation and sharing of intellectual capital (Yli-Renko et al. 2001, Nahapiet and Ghoshal, 1998).

4. Knowledge-based view for NTBF

NTBFs can compete with large firms in the global frontier because of their "shorter communication channels within the firm, the more ad-hoc nature of their decision making, their flexibility in reacting to changing markets and new business opportunities, and their ability of exploiting information and knowledge from outside the firm" (Schuetze 2001). Taking into account that it would be inefficient and highly unlikely for this type of firm to integrate all the required knowledge and resources, much of the information and knowledge required (scientific, technical and market) comes through networking (Schuetze 2001). Turning this argument upside down, Powell (1990) argues that firms more likely to engage in network arrangements will be those needing to exchange difficult-to-codify, knowledge-intensive skills that are best transferred through processes of collaborative information sharing.

Adopting the "knowledge-based view of the firm", a view that challenges the perception of the boundaries of the organization (Sveiby, 2001), the base of the competitive advantage of a NTBF in forming its "innovative capability" is: i) its members' knowledge, ii) the firm's capacity to combine this knowledge with external knowledge and to integrate it into its innovation process, and iii) the firm's capacity to commercialize its knowledge-intensive results. The management of a NTBF's most precious assets, its knowledge and competencies, either from the organization itself or the external environment, becomes strategically important. By recognizing, either implicitly or explicitly, the strategic importance of both internal and external knowledge and competencies, NTBFs are transformed into extremely porous organizations that have to manage the "quantity and quality of their openness" when establishing and maintaining knowledge networks.

5. A knowledge-based strategy formulation for NTBFs

A knowledge-based strategy formulation should start with the competence of people which can produce value in two directions: by transferring knowledge from internal and external resources and then converting it into useful knowledge for the organization they belong to. The strategy-formulation issues are concerned with how to utilise the leverage and avoid blockage that prevent the sharing and creation of new knowledge. The key to value creation lies with the effectiveness of such transfers and conversions (Sveiby, 2001). Drawing on the findings discussed in the previous paragraphs it is evident that NTBFs' most precious assets, namely knowledge and competencies as well as the way these are formed across the boundaries of the organization in order to create value, need special consideration when formulating a NTBF's strategy.

The aim of this paper is to develop an easy-to-use management tool that will take into consideration these NTBF characteristics. The tool will permit the construction of a flow diagram with which one can depict tangible and intangible exchanges of a focal NTBF. In this respect, decision makers can easily identify where value is created in a NTBF in order to position the company in the future. For the

visualisation of exchanges, the HoloMapping technique, initially proposed by Allee (2003), is used to a large extent. Additionally, special consideration is given to the mapping of the exchange of intangible goods which constitutes the core of the company's competencies. Assuming that more knowledge sharing is no guarantee of improved performance (Haas and Hansen, 2007), it is necessary to identify the nature of knowledge flows to and from the NTBF in order to asses the best possible way the "quantity and quality of the NTBF's openness". In this respect, for the illustration of the intangible exchanges the paper builds upon the combination of the concept of weak ties from social network analysis with the notion of complex knowledge, as this combination was initially proposed by Hansen (1999). Hansen (1999) draws on product innovation literature and social network research in order to consider knowledge sharing among people from different teams as a dual problem of i) searching for useful knowledge and ii) transferring this knowledge across these teams while taking into account the complexity of knowledge that is transferred. In his work, Hansen (1999) developed this framework for large multiunit firms in order to explain knowledge sharing across organizational subunits. It is argued that this approach can easily be adapted to NTBFs, structures where the organizational boundaries are blurred and the relations between NTBFs and external partners are frequently stronger than relationships of different business units of the same large company.

6. The knowledge search problem

The first step when searching for useful knowledge in an NTBF is to look in the company. Taking into account the NTBF's limited resources and given the fact that most NTBFs have a knowledge focus in a specific knowledge area, in many cases an NTBF member will look at his own or his company's network. As discussed earlier, in order to commercialize their knowledge-intensive innovative products and/or services NTBFs maintain a network of persons and organizations with whom they maintain relations. These connections can be strong or weak and maintaining them requires effort and resources. Hansen (1999) argues that three aspects influence the decision to maintain weak or strong ties: knowledge redundancy, cost and organizational adaptation. Regarding the first aspect, Granovetter's seminal work (1973) is used to argue that NTBFs with numerous weak ties are likely to have a more advantageous search position because their nodes in the network are likely to provide non-redundant complementary knowledge. Hansen (1999) argues that non-redundant knowledge can be either i) knowledge that can be directly used or ii) knowledge about where and how to find useful knowledge. The second aspect, cost, is positively related to strong ties as it is considered costly to maintain direct relations with other organizations or persons. The third aspect, network binding, is closely related to the notion of loose coupling (Weick, 1976 in Hansen, 1999), which helps explain the problem of autonomy versus connection in a network. "Organizational entities that are not tightly linked to other entities are more adaptive because they are less constrained by the organization system of which they are part" (Hansen 1999). On the one hand, NTBFs need connections to other organizations because they need to benefit from knowledge residing elsewhere, and on the other, autonomy is important for product innovation. Consequently, NTBF's managers have to trade-off between autonomy and connection in regard to the overall business strategy.

7. The knowledge transfer problem

Once the useful knowledge is identified, it has to be transferred to the focal point. Hansen (1999) identifies two problems why there may be a transfer problem: willingness and ability. If the knowledge transfer is among the members of the focal NTBF, the small size of the firm "solves" the problem informally in most cases. In the case that the knowledge transfer is with persons or organizations outside of the NTBF, i) the transfer has to be feasible and ii) the external partner "has to be convinced" to share his knowledge.

The ability to transfer knowledge concerns both the "sender" as well as the receiver (Cohen and Levinthal, 1989) and is positively related to the complexity of knowledge. Hansen (1999), based on the work of Winter (1987) and Kogut and Zander (1995), argues that the main dimension of complex knowledge is its level of codification, "the degree to which the knowledge is fully documented or expressed in writing at the time of transfer". Although not identical, knowledge with a low level of codification corresponds closely to the concept of tacit knowledge upon which NTBFs can better build their competitive advantage compared to larger firms (Koskinen and Vanharanta, 2002). An aspect of the complexity of knowledge is its modularity. According to Fodor (1983), modularity is the notion that complex systems can be partitioned into a set of autonomous modules. The level of modularity is determined by the extent i) the input for each module is limited to the necessary and sufficient information required for the module's task and ii) any particular module is affected by the operation

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(and output) of other modules. The extent of the modularity of the transferred knowledge determines the interaction among the parties that are sharing knowledge. In the case of non-codified and highly dependent knowledge the receiver has to first share knowledge (that might also have a significant scientific or commercial value) before the requested knowledge is transferred. This interaction might also be a continuous process and not a one-off interaction. The more non-codified and more dependent the requested knowledge, the stronger the required interaction and vice versa.

8. Knowledge search and knowledge transfer problems combined

The above-presented positions were supported by empirical findings by Hansen (1999), who demonstrated that knowledge transfer is facilitated among partners with weak ties when the exchange implicates knowledge with low levels of complexity. On the other hand, strong ties are required for the exchange of knowledge with high levels of complexity. These results were used for the development of the mapping technique presented further below. Considering the strength of ties and the complexity of the transferred knowledge as important aspects of the knowledge- and competency-creation process of an NTBF, these aspects were incorporated into the strategy formulation process.

9. The importance of proximity

The flow of knowledge between actors of the innovation process is, in spite of the changes posed by the emergence of the knowledge-based economy, heavily influenced by geographical proximity. Gertler et al. (2000) argue that “close proximity between innovation actors and organizations strongly facilitates the creation, acquisition, accumulation and utilization of knowledge rooted in inter-firm networking, inter-personal relationships, local learning processes and ‘sticky’ knowledge grounded in social interaction”. Taking it a step further, a number of authors claim that the emergence of the knowledge-based economy, and changes in the architecture of the innovation process have actually increased the value of proximity for innovation. Along these lines, Sonn and Storper (2008), who analyzed US patent citations between 1975-1997, concluded that “the proximity in the creation of economically useful knowledge appears to be becoming even more important than was previously the case”. Storper and Venables (2004) strengthening this argument, affirming that face-to-face meetings, which are facilitated by proximity, can reduce moral hazards in the relationship which are extremely uncertain, such as in the formation of collaborative projects to develop new knowledge, where complete contracts are impossible and bureaucracies too costly. In this regard, relationships, which depend on face-to-face meetings and consequently proximity, are the key untraded interdependencies that allow the actors of the innovation process to coordinate (Storper, 1997).

Following Johnson, Siripong and Brown (2002), who argued that distance should be defined as a discontinuous variable with distinctive threshold values, it is claimed that the most important threshold is the distance beyond which face-to-face exchange of knowledge is not possible at least once a day.

10. Mapping technique presentation

The technique presented below attempts to visualize the flow of tangible and intangible transactions or activities (which hereinafter are referred as transactions) among the different actors implicated in the business life of an NTBF. To a large extent it is based on the HoloMapping Technique (Alle, 2000, 2003) that maps the “value network” of an organization by depicting the patterns of tangible and intangible exchanges. In addition to the “value network” approach, the proposed technique, developed exclusively for NTBFs, also seeks to depict the strength of ties between the actors of a transaction as well as the complexity of knowledge that is transferred (in the case where the deliverable is intangible).

In the proposed mapping technique the focal NTBF is presented as a circle in the centre while its members are presented as ovals. Organizations and persons that have interactions with the focal NTBF are presented as squares and ovals respectively. Partners interacting with the focal NTBF and that are geographically located at a driving distance that permits frequent face-to-face interactions, are presented within certain boundaries. For the European environment we consider these boundaries as the regional level and for the US environment the county level (Fig. 1).

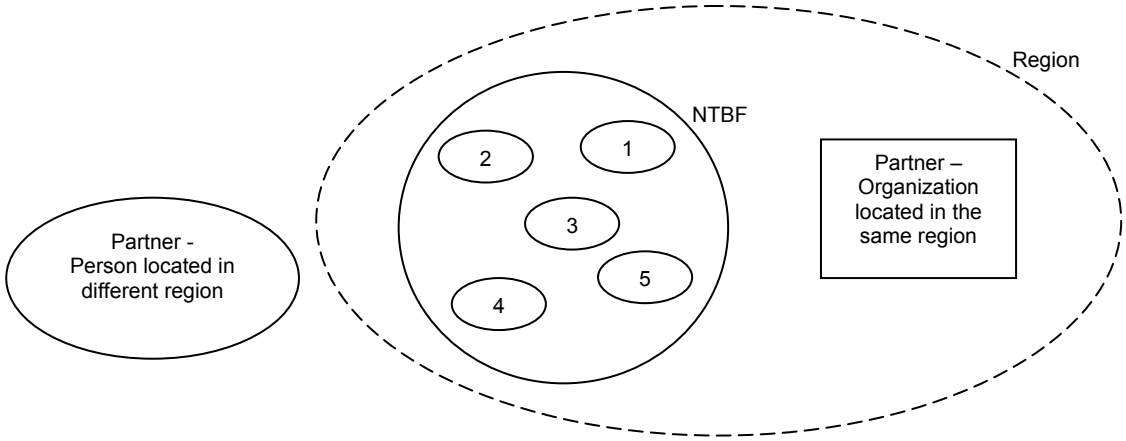


Figure 1: Actors of the exchange map: focal NTBF, NTBF members, partner organizations, partner persons

The actors of the system are engaged in transactions that are presented as arrows originating from one actor and ending to another. A text on the arrow describes the item involved in the transaction (hereinafter referred as deliverable) which can be either tangible or intangible. Transactions depicting tangible deliverables are distinct to those depicting intangibles deliverables (Fig. 2).

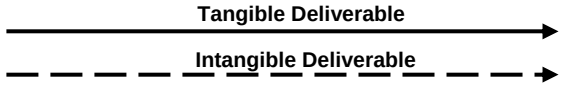


Figure 2: Transaction of the exchange map: tangible vs. intangible exchanges

Actors that are entering into a transaction have a relation with certain strength. The weakness (or the strengthens) of the ties between the implicated actors is depicted distinctively (Fig. 3)

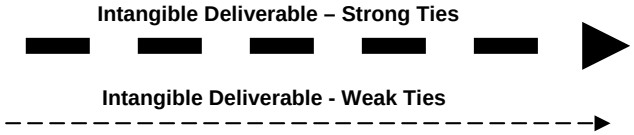


Figure 3; Transaction of the exchange map: strong vs weak ties

For the transactions that have intangible goods as deliverables, consequently implicating the transfer of knowledge, the technique integrates the codifiability of the transferred knowledge. Intangible deliverables that integrate knowledge transfer with low levels of codification are depicted differently than intangible deliverables that integrate knowledge transfer with high levels of codifiability (Fig. 4).

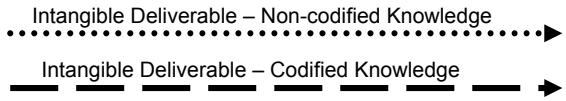


Figure 4: Transaction of the exchange map: strong vs weak ties

In order to measure i) the strength of ties in the transaction of tangibles and intangibles deliverables and ii) the complexity of knowledge involved in the exchange of intangibles, a questionnaire initially developed by Hansen(1999, Hansen 2002) is used[1].

The aim of the technique is to give a clear and "easy-to-read picture" of the NTBF. With the output from this procedure the NTBF's decision makers can:

- draw the "value and knowledge network" of the company
- identify gaps and discontinuities in the exchange of knowledge
- assess the level of autonomy and connectedness

[1] For reasons of space, the questionnaire is not presented as an appendix to this paper.

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- direct the growth of the company in the future

The map produced is practically a snapshot, at a given moment, describing the exchanges that have occurred over the previous six months of the NTBF's business life. This snapshot can (and should) be compared with other snapshots of different points of time. In this respect the above-presented technique can be used as a practical framework to asses the role of knowledge in relation to strategy.

11. Strategy formulation process

In the knowledge-based society, where the open innovation model is being applied in more and more industries, the innovative firm is taking more and more open forms in order to create (or to be integrated) in the innovation process. By opening its innovation process (or tapping into another firm's innovation process), the firm builds porous boundaries in order to combine its own knowledge and competencies with those of others. Assuming that i) knowledge is the centre of the value-creating process of a NTBF and ii) that NTBFs, by definition, follow what von Krogh et al. (2000) call advancement strategies, the search and transfer of what is conceived as useful knowledge as well as its conversion into new added-value knowledge is of a major strategic importance.

The scope of the proposed methodology is to stimulate the identification, transfer and utilisation of useful knowledge as part of the overall business strategy. The first step is to identify useful knowledge among the employees as well the stakeholders of the NTBF. Identifying useful knowledge inside the a NTBF does not require further discussion as internal relations are "clear, visible" and often flat.[2] However, identifying useful knowledge in the external environment is not as simple: relations have to be considered, knowledge complexity has to be assessed and the extent to which this knowledge transaction can be transformed, if necessary, into a mutually beneficial exchange has to be examined. A number of questions have to be answered in order to proceed from the knowledge identification to the knowledge transfer.

Who has the requested knowledge? This question is not only a "who knows what" question which is more relevant when searching among the members of the NTBF but also a "who knows the whereabouts of the requested knowledge?" which is more relevant when the requested knowledge lies outside the firm.

What are our relations with the actor holding the requested knowledge? The second question seeks to identify ways to strengthen ties in the relation with the actor/partner holding the requested knowledge. What drives this relationship? Is it based on friendship, a strategic alliance, a mutually-beneficial business relationship, or a potential partnership etc.?

What is the nature of the requested knowledge? The third question is related to the knowledge complexity that determines the ability to accomplish the knowledge transfer. Knowledge complexity is not objective. On the contrary, it is has to be regarded within the framework of a specific knowledge transaction, between specific persons in a specific context. In this respect, the nature of knowledge is determined by the transfer ability of both the "sender" and "receiver", in a specific context and in a specific time frame.

How can we transfer this knowledge and what is the compensation requested for this transfer? The fourth question is related to the willingness of the "knowledge owner" to share his knowledge and the "price" for it. It is worth mentioning that in many cases the knowledge-transfer process can not be predetermined and this depends heavily on the complexity of knowledge and the absorptive capacity of the receiver, making the transfer and its recompensation difficult to predetermine. Additionally, the "price" varies largely depending on the nature of the relationship between the sender of the receiver (e.g. the price for valuable advice given by a small manufacturer to a NTBF during the R&D phase can be the "promise" that, if the product reaches the market, the manufacturer is responsible for producing it).

[2] One of the two main explanations why there may be a problem in transferring knowledge is willingness of the source to share its knowledge (Hansen, 1999) that is determined by the relationship of the two parties as well as the context in which the potential transfer occurs. In large organizations where "not everybody has a (at least social) relationship with everybody" the reasons of the unwillingness to share knowledge (inability, competition, luck of time etc.) are not necessary clear to the "knowledge seeker". On the contrary in small organization reasons for willingness or unwillingness to share knowledge are "clear and visible".

Apart from compansation, are there additional costs associated with the transfer? The fifth question tries to examine the non-monetary cost associated with the transfer of knowledge. As mentioned earlier, a NTBF's resources are limited and valuable, and the cost to absorb a knowledge transfer might prove costly in terms of man days of key members of the NTBF. Additionally, in many cases a NTBF has to "give up" valuable knowledge in order to absorb new knowledge. In this later case trust plays an important role.

Does this knowledge transaction contribute to the formation of a "collaborative" competitive advantage? The final, and probably the most crucial, question concerns the examination of the probability that this knowledge transaction is part of the formation of a knowledge-based strategic alliance forming a sustainable competitive advantage that is difficult to imitate. If this is the case then it becomes very crucial to "protect" and stimulate this relationship.

12. Concluding remarks

In everyday business life, the above-mentioned questions are often difficult to answer per se. What this paper terms "useful" or "requested" knowledge is in many cases not clear for the knowledge "seeker" and this is especially the case during the product development phase, a phase that dominates the day-to-day work of a typical NTBF. To this difficulty we have to add the fact that relations and knowledge are not "things" but evolving processes. In this respect, "no one agent can own knowledge, rather it is an emergent part of the social process of interaction" (Higgins and Southern, 2007). In this respect, a NTBF is viewed a living and evolving system with socially constructed dynamic and changing relationships and interdependencies.

The increasing importance of formal and informal collaborative arrangements and their result, namely the NTBF's porous boundaries, have raised far-reaching implications for management. Insights from the evolutionary complexity theory suggest two respective principles (Mandeville, 2005): i) facilitation of self-organization and ii) access to and management of complementary knowledge.

Networks are best understood as complex systems in which none of the economic agents (including managers) has direct control (Hearn et al., 2003). Adding to the complexity of networks, the assumptions that: i) knowledge is socially constructed and ii) the creation of new knowledge introduces additional uncertainty and complexity, the resulting consequence is the incapacity to impose order (Mandeville, 2005).

Under these conditions, what is the role of the manager? Byrant and Wells (1998 cited in Mandeville, 2005) suggest that the approach should be process-oriented, focusing on system design. This includes recognizing that self-organization is a vital process in complex systems. "Thus the appropriate role for managers is to help shape and create contexts in which appropriate forms of self-organization can occur so that desirable patterns can emerge. These contexts can be both within the firm and/or include other firms. Managers can help shape the parameters that define the appropriate context, while allowing the details to unfold" (Mandeville, 2005). In this respect, the innovative firm is a living and evolving system with socially constructed dynamic and changing relationships and interdependencies, and its managers, rather than being an "external" controller of human behaviour, are part of a system that is codetermined by their actions (Tsoukas, 2003). Managers of knowledge-intensive organizations are today more like football trainers in that they are setting the goals and ensuring smooth and effective linkages between actors of a dynamic network that has to find self-organizing patterns in a dynamic and ever-changing environment (Tsoukas, 2003) than managers that have to set-up processes which include top-down orders and bottom-up reports. Activities that form the backbone of a NTBF's strategy should be aimed at improving the capacity-to-act of people both inside and outside the firm.

Consequently, the proposed methodology is not viewed as a linear roadmap that a NTBF manager has to follow in order to come up with easily applicable strategic decisions that determine cause and effect. On the contrary, it is an effort, on the one hand, to study the emergent patterns in what is considered to be a chaotic or disordered system and, on the other, to stimulate the creation of new patterns in the system that would be consistent with the NTBF's strategy.

The presented methodology is specially designed to address the needs of NTBFs, companies with a limited number of employees, partners and stakeholders. In this regard, the methodology presented here is not suitable for bigger organizations, as the mapping effort and the resulting complexity of

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relations do not produce a valuable result. It must also be noted that the paper is part of a wider research project that will explore further how to apply the proposed methodology to a number of NTBFs.

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