Jari Kaivo-oja

TOWARDS INTEGRATION OF INNOVATION SYSTEMS AND FORESIGHT RESEARCH IN FIRMS AND CORPORATIONS

The Classical Takeuchi-Nonaka Model Reconsidered and Reformulated

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ABSTRACT

Innovation in a knowledge-based economy is diverse and pervasive. It is not just based on research, or science and technology, or enterprise and ingenuity – although all of these remain very important contributing factors. Innovations depend on organizational, social, economic, marketing and other knowledge. Innovation activities require intellectual and artistic creativity. Technological regime literature suggests that firms within an industry tend to behave in highly correlated ways. Another tradition in innovation research literature, the strategic management literature emphasizes firm differences and acknowledges the possibility that behavioral heterogeneity may be observed within industries.

In the article the role of foresight systems elements is analyzed in relation to the innovation systems. Foresight can be seen as a relevant competence. It includes the ability to think in terms of forces that are not obvious and can't be measured but are shaping the future. In business, it means sensing a coming wave so you can ride it or conscious choice to work and innovate against the trends and waves. Typically foresight research produces foresight knowledge concerning trends, alternative development options and scenarios and weak signals. In the paper, the use of foresight knowledge in relation to the innovation processes is discussed widely. The author points out that in addition to foresight knowledge, also other kinds of knowledge are needed in the innovation processes. Other forms of time-related knowledge are hindsight and insight knowledge. Author points out that systems-thinking require the ability to synthesize or integrate elements rather than breaking them into parts for the purpose of analysis. In this article author presents alternative interaction models, which as such may explain why there are actually firm differences in technology and innovation regimes. The interactive system model concerning foresight and innovation systems interaction includes 7 alternative interaction models of foresight system and innovation process. This model includes many alternative innovation process models, which are relevant for companies and corporations facing the global competition pressures. In different innovation models, the strategic role of foresight knowledge is different.

Innovation pressures can be managed in a better way, if foresight knowledge is used in a smart ways, not relying on universal and linear innovation process models. Author emphasizes that foresight knowledge is not just catalyst knowledge to innovation process. In the study author demonstrates how foresight knowledge is having many-sided functions in interactive innovation processes.

1 INTRODUCTION

The study of innovation is a relatively young and fast-growing branch of social science. Joseph Schumpeter (1934) can be seen as a founding father of this research field. In his book *Theory of Economic Development*, Schumpeter pointed out that the main function of entrepreneurs in private firms is to combine existing resources to put forward "new uses and new combinations" or "innovations". Innovative actions have taken different forms in different historical periods in different countries (Freeman and Louca 2001). One interesting question in innovation research is how private firms put forward new uses and new combinations. It is obvious that firms need some kind of forward thinking and related foresight systems. On the other hand organizations need also historical understanding of the past (hindsight analysis) in order to understand current problems and situations (insight analysis). Time perspective helps to understand all kinds of evolutionary processes. Historical research and futures analyses are complementary research programs (see. Kaivo-oja et al 2004).

Today innovation processes are influenced by many factors. They occur in interaction between institutional and organizational elements, which together may be called systems of innovation. The factors like political, economic, social, technological, environmental and value changes (so called PESTEV factors) influence innovation processes. The "systems of innovation approach" has received considerable attention in the scientific community. It is considered to be a useful and promising analytical tool for better understanding of innovation processes as well as the production and distribution of knowledge in the economy. The "systems of innovation" approach has great potential. However, it is also associated with conceptual and theoretical problems and weaknesses. In this article I shall discuss the interactions between innovations systems and foresight research. (see e.g. Lundvall 1992, Edquist 1997, 1-35)

Personally, I think that this kind of discussion is useful, because there are a lot of potentials to improve this critical interaction between foresight systems and systems of innovation. Firms and organizations operate in uncertain and rapidly changing environments where no one best way can be determined a priori. As a logical result, a diversity of organizational strategies and behavior is observed. Already Nelson and Winter (1982) introduced the notion of "technological regimes" to characterize these regularities. Since then many empirical studies have contributed to establishing the idea that firms and organizations in the same regime tend to organize innovative activities in similar ways (see e.g. Pavitt 1984, Malerba and Orsenigo 1993, Nelson and Winter 1982, Nelson and Winter 2002, Audretsch 1997). This kind of linear thinking leads us to think that technologies, like institutions, create a set of incentives to invest in and organize innovation and other activities. According to this theoretical tradition technologies also evolve slowly and path-dependently over time. Path dependency is the view that technological change in a society depends quantitatively and or qualitatively on its own past. Technological trajectories (Dosi 1982) (in the dynamic view) or regimes (in cross-sectional view) are therefore seen as a useful concept to characterize firms´ industrial operating environments, where technology push (supply side) and technology pull (demand side) forces exist (see Schmookler 1962, Ende and Dolfsma 2004). Dosi (1982) noted in his classical article that the theory of a technological paradigm does not explain a general theory of technical change rather it tries to explain why certain technological developments emerge instead of others.

According to "technology-push" theory, research leads to inventions, which then leads to the development, production, marketing, and introduction of innovations to the market. Radically new inventions lead to the emergence of completely new industries and create renewed momentum for economic development. The supply of new technologies is, therefore, more important than the adaptation to the existing patterns of demand.

In the case of the "demand-pull" theory, Schmookler (1962) found that the time series for investment and patents showed a high degree of synchronicity, with the investment series tending to lead the patent series more often than the reverse. He found that it was investment that usually led the upswing from the troughs of economic fluctuations. On the basis of this evidence, Schmookler argued that fluctuations in investment could be better explained by external events than by the course of invention and that, on the contrary, upswings in inventive activity responded to upswings in demand.

The empirical literature on technological regimes argues strongly that the firms within an industry behave in corrected ways, because they share sources of information and technology (sources like suppliers, universities, other industries) and perceive similar opportunities for innovation. Firms in the same industry are also likely to have same or similar users that provide ideas and demand for innovation. This kind of theoretical thinking leads us to quite straightforward assumptions concerning the foresight systems in firms and organizations. Actually the assumption is that all the firms and organizations have similar kind of foresight systems in different industries. Recent studies in innovation research indicate that firms in most industries are found to follow multiple patterns of innovation behavior.

In important recent empirical innovation research of Leiponen and Drejer (2005) found that at very detailed levels of industry classification, in four- and five digit NACE industries in Finland and Denmark, only about half of the observed industries have a dominating innovation regime. They identified five innovative behavior/technological regimes in each country: (1) supplier dominated regime, (2) production intensive regime, (3) scale or science based regime, (4) market driven regime and (5) passive/weak innovators regime. Leiponen and Drejer (2005) found also that the majority of industries in both countries have at least four of the five innovation regimes represented. This kind of interesting empirical findings gives us good reasons to rethink the role of foresight systems in innovation process. Firms maybe do not have homogenous foresight systems or perfect foresight like many economists tend to assume routinely in conventional economic theory.[1]

As background information it is also interesting to note that there is wide diversity of national policy instruments in the science and technology area (David and Foray 1995). This kind of diversity in national policies may also increase diversity in innovative behavior/technological regimes.

[1] General equilibrium theory of economics is based on the assumption of complete foresight (Morgenstern 1935, 171-173). See good discussion of this assumption in Guesnerie (2002).

2 FORESIGHT AND INNOVATION PROCESS

In evolutionary economics key assumption is that companies differ in terms of their innovation behavior. Firms are viewed as bounded rational actors, who evolve largely though local search (see eg. Simon 1982). According to this evolutionary theory, firms in the same environment might adopt different strategies, provided their landscape is "rugged" or "complex" enough (see e.g. Levinthal 1997). In a simple non-complex decision-environment, firms would easily find their way to the global optimum, but in a rugged environment their search efforts might lead them to follow very different trajectories, and as a result, firms might end up in different local optima. The interesting paradox of evolutionary economic theory is that it has generated the notion of technological regimes that are assumed to apply at the level of industries. Firms and organizations within the same industry are argued to be subject to the same technological and knowledge conditions, which induce correlated behavior (Nelson and Winter 1982, Winter 1984). Limitations regarding firms´ abilities and competences to acquire and process information form the foundation of the theory. According to Dosi (1982) firms´ *perception of a limited set of possible technological alternatives* and logical future developments leads to path dependence. In innovation research Winter (1984) and Audretsch (1997) have argued that the fundamental drivers behind so-called Schumpeterian regimes are the sources of information. When information is unevenly available, opportunities for innovation depend on the position of firms in the industry landscape; either incumbents or entrants may be advantaged depending on the regime. In recent research Verspagen (2005) has noted that discontinuities and disequilibrium effects brought by clustering of radical innovations may be so strong and so pervasive that as to spread through the whole economy and sustain economic growth for a long period of time. In a recent comprehensive survey on advances and challenges in innovation studies Castellacci et al (2005, 104) have noted that it is necessary for a deeper understanding of the impacts of innovation on macroeconomic growth to develop neo-Schumpeterian or evolutionary approach (Dosi 1982, Freeman et al 1982, Nelson and Winter 1982, Nelson and Winter 2002).

Another approach towards technological regimes has emphasized *appropriability conditions* as an important factor determining the differences in innovation behavior (Levin et al 1987). Recent research has elaborated on the inter-industry differences in the use of patents, secrecy, and lead-time in protecting the returns on R&D investments (Cohen et al 2002). In the literature of innovation research technological opportunities as a distinguished factor across industries was alluded to already by Winter (1984) and later by Cohen and Levinthal (1989) and by Klevorick et al (1995).

In the field of innovation research Pavitt (1984) presented widely cited taxonomy of technological regimes. His taxonomy is a more holistic account of how technological regimes play out in different industries. Especially Pavitt examined (1) the sources of information for innovation, (2) main motivations behind R&D (cost-cutting or product differentiation), (3) appropriability mechanisms and (4) the importance of product and process innovation in different industries. These industry-level tendencies led Pavitt to characterize four distinct regimes: Scale-intensive industries, (2) supplier-dominated industries, (3) science-based industries and (4) specialized supplier industries. Recent empirical research in this field (see Souitaris 2002) indicates that industries differ with respect to firms´ innovation behavior and these differences matter for industry structure and innovativeness.

The technological regime literature emphasizes bounded rationality and heterogeneity in achieving optimal solutions. This theoretical tradition portrays firm behavior as largely industry specific. In contrast, strategic management literature specifically focuses on the differences across firms and their implications for firm performance. Research on competitive strategy assumes that companies within the same industry can follow different strategies, form example, cost leadership, extraordinary benefits to consumers and product differentiation, or "niche strategy". Cost advantage is based on lower costs and comparable benefits, Differentiation advantage is based on higher benefits and comparable costs. Niche strategy is based on higher benefit-cost relation in narrow market space. (Caves and Porter

1977, Porter 1980, Dranove and Marciano 2005, 33). Firms can be analyzed from different perspectives. Typical perspective is resource-based view of the firm. (Conner 1991, McGahan and Porter 1997). Another perspective is the dynamic capabilities perspective (Teece et al 1997), which sees firms´ knowledge resources as the basis for differentiation in the marketplace. Differentiated capabilities create competitive advantage, if competitors are not able to replicate them very rapidly. Organizational knowledge and capabilities can be the source of different strategies and behavior across firms and industries, consequently, the source of profitability differences.

Strategic management literature suggests that firms intentionally seek to find different approaches those competitors of theirs. The development of effective foresight system or innovation system can be seen as generic ways to see to find competitive advantage. Innovation research has suggested that there are two strategic groups emerging in the industry, innovators and imitators (Lee 2003). Typically risk lovers like to innovate and risk-avoiding agents tend to imitate. The fundamental drivers behind the formation of strategic groups may relate to differences in risk aversion or initial qualities of assets across firms (Caves and Porter 1977). Imitation behavior tends to strengthen the existing path dependent models of behavior in the marketplace, but innovations (especially radical innovations) can in some cases break path dependent model of behavior.

Hamel (2000, 18) has presented the following innovation classification of firm level innovations (see Figure 1).

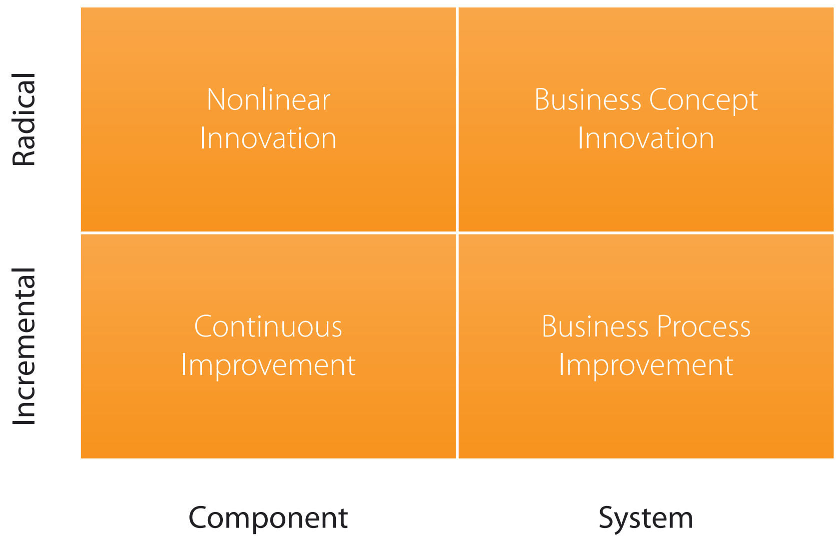

Figure 1. Radical and incremental innovations in a firm (Hamel 2000, 18).

Hamel (2000, 15-18) emphasizes strongly the role of radical innovations in competition. Especially business concept innovations are important according to Hamel´s analysis.

Thus, technological regime literature suggests that firms within an industry tend to behave in highly correlated ways. Another tradition in innovation research literature, the strategic management literature emphasizes firm differences and acknowledges the possibility that behavioral heterogeneity may be observed within industries. In this article I present alternative interaction models, which as such may explain why there are actually firm differences.

In current Kim and Mauborgne (2005) has presented idea of "Blue Ocean Strategy", which is based on idea of creating uncontested market space and making the competition irrelevant. This kind of "Blue Ocean Strategy" is different from "Red Ocean Strategy", which is based on traditional ideas of market competition (see Table 1).

Table 1. Red Ocean vs. Blue Ocean Strategy (Kim and Mauborge 2005, 18).

Red Ocean Strategy	**Blue Ocean Strategy**
Compete in existing market space.	Create uncontested market space.
Beat the competition.	Make the competition irrelevant.
Exploit the existing demand	Create and capture new demand.
Make the value-cost trade-off	Break the value-cost trade-off
Align the whole system of the firm´s activities with its strategic choice of differentiation *or* low cost.	Align the whole system of firm´s activities in pursuit of differentiation *and* low cost.

Today it is possible that firms choose “Blue Ocean Strategy” instead of “Red Ocean Strategy”. Thus, the critical point in this article is that firm level differences may not be explained fully by different R&D systems and innovation systems, but also by the complex nature of foresight system in firms. According to my view the gap between demand-pull and technology-push theories is not sufficiently bridged. One reason is that the role of foresight systems is often neglected as a interaction mechanism, which improves technology push and technology pull forces inside a firm. Acknowledgement of the critical coordinative role foresight system could make bridge more reliable and functional.

3 INNOVATION SYSTEM AND FORESIGHT: SYSTEMIC INTERACTION MODELS

Innovations depend on organizational, social, economic, marketing and other knowledge like political, technological and environmental knowledge. Innovation activities require intellectual and artistic creativity. The role of foresight systems should be analyzed in relation to the innovation systems, production and marketing. There is a gap in culture between the scientific community and industry (Irvine and Martin 1984, Stankiewicz 1986). Foresight system's one practical function is to make this science-industry gap smaller. Thus, foresight can be seen as a relevant competence. In many theoretical analyses the functional role of foresight system is neglected. Intelligent foresight system includes the ability to think in terms of forces that are not obvious and can't be measured but are shaping the future. In business, it means sensing a coming wave so you can ride it or conscious choice to work and innovate against the trends and waves.

Systems thinking require the ability to synthesize or integrate elements rather than breaking them into parts for the purpose of analysis. That is why we should pay attention to potential roles of foresight in relation to innovation process. It is also important to understand that in different interaction models the role of technology push and technology pull mechanisms is different. As a starting point of the interaction between foresight and innovations systems can be used the Takeuchi-Nonaka (1986) model. (Fig. 2). We simply assume that innovations and foresight processes are mostly happening in the R-D system. R&D, Manufacturing (or production) and marketing system activities are seen as separate processes.

[2] Takeuchi and Nonaka (1986) presented sequential phases of development process in a firm. Phases are in Takeuchi-Nonaka model (1) R&D, (2) manufacturing and (3) marketing. In this Kaivo-oja model foresight and innovation processes are together R&D phase and other processes are production and marketing. In this way Kaivo-oja interactive system model is non-linear phase model of Takeuchi & Nonaka (1986).

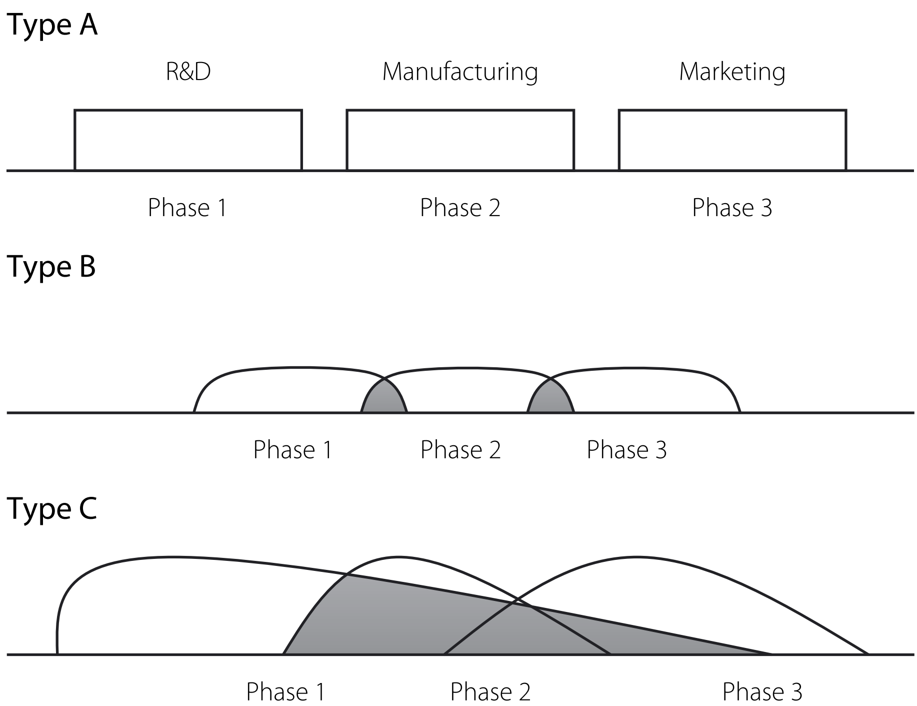

Figure 2. *Sequental (A) vs. overlapped (B and C) phases of development (Takeuchi and Nonaka 1986).*

In the classical Takeuchi and Nonaka model (1986) different phases (R&D, manufacturing and marketing) are following a linear model. We can expect that in reality things are not happening like the liner model describes. For example, manufacturing as a process can happen before R&D activities or marketing can lead to deeper R&D activities. Product development game can be more complex game than described by Takeuchi and Nonaka (1986).

Figure 3. *The interaction models between foresight system and innovation process: Model I: Innovation-Foresight-Other processes (I-F-O) model.*

If we think the relation of a foresight system to innovation process in general level, we can propose that basically there are at least seven basic models. In the first IFO-model innovation process is before foresight process and then other processes (production and marketing) are performed in a firm. In the IFO model the role of foresight is mainly innovation-based process, where agents of foresight system try to transfer innovation to production and marketing processes. The IFO model is mostly based on the technology push mechanism.

Figure 4. Model II: Foresight-Innovation-Other Processes (FIO) model.

In the second model FIO-model foresight system plays a catalytic role in relation to innovation process. Typically in FIO-model trend analyses, scenario processes and weak signal analyses are used to stimulate innovation process inside the company. The FIO model is mostly based on the technology push mechanism.

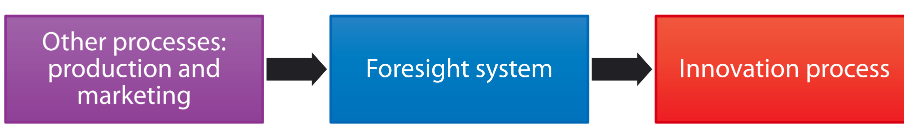

Figure 5. Model III: Other industrial processes-Foresight-Innovation (OFI) model.

Third (OFI-model) and fourth model (OIF-model) are based on other firm-level processes and foresight system and innovation processes are more or less secondary ones to firm's production and marketing systems. In the OFI-model production and marketing unit of a firm or organization give tasks to the agents of foresight system and after that foresight agents stimulate and catalyze innovation process of a firm. The OFI model is mostly based on the technology pull mechanism.

Figure 6. *Model IV: Other industrial processes-Innovation-Foresight (OIF).*

In the OIF-model production and marketing units of a firm help innovation to arise and after that foresight unit makes other analyses relevant to new innovation. The OIF model is mostly based on the technology pull mechanism.

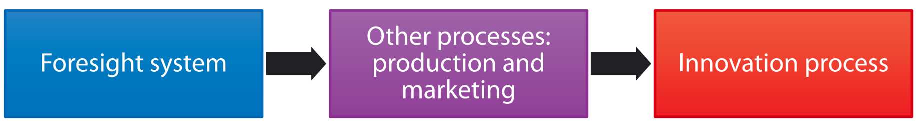

Figure 7. *Model V: Foresight-Other industrial processes-Innovation (FOI).*

In the FOI model foresight analysis is performed before production and marketing processes and these two phases lead to innovation process. The FOI model is mostly based on the technology pull mechanism.

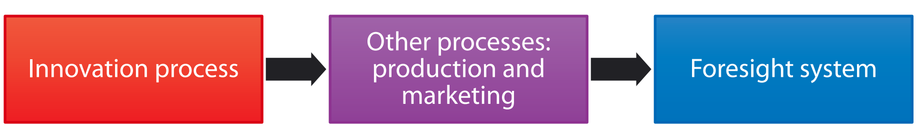

Figure 8. *Model VI: Innovation-Other industrial processes-Foresight (IOF).*

In the IOF model innovation process is performed before production and marketing process and these two phases lead to the need of foresight analyses. The IOF model is mostly based on technology push mechanism.

Figure 9. Model VI: Interactive simulative process model (ISP).

In the ISP model all three processes are performed simultaneously together. This process is very interactive and all activities are complementary. The ISP model is based on both technology push and technology pull mechanisms.

Theoretically, I have presented 7 alternative interaction models, which all are possible in modern firms and corporations. We see that foresight system can play and actually often plays an important in relation to innovation systems. Often foresight activities are performed by knowledge-intensive business companies and these kinds of companies are also co-producers of innovation (see e.g. den Hertog 2000). Theoretically these kinds of complex interactions can also explain also new empirical findings of Leiponen and Drejer (2005). We can expect that the five technological or innovative regimes (1) supplier dominated regime, (2) production intensive regime, (3) scale or science based regime, (4) market driven regime and (5) passive/weak innovators regime are based on different kind foresight system-innovation system interactions.

In Table 2 technological and innovative regimes defined by Leiponen and Drejer (2005) are connected to different foresight-innovation interaction models presented above.

Table 2. Technological/innovative regimes and most possible interaction models between foresight system and innovation process.

Technological/innovative regime	Most possible interaction models
Supplier dominated regime	IFO (innovation concerning supply chains or sub-contractor relations lead to foresight process), IOF, (innovation concerning supply chains or sub-contractor relations lead changes in production) OFI (changes in supply chains or sub-contractor relations lead to foresight process), OIF (changes in supply chains or sub-contractor relations lead to innovation process), ISP (general model)
Production intensive regime	OFI or OIF (changes in production and marketing lead to foresight analysis or novel innovation process), ISP (general model)
Scale or science based regime	FIO (science based foresight leads to innovation), FOI (science based foresight leads to production changes), IFO (science produces innovation and need for foresight analysis), IOF (science produces innovation and fast changes in production), ISP (general model)
Market driven regime	OFI (production or market change leads to foresight and innovation), OIF (production or market change leads to innovation and innovation-related foresight), FIO (foresight done concerning production and market development leads to innovation and related changes in production and marketing), FOI (foresight done concerning production and market development leads to changes in production and this change creates innovation), ISP (general model)
Passive/weak innovation regime	No remarkable interaction, ISP (general model)

This table 2 helps us to explain different technological/innovative regimes in relation to firm level foresight and innovation processes. On the basis of this elaboration we can conclude that assumption about perfect foresight is far too simplistic explanation concerning firm behavior concerning innovation or technological regimes.

4 INNOVATION PROCESS AND UTILIZATION OF FORESIGHT KNOWLEDGE

On the basis of previous section we can see that innovation process can follow foresight analyses or a foresight process is performed after an innovation process. In these two alternative cases the role of foresight knowledge is different. On basis of previous analysis we can present the following Table 3, where we describe utilization types of foresight knowledge in different interaction processes described in previous sections of this paper.

Table 3. The role of foresight knowledge in different interaction models between foresight system and innovation process.

Interaction models	The role of foresight knowledge
IFO-model	Promote innovation realization in production and marketing processes
FIO-model	Catalyze first innovation process and then production and marketing processes
OFI-model	Analyze current production and marketing processes (trends, scenarios and weak signals) and make new innovations on the basis of foresight analysis
OIF-model	Do foresight analyses on the basis on production and marketing analyses and related novel innovations
FOI-model	Catalyze first production and marketing analyses and then produce novel innovations
IOF-model	Do foresight analyses on the basis on novel innovations and related novel production and marketing processes
ISP-model	Implement 3 system interaction process simultaneously, which lead to better foresight analyses and new innovations in production and marketing field

Tuomi (1999, 64) has noted that in organizational knowledge management, it seems that part of the problem is addressed by adopting a technical rationality view, and applying socio-technical models in organizational practice. If we adopt this kind of approach, there is no difference in designing manual work procedures and innovative knowledge work. We can expect that knowledge workers in most cases do have more perfect foresight than manual workforce. If we talk about work that in any reasonable sense deserves to be called knowledge work, it has to be realized that such work always has an element of unpredictability in it. One reason for unpredictability of knowledge work is that in complex decision-environment we cannot predict what kinds of issues and topics emerge in foresight processes. Even more difficult is to predict systemic consequences of innovation processes.

In Table 3 we have described the role of foresight knowledge in different interaction models. We can logically conclude that we should not use foresight knowledge in similar way in different interaction models. The function of foresight knowledge in relation to innovation, production and marketing processes is clearly different in different interaction models. Often the function of foresight knowledge is said to be a catalyst element of innovation process. On the basis of previous analysis this kind of catalyst function of foresight knowledge is far too limited. This kind of wrong assumption can lead to losses of competitive advantages in knowledge-based competition.

5 TOWARDS DEEPER INTERACTION BETWEEN INNOVATION CREATION AND FORESIGHT SYSTEMS

As I have noted in previous sections, foresight systems do matter in the process of innovation creation. In continuously changing markets characterized with rapid change, relative ease of entry and exit by rival companies, emerging technologies and changing customer demands, the best practices are quickly turning to old practices. Under these turbulent conditions sense-making is becoming more critical to companies future success and than actual decision-making process (Weick 1995). This kind of changing decision-environment with sense-making needs requires the use of foresight system. If we do not understand current trends, alternative development paths, important weak signals and other developments in the marketplace, it is not possible to make sense of changing factors in decision-environment. In futures and foresight analyses we can use many methods in foresight analysis. Aaltonen and Sanders (2005, 27-31) has classified the foresight methods in 4 groups: (1) Mathematical complexity methods, (2) social complexity methods, (3) engineering approaches and (4) system thinking tools. Mathematical and social complexity methods allow the analysis of emergent systemic processes, but engineering approaches and system thinking methods are focused on system design level. On the other hand, mathematical complexity methods and engineering approaches help to remove ambiguity, because they are providing systemic rules. Social complexity and system thinking methods allow ambiguity, because they provide analyses, which are fundamentally based on system heuristics. Aaltonen and Sanders (2005) has noted that complexity of systems can be used as a sense-making framework for methodology. They have noted that one of the characteristics of a complex adaptive system is sensitivity to new and initial conditions; and if the sensitivity to new and initial conditions provides opportunities for influencing the future of the system, then foresight methodologies should have the ability to identify these points of influence. This new theoretical point is very important also to innovation studies and related foresight analyses. This all means that the methods used in foresight system are having impacts on innovation system.

Foresight systems are used as a part of strategic and visionary decision-making a long time. Mintzberg et al (1998, 353) have proposed that there have been a long learning process by experience in strategic management since 1960s: First in 1960s were introduced designs for predictable futures and then in 1980s multiple scenarios. In the beginning of 1990s diversification of methodologies increased and in late 1990s firm started to build up strategic visions to cope with generic uncertainty. Diversification of strategic management methods has created different schools of strategic thinking like design school, planning school, positioning school, learning school, entrepreneur school, cultural school, power school, environmental school, cognitive school and configuration school. This strategic literature analysis indicates strongly that firms are having tailored management systems.

Traditionally firms have analyzed current trends, performed scenario analyses and more and more tried recognize so-called weak signals in their marketplace (Linneman and Klein 1979, Malaska 1985, Ackoff 1993, Mendonca, Cunha, Kaivo-oja and Ruff 2004). On the basis of these kinds of foresight analyses firms have traditionally find their missions, visions and strategic intents (Westley and Mintzberg 1989, Collins and Porras 1991, Cambell and Yeung 1991, Mintzberg, Ahlstrand and Lampel 1998, Malaska and Kasanen 2003).

We can claim that so-called general theory of futuribles (Malaska and Virtanen 2002) is not systematically connected to innovation research tradition (see e.g. Edqvist 1997). In this paper, I have presented one systemic and interactive way to integrate complementary research traditions of innovation systems and foresight research.

Foresight system has three critical elements: (1) Skillful use of these kinds of foresight methods and tools is one key element of foresight system. Two other critical elements of firm-level foresight system are (2) internal strategic structure and architecture of a firm with specific decision-making needs and (3) firm´s network structures outside the internal strategic architecture (especially customer networks and sub-contractor networks). Foresight analysis is mostly focused on future development and events. Typical questions in foresight analyses are: What is probable? What is desirable? What is feasible? What is important? Who are strategic stakeholders? How things go on in the future?

In real-life situations it may not be easy to describe borderlines between foresight system and innovation system. However, in firms, these systems are used interactively as indicated in my systemic interaction model with 7 basic interaction models in section 3.

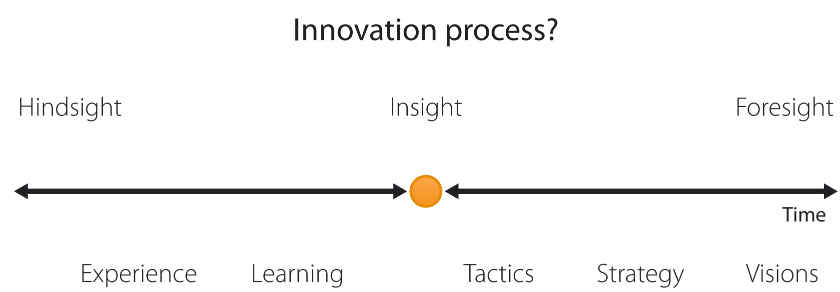

Figure 10. Time frames: hindsight, insight and foresight in an innovation process.

Foresight is closely also connected to other time frames: to hindsight and insight analyses, because most foresight analyses are based on hindsight and insight knowledge (see Figure 9). Experiences and especially learning process of the past have impacts on foresight analyses related to innovation process and commercialization: Tactics, strategy and future visions. It is always possible to analyze firm-level innovation processes from this kind of dynamic time perspective. This kind of time-related perspective helps to integrate innovation systems research to foresight system research.

Hindsight, insight and foresight analyses provide complementary knowledge to us. This kind of complementary perspectives can make innovation studies even more richer and valuable research contributions than today it is providing. Evolutionary perspectives require always this kind of time-related perspectives (see e.g. Hodgson 1993, Mannermaa 1991).

6 SUMMARY

In this article, I have discussed and elaborated potential interaction models between firm level innovation system and foresight system. Foresight analyses can be seen as an effective sense-making tool in rapidly changing markets of the global economy. As a result of theoretical elaboration, a systemic interaction model with 7 different alternative interaction models was presented by the author. These models can be seen as a novel reformulation of classical Takeuchi and Nonaka (1986) development model. In this paper I have also connected all the presented 7 interaction models to novel innovation regime models of Leiponen and Drejer (2005).

In the paper it was pointed out by the author on the basis of current new innovation research findings that technological regime literature suggests that firms within an industry tend to behave in highly correlated ways. Another tradition in innovation research literature, the strategic management literature emphasizes firm differences and acknowledges the possibility that behavioral heterogeneity may be observed within industries. In this paper was noted that strategic thinking has developed in an evolutionary way since 1960s and today there are diverse strategic thinking schools, which rely on different thinking models. This may also explain partly, why there are alternative technology and innovation regimes in firms and corporations.

In this article the author presents alternative models of foresight system-innovation process interaction, which, as such, partly may explain why there are actually firm-level differences in innovation behavior. The most important point in this article is that firm-level differences in technology/innovation regimes may not be fully explained by different R&D systems and innovation systems as such, but also they can explained by the complex nature of foresight system in firms. This is a novel explanation to diverse technology/innovation regimes in innovation research. In this paper foresight system thinking was connected to innovation system thinking by the author. This is new research approach in the tradition of innovation system research. I also connected traditional technology push and technology pull theories to this novel systemic framework.

In this article the author strongly emphasizes the role of time frames in innovation studies. Hindsight, insight and foresight analyses provide complementary knowledge to us. This kind of complementary perspectives can make innovation studies even more richer and valuable research tradition in the future. Evolutionary perspectives require always these kinds of time-related perspectives (hindsight, insight and foresight analysis).

The future challenge in innovation systems research is to see and understand what the strategic role is and actual importance of foresight systems in firm-level innovation processes. I hope that this article has partly narrowed the gap between foresight research and innovation systems research.

One conclusion is very clear. Foresight systems do not only play as a catalytic role in relation to the innovation systems. The theoretical analysis in this paper indicates that foresight knowledge can play a much greater role in innovation processes than is expected in previous scientific literature.

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TOWARDS INTEGRATION OF INNOVATION SYSTEMS AND FORESIGHT RESEARCH IN FIRMS AND CORPORATIONS

The Classical Takeuchi-Nonaka Model Reconsidered and Reformulated

In this article the author presents alternative models of foresight system-innovation process interaction, which may explain why there are actually firm differences in innovation behavior. As a result of theoretical elaboration, a systemic interaction model with seven different alternative interaction models are presented. These models can be seen as novel reformulation of classical Takeuchi and Nonaka (1986) development model. In the paper author connects all the presented seven interaction models to novel innovation regime models of Leiponen and Drejer (2005). The most important point in this article is that firm level differences in technology/innovation regimes may not be fully explained by different R&D systems and innovation systems as such, but also by the complex nature of foresight system in firms and corporations. This is a novel explanation to diverse technology/innovation regimes in innovation research field of firms.

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