Innovation management: different approaches to cope with the same trends

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Abstract: The constant failure rate of new product introductions in the last decades implies that little progress in innovation management can be witnessed. Innovation management is seen as an activity in a multi-level system. The main trends in this system will be described. These trends are inter-related in a complex way and, as a result, the focus in innovation management should be on the combined effect of these trends and on the events that could destabilise the entire system. This article describes four general consequences of the trends in innovation management:

1 the end of the linear model

2 the rise of the systems approach

3 the inherent uncertainty and need for learning

4 innovation becomes more entrepreneurial.

These consequences can lead to entirely different approaches to innovation management, two of which will be discussed. The article concludes that significant progress in innovation management has been obtained, but the failure rate has remained the same because of the changing conditions.

Keywords: innovation management; innovation system; trends.

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1 Introduction

Innovation processes constitute a risk for companies since they require investments with an uncertain result (Urban and Hauser, 1993; Tidd *et al.*, 2001). The uncertainty of the result is illustrated by Crawford (1979), who estimates that one-third of the new products that are introduced in the market become a success. Similar results are found by Booz, Allen and Hamilton (1982). It is remarkable that this success rate has not increased significantly in the last decades (Crawford, 1977; 1987; Wind and Mahajan, 1997).

The constant failure rate in innovation processes implies that little progress in innovation management practices can be witnessed. In this article, trends that have an impact on innovation processes, the resulting changes in these processes and the growing insight into these processes will be investigated to conclude whether innovation management practices have progressed.

Innovation management practices, in a narrow sense, refer to managing the process of developing new products within an organisation. However, investigating trends in economy and society that have an impact on innovation processes and the changes that result from them requires a broader perspective. Innovation occurs in the context of a so-called innovation system (Freeman and Lundvall, 1988; Nelson, 1993; Lundvall, 1992; Barré *et al.*, 1997). A system perspective makes sense for various reasons. Firstly, the successful market introduction of an innovation often depends on the adoption of new organisational practices (in terms of marketing, manufacturing and so on), the availability of complementary products and services, infrastructural (re)arrangements and so on. Secondly, organisations often innovate in an alliance or a network of actors because most organisations do not have the resources to develop and manage the entire system. Thirdly, firms cannot innovate successfully without institutions (rules and standards), qualified people, an adequate infrastructure and a high-level and finely tuned knowledge infrastructure.

Different definitions for innovation systems can be found (for an overview see van der Steen, 1999). We will consider an innovation system as the organisational arrangements to manage innovation processes and the institutional arrangements that support, stimulate and regulate the management of these processes and the subsequent diffusion of technology (adapted from Carlsson, 1995). This definition implies that both the organisations that are directly involved in managing innovation processes and the organisations and institutions that arrange the general conditions for innovation are considered part of the same system.

In this article, the innovation system is considered a system with multiple layers because of practical and theoretical considerations. In practice, the organisational institutions (*i.e.*, innovation managers) that decide the structure of a particular innovation process (*e.g.*, whether the process is linear sequential or parallel) have a different effect on innovation from the institutions that regulate innovation in general (*e.g.*, regulations that determine whether patents are protected). In theory, definitions of innovation systems emerge on the national level (*e.g.*, Freeman, 1987; Lundvall, 1992; Nelson, 1993) as well as on the corporate level (Trott, 2002).[1] Following van der Steen (1999), we will distinguish a micro, meso and macro level in the innovation system. The micro level refers to an organisation (or a network of organisations), the meso level to an industry and the macro level to a country. Each of these levels comprises specific institutions, rules, procedures and practices with a direct or more indirect impact on innovation processes.

This article focuses on three questions:

1 What are the main trends in each of the levels of the innovation system (Section 2)?

2 What are the main consequences of these trends for innovation processes (Section 3)?

3 Are there alternative innovation management approaches to cope with these consequences (Section 4)?

In Section 5, the answers to these questions will be summarised and discussed to conclude whether innovation management practices have progressed or not.

2 Trends in the layers of the innovation system

The main sources of the trends are Corcoran (1994), Germeraad (2001), Gupta and Wilemon (1996), Scott (2001), Smits (2002) and Wind and Mahajan (1997). These sources discuss trends in innovation management or related fields like R&D or technology management.[2]

Trends at the macro level

1 globalisation and the shift in the economic power of countries and regions

2 structural changes within economies

3 increase in, and shift in modes of, communication.

Trends at the meso level

1 increased competition

2 rapid advances in technology

3 increased accountability to customers and societal pressure groups

4 increased focus on core competences

5 more alliances.

Trends at the micro level

1 Organisations demand a more direct contribution of innovation to business goals.

2 Broadening of decision-making processes in innovation.

2.1 Trends at the macro level

Ad 1 Globalisation and the shift in economic power of countries and regions

Globalisation is reflected in different ways. Firstly, the distance people travel across countries has raised remarkably relative to the distance traveled within countries. Secondly, a similar trend can be witnessed for the transport of goods across countries. Globalisation increases the demand for similar products all over the world, yet at the same time, also seems to stimulate a renewed interest in local products, habits and cultures. Trend and anti-trend, rather than wiping out each other, seem to live side by side. Along with the globalisation, a shift in the economic power of countries can be witnessed in the last decades. Asian countries – South Korea, Japan, Singapore, Taiwan and lately China and India – have quickly become industrial and economic powers in the world. From an institutional perspective these countries have formed national innovation systems that show up many differences from the dominant western model. These systems vary from strictly top-down with a heavy focus on planning (*e.g.*, South Korea, China) to horizontal ones with a focus on negotiation and consensus building (*e.g.*, Japan).

Globalisation and the shift in the economic power of countries have profound consequences for both the supply and demand of knowledge, technological components, products and services across the world. On the one hand, companies in the western world have witnessed an increase in the potential demand for their products since globalisation expanded their potential market. On the other hand, companies that traditionally have a strong position in their home-market can be confronted with more intense competition. Because high-wage countries can hardly compete on price in global markets, they are increasingly forced to develop new products and services. This development is one of the major driving forces behind innovation in OECD countries. Both consequences of globalisation have an effect on the development and production of products as well as on the type of products that is marketed. The development of products has become more international. Gassmann and von Zedtwitz (1999), for example, describe that Swiss and Dutch companies from 1986 onwards had more labs outside than inside their country because they have a small home market and a lack of R&D resources in their own country. Similarly, from 1985 to 1993 overseas investment in R&D increased three times as fast as domestic R&D (Gassmann and von Zedtwitz, 1999). The increased globalisation has also caused a transfer of production sites from the original home countries of organisations to low-wage countries or to countries with new customers. The type of products changes, too, because of globalisation. Some products are specifically designed to reflect local preferences, some products have a global platform on the basis of which local differences can be implemented, and some products become truly global products.

Ad 2 Structural changes within economies

> "Important sectors of our economic system are currently going through a period of structural transition. This transition results in changes within one sector, shifts between sectors, mergers between sectors and the emergence of completely new sectors. Moreover, partly because of a growing knowledge intensity (demonstrated by the rise of knowledge intensive services), the boundaries between different sectors are becoming blurred." (Smits, 2002,p.867)

Each change will be illustrated with an example. The Dutch agricultural sector serves as an illustration of the changes that can be witnessed in a sector. This mass production-based and until recently very successful sector[3] has industrialised to a large extent and productivity has risen accordingly. However, the environmental problems and the problems with swine fever, BSE, foot-and-mouth disease and various severe crop diseases that come with industrialisation will probably require another round of structural change in the agriculture sector. This change is reinforced by the deterioration of the competitive position of the Dutch agricultural sector in global markets because of price competition from countries like Spain, Ecuador, Kenya and Israel. The shifts between sectors can be illustrated with the decline of the industry and the growth of the services sector in The Netherlands during the 20th century. The emergence of an integrated information and telecommunications industry serves as an example of a merger of sectors. A completely new sector is referred to as the 'Cultural industry'. In Jacques Delors' white paper, 'Growth, Competitive Strength, Employment. Towards the 21st Century: Roads and Challenges', the potentially important role of this industry was pointed out (European Commission, 1994). The blurring of boundaries between sectors can be illustrated by insurance companies and banks that cooperate, merge and start to market each other's products and to develop new products and packages of products. Many more examples of blurring sector boundaries can be found: petrol stations start selling fast-moving consumer goods, food retail shops start selling computers and insurance, and so on.

The consequences of these structural changes can be profound; consumers will notice that new types of products and new packages of existing products are offered. An example is the combination of television, internet, fixed and mobile telephony that consumers can receive nowadays from one provider. Similar packages can be conceived across many industries. Employees in these sectors may notice alliances with new types of organisations and changes in the management procedures, like innovation management practices. The merger of the computer and the telecommunications industry, for example, also meant that quite distinct practices of innovation management from these industries had to be aligned (Berkhout and van der Duin, 2006). The telecommunications industry, at least in Europe, traditionally established standards and tested intensively before a new telecommunications service was introduced. The software industry traditionally releases beta-versions of software first and then improves the quality of the software in subsequent versions.

Ad 3 Increase in (and shift in modes of) communication

The development and large-scale diffusion of new modes of (tele-)communication, like communication via the internet, mobile telephony, satellite communication and broadcasting, together illustrate the rapid technological development within a sector (see trends at the meso level).

The effect of this development pervades all sectors and all levels of the innovation system. It can be considered a driving force of the globalisation. It drastically changes the communication patterns in organisations, and it enables virtual teams in innovation projects. New communication technologies, like the internet, enable the distributed R&D organisation (Howells, 1990).

2.2 Trends at the mesolevel

Ad 4 Increased competition

Several developments stimulate a more intense competition. Firstly, as we already discussed, globalisation has increased both domestic and global competition in many markets (Gupta and Wilemon, 1996). Secondly, some markets, like electricity, water and gas provision, public transport and medical services, which used to be state-owned utilities (in Europe), are liberalised. Liberalisation opens the market for competitors from abroad. In The Netherlands, for example, a large number of competitors in telecommunications emerged after the liberalisation of the telecom market. Thirdly, as was stated in trend two (structural changes within economies) originally distinct markets seem to mingle.

Liberalisation of markets, globalisation and the mingling of markets enormously increase the number of potential competitors, many of which try to develop and introduce innovations and thereby increase the pressure on separate innovation processes. The mingling of markets furthermore implies that products are marketed in new combinations (*e.g.*, buying a computer from a company providing distant education programmes), new distribution channels and new types of introduction strategies for innovations to emerge.

Ad 5 Rapid advances in technology

An example of rapid advances in technology is provided by the developments in computers, telecommunications and information sciences (Wind and Mahajan, 1997). Similar developments can be found in other fields of expertise like electronics, biotechnology and genetic technology. Existing technologies become more complicated, and, in addition, new technologies emerge, fragment, and divide again (Scott, 2001). In addition to the fragmentation of technological knowledge, the opposite, a merger of hitherto separate fields of technological knowledge, is also visible.

A consequence of the advances in technology is that the knowledge required to develop new products has evolved. Tidd *et al.* (2001) show that the number of technologies required to develop and produce mobile phones has grown considerably in a few years. In many cases technological competences to develop new products have become too complex to be mastered by a single company. In order to cope with these advances in technology, companies develop new ways of learning and knowledge management, focus on core technologies and competences and decide to cooperate in a network of actors with complementary assets.

New technologies, like CAD/CAM, also enable tools that facilitate innovation activities. CAD/CAM enables the building of platforms from which quick changes and product improvements can be derived on a continuing basis (Germeraad, 2001).

Ad 6 Increased accountability to customers and societal pressure groups

Customers have become more demanding with regard to products (Urban and Hauser, 1993). Products have to be personalised, of high quality, easily understandable and yet have to contain high-end features. Changing demographics, values, expectations and behaviours of consumers have an impact on customer demands (Wind and Mahajan, 1997). To fulfil these demands, product assortments and variants have increased in many markets; some authors even notice a growing market fragmentation (Gupta and Wilemon, 1996).

Along with the trend of increasing consumer demands, further stimulated by consumer pressure groups, governments introduce stricter legislation and regulation regarding product safety, liability and pollution restriction. So an increased government and public scrutiny of business decisions in ethical, social and environmental issues can be noticed (Gupta and Wilemon, 1996; Wind and Mahajan, 1997). These trends not only enlarge the list of requirements that new products have to meet, they also enlarge the responsibilities with regard to testing of products prior to introduction. Environmental concerns, for example, require product designs that are easy to dispose or reuse.

Ad 7 Increased focus on core competences

Companies focus on core competences rather than diversify into completely different activities (Hamel and Prahalad, 1994). Chiaromonte (2003) asked both managers and industry experts to rate the statement, 'Core competencies development is crucial'. The results indicate that a majority of the respondents agree.

The focus on core competences can impact innovation activities in an organisation. Firstly, innovation can be considered by some companies a noncore activity, which means that innovation processes are delegated to external partners. As a result, some companies decided to sell or close their R&D organisations. Secondly, companies may choose to focus on specific types of knowledge, which means that the remainder of the innovation activities should be coordinated with external partners to make all the necessary knowledge available.

Ad 8 More alliances

The number of alliances increases in many industries. More particularly, over the last two decades the number of technology-based strategic alliances between firms exploded (Hagedoorn and Schakenraad, 1990). In general, many companies are engaged in mergers, acquisitions and strategic alliances (Wind and Mahajan, 1997). Other forms of alliances are becoming more important as well. Scott (2001), for example, found that customer and supplier involvement are considered important by many companies.

A consequence of this trend is that innovation is more and more organised in networks (Biemans, 1989). An increased need for the involvement of external organisations in the new product-development process is felt by many companies. Many drivers for this trend can be distinguished. The resource constraints for R&D are forcing companies to innovate in alliances (Gupta and Wilemon, 1996). By sharing the costs of innovation, alliances decrease the cost and thereby also reduce the risk of innovation processes. Alliances have consequences for R&D management since alliances demand extra attention and are prone to political games and misunderstanding (Tidd *et al.*, 2001). Furthermore, alliances imply that the leadership role has to be shared among partners.

The result of the increased coordination is that company boundaries seem to blur. Some units of an organisation may more closely cooperate with units of another organisation than with the same kind of units in their own organisation. In this situation, strongly linked systems of fuzzy components emerge.

2.3 Trends at the micro level

Ad 9 Organisations demand a more direct contribution of innovation to business goals

Many companies increase the pressure on R&D to be accountable to business needs. R&D is requested to contribute both to short- and long-term business results (Corcoran, 1994; Gupta and Wilemon, 1996). From a corporate perspective, R&D spending can be seen as an investment in future profits. In the short term, this spending can actively contribute to an innovative image of the mother company. In both ways, R&D efforts can increase the shareholder value of the entire company to which it belongs. In practice, however, R&D spending is also seen as a large overhead that should be curtailed to decrease corporate costs and thereby increase the shareholder value. So, both increasing and decreasing the R&D spending may increase the shareholder value of the mother company, but decreasing the spending is much easier.

The focus on the direct contribution of R&D on company results has profound consequences. Although the opposite strategies of increasing or decreasing R&D spending may improve the share-holder value of the mother company, the common thread in these strategies is that R&D is forced to become more market driven and more profit oriented (Gupta and Wilemon, 1996). Budgets shrink and a more efficient use of the R&D resources should result in more profits (Corcoran, 1994). In general, R&D managers are trying to pull research closer to other divisions of the company. One way to do so is to organise innovation projects in programmes that are directly related to the company strategies (Roussel *et al.*, 1991). Other reactions of R&D departments are to shift attention from major innovations to minor innovations or process innovations (more D than R) (Corcoran, 1994; Szakonyi, 1998). In some cases, former R&D institutes become a kind of service centre that is paid per hour. In other cases, R&D institutes cooperate with universities and national labs, to compensate for the lack of scientific research in their labs (Corcoran, 1994).

The majority of small- and medium-sized enterprises has no R&D capacity and has problems to understand and acquire technology that is developed outside. However, these companies will also have to innovate in order to survive. Forming strategic alliances (*e.g.*, co-makership relations) with R&D-based firms is one way to solve this problem. Many attempts of regional, national and even international governments to stimulate small- and medium-sized companies to innovate make clear that this is not only an important but also a very difficult challenge.

Ad 10 Broadening of decision-making processes in innovation

'The broadening of decision-making for innovation processes in terms of players and aspects has become manifest over the past few decades' (Smits, 2002,p.869). The introduction of new products often requires the adoption of new organisational practices (in terms of marketing, manufacturing and so on), the availability of complementary products, services and infrastructural (re)arrangements and so on.

This trend has important consequences for the management of innovation processes. Decisions on these processes become interlinked with many other decisions. As a result, other innovation management approaches and decision procedures are proposed. Following a modular approach, for example, means that separate parts can be developed by different partners. Coordination of decisions among partners can stimulate the emergence of large networks of organisations that together develop a system. Large networks were formed, for example, prior to the market introduction of DVD and Bluetooth.

2.4 Combinations of trends

The trends emerge on different levels of the innovation systems. Yet some of the trends, like globalisation, seem to pervade all levels. The description of the trends also reveals that many trends are interrelated. Relationships among trends may take different forms:

- Some trends stimulate another trend (*e.g.*, globalisation (Trend 1) probably increases the level of competition (Trend 4)).
- Some trends have a combined effect (both globalisation (Trend 1) and rapid advances in technology (Trend 5) may stimulate alliances among organisations (Trend 8)).
- Some trends have a similar cause (both the increased number of alliances (Trend 8) and the focus on core competences (Trend 7) are affected by the rapid advances in technology (Trend 5)).

In short, a network of many interrelated trends becomes visible.

The interrelationship between the trends implies that trends will probably not always evolve steadily. When the network of trends is in a kind of dynamic equilibrium, separate trends may evolve steadily and simple extrapolations of separate trends may provide reasonably good predictors for the future. When such a network of trends is in disequilibrium, trends are affected and simple extrapolations of separate trends may be poor predictors.

The description of the trends also reveals that some trends seem to evoke some type of anti-trend. Along with globalisation, for example, a renewed interest in local culture and products can be noticed. Technology specialisation or fragmentation is visible, as is the counterpart: mergers or a combination of hitherto separate fields of technology. The combination of a trend and an anti-trend may lead to some kind of delicate balance that only temporarily reaches equilibrium and therefore only temporarily develops at a predictable and stable pace. This strengthens the notion that simple extrapolations of separate trends may be poor predictors.

A managerial implication of these notions is that the entire network of trends has to be monitored. The interrelationships between the trends also imply that their combined effects should be managed.

> "I learned that some organizations were managing clusters of these trends, but no company was dealing with and blending the opportunities from all of the trends. The most successful companies will be the ones that face the majority of these trends head on and adopt effective strategies to thrive in this new environment." (Germeraad, 2001,p.15)

In managing clusters of trends, constant adaptivity is required (Corcoran, 1994). "The globalization of markets, the regionalization of technical and scientific expertise, and the rapid change in technologies are forcing technology-based companies to continuously adjust their R&D organization." (Gassmann and von Zedtwitz, 1999,p.231)

3 Consequences for innovation management

In the previous section ten trends are described. The main changes in innovation management that emerged with these trends will be summarised in this section. Before doing so, it is important to notice that the trends from the previous section are interrelated but their combined effect sometimes results in hardly reconcilable requirements for innovation management. "In addition to efficiency, quality, and flexibility, companies need to simultaneously cut costs, increase quality levels, shorten product development time, and introduce innovative products that customers value." (Gupta and Wilemon, 1996,p.498)

We have grouped four major insights from innovation studies and management literature under four headings:

1 the end of the linear model

2 the rise of the systems approach

3 the inherent uncertainty and need for learning

4 innovation becomes more entrepreneurial.

Ad 1 The end of the linear model

For many years now the linear model of science, research, technology and innovation, together with a view of innovation processes as an autonomous development, was the prevailing perspective. This has changed quite rapidly over the last four decades. Scholars such as Nelson and Winter (1977), Bijker *et al*. (1987), Etzkowitz and Leydesdorff (2000) and Ziman (2001) emphasise that science and science-based innovation is the result of social and economic processes, and thus – almost per definition – is not a deterministic process. Furthermore, several authors describe how R&D management practices have evolved from a basically linear innovation process to a more iterative and flexible process with constant input of market and technology information (Liyanage *et al.*, 1999; Niosi, 1999; Rothwell, 1994; Roussel *et al.*, 1991).

The linear model is further contested by the recent rise of research in innovation services. Barras (1986) introduced the concept of the reverse product cycle, and in doing so turned the linear model completely upside down. Recent research (den Hertog *et al.*, 1998; Hipp, 1999; den Hertog, 2000; Gallouj and Weinstein, 1996) refines this model further by showing that in service innovations, too, interactions and feedback play a very important role.

Another body of literature of relevance here focuses on the role of users in innovation processes (von Hippel, 1988; Silverstone and Haddon, 1992; Grupp, 1992; Smits *et al.*, 1995; Oudshoorn and Pinch, 2004). Authors like Rip and Kemp (1998), OECD (1992), Gibbons *et al.*, (1994), Freeman and Lundvall (1988) and Schmoch (2001) point out the numerous and frequent interactions and feedback processes between users and

producers in innovation processes. From this literature it becomes clear that users are involved in innovation processes during the design stage as well as during the actual use of innovations. In this context, Silverstone and Haddon (1992) introduce the concept of domestication of innovations. They point out the strong interaction between designers and users after the introduction of an innovation on the market leading to (sometimes a whole series of) modifications. The central message of this rapidly growing body of literature is that users will play an increasingly important role in innovation processes, the reason for this being that users want a stronger grip on innovation processes. The producers of innovations on the other hand are interested in broad societal acceptance of innovations, access to tacit knowledge and – induced by the variety of modern technologies such as ICT – increasingly in mobilising the creative potential of users.

Ad 2 The rise of the systems approach

The systems approach gets a lot of attention in innovation studies these days. As was already said, organisations are not innovating in isolation but in the context of a system (Freeman and Lundvall, 1988; Nelson, 1993; Lundvall, 1992; Barré *et al.*, 1997). As a consequence, their performance is dependent on the quality of that system, more particularly on the quality of the subsystems (R&D, users, intermediary and supportive infrastructure) and, maybe even more, on the mutual tuning of these subsystems (Freeman, 1997; Smits, 2002). Another consequence of the systems approach is that more and very heterogeneous actors, often at very different levels and operating in various arenas, are involved in (the management of) innovation processes (Kuhlmann *et al.*, 1999).

A further characteristic of the systems approach is the concept of 'path dependency'. If an innovation is more integrated in a large system, this system may limit the potential changes that can be implemented in this innovation. Improvements in a new telecommunications service, for example, can be restricted by prevailing standards in infrastructure, hardware, procedures and so on. It seems as if systems do have a memory that should be taken into account when studying the dynamics of this system (Rosenberg, 1976; Hollingsworth and Boyer, 1997).

Ad 3 The inherent uncertainty and need for learning

The uncertainty of innovation systems is reflected in various ways. Firstly, the trends on the different levels of the innovation system (see previous section) are interrelated in a complex way. In such a system, simple extrapolations of separate trends may turn out poor predictors. The inability to predict the development of trends causes uncertainty. Secondly, many actors from various perspectives are involved in innovation processes. This implies that innovation is a complex process, difficult to comprehend. Actors involved in innovation processes do not possess perfect information and they must function under conditions of bounded rationality (Simon, 1976). The boundaries of organisations involved in an innovation process become fuzzy. Sometimes, business units of competitive companies closely cooperate in innovation projects and thereby seem to form a kind of virtual organisation. This complex interaction between actors causes uncertainty. Thirdly, a very fundamental source of this uncertainty relates to the 'manmade' character of innovation. Because innovation is the work of man, it can never

be predicted (Grupp, 1993; Irvine and Martin, 1989). Technology does not offer itself as ready-made packages, but far more as opportunities. It is up to users to trace these opportunities, make clear what they mean for them, assess the implications of implementation and, finally, make a selection and develop plans to make sure that the selected opportunities are indeed turned into successful innovations (Smits *et al.*, 1995). This being said, it will be clear that innovation is not a matter of optimising, but a process of trial and error in which various types of learning (learning by doing, learning by using, learning by interacting and learning on system level) play an important role (Rosenberg, 1982; Barré *et al.*, 1997; Lundvall and Borras, 1998).

Ad 4 Innovation becomes more entrepreneurial

The trend that organisations demand a more direct contribution of innovation activities to the business goals (see Trend 9 in the previous section) means that innovation practices have changed. Large companies with multiple business units and an R&D organisation, for example, demanded that R&D more closely tune their efforts with the business units. This tuning is not without risks. Innovation is renewal of a system, which cannot always originate from that same system. Some of the R&D organisations of large companies were trapped in a very close relationship with other business units (Bennett and Cooper, 1982). These units tend to request the development of minor improvements on existing products. The R&D organisation, however, is far too expensive to be deployed in this way. As a result, many R&D units are dismantled. So, R&D with a focus on the revolutionary changes in the long term bears the risk of being curtailed because of its lack of short-term results, whereas R&D with a focus on minor improvements in the short term bears the risk of being curtailed because it is too expensive for the task it performs.

This trap can be escaped by combining long-term and short-term work, but inevitably short-term work has become more important (Corcoran, 1994). Another approach to escape the trap is to commercialise knowledge, ventures and other intermediate results of innovation activities and thereby contribute to short-term business goals with long-term activities. A traditional activity of R&D in many industries, exploitation of patents, for example, has become more important. 'There has been a surge in patenting as the firms strive to create market exclusivity' (Bowonder *et al.*, 2000,p.40). Licensing in and out evolves as a business unit with the goal of realising full value from patents. Patent outputs have increased while R&D intensities remained the same (Bowonder *et al.*, 2000). Rather than just patents, R&D organisations increasingly buy and sell all types of intermediate results from innovative activities. A new 'commercial' activity of R&D is venturing. Traditionally, in many large corporations, innovations were developed in the isolation of a corporate institute and subsequently handed over to the mother organisation, which bore the business risk of introducing the innovation into the market. These corporate R&D institutes are traditionally funded as cost centres within the main corporation. These costs are a drain on current earnings. However, the cost centres are turned into profit centres, for example by venturing. By setting up a new venture as a spin-off company, R&D costs can come off the income statement (Germeraad, 2001). Furthermore, these new ventures can form a home for ideas and people and thereby retain talents that otherwise would have opted for another job. In general, innovation management is pressured to participate in the introduction of innovations into the market (Gupta and Wilemon, 1996; Scott, 2001).

The traditional R&D unit has evolved from a technology-oriented lab that was considered part of the company's overhead into an accountable business unit that sells, buys and barters patents, licences, knowledge, researchers, small research companies and research facilities. Moreover, this business unit also accounts for a considerable business risk by investing in new ventures, spinning in and spinning out. In short, R&D has evolved into a research broker that, because of its extensive external contacts, may occupy a key role in the network of actors that cooperate during innovation.

In the next section, we will present two alternative approaches to innovation management that – each in its own way – try to anticipate the trends as described in the foregoing. One of the questions we will try to answer is how far they build on the theoretical insights discussed in this section.

4 Alternative approaches to innovation management

Organisations and scientists may more or less agree on the main trends and their impact on innovation in general; the specific innovation management approaches that are proposed, however, differ considerably. In fact, entirely different visions of innovation management live side by side, two of which will be described in this section. Rather than giving a complete overview, the characteristics of two rather extreme approaches will be identified. These two approaches are referred to as *the strategic planning approach* and *the adaptive learning approach.* The strategic planning approach basically implies that in order to face the trends and developments with an impact on innovation, sophisticated mechanisms (organisations and procedures) of planning are proposed that enable the coordination of many different, yet complementary, activities of innovation on various levels.[4] The adaptive learning approach basically implies that in order to face the same trends and developments, the activities and responsibilities to cope with them are completely delegated to teams or organisational units with a large mandate. These teams or units are focused and have the ability to respond quickly.

Both approaches will be elaborated by describing how they relate to the four main changes in innovation from the previous section (*i.e.*, 1) the end of the linear model; 2) the rise of the systems approach; 3) the inherent uncertainty and need for learning; and 4) innovation becomes more entrepreneurial). The organisational structures and knowledge management approaches that come with the two innovation management approaches will be described in order to further clarify the management implications of these approaches.

4.1 The strategic planning approach

4.1.1 Strategic planning approach and the end of the linear model

An important change with traditional linear approaches to the innovation process is that after the completion of one or more phases of an innovation project, it is decided how and whether to continue this project. This so-called stage-gate process (Cooper, 1990) often means in practice that a committee is formed to evaluate ongoing projects. These committees decide on the basis of various criteria whether projects should be continued, and if so, whether more or less resources should be reserved for the project. In fact, ongoing projects are considered to be options for future profit, and committees are requested to indicate in which projects a company should invest to maximise

future profit. These committees and their evaluation of ongoing projects enable a more flexible and efficient innovation management style than just awaiting the result of the entire innovation process. Yet these committees also entail time-consuming procedures and bureaucracy.

4.1.2 Strategic planning approach and the rise of the systems approach

As was explained in the previous section, an innovation is seen as part of a system containing many complementary products and services, the development of which often refers to different disciplines. Therefore, innovation teams are often multi-disciplinary. In the strategic planning approach, a basically hierarchical, centralised organisational structure is formed to translate the central vision and the strategic plan to lower levels of the organisation. In order to centrally guide many projects, without having to coordinate between all possible pairs of projects, a clear future vision is required and explicit strategic planning procedures are adopted. As a result, in the strategic planning approach, formal communication occurs mainly within projects and from the projects to managers, whereas the connection between projects is basically provided by discussions among managers and by the guidance of the strategic plan.

4.1.3 Strategic planning approach and the inherent uncertainty and need for learning

In order to cope with the increased uncertainty of the environment, more sophisticated types of innovation processes are described in some companies. These processes are well-structured and many procedures are formulated to indicate how these processes should be completed and which requirements the resulting innovations should meet. In these companies learning has become a formalised procedure, for example by demanding an evaluation after the completion of an innovation project. Different archetypical roles for team members in innovation projects are described in terms of a unique set of competences. Employees are assessed and subsequently occupy the role that best matches their characteristics. In order to fully master the competences that come with their role, employees join formal education programmes.

4.1.4 Strategic planning approach and the entrepreneurial nature of innovation

It is recognised by many companies that the current internal company and external market environment requires a more entrepreneurial approach to innovation. In the strategic planning approach, committees are formed (again) to evaluate and subsequently fund (internal or external) venture proposals. In practice, this approach is time-consuming and most often delivers results of a dubious quality. Starting corporate venturing in a rather bureaucratic company may prove an expensive experiment.

4.1.5 Strategic planning approach and organisational structure

In practice, in the strategic planning approach, some kind of a matrix structure may be designed in which team members have a line manager and a project manager. The line manager has a team of employees with a similar disciplinary background, and is responsible for knowledge build-up, human resource management and planning of

employees across projects. The project manager requests some time from team members and is responsible for the planning, the team forming and the end result of a project. In practice, these types of organisational structures require a relatively large overhead.

4.1.6 Strategic planning approach and knowledge management

In the strategic planning approach, mostly a so-called codified approach of knowledge management is adopted. A codified approach means that all knowledge is centrally managed in a system, like an intranet or a portal (Hansen *et al.*, 1999). This type of solution seems logical in the strategic planning approach for three reasons. Firstly, it enables central control of content. Secondly, the strategic planning approach entails many procedures and requirements that should be easily accessed by project leaders and members. A codified system can provide this. Thirdly, the changing environment requires extensive environment scanning. The result of this scanning process can easily be used in projects when it is available from a central system.

4.2 The adaptive learning approach

4.2.1 Adaptive learning approach and the end of the linear model

The standard linear process of innovation is abandoned, but rather than replace it with a well-structured and more sophisticated approach, a far more simple approach is adopted in order to increase the agility and responsiveness of the organisation to the changing environment. The responsibility and the activity of innovating are almost fully delegated to a team or unit. Members of the team usually devote most of their attention to one project rather than switch between multiple projects. The combination of full-time focus and a personal responsibility is further combined with a high level of freedom regarding how to complete the innovation process. In practice, this means that the standard linear model of innovation is rejected because teams can choose an appropriate innovation process depending on the specific situation. This approach enables more freedom to design a proper innovation process and to adapt it when the situation changes. Yet this approach also requires that project leaders should have ample expertise and experience with structuring projects because they do not rely on a centrally specified, well-proven and well-known process. Furthermore, these project leaders should be true leaders because the entire team has to decide about the type of innovation process rather than follow standard processes and procedures.

4.2.2 Adaptive learning approach and the rise of the systems approach

Both in the strategic planning approach and the adaptive learning approach, it is often recognised that different types of disciplines are required to form an innovation. If the innovation should fit into a larger system, coordination with other project teams or other organisations may become important. Brown and Eisenhardt (1997) found that in the adaptive learning approach organisations tend to be far less hierarchical. Hierarchy enables interproject coordination. In the adaptive learning approach, this coordination is provided by more formal and informal interproject coordination.

4.2.3 Adaptive learning approach and the inherent uncertainty and need for learning

Learning both at the project level and the level of the project member has become a responsibility of the team and the project members rather than the responsibility of the organisation, which has turned learning into a formal process with evaluation mechanisms, lists of competences and personal education programmes.

4.2.4 Adaptive learning approach and the entrepreneurial nature of innovation

It is recognised by many companies that the current internal company and external market environment requires a more entrepreneurial approach to innovation. In the adaptive learning approach, teams may decide to start a venture after completing a project. The chance that ventures will be started is probably much higher in the adaptive learning approach than in the strategic planning approach since teams are more dedicated to the project. In the adaptive learning approach, the teams are more involved with the project and are fully responsible for the result and how to attain it. Rather than assigning company committees to evaluate venture proposals, these proposals may be evaluated by the project members themselves by asking them to bear some of the financial risk that come with the venture. These members are sometimes facilitated by venture capitalists.

4.2.5 Adaptive learning approach and organisational structure

In the adaptive learning approach, a project-based organisation seems more logical than a matrix structure. The full-time dedication of employees to subsequent projects and their larger personal freedom and responsibility seem to be more in line with a project-based structure where they themselves find a new project once the former project has finished. This approach may decrease the overhead but, on the other hand, may increase the chance that employees are temporarily without work.

4.2.6 Adaptive learning approach and knowledge management

In the adaptive learning approach, mostly a so-called personalised approach to knowledge management is adopted. A personalised approach assumes that knowledge is mainly stored in human beings rather than systems (Hansen *et al.*, 1999). Moreover, professionals are usually not keen to complete obligatory information requests from centrally managed information systems. In the adaptive learning approach, employees with a similar disciplinary background can form virtual teams to share information.

The differences between the strategic planning approach and the adaptive learning approach are summarised in Table 1.

The table once more stresses the differences between the two innovation management approaches. Both approaches recognise the four changes in innovation processes described in the previous section, yet the innovation management style that is adopted to cope with these changes is completely different. Both approaches are extremes on a continuum of possibilities. As Gassmann and von Zedtwitz (1999,p.231) state, “The search for an optimal balance between coordination and control is reflected by hybrid structures and intermediary configurations detected in some of the investigated companies”. The same applies to other aspects that distinguish the two approaches.

Table 1 Two alternative innovation management approaches

	Approach 1: The strategic planning approach	*Approach 2: The try-and-learn approach*
The end of the linear model of the innovation process	The innovation process is well described and well structured in many procedures. The strategic planning approach is a process-bound environment that allows iterations, feedback loops and go/no-go decisions at the junction of stages.	The innovation process is more open and flexible (depending on the context the project leader decides), with design freedom to create improvisation within current projects.
The rise of the systems approach	The relationships of an innovation process with other activities are taken care of by formal coordination of managers and by a central vision.	The relationships of an innovation process with other activities are taken care of by informal and formal coordination on the level of project team members.
The inherent uncertainty and need for learning	Uncertainty is high and therefore many optional procedures and sub-processes have to be considered when designing the innovation process. Learning is part of a formalised procedure (with competences, profiles and education programmes)	Uncertainty is high and therefore the choice to adapt the innovation process is left to the project leader and his or her team. Learning is the responsibility of the employees.
Innovation becomes more entrepreneurial	Systematic patent portfolio management has become important. Official committees evaluate venture proposals.	Venture activities are started by project members if they want to invest personally. These members are often facilitated by professional venture capitalists.
Organisational structure	Hierarchical, fixed structure with power, centralisation and extensive control systems. Mostly some kind of matrix structure.	Semi-structured with clear responsibilities and priorities. Mostly some kind of project-based organisation and many (in) formal coordination mechanisms.
Knowledge management	Mostly a so-called codified approach of knowledge management with a centrally coordinated system containing disciplinary knowledge and necessary rules and procedures.	Mostly a personalised approach, for example by facilitating virtual teams of professionals that want to develop and share knowledge.

5 Conclusions

The first research question (What are the main trends or changes in each of the levels of the innovation system?) is answered in Section 2. Several authors present similar lists of trends. We condensed their material in ten general trends on three levels:

1 Trends macro level
   a globalisation and the shift in economic power of countries and regions
   b structural changes within economies
   c increase in (and shift in modes of) communication.

2 Trends meso level

   d increased competition

   e rapid advances in technology

   f increased accountability to customers and societal pressure groups

   g increased focus on core competences

   h more alliances.

3 Trends micro level

   i organisations demand a more direct contribution of innovation to business goals

   j broadening of decision-making processes in innovation.

The trends are interrelated in a complex way. The relationships among trends have important management implications. Firstly, management should manage clusters of trends rather than react to separate trends. Secondly, because of their complex interrelationships, separate trends may develop quite regularly for a period of time when the system of trends is stable and then, quite suddenly, change in a volatile way if the system becomes unstable. This implies that simple extrapolations of separate trends may provide invalid predictions. This also implies that predictions require a focus on those events that can make the system unstable. Events that can destabilise a system of trends are, for example, wars and natural disasters. More subtle events like strikes, fluctuations in oil prices or stock markets and changes in regulation can sometimes also destabilise innovation systems.

The ten trends reinforce each other but their combined effect sometimes results in requirements for innovation management that are hardly reconcilable. The second research question (What are the main consequences of these changes for innovation processes that occur within the system?) is answered in Section 3. These consequences are:

- the end of the linear model
- the rise of the systems approach
- inherent uncertainty and need for learning
- innovation becomes more entrepreneurial.

Agreement about the trends and their general consequences for innovation does not imply that there is agreement about the best innovation management approach. The third research question (Are there alternative innovation management approaches to cope with these changes and consequences?) is discussed in Section 4. In Section 4, two completely different innovation management approaches are described, the strategic planning approach and the try-and-learn approach, both of which comply – each in its own way – with the general consequences.

Having said this, several questions can be raised. Is one of these approaches generally superior? Does the quality of the approaches depend on the context in which they are applied? If so, in what context is each of these approaches superior?

The strategic planning approach allows for a certain amount of feedback, emphasises the coordination of efforts of different departments and includes formalised learning processes. However, the approach is based on a predetermined structure that has some disadvantages. If more feedback is necessary, external parties need to be coordinated, too. If these parties adopted different processes, the cooperation may become problematic. Some large companies or organisations (like the army) therefore force suppliers that develop new products to adopt very specific procedures during their operations in order to comply with their own procedures. In these cases intimately related industrial systems emerge. If certain learning processes are necessary, which the formal learning processes do not prescribe, learning is hampered.

The try-and-learn approach also meets most of the theoretical conclusions, however in a completely different way. The market information that is necessary and the partners that should be included in a strategic alliance are assessed step-by-step. The advantage of the try-and-learn approach is its flexibility and its ability to react to new developments, new actors and new information needs. The disadvantages, however, are clear too: long-term planning is impossible, and results and costs are unpredictable. Looking at these two approaches, the parallel with the controversy between Simons' 'rational planning' and Lindbloms' 'muddling through' is striking. What we can learn from this old controversy is that the 'truth' will be somewhere in the middle. Where exactly in the middle depends on the nature of the specific innovation process and the context in which it has to develop. In the case of infrastructural innovations with a long planning horizon, as for instance changes in essential parts of the telecommunications system and changes in the heart of the public electricity network, the strategic planning approach will fit best. However, in the case of innovation processes in rapidly developing markets without established standards and integrated systems, as for instance those for some consumer products and knowledge-intensive services, the try-and-learn approach will be more advantageous.

The major lesson of this paper is that the combined effect of trends in the external environment of innovation projects has increased the pressure on these projects. Traditional approaches of innovation management with linear innovation processes no longer hold and new types of innovation models are needed (see also Berkhout, 2000). These models will have to be adapted to the specific nature and context of the field of application. These models should meet the following requirements:

- The innovation model should enable adaptation to the context.
- The innovation model should be a multiple-level framework.
- The innovation model should describe continuous innovation processes and should describe simultaneous complementary processes rather than a singular process.
- The innovation model should enable more flexible processes.

It goes without saying that models of innovation processes based on these starting points do not have much in common with the old linear model.

Finally, are the almost constant and high failure rates in innovation processes a signal of a lack of progress in innovation practices? This article shows how the pressure on innovation has increased and that the procedures of innovation have changed accordingly. Empirical work (*e.g.*, Griffin, 1997) shows that some companies still adhere to old-fashioned innovation practices. From the case studies described in this special

issue, it will become clear that many companies are trying to develop more advanced practices of innovation. In these approaches, elements of the strategic planning approach and the try-and-learn approach can often be recognised. In this way, innovation management, as innovation itself, has turned into an ongoing learning process. The context of innovation management has become much more complex. Therefore, the constant failure rate can be seen as the result of this learning process. The progress in innovation management practices compensated for the increased complexity in the context of these practices and, as a result, the failure rate remained constant.

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Notes

1 Trott (2002) summarises the main characteristics of organisations that facilitate innovation activities (pp.70–74). The combination of these characteristics can be seen as a corporate innovation system.

2 The decreasing length of product life cycles is mentioned as an important trend in many articles. Most of these articles just take this decrease for granted. Empirical investigations show that product life cycles do not decrease (Bayus, 1994). This trend is therefore removed.

3 The Netherlands is, despite its very small size, behind the USA and France as the third exporter of agricultural products and services.

4 The description of the strategic planning approach and the adaptive learning approach is based on various sources and experiences. The main sources are Brown and Eisenhardt (1997), Chiaromonte (2003) and Scott (2001).