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Jin Chen, Alexander Brem, Eric Viardot, Poh Kam Wong

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Dirk Meissner
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21

INSTITUTIONAL DESIGN OF INNOVATION TOWARDS THE 'ACTIVE INNOVATION PARADIGM'

Dirk Meissner

The understanding of innovation and its overall emergence has changed considerably over the years. Traditionally innovation has been viewed as the 'implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations'. (OECD, Eurostat, 2005). Innovation practice meanwhile shows that innovation is by nature a value-free term and comprehensively covers the whole spectrum of activities from discovery to first-time practical application of new knowledge. Moreover, innovation aims to fulfill recipients' requirements and goals in a new way, and it stresses that risk and uncertainty are inherent at all stages of innovation processes. This understanding has evolved from innovation concepts, models of innovation and innovation processes over decades (for example, Carlsson, Jacobsson, Holmen, and Rickne, 2002; Godin, 2006).

Meanwhile, there is a broad range of models for innovation processes. All these models share a common understanding that innovation activities can broadly be described and visualized in process models. Some models describe the life cycle of innovation by an S-shaped logistic function, which consists of three separate phases reflecting the application phases of its development: emergence, growth and maturity (Howard and Guile, 1992; Mitrova, Kulagin, Grushevenko, and Grushevenko, 2015; Perani and Sirilli, 2008). Other concepts emphasize the characteristics of innovation, which are defined according to innovation development stages, that is, Maidique (1980) distinguishes the recognition of the invention, development, realization and distribution as phases of the innovation process. In general, linear models of innovation distinguish the discovery (invention), the definition of possible spheres of applications of the results of innovation, its development, design and use as phases of the innovation process (see for example Niosi, 1999; Godin, 2006; Meissner, 2015; Carayannis, Meissner, and Edelkina, 2015 for a simplistic description of innovation processes).

The evolving understanding of innovation as a *process* of activities raises new challenges to innovators and the governance of innovation activities. Although innovation is commonly regarded as the outcome of a process of activities, these are by no means always succeeding in a linear shape, but rather involve several feedback loops. Hence, typical activities and steps are common for many innovation projects, but the uncertainty of achieving results and finishing an activity with the required quality forces innovators to solicit feedback between the activities in

order to improve the final solution. These challenges are expressed in the increasing complexity of innovations, which are in turn also determined by the complexity of the surrounding framework conditions. Consequently, the complexity – expressed by the number of information sources, knowledge and application fields for innovation – is rising. In this light, innovators need to analyze and process more information for the same purpose (Carayannis and Campbell, 2011; Carayannis and Turner, 2006; Gokhberg, Kuznetsova, and Roud, 2010; Gault, 2009; Godin, 2010).

Furthermore until recently innovation was considered a process or a sequence of activities and steps, but the surrounding factors such as company culture for innovation and the meaning of human resources for innovation were only partially reflected. The latter is especially relevant for the complexity, which requires unorthodox thinking and must be socially accepted to succeed. Hence, innovation includes new technological, economic, organizational and social solutions, which are not necessarily marketable in an economic sense with direct monetary impact but are applied and used.

The rise of the open innovation paradigm clearly goes beyond the intensification of business R&D internationalization, because innovation is more than R&D, and more opened up processes entail crossing more than geographical borders but also institutional and disciplinary ones. Led by multinational companies, innovation now involves multiple innovation actors, including smaller firms, public research, suppliers and customers. It challenges the adaptiveness of market actors, which must reinvent their business model to survive an increasingly knowledge-based global competition. But it challenges even more corporate management traditional approaches, and instruments may not be fully effective in maximizing benefits from the globalization of innovation markets and networks. The single most important response should be offensive, consisting of the promotion of all forms of international linkages as a way to strengthen the company's innovation ecosystem, with a particular attention to external linkages. Another important objective should be to care even more about the quality of internal framework conditions for innovation, including appropriate specialized infrastructures supporting and servicing innovation, such as central corporate service units, in order to be able to retain or attract increasingly mobile talented people.

In this light governance of innovation becomes an even more important crucial asset of companies with the aim of strengthening economic performance by means of innovation (Tsai and Yang, 2013; Rubera and Kirca, 2012; Hansen, 2014). Furthermore shareholders carefully monitor the company's innovation pipeline thus underlying activities to strengthen the output and economic impact from innovation-related investment. Thus, management is forced to align the corporate governance model continuously to meet shareholders' expectations while at the same time keep the balance with employee motivation.

Other major changes in the innovation activities of companies are switching the focus away from pure product/service innovation towards a more integrated business model innovation, which implies that innovation is more than the product or process in its purest sense; rather, it is accompanied by services and modeled around a business itself. Thus, more attention is given to the overall lifetime of an innovation in the company's portfolio of technologies and innovation, and more freedom to managing these is given.

Governance of innovation

Governance models for innovation have changed over time in line with the development and adjustment of innovation process models. Innovation process models, however, can hardly do more than describe the governance scheme applied within a company, including all different

interfaces. Overall, the management adage that 'structure follows strategy' remains in place and valid; for example, a company's organizational model needs to be aligned to allow implementation of strategic decisions. Still it's not about organizational structures only but also about the corporate company cultural dimension and related management models to create and maintain innovativeness. Furthermore, companies are challenged in finding appropriate solutions for the missions, tasks, duties and powers of innovation management inside the company, especially in light of their embeddedness in company operations. When developing a powerful innovation management (IM) scheme, companies are challenged with three overarching questions (Figure 21.1):

- How innovative does the company/Strategic Business Unit (SBU) have to be?
- How efficient is IM in supporting the innovation process?
- Where does IM need to improve?

The ongoing public debate about innovation inherits the danger that companies consider innovation important and develop responses to increasing innovativeness many times over. This obvious reaction to environment, however, might lead to developing and implementing ever different concepts which aren't necessarily in line with the actual challenges the respective company faces. Therefore, in the first instance companies need to find a response to the underlying question *how innovative they need to be*. This requires a profound understanding of the customer and market requirements towards innovation in all facets, for example, frequency of innovation, scope and shape, opportunities and benefits arising from innovation and expected contributions from IM to the company. These are essential to bear in mind when it comes to fine-tuning the company's IM organization and the subsequent processes. The second dimension relates to *determining the current IM performance*, namely the efficiency of IM and the subsequent processes implemented. IM performance measurement is an absolute necessity for companies to employ, but it's also one of the most sensitive and delicate undertakings to develop and implement. The reason is found in the nature of innovation activities, which require substantial human resource investment in the shape of codified and tacit knowledge and social skills. Tacit knowledge and social skills are important assets for teamwork, and it's usually thought that company employees possess such sufficiently. But in order to assess IM performance these skills need to be codified

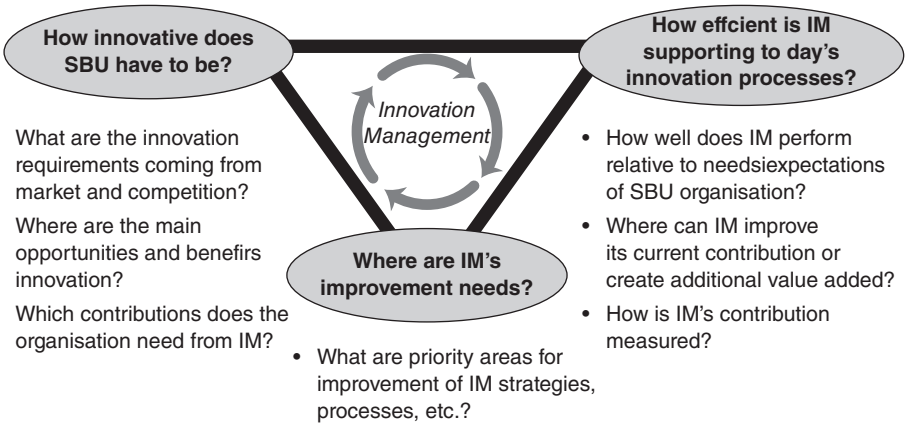

Figure 21.1 Key issues for determining the company's innovation management role

and included in respective indicators, which has been a challenge until recently. Finding appropriate responses to assessing the *efficiency of IM supporting the innovation process* appears equally challenging. This refers especially to assessing the IM performance relative to needs and detecting respective improvement fields and value creation which underlie IM improvement and actions.

These simplistic approaches cannot be treated as real models of the innovation process, but rather as a schematic description. Although genuine models that are more complex were developed in the scientific literature in the second half of the 20th and the early 21st centuries, these models remain idealistic descriptions of innovation generation. Such process models have certain implications for the organization of innovation in companies, research institutes and engineering companies; however, they will change each time a new innovation project is started. One can also argue that there is in fact no definite innovation project, but rather overlapping activities of different kinds and intensities, which form the basis for the next generation of innovation. It is evident that a significant share of the innovation management literature describes the innovation process as somewhat linear, especially in the early works (Usher, 1954, 1955) but also in more recent papers (Kamal, 2006; Baregheh, Rowley, and Sambrook, 2009). The full overview of innovation process models is shown by Kotsemir and Meissner (2013).

The most recent open innovation model emerged when Chesbrough (2003a, 2003b) postulated the open innovation paradigm, which highlights the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively. It assumes that firms can and should use external ideas as well as internal ideas and internal and external paths to market, as they look to advance their technology (Chesbrough, 2006). Innovations are no longer 'just' seen as a process, involving various functions. Rather, it is explained by the participation of a number of different entities, including suppliers, public R&D facilities and (business) external R&D facilities, as well as customers with varying degrees of intensity

Governing innovation under the open innovation paradigm

The management of innovation not only covers traditional methods and instruments of R&D management but strongly emphasizes output/result orientation, regardless of place of generation and origin of innovation. Innovation management hence is the effective and efficient generation of knowledge and competences required to meet customers' requirements and expectations with new or slightly modified solutions for known or unknown problems, challenges, needs and/or requirements. Solutions include products, processes and services, be they either in a commercial or noncommercial sense, as a way of contributing to societal welfare. Second innovation management includes functions to support the implementation of solutions to application in a wide sense be it production introduction, marketing, after-sales services, etc. Hence innovation management is the planning organization controlling and monitoring of innovation processes and the provision of framework conditions conducive to innovation, both internal to the organization and external.

Traditional innovation management puts a special emphasis on the R&D management process as the most important determinant of innovation. Although different sources of innovation such as competitors analysis customer orientation and, to some extent, external collaboration with suppliers, competitors and the public research base is integral to these models, the management of the interfaces to these sources and competences is not stressed. With the occurrence of open innovation, the management process thus is characterized by a strong alignment of institutional (e.g. usually company) internal innovation strategies with external partners and sources.

Figure 21.2 shows a simplified innovation management process highlighting the challenges arising from open innovation.

The basic principles of the innovation management process have not changed considerably over the last decades. R&D still plays the major, if not the utmost, role in the overall process. What has changed and continues to change is the role and meaning of different sources for innovation and the increasing importance of various exploitation paths. It follows that especially the management of interfaces – both company internal interfaces between different departments and functions and interfaces to external organizations – becomes crucial. Additionally shareholder expectations towards the company's overall performance and innovation pipeline especially continue to increase. From this it's obvious that the innovation process takes a more dynamic form involving multiple actors. Though R&D remains one crucial element of the overall process, other subprocess became more and more important and prominent.

Other major changes in companies' innovation activities are a shifting focus away from pure product/service innovation towards a more integrated business model innovation. That implies that innovation is more than the product or process in its narrow sense; rather, it's accompanied by services and modeled around a business itself. Thus, more attention is given to the overall lifetime of an innovation in the company's portfolio of technologies and innovation, and more freedom to managing these is given. As a result, alternative ways to do business with innovation are increasingly important and considered.

Despite the original function of intellectual property schemes as a tool for protecting inventions and markets, open IP practices are more and more the industry standard in the sense that

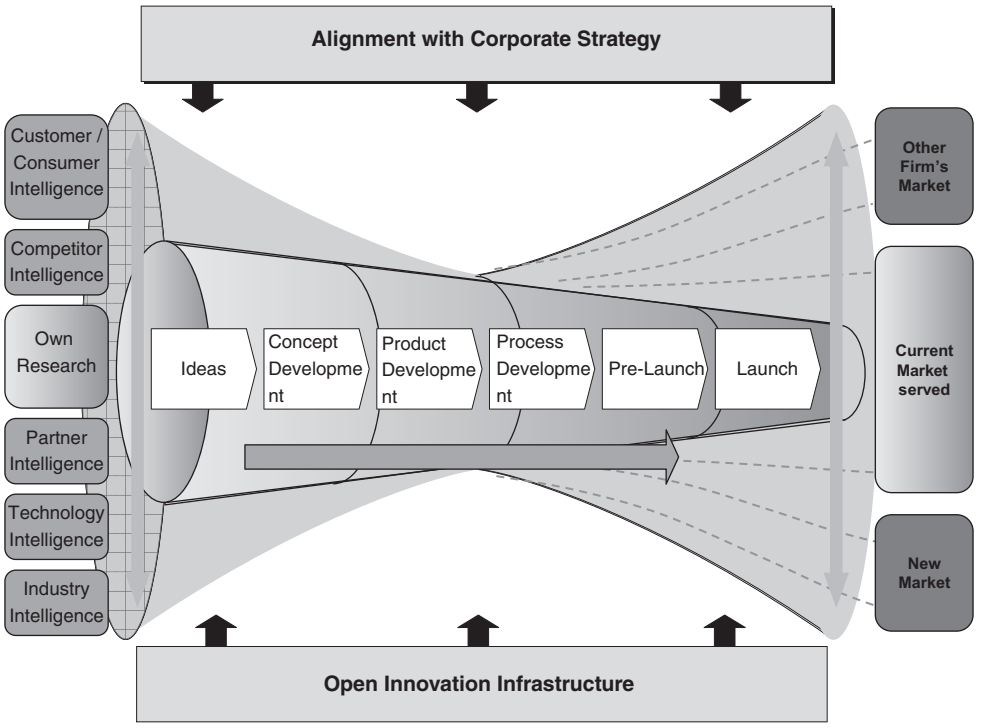

Figure 21.2 Company innovation management in the light of open innovation

open standards are becoming an issue not only in the software industry but in many other industries. Moreover complementary IP (e.g. trademarks, design utilities and trade secrets) are gaining importance in addition to patents and licenses, thus resulting in an increasing complexity of IP management. Also the contribution of the overall IP portfolio of companies is explicitly appreciated by financial investors; thus, more sophisticated valuation standards and methodologies for intangible assets are required/requested.

In line with new business development strategies, companies increasingly either establish new internal venture capital funds or expand their existing venture capital activities which aim at developing promising internal research streams towards market activities and/or are used as strategic investments into upcoming young enterprises which are suited to complement the current product portfolio of the companies. In this respect corporate foresight studies of all types are being applied for emerging technology and detecting business potential as well as increasingly strategic in-licensing. Such tasks are typically being dealt with by internal business development and licensing units and 'search and evaluation' units. In this light selected technology partners are provided with early technology information so they can benefit in their early product development cycles, and partnerships with nonsuppliers in collaborative research projects are searched for; hence, collaborative research is initiated in new fields of research but is still in the precompetitive phases. One major characteristic of such precompetitive R&D collaboration is the objects of cooperation – the majority of cooperation projects turn out to be focused on technology platforms or crosscutting technologies with multiple-application potential.

Eventually the attraction and keeping of talent is considered an ever more important issue for companies. Consequently, most companies are starting to enhance and intensify relationships with academic institutions, as well as designing human resources management and development programs to retain the key staff in their institutions.

Finally it can be concluded that the rise in open innovation still raises significant challenges to all actors. Thus far, the majority of companies are beginning to open their innovation processes towards many different partners and creating innovation networks. However, the big challenge of managing the interfaces between the different actors and sources remains unsolved.

The assumption that innovation equals more or less R&D leads to numerous concepts aiming at increasing the effectiveness and efficiency of R&D, thus generating more and better innovation and increasing shareholder value in the long term. Consequently, the long dominant focus on R&D activities has switched from an internally dominated orientation towards opening up screening and using external sources and capacities that are complementary and in some cases even a substitute for the existing internal competence base. Hence, leading innovators implemented different measures to meet the challenges of rising innovation process management complexity:

- **Strategic Alignment**: Missions of R&D are aligned with corporate strategy and business unit (BU) strategies. This alignment is done frequently – at least biannually. In this case, BU and corporate strategies are changing over time and are designed for continuous adjustment.
- **Inbound Increase:** Diverse access to the ideas of growth opportunities is secured by expanding the idea generation pool. Idea generation for innovation is no longer thought of as a company's internal challenge but includes a much broader range of external idea sources.

- **Effectiveness and Efficiency Increase:** Stock markets and shareholders expect effective and efficient innovation undertakings, which forces management to enhance the hit ratio based on business development capabilities and to streamline processes and interfaces.
- **Outbound Increase:** More attention is given to active commercialization of knowledge and technologies by screening and identifying cross-market opportunities and selling IP in different forms.
- **Open Innovation Infrastructure:** Opening the innovation activities challenges existing innovation monitoring and controlling, requiring new metrics and controlling tools but also an internal culture-related infrastructure that enables open innovation.

The mechanisms behind open innovation often follow similar structures. Measurement of the success and profitability of innovation is not focused on short-term immediate effects only but take a longer perspective. Hence, initiators are often employed in companies that leave enough flexibility to work on open innovation ideas (social science). These companies usually expect a return at a later stage. The rationale behind this is clearly a growing awareness of the meaning of and conditions for purely basic research activities, which by nature allow experiments and free thinking. Although it is widely accepted and expected that the public sector is in charge of financing such early-stage research in public research institutions and higher education institutions, the private sector actors (e.g. innovators) increasingly take the initiative to support these public institutions in many ways. Here companies developed a broad range of models encouraging links of internal innovation (R&D) departments with the pubic science base, including public-private partnerships and industrial PhD programs, among others.

Furthermore large companies often involve small companies in targeted product, process and service development, which allows companies to have a fresh look at their strategic intents, reducing their own risk and resources invested and receiving inspiration. Entrepreneurs increasingly build IP-protected add-on products based on the outcomes of open innovation–related cooperation. The results will further enlarge the spread of open innovation. That trend goes along with the changing behavior of large companies, which often provide a platform for commercial developments by themselves and others (e.g. industry-specific applications often provided by SMEs).

Open innovation remains a fashionable but still ill-defined term. Companies have been engaged in joint R&D efforts with external partners, such as customers, suppliers, universities and third-party companies, for several decades; thus, activities on open innovation have changed little in the last years; only collaborative research with customers has further increased, and in several cases 'triangular' partnerships are set in place with customers and universities. What is more important, however, is that usually few customers are selected for in-depth innovation relationships, and partnerships are built around areas of mutual interest. Often, companies would have not invested without the related customer request and commitment.

The company's focus is increasingly on businesses where technology is a differentiator and offers the opportunity to become a global market leader. Thus, R&D is mainly organized in decentralized structures built around these businesses and not around competencies. Overall technology management might follow a top-down or bottom-up strategy (strategy dimension), formal or informal management processes (process dimension), possess a dedicated infrastructure or networked approach (organization dimension) and dedicate funding significantly or limited from corporate funds (Figure 21.3).

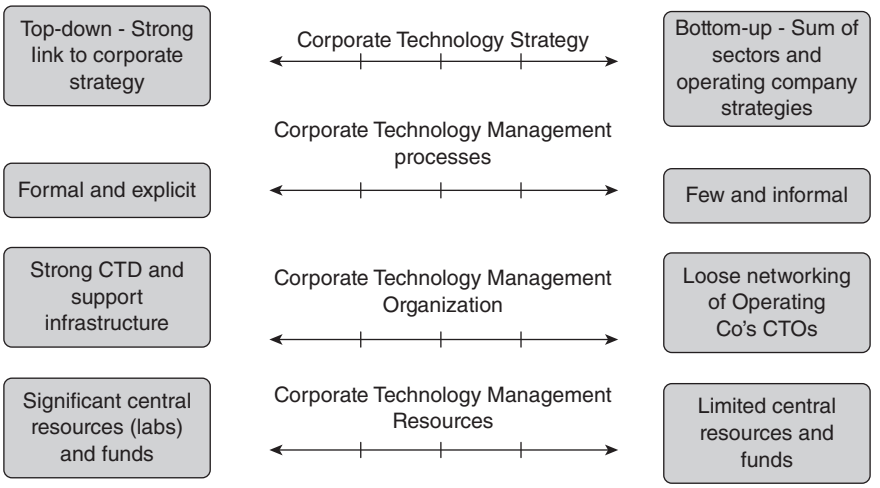

Figure 21.3 Characteristics of an innovation management organization

A significant proportion of the R&D budget is spent on growth (compared to expanding or defending the core) and on longer-term developments. In line with this development, several different paths of R&D can be observed:

1 **R&D with clear aim of business applications:** This part of R&D is in the first instance focused on internal resources with accompanying programs related to joint developments with customers and/or other external partners. Increasingly, the number of joint developments is considered one of the key performance indicators in R&D. Prior engagement into such joint development partners are assessed using standardized criteria in the selection process:

   - Clear common technical objectives and diversity of opinions.
   - Agreement on confidentiality and commercial targets. It is common for joint development partners to accept a limitation on exclusivity for up to few months in order to allow for higher investment on the leading partner side.
   - Visibility in the customer organization at all levels to ensure consistency in case of changes in key relationship people.
   - Common resources with budget and people. Quite often, the project manager is from the customer and the lead company will provide a dedicated front office engineer to ensure process moderation but also continuous collection of future customer needs.
   - Complementary skills to build critical mass and reputation of the partner.

   The overall objective is to create a 'virtual circle' of long-term relationship and joint development. The process to start such collaboration is like a 'Trojan horse'. Regardless of a company's experience in joint developments, it's important to create excitement for the customer (e.g. propose ideas for breakthrough innovations) in the starting phase. Moreover projects are often started with modest developments resulting in overdelivery and thus building long-term relationships with engineers.

2 **R&D with the ambition to generate substantial innovation (radical):** This type of R&D is mainly internally driven with limited external support. Such support refers to

cooperation with leading academics, if at all. Usually, two parallel approaches are used: In a bottom-up approach the ideation process is jointly run with clear business orientation in companies' divisions involving all business units and relevant corporate functions with one central coordinator. Top-down approaches stress blue sky thinking to define topics around a business vision. Dedicated teams screen outside competencies and seek creative solutions around product targets and process alternatives.

3 **R&D in incubators or similar institutions:** Incubators usually aim at building and strengthening network relations. Often incubators are accompanied by PhD or master studies programs, which are designed to attract human resources in the long run. The key success factor of incubators is the dedication of people to it. These people will ensure the implementation of research results stemming from incubator activities and ensure the existence of relations even when they leave R&D at a later stage. Results from the incubator are seldom directly measurable but help indirectly in longer-term innovation success.

In total the three types of R&D activities have different weights. R&D with a clear aim of business applications usually accounts for the largest share of the total (typically around 80 to 85 percent), while R&D with the ambition to generate substantial innovation (radical) accounts for 10 percent and incubators are the remaining 5 to 10 percent of the total R&D budget. Such changes in the split of R&D budgets require new organizational approaches. Increasingly pure R&D or technology councils are being replaced by councils with a wider reach, which are often called technology and innovation councils, innovation councils or innovation committees. The objectives of these councils are manifold:

- The definition of core technologies and coordination of activities across the divisions and corporate research and innovation centers
- The definition and review of external partnering strategies, including partnering strategies with academics and public research organizations, as well as other companies
- The systematic screening of surrounding technologies intellectual property rights and businesses
- Company-internal reward systems to build incentives for staff in different functions to contribute to innovation
- The design of an innovation culture in the company
- Proactive public relations work to build respective company images with customers, suppliers, the research community and society

With the increasing pace of innovation-driven competition, companies are constantly reinventing themselves and purposely enter and leave new areas in a life cycle 'wave' in order to always be able to differentiate. In particular high-tech companies focus their activities on businesses, offering value added by technology and knowledge advances and leave the market fields in case of commoditization. With such increasing pace of innovation, the speed of market introductions with widely linked technologies is only partially feasible for one company alone. Thus, companies try to use benefits of economies of scale in building up new markets, which requires multiple market players.

Important innovation activities outside of typical R&D activities focus on market trends, customer relationships (coordination) and safety regulations, but also globalization of internal R&D activities has become a major issue for most companies. While globalization was thought of as relevant for product and process development activities producing incremental innovation adapted to local and regional needs, the same holds true for more substantial research activities.

Thus, R&D facilities are opened around the world to not only serve local customers but also provide a sound technical and technological basis for global companies. Hence, such facilities are settled where the infrastructure and framework conditions meet the companies' requirements most.

This trend is accompanied by the increasing openness of companies to engage in cooperative relationships with the public research base, regardless their location in the world. The quality and availability of research done in public entities count obviously more than related transaction costs associated with the transfer of technology and knowledge. Also it became evident that companies expect and highly appreciate a cooperation culture in the public research entities.

Collaborations with customers, suppliers and academia to achieve innovation has been common in most industries for many years. Thus, open innovation is not considered a new topic in principle. However, some related activities like out-licensing and spinning off are considered more important for the future. Despite the rather widespread diffusion of open innovation, it is not the cooperation and involvement of customers in the innovation process; rather, the challenge lies between different company R&D sites. It has been recognized that knowledge sharing and knowledge management have become the main challenges associated with globalized and decentralized innovation activities, especially when different SBUs are involved and selected partners engaged at different development stages. Therefore, the open innovation model can globally generate inputs from the best sources and share these on a global level. Continuous developments are made to find new opportunities based on new partners, structures (e.g. corporate ventures) and processes (e.g. cross-value chain collaboration). Relevant networks and clusters will become more important to leverage open innovation activities in the future. However, the need for more activities in this field with suppliers, academics and other partners is recognized and actively pursued with different initiatives. The most difficult steps in moving towards open innovation will be the change in culture and identifying appropriate partners.

To engage into lasting relations with external innovation partners, companies increasingly focus on the following factors:

- human resources
- research and innovation excellence
- Innovation culture/awareness for innovation/openness towards risk

The *human resources* dimension involves the availability of qualified staff; related education/further education opportunities; and soft factors such as the ability of systemic thinking, partners' mind-sets and openness, as well as curiosity and empathy paired with dedicated project management and project work skills. In addition, problem identification and formulation capabilities are preconditions for collaborative efforts, and cultural openness is required.

Excellence in research and innovation refers to the reputation of partners, including quality of work and projects, credibility and matching competences. It requires research and innovation staff having dedicated networking capabilities across institutional borders together with systemic thinking and communication skills, as well as interdisciplinary thinking and cross-disciplinary research under broader umbrella topics.

Another important factor is *innovation culture, awareness for innovation* and *openness towards risk*. These include awareness for the application of research, fast responses/quick decisions, the willingness to go in new, unusual ways and openness to experiment. Furthermore, the attitudes of partners in light of acceptance of/openness towards external sources for research and innovation proposals and respective agendas is crucial to match.

Organization of IM

Different company units are involved in the innovation process to different extents. Figure 21.4 shows the different innovation (e.g. R&D) phases and how the meaning and role of innovation management vary between these stages. During the initial idea screening phase, which is characterized by high uncertainty of completion, innovation management takes a role as a process driver with entrepreneurial behavior. The closer the innovation project gets to prototyping and manufacturing, the less innovation management units are involved. Instead, business units take more active roles in driving the project towards fully taking over with respective profit/loss responsibilities.

'Corporate innovation' often finds it challenging to obtain recognition by companies' operational units because the value generated in these units is frequently longer term and more difficult to measure in the short term. Obviously, business units as a process driver will favor current product improvements to maintain the BU competitive position, which naturally requires a short-term view of BU performance. From this the question emerges which role IM can take and play in the overall company innovation activities. It appears that IM is often part of corporate activities and perceived as a service unit, like many others in the corporate world. In order to empower IM and generate more value and impact from IM it is essential to change the IM role from a pure service provider to an innovation driver (Figure 21.5).

Innovation drivers fulfill different functions in organizations. The innovation service unit is mainly involved in developing new solutions, either on its own initiative or on request by business units. These original duties and functions are extended by an active communication role, which preaches the importance of innovation and provides a communication and information platform inside the company, bringing the different units together by different means. Furthermore, long-term innovation strategic development and external partners relationship management are additional key duties. Eventually, active intellectual property management, in line with

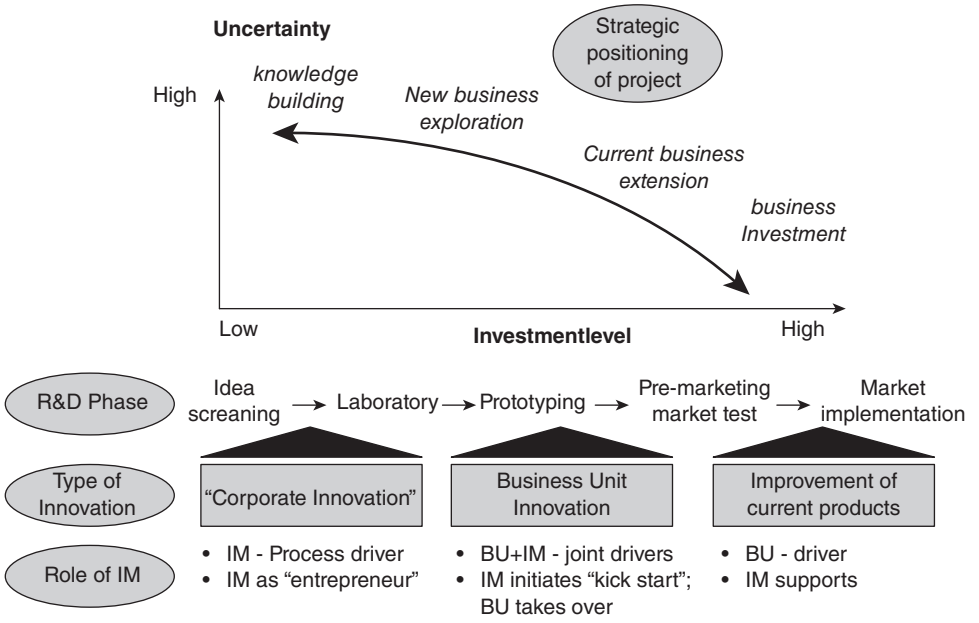

Figure 21.4 Innovation process stages and organizational meaning

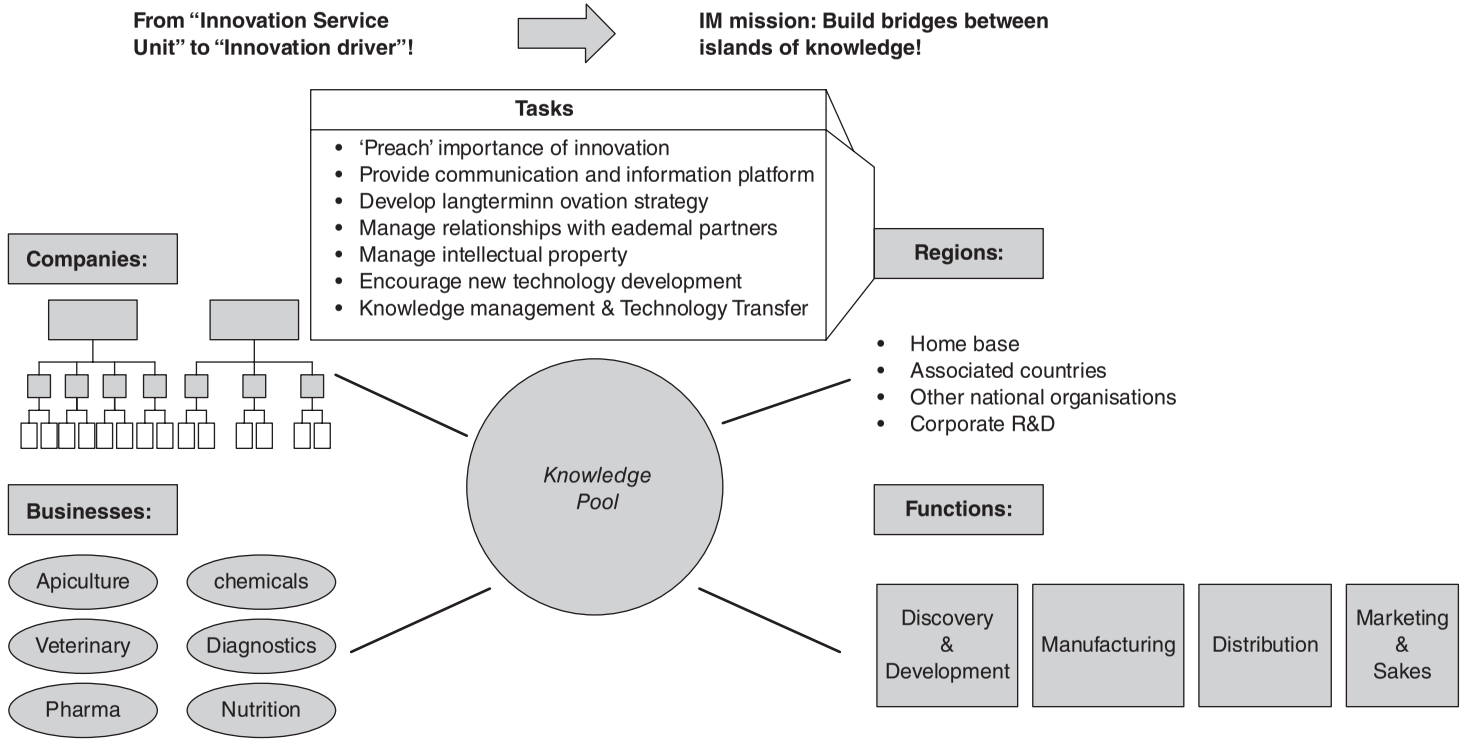

Figure 21.5 IM from a service to a driver role

the legal department and IP office, is also among the duties, in addition to encouraging new technology development and knowledge management, as well as technology transfer.

These duties can be structured along the lines or what and how. With respect to 'what' IM assesses:

- the innovation project portfolio fit with market and competitive conditions;
- portfolio contributions to supporting the corporate strategy;
- the commercial balance of the innovation project portfolio.

Furthermore IM has to enforce:

- the elimination of weak points in the project portfolio;
- the implementation of a seamless company innovation process;
- the coordination of innovation projects with existing resources.

These dimensions relate mainly to achieving the goals set in the company innovation strategy. The second dimension addresses the 'how', for example, always making sure the IM runs smoothly and seamlessly. This includes questions such as:

- Are clear priorities set?
- Is adequate competence available?
- Are the R&D projects handled cost-effectively?
- Are the R&D throughput times as short as possible?
- Are the decision-making processes reliable and fast?
- Are the non-R&D sectors adequately involved?

Innovation programs are managed by a program manager who has authority over members from different units. The program manager has the responsibility for defining the technical strategy of the program (road map of technological goals), the budget responsibility for the program and receives the money after presenting the budget to the corporate chief technology officer and any colleagues. The program manager allocates the money where the resources are, that is, to the laboratories that have a (some) particular area(s) of technical expertise related to the program. Typically the program manager belongs to one of the labs but has line authority over the members of the multinational program team. The program managers work alongside the directors of the laboratories, who have the primary responsibility for the people in their laboratories under a matrix structure.

Eventually, it must be determined if IM is centralized or decentralized. A centralized IM approach enables cross-fertilization of ideas, providing a multidisciplinary pool of resources, which can provide a more innovative environment. Also it enables the company to exploit a commonality of technologies, allows for closer linkage with corporate strategy, maintains a longer-term perspective and provides economies of scale. On the other hand, centralized IM features potentially poor linkage to end-market needs and the threat to engage in research that is interesting rather than useful. It might turn out that return on investment can be very low and linkages with operating units can be weak, resulting in product and process transfers that fail.

In the decentralized IM organization, technology activities are closely linked to the business aims and end markets, and the transfer of products and processes from technology to manufacture is eased. This allows greater accountability for success and failure; thus, this approach is sometimes preferred by shareholders for its business effectiveness. But skills and investments in

different competences and capabilities can be duplicated, and a short-term focus fails to safeguard the long-term future, and project continuity is threatened by close linkages to short-term budgetary pressures and putting out fires.

Emerging challenges for IM

Company IM typically has a holistic view of innovation projects, including projects with short-term commercialization potential, for example, one to two years, and the following generation, which can be commercialized in three to five years. The underlying challenge is to fine-tune the sequence of innovation for commercialization to the respective market and customers and design the adequate innovation pipeline across business units. From the corporate level there is hardly a 'one size fits all' solution for all business units under the corporate umbrella. A match in terms of the implementation of performance measures at the corporate and business unit level (e.g. innovation metrics and innovation balanced scorecards) need to account for the market-specific features strongly while also matching them with technology-induced features.

Increasingly companies are establishing IM units with close proximity to markets in a more networked shape by means of stepping back from strong corporate units. Strongly network-oriented IM organizations show that corporate units act more as coordinators between different local units, for example, innovation and technology strategy is orchestrated and implemented by the corporate unit. In this arrangement, the corporate unit is likely to act as a moderator and facilitator of competition between the localized IM units for specific IM projects. A rather new facilitation instrument is that corporate IM launches a call for competitions in technology development that are open to local IM units. Corporate IM takes a role of a coordinator, assuring the innovation project pipeline is in agreement with corporate strategy and budgets are used efficiently. Other positive effects from such an approach are the coordination of IM projects across units, the access to local talent (which is one main driver for establishing dedicated units) and the smaller size of each unit (which allows a more flexible reaction to technological and market changes). Furthermore, technology and market intelligence is strengthened through the local presences. However, this requires a more elaborated internal knowledge management system that takes also account of the competition between local units.

Another challenge comes with the broader and more complex nature of technologies, which are frequently composed of several other technologies, into one solution. The long-term observation of technological development thus is also a more complex undertaking for companies who need to dedicate respective budgets to technology intelligence. Data and information analysis (e.g. most big data approaches) are a means of responding to these challenges but require substantial initial investment. Beyond the actual detection of technological trends IM needs to take a more communicative role inside the organization to ensure timely and targeted diffusion of respective findings and related information.

This is all in line with the coordinated technical support for business units and the transfer of services and core technologies developed by R&D to business units. Furthermore, operation and maintenance (O&M) technologies are undergoing major changes in light of maintenance strategies that are more and more driven by data analysis–based strategic orientation (e.g. preventive maintenance). Here IM is asked to develop respective approaches and instruments for powerful O&M solutions.

Given IM's central position in the corporate organization, the unit is asked to take a more proactive advisory role towards business unit IM entities but also for business units' strategic development units and activities. In addition IM is responsible for developing technology

acquisition strategies to achieve business strategy goals, manage outsourced product/technology development and finally manage internal and external technical resources.

Revisiting innovation models towards the 'active innovation' paradigm

The most recent innovation models increasingly postulate external relationships of innovators in many different shapes, including the acquisition and incorporation of knowledge and technology from outside the organization. Such knowledge and technologies can be either publicly accessible or privately owned by other companies, individuals or research institutions. Furthermore, external knowledge and technologies are available either in a codified or personal published, undisclosed form. R&D service providers and public and private research institutions, and increasingly training institutions, contribute much to build, develop and diffuse existing, publicly available 'knowledge and technology pools'. These institutions also provide partners and/or service providers external innovation-related activities (especially R&D activities). Companies' internal R&D activities – as part of the innovation process – are available in the company's knowledge and existing technologies, which are not only a prerequisite for implementing in-house innovation activities but also for the use of external sources for innovation.

The most recent generation of innovation models isn't directly related to earlier ones. Examples of these models include the value chain evolution theory developed by Christensen and Raynor (2003), the strategic innovation process model proposed by Afuah (2002), the 'category-maturity life cycle model' Moore (2005) and the business strategy innovation model Hamel (2000)). Moore's and Hamel's approaches show the potential to incorporate innovation process model thinking. These models cannot really be treated as descendants of sixth-generation models. They draw on some features from the system and evolutionary models. However, they do not apply system or evolutionary models at a micro level, but rather develop third-generation models with new aspects such as network infrastructure or a greater emphasis on outsourcing added. The models discussed in this chapter share a common feature in that they all aim to explain the emergence of innovations from conceptual and process perspectives but don't take account of the side resource of innovation. While the current open innovation paradigm remains dominant in innovation model thinking, even this innovation understanding and model (and thus innovation processes) need to be extended by the human resource dimension and the meaning and impact of organizations' innovation milieus. A company's innovation milieu is strongly interrelated with human resources management and policies for attracting and retaining talent.

Frequently, attracting talent to companies for innovation is less problematic than keeping talent on board and motivating people to perform outstandingly. This is challenging because firms lack staff who have capabilities that are not only directly related to actual innovation activities (e.g. often related to R&D) but also capabilities in management and legal affairs. Firms need these additional competences in light of the increasingly external nature of innovation.

Furthermore, the economic pressure on companies leads to higher expectations by the corporate leadership for the innovation-related activities by all company units. The instruments used for monitoring and assessing innovation projects are improving considerably. Firms' needs for innovation-related competences and corporate management's higher expectations for innovation are very important determinants of current corporate activities, although both carry the risk that innovation is understood a self-fulfilling prophecy. In other words, once companies invest in innovative projects, the corporate leadership expects returns on investment in ever shorter periods to meet externally imposed expectations. Accordingly, it is important to

reconsider how innovation and human resource management are organized internally to prepare staff to respond to these challenges.

Equally important is the incorporation of public attitudes and the perception of innovation, which developed into a major driver for the acceptance of innovation by society. Therefore, technology intelligence needs to take a broader perspective, including societal attitudes and perceptions in assessing technologies and technology trend prediction.

Therefore, the current predominantly open innovation paradigm needs to be modified to incorporate a stronger emphasis on the human resources involved in innovation. There are signs that companies are already paying more attention to the human factor for innovation and public perception. Consequently, companies will strive for an 'active innovation' model that builds on the open innovation paradigm.

In this respect, IM governance should employ approaches that combine the open innovation concept with the human factor and public perception, or in other words, the 'company innovation ecosystem' and the 'product innovation ecosystem'. The 'product innovation ecosystem' is understood as a community of users of an innovation which are driven by their specific agendas, which are also embedded in society. Hence, in order to accelerate understanding of the relationship between 'company innovation ecosystems' and 'product innovation ecosystems', more efforts in research are required.

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