Integration of Technology Management and its Development

INTERLEVEL OVERLAP AND TECHNOLOGY IDENTIFICATION

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Introduction

In many companies, product development technology is usually a key instrument in the organization of manufacturing as well as administrative tasks (Walters and Millward, 2011). Integration of technology and business processes presents a strategic link for creating efficiencies in the development of highly complex products (Narasimhan et al., 2010). Integration of individual technological processes and their inputs and outputs, integration of technology and other business processes, or integration of market demands and technological capacities, etc., all these processes require building up a functional technology infrastructure/network. This technology infrastructure should be designed to run production as well as other business processes, including data centres that enable ICT to be used as a platform upon which business decisions are made (Gold et al., 2001). Purposeful technological infrastructure should be a functional part of an organizational structure, especially as regards to the distribution of technological competence, information and responsibilities among business departments.

An organizational absorptive capacity is critical for establishing an appropriate technology infrastructure.[1] If an organization considers its better learning culture as a prior step in the utilization of a new technology infrastructure, then the new technology can have a more positive impact on the conditions that stimulate business innovation (Cegarra Navarro et al., 2010). Usually, top management plays an important link in effective deployment of new technological know-how, but their impact is usually indirect and a function of the technology management (TM) absorptive capacity (Elbashir et al., 2011). Therefore, strategic and technology management should share their objectives, e.g., to help transforming the organization into a more effective, innovative and responsive form through the technology (Kamal, 2011). A creative teamwork environment, creation and absorption of technology-related know-how with a higher value added, continual learning, more complex innovation, and the creation of business and market-accepted technology should be central to integrated TM.

Integrating technology capacities with customers‘ needs, technology with business strategy, technology and other business processes, and technology elements and processes often requires *a three-step mechanism of TM*, namely *integration of technology identifi-*

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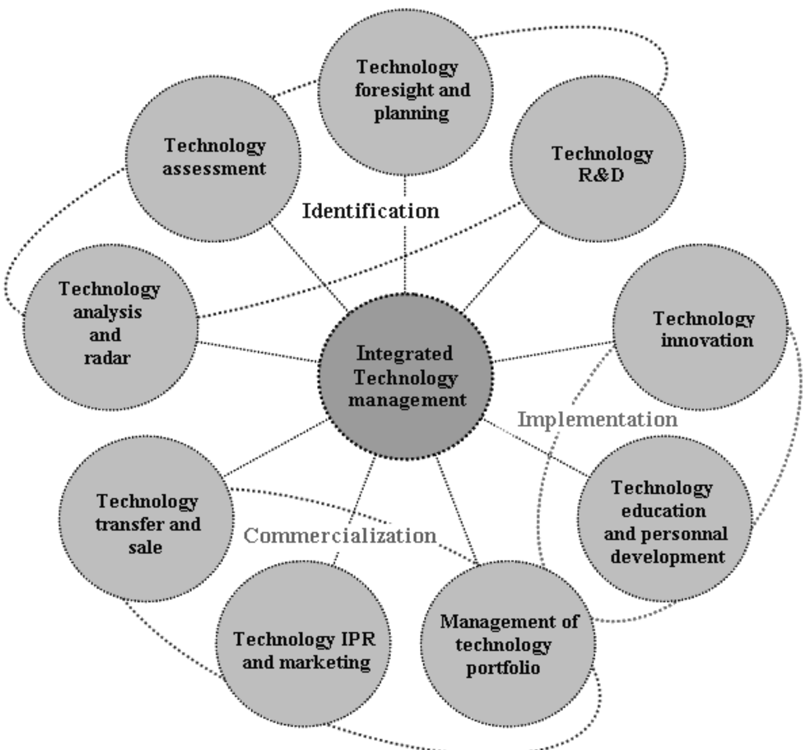
1 Business ability to obtain, absorb and take advantage of new external know-how and information.

cation, implementation and potential technology commercialization processes. All these processes should be properly connected and realized systemically (*Figure 1*). *Technology identification* requires adequate external and internal technology analyses, eventually the creation of Technology Radar (Veugelers et al., 2010); further technology assessment should provide a course for technology planning and for subsequent applied research and development (R&D). *Technology implementation* requires a technological change/ innovation, which calls for an adequate adaptation mechanism that should allow tracking new technology in a company, including technology development needs, change in organizational culture, and new personnel tasks (Kamath et al., 2011). The new object of business in many industries has become subsequent *technology commercialization* (TC). Technology commercialization is usually accompanied by the acquisition of adequate intellectual property (IP) rights that can be a driver of shareholders' values, but also an open-ended stopover for economic growth of the company. Therefore, it is important to appropriately plan also TC within a technology strategy and to adapt formal as well as informal integration mechanisms, because these are usually positively associated with successful TC. Informal integration mechanisms can also moderate required capability sources for TC (Zahra and Nielsen, 2002). *This study is mainly focused on identifying integrative aspects between strategic and technology management and within technology identification processes that are most important for the effectiveness of TM.*

Figure 1
Systemic processes of integrated technology management



Source: Own diagram.

1. Strategic and operative technology management integration aspects

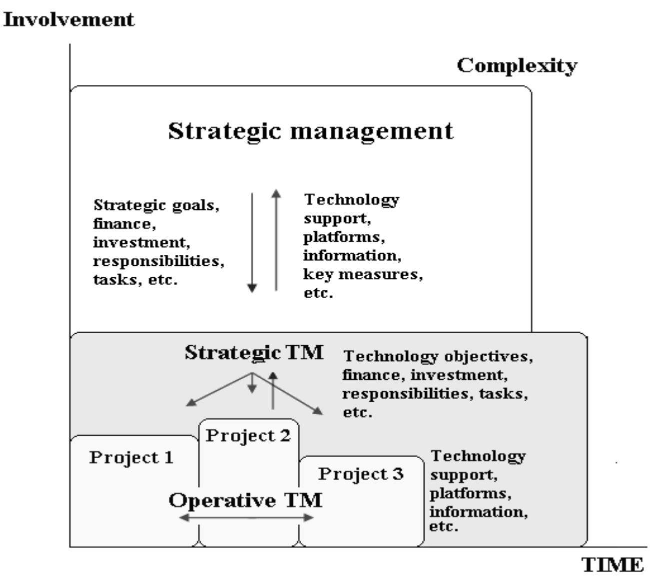
The first step in the TM integration is to identify and "impose" strategic technological issues in strategic management. The field of *strategic management* deals with major intended and emergent initiatives taken by managers or owners of a company involving the determination of a vision, mission, key long-term goals and plans, and the allocation of investment necessary for those goals and plans. *Technology management* is more operationalised management that includes effective identification, selection, acquisition, research, use and protection of technology (elements, processes and infrastructures) necessary to achieve and sustain market positions and business performance of an organization in conformity with its strategic objectives. Strategic management should provide TM with strategic technology goals, tasks, responsibilities, finance, investment, information and control. TM should provide strategic management with information, proposals for investment, technology infrastructure and support. *Each assessment of TM should consider its three vertical levels:*

Strategic management level − How technology should be implemented and managed in different areas of our business (in production, supply chain, marketing, management, administration, control, etc.)?

Strategic technology management level – What value-added, profit and competitive advantages does technology bring to a specific business unit?

Operative technology management level – How to optimize internal processes in order to manage technology and its components effectively? (*Figure 2*)

Figure 2
Integration of different levels of TM



Source: Own diagram.

Strategic technology management attempts to address technology-related priorities contained in the field of strategic management through technology goals, strategy and budgets and thus provides an overlap/integration within technology-related managerial activities. Technology goals, strategy and budgets thus serve as the basis for implementation of business strategy through the technology. Strategic technology management should create conditions to enhance and sustain a technology system and an infrastructure of an institution in order to improve its technological capacities and effectiveness. *The key questions of strategic technology management (STM) include the following:*

- Where do you want to be in the next 3-5 years and *what role will technology play* in your business growth?
- Which technology is to be used, and *how to acquire the right technology* (make or buy strategy)?
- Will you use technology to manage and support your strategic goals, and will *the technology be a key tool to support* your strategy?
- Which technological *competences and capabilities* are needed for a better competitive advantage of your organisation?
- Who will be *responsible for the technology*, and what measures will be used to assess the technology execution?
- What will be the investment level on technology development, *cost/benefit potential*, ROI, and risks of your technology investment?
- How to *introduce technology* to a market as embedded in products, services or networks?
- How to organize *technology management processes*?
- Etc.

For example, IBM, Microsoft, Oracle, HP, Cisco, Corning and many other companies offering strategic technology solutions, develop and adopt perspective technology and go looking out for applications of that technology by offering a targeted array of products and services, but serving a broad spectrum of customers and market segments. *IBM* has changed its strategic technology orientation by focusing more on supply chain consulting and IT services. It has shifted about $1 billion from hard technology R&D to soft technology consulting services. The consulting services now make up nearly 56% of the IBM's revenues. For this purpose, the company has formed so-called On Demand Innovation Services that have employed about 200 scientists and analysts. IBM also provides technology strategy consulting services that help different organizations create better technological values and achieve competitive advantages through the optimized alignment of technology and business strategy (IBM, 2011).

Operative technology management should enable the transfer of strategic technology decisions into concrete projects and actions through technology execution and control. For these purposes, operational TM utilizes technology-related activities, tools and measures. The ratio of operational tasks is higher here than in strategic technology management. The tasks are usually divided into several subtasks. These tasks are more specific, short-term in nature, and their implementation can usually be directly expressed and quantitatively measured. Nevertheless, the qualitative measures such as *utility, functionality, or applicability* have recently been increasing in importance in TM as well. The detailed specification and direct implementation of a technology strategy is the task for operative technology management. It is necessary to ensure basic conditions conducive to an established level of efficiency. All strategic decisions should be transferred to concrete measures and daily operations. It is advisable to integrate technology management processes on all levels and to align them with existing business processes, resources and structures (Spath et al., 2009). *The key questions of operative technology management include the following:*

- How do we utilize our technology and support business processes?
- How do we transfer our technology know-how and information?
- Is our technology controlling in line with strategic objectives?
- What is the value added of various technological applications?
- Etc.

Technology artefacts such as technology classification, portfolio structure, or technology infrastructure are the usual outcomes of strategic technology management. All the technology elements of a technology system should be included in the technology infrastructure of a company. The creation and exploitation of these artefacts requires appropriate methods, tools and ICT solutions for data mining and knowledge management. Methods for collection and analysis of information are also needed for operational technological activities, and planning methods are needed for organizational tasks. Engineering methods and tools are needed for research, selection, creation and development of new technology applications (Sahlman and Haapasalo, 2009). Data centres and a knowledge management system create an ICT backbone of technology infrastructure so as to effectively use, store and manage technological assets of a company.

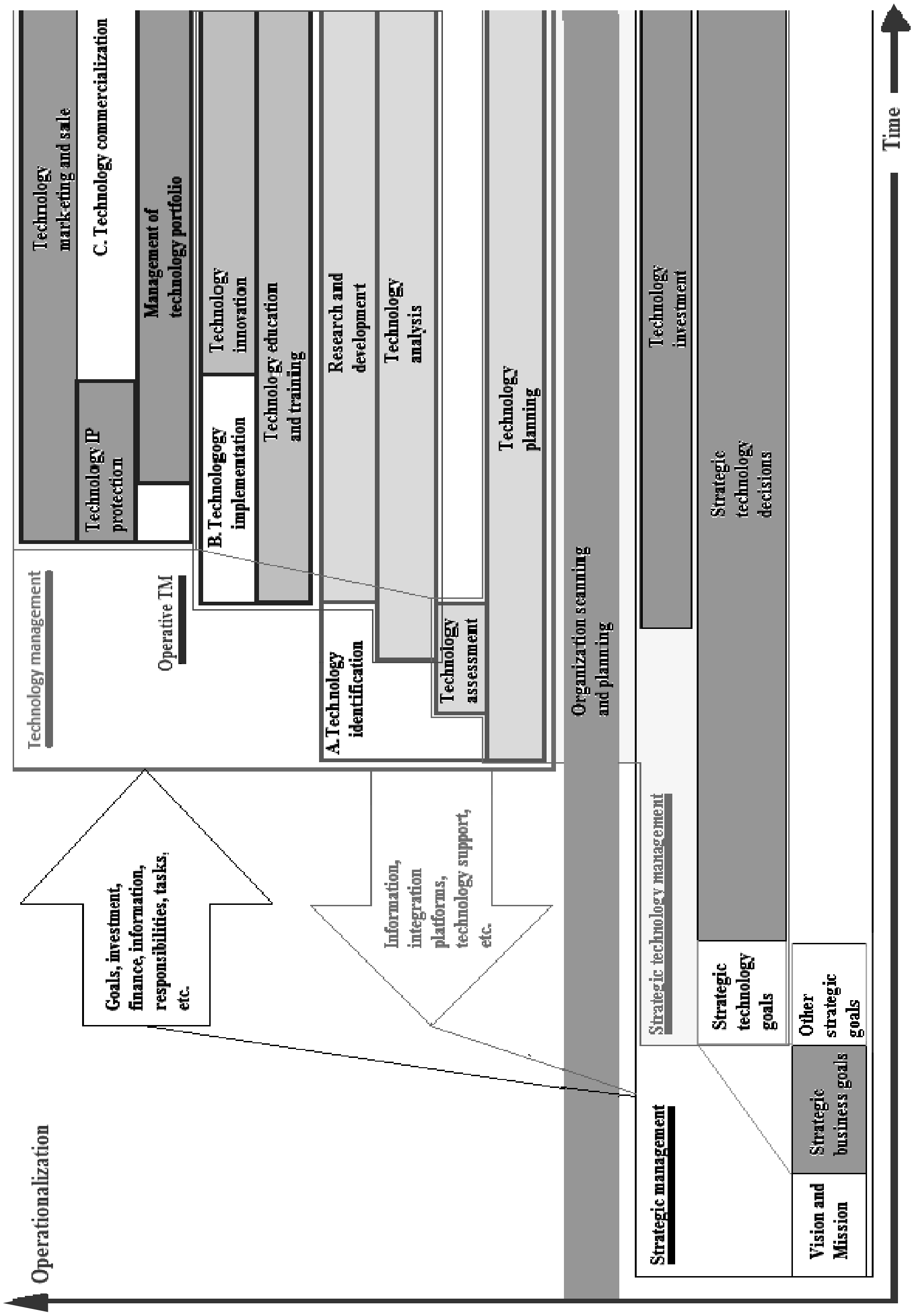
Nevertheless, the *organization of TM* and the form of decentralization and centralization depend on many interrelated factors such as technology, production processes, degree of ICT applications, management style, company size, business organization, strategy, traditions, etc. TM is often an implicit interlevel process, which is performed in various parts of an institution, for example, as a part of strategic management and planning, R&D management, production management, supply management, quality management and control. Many companies do not have any formalized processes and responsibilities for TM. Existing formal technology-related processes are typically only identified for preproduction processes. Decisions on technology are usually made based on general business principles, strategy and guidelines. Technology planning is usually only part of strategic or production management. Thus, the technology system and its capacities are not properly integrated and utilized. The process of TM should start by defining technology goals and roles in strategic management. This definition requires some previous analysis and forms the basis for technology investment and strategic settings. A technology strategy should be the main document for technology applications in an institution. A technology deployment plan, roadmap and internal technological guidelines should be normative for technology-oriented companies. A map of technological processes may facilitate this integration, as can technological forecasting, planning, and implementation in line with the technology strategy (*Figure 3*).

2. Integration within technology identification processes

Strategic technology management creates high-level conditions for individual TM activities. However, creating these conditions requires systematic business and technology-oriented analyses. *Technology analysis* and *technology radar* are TM activities which enable a company to constantly monitor determinants and conditions of technology applications, both inside and outside the company, and then to innovate technological processes or to update its technological system as a whole. Technology analysis should indicate possible technology solutions to find the best fit as overall replacement or replacement for a specific application (Legg, 2005). To some extent, technology analysis is also a macro discipline, because of a general need for wider cooperation of analysts with the environment for more comprehensive results. This integration calls for the creation of a sound business and technology reputation through the links of effective marketing and PR activities.

The instruments and techniques of *technology analysis* encompass aspects such as: exploring and a common attitude to the description of various technological processes and elements, creating their purposeful taxonomies, tracking and classification of technology trends, limits and risks as well as social and technical preferences in the environment. Technology analysis as a systematic process can apply textual or other analytical instruments (i.e., technology watch, tech mining, cost-benefit analysis, etc.) to detect trends in the technological environment (Yoon et al., 2010; Porter, 2010). It is appropriate to purposefully link analytical and exploratory methods, non-expert and expert studies, and individual or participatory technology analyses for more comprehensive results.

Figure 3
Possible strategic and operative TM overlap



Source: Own diagram.

Future-oriented technology analysis (FTA) should be complementary to a conventional technology analysis as an agenda-setting process focused more to support business anticipatory intelligence.[2] FTA processes should start collective learning and vision building, which can link varying factors and subjects governing innovation trajectories. FTA usually links technology foresight, technology forecasting and assessment (Cagnin et al., 2008). It is also important to adequately establish decision criteria consistent with the business and technology strategy. This enables TM to better select and combine appropriate technological elements for further R&D, new applications, or for the creation of more complex technological goals and links within the technology system and for the determination of specific technology programs (Van Wyk, 2007).

The well-known example of a systemic well-integrated technology analysis is in the *Deutsche Telekom Laboratories,* which initially introduced a specific instrument to strengthen the technology intelligence capacities called *technology radar* (TR). This technology radar can give TM a comprehensive overview of observed technological developments and their perceived trends and relevance (Thom and Rohrbeck, 2009). *The main task and links of TR in Deutsche Telekom* are early recognition of new technology, technology trends and risks in the environment to:

- *raise awareness and resistance* to new business threats and opportunities related to the technological progress;
- *stimulate* technological and product innovation;
- *facilitate* acquisitions of external technology;
- *reduce duplications and inefficiencies* in R&D;
- *effectively integrate new technology* in a business technological portfolio, etc. (Rohrbeck et al., 2006).

The technology radar should consist of these expert processes: identification of resource efficiency potentials and technology requirements, identification of technology trends, expert interviews and trend assessment, and establishing measures for further technology implementation (Lang-Koetz et al., 2010).[3] To better visualize the stages of technological R&D and implementation, a systemically updated *radar chart* can be used, which can classify potential technology, e.g., by application fields, application status, and importance to the company. Thus, the TR is used primarily to support and link technology planning and budget allocation for selected technology products. It also helps define future research and business trends and provide valuable information to develop new products and services (Rohrbeck et al., 2006). This chart enables

2 *Future-oriented technology analysis* is a set of processes dealing with the long-term dynamics of technology in society (Cagnin et al., 2008).

3 *Technology radar* processes usually operate on the basis of an established international network of scouts/experts, who provide TM with information about possible technological development fields and trends in various areas of business importance. Then, these trends are evaluated by experts within the company.

defining the link between fundamental and applied research within the development of production and market concepts. In terms of product integration, the chart allows the company to connect its individual business programs (*Figure 4*).

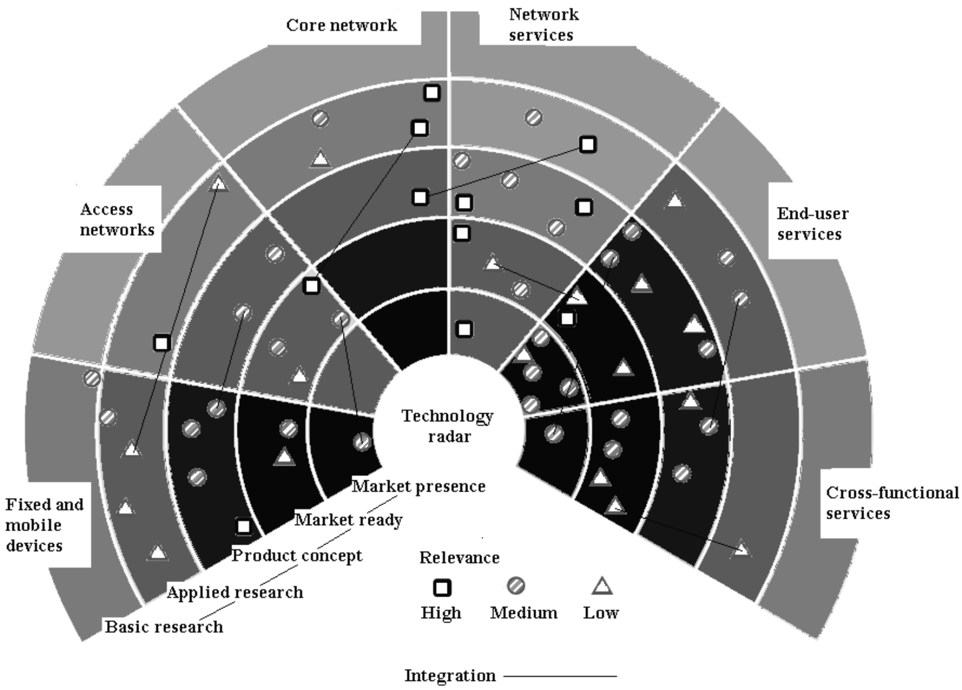
Technology assessment (TA) as the second part of the technology identification phase, should be linked to systematic technological analyses and monitoring.[4] TA is rarely only an intra-institutional process because of the need to link processes of technological innovation with wider professional public requirements, such as industry associations' needs, chamber of commerce and patent office rules, etc.[5] TA enables to *shape technology* innovation, through obtaining public funding, successful diffusion, or regulatory issues (Fleischer and Grunwald, 2008). For the quality of TA, it is important to integrate the *passive content of TA*, that is to say, the assessment of past and present technology characteristics/processes/impacts, and the *active content of TA*, i.e. the assessment of future technology impacts, their expected determinants and risks. *The main links of TA to business processes should include*:

- estimating *sales possibilities* of products/services/technology and economic results of technological applications;
- balancing *technology capacities and socio-environmental options* and limits, etc.;
- identification of direct and indirect mostly *medium-term technology impacts* on the company and its environment;
- minimizing *unsuitable investment, cost and activities* related to the technology development; and
- identification of *wider alternatives* to the technology development.

4 *Technology assessment* can be considered as a specific kind of interdisciplinary technological research, as well as the support for more comprehensive R&D and technology strategies.

5 This trend has been going on since the 1970s, in relation to the first *Office for Technology Assessment at the US Congress*. At that time, TA was mostly concerned with potential negative or unsolicited environmental, social and economic outcomes of technological development (Leyten and Smits, 1996).

Figure 4
Integration within technology radar (Deutsche Telekom)



Source: Deutsche Telekom, 2011.

For example, as a part of the *Intel's* proactive attitude to *PC fleet management*, the company assessed its technology strategy of using mobile business PCs to see if thinner solutions could offer better advantages. The company compiled the complex inventory of computer models and devices to evaluate its technology platforms. Intel also evaluated employees' needs and business requirements for both the IT organization and the enterprise as a whole (*Table 1*). Intel especially considered future computing needs in the areas of information security, business continuity, manageability, and service desk support. The Intel's main strategic goals include cost control, business growth, and collaboration. This TA enabled to integrate market requirements with the technology strategy and employees' needs, technology programs related to specific computer models and devices, and the company's overall technology capacities and strategic objectives.

Technological foresight and planning should be an essential part of TM as well, including SMEs that can participate in trade, regional or national foresight processes. Technology foresight should build upon a systemic technological analysis and assessment processes that may provide necessary information about technological progress inside and outside the company, and its impacts on long-term prognoses and planning (Jemala and Svatý, 2010). This enables companies to integrate technology goals with requirements of industries, regions or economies, and to transform them into joint technological R&D plans and projects. Foresight processes should connect past business dependencies with actual and expected technological needs and serve not only to improve strategic decision-making about technology, but also about other business processes. These processes should enable exploration of future opportunities, trends and risks in a systematic and systemic manner in order to establish priorities for technology plans and investment.

Table 1

Integrated computing requirements as result of Intel's TA on mobile business PCs

Integration categories	Specific technology needs
A. Mobility and flexibility links	• Increased flexibility so that the employees can choose where and how to work, ability to take technology with them and to telecommute sometimes 100% of time. • Greater choice of SW applications, including employees' personally owned applications.
B. Productivity links	• Ability for users to create content, store work in progress, manipulate data, analyze, and innovate.
C. Robust feature set and high performance links	• Support for computer and network-intensive tasks: - Graphics and multimedia, including high-definition video and a full graphics processing unit. - Animation and real-time collaboration, 3-D virtual worlds.
D. Flexible computer model links	• Cloud computing and software as a service (SaaS). • Better Internet applications. • Remote execution.
E. Information security and business continuity links	• Ability to encrypt hard drives so that data is protected in case of lost or stolen equipment. • Support for remote management, including monitoring and repair.
F. Innovation links	• Ability to develop and adopt new usage models.

Source: Intel, 2010.

This broad participatory long-term planning requires systematic forecasts which make it possible to recognize early signals/indicators for a change in the internal and external environment (weak signals). It can help develop multi-organizational and multifunctional connections, based on new technological stakeholders' participation (sociologists, ecologists, healthcare experts, media, etc.), as well as allow TM visualizing future trends, opportunities and risks, e.g., in the technology field (Svatý and Jemala, 2009). However, there is still a surfeit of information that has outlined the various organizational and technical challenges posed by new *technology integration solutions* (TIS), and only a few studies have examined the real role of stakeholders when implementing TIS (Kamal et al., 2011). In addition, there is still a lack of links of foresight results to particular R&D and technology strategies (Battistella and Toni, 2011). Therefore, clear guidelines for future R&D actions and participation, identified trends and risks for more realistic policies, strategies, technology plans and programmes on a business, regional, or national level should be the main links of foresight.

For example, *The BMW Regional foresight exercise in Ireland* (2005–2025) linked national, regional and local agencies, regional and local authorities, third-level institutions (e.g., providers of physical and social infrastructure), and business representatives to shape the development of the BMW Region[6] over the next 20 years. The main intention was to develop an integrated strategic vision and associated investment priorities for the BMW Region. In doing so, the foresight helped to identify several key integrating priorities to foster the growth of the region in the medium and long term, such as:

- development of the *road infrastructure* network;
- provision of universal *broadband access*;
- investment in *international access* to the region;
- development of *clusters* of excellence;
- investment in *childcare infrastructure* and services;
- raising *R&D capacities* of regional institutes and laboratories, etc. (BMW, 2005).

Processes of technology identification can be completed and integrated through effective research and development. *Technological R&D* plays an important role in creating a longer-term strategic competitive advantage for enterprises, industries and regions. Research and development are subjects to different location drivers. Therefore, technological R&D should be linked to technology foresight and strategy, taking into account local conditions, marketing forecasts and plans. Currently, organizations often create various forms of international cooperative R&D, from acquisitions of foreign R&D through technology transfers, logging into a cluster to creation of strategic research alliances in various fields. Many times, the most of technological R&D is performed by technology providers and suppliers (Schmidt et al., 2011). Frequently, there is a need for open technology innovation strategies which presuppose higher demands on TM to establish effective and safe cooperation agreements and platforms.

The appearance of global R&D networks and the public support to international R&D projects bring TM new possibilities and risks. The main advantage is in utilization of experience and capacities of a number of grouped foreign entities, including educational, insurance and investment institutions. The principal difficulties are usually in the physical distance among remote R&D units as well as between R&D units and business headquarters. Distance impacts transaction cost, management, and communication in terms of frequency and quality, and causes so-called agent-related problems. Problems of organization and control of such international R&D projects do not

6 The *BMW Region* covers a large and diverse area of Ireland. It comprises 6 border counties of Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth; 3 western counties of Galway, Mayo and Roscommon and 4 midland counties of Laois, Offaly, Longford and Westmeath. The Region accounts for some 47% of the land area of Ireland, 26.5% of the population and contributes some 19% of the country‘s GDP (BMW, 2005).

always allow exploitation of potential synergistic effects. On the other hand, solely local specialization of technology-related R&D projects can lead to the occurrence of the not-invented-here syndrome and to the breakdown of follow-up R&D functions (Zedtwitz and Gassmann, 2002). Thus, management of technological R&D requires more complex solutions, effective diversification and distribution of business resources and capacities, and improvement of project-based communication channels, taking into account benefits to the local environment and global innovation networks.

If we look at the *development of the technology identification processes* through bibliometrical statistics, it is clear that *technology assessment* is the most significant process, followed by *technological development and research,* even in terms of their growth dynamics. From the time perspective, the most developed processes have been technology assessment, and research and planning since about the 1970s. The least developed processes are technological analysis and foresight, even over time. The reasons may be in the wrong naming and interchangeable use of these processes (also by practitioners), which should practically be follow-up processes within a systemic technology identification phase. In terms of the development of particular integration aspects within technology identification, *technological assessment and development* registered the most hits. From the time perspective, the initial integration aspects can be seen in the processes of *technological assessment in the 1960s*[7]*,* and in the processes of technological planning in the 1970s[8], i.e., in the time of the first working laser demonstration or PC applications connected with the floppy disk or the microprocessor inventions (*Table 2, Chart 1*)**.**

7 One of the first articles dealing with the integration aspects in technology assessment processes, named "*Don't Hamstring the Talented*", was published in *Saturday Evening Post* in *1960.* The author presented a view of and insight into the technological advancements and increasing predominance of the Soviet Union over the US in various fields, strategies and initiatives that were undertaken by the US to overcome Soviet technological advantages, and the role of the state and administration of creative development in technological advancement (Rickover, 1960).

8 The initial integration aspects in technology planning processes can be found in the article named "*New approaches to technological forecasting – Morphological analysis: An integrative approach*", which was published in *Business Horizons* in *1970.* The author described morphological analysis as an integrative approach that supported the assessment of all possibilities for better technology forecasting. The technique was demonstrated by developing a function-technology matrix for colour television set circuitry. The results included a forecast and scenario for the 1980s (O'Neal, 1970).

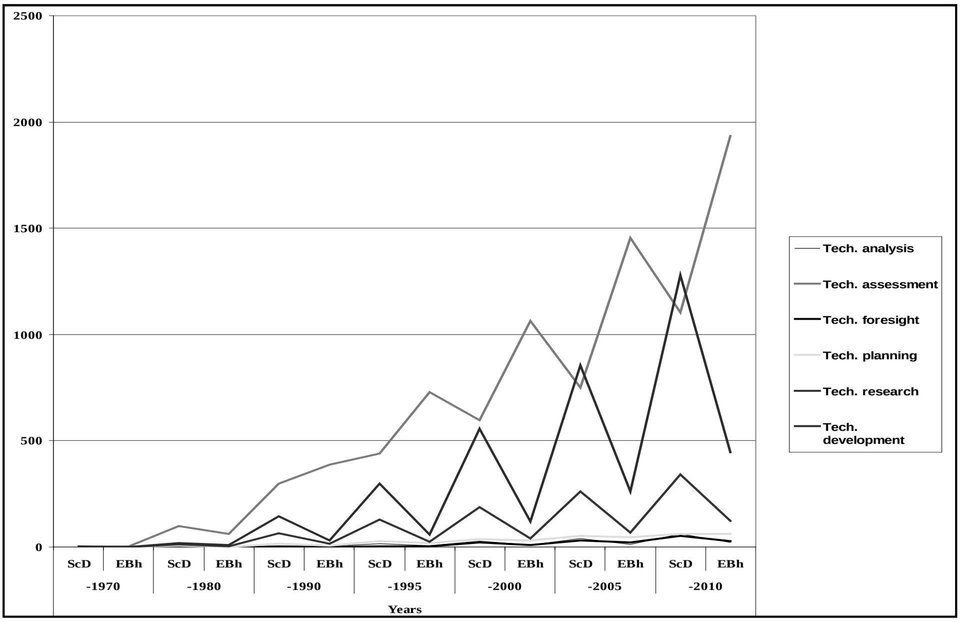
Table 2
Development of technology identification integration processes – Cumulative number of professional articles[9]

	Years															
	-1960		-1970		-1980		-1990		-1995		-2000		-2005		-2010	
	ScD	EBh	ScD	EBh	ScD	EBh	ScD	EBh	ScD	EBh	ScD	EBh	ScD	EBh	ScD	EBh
TECH. ANALYSIS	**–**	**–**	**–**	**–**	**1**	**1**	**7**	**2**	**14**	**6**	**27**	**9**	**39**	**13**	**60**	**20**
Tech. analysis + integration	–	–	–	–	–	–	1	–	3	–	8	–	17	–	29	2
Tech. analysis + strategy	–	–	–	–	–	–	1	–	2	1	8	1	16	1	27	2
TECH. ASSESSMENT	**–**	**1**	**1**	**2**	**99**	**60**	**297**	**386**	**440**	**730**	**597**	**1064**	**749**	**1453**	**1105**	**1934**
Tech. assessment + integration	–	–	–	2	23	3	52	4	82	5	112	20	158	48	227	90
Tech. assessment + strategy	–	1	1	2	31	16	124	86	191	160	261	256	355	501	546	913
TECH. FORESIGHT	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**4**	**4**	**20**	**10**	**30**	**21**	**51**	**27**
TF + integration	–	–	–	–	–	–	–	–	2	–	9	–	15	–	27	–
TF + strategy	–	–	–	–	–	–	–	–	2	5	14	6	23	8	41	15
TECH. PLANNING	**–**	**–**	**1**	**–**	**5**	**1**	**16**	**7**	**29**	**18**	**37**	**31**	**51**	**46**	**63**	**62**
Tech. planning + integration	–	–	1	–	3	–	8	–	13	–	17	1	25	2	34	4
Tech. strategy + integration	–	–	–	–	–	–	17	–	40	–	68	–	96	–	120	–
TECH. RESEARCH	**–**	**–**	**2**	**1**	**12**	**3**	**65**	**14**	**129**	**24**	**189**	**40**	**260**	**69**	**340**	**123**
Tech. research + integration	–	–	–	–	–	–	12	1	30	1	38	1	68	2	104	2
Tech. research + strategy	–	–	–	–	–	–	10	–	25	–	37	–	72	3	114	3
TECH. DEVELOPMENT	**–**	**–**	**–**	**–**	**18**	**8**	**146**	**31**	**297**	**59**	**557**	**120**	**856**	**262**	**1280**	**446**
Tech. development + integration	–	–	–	–	5	–	50	1	111	2	208	4	336	5	492	7
Tech. development + strategy	–	–	–	–	4	–	9	4	20	7	46	13	80	26	128	37

Source: Sciencedirect, 2011; EBSCOhost, 2011.

9 *Table 2 and Chart 1* were compiled based on the bibliometrical statistics. The listed numbers refer to the number of professional articles published in titles, abstracts, and key words of refereed journals and books registered in the Sciencedirect database (ScD) and in scholarly (peer reviewed) journals of the EBSCOhost database (Ebh).

Chart 1
Development of technology identification processes – Cumulative number of expert articles



Source: Sciencedirect, 2011; EBSCOhost, 2011.

Conclusions

TM is often an implicit interlevel process that is performed in various parts of an institution, as a part of strategic management and planning, R&D management, production management, supply management, quality management, or control. Many companies do not have any formalized processes and responsibilities for TM. Existing formal technology-related processes are typically only identified for preproduction processes. Decisions on technology are usually made based on general business principles, strategy and guidelines. Technology planning is usually only a part of strategic or production management. Thus, technology systems and their capacities may not be properly integrated and utilized.

Integration of technology identification, implementation and potential technology commercialization processes should be an essential part of TM. These processes must be carried out systematically and, if possible, in parallel. Usually, top management plays an important role in effective deployment of new technological know-how, but its impact is usually indirect and a function of the TM absorptive capacity. Therefore, strategic and technology management should share their objectives, e.g., to help transforming the organization into a more effective, innovative, and responsive form through the technology.

Technology identification usually requires adequate external and internal analysis; or the creation of technology radar, subsequent broader technology assessment, foresight/planning and R&D. If we look at the development of technological identification processes through the bibliometrical statistics, it is clear that *technology assessment* is the most significant process, followed by technological development and research. Technology assessment is also the most developed process of TM according to this study. A large part of all technology assessment processes are focused on medical technologies. These are highly monitored by the public, which partly explains the increased number of professional publications in the field.

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Integration of Technology Management and its Development:

INTERLEVEL OVERLAP AND TECHNOLOGY IDENTIFICATION

Abstract: Innovation processes have become more open and complex. Large corporations and vertically integrated R&D labs are giving way to distributed networks of innovation which connect different companies and organizations into innovation ecosystems. Business and technology strategies of smaller companies and public policy should follow this trend and reconsider the roles of technology, human capital, competition policy, intellectual property, and public data in promoting the environment for open innovation. Integrating technology and business trends, technology and business strategy, technology capacities with customers‘ needs, technology and business processes; this requires *a three-step mechanism of technology management* (TM), namely *integration of technology identification, implementation and potential technology commercialization processes*. TM requires the creation of a functional technology network and good communication channels between strategic and technology managers, technologists and workers, and between a company and its stakeholders. This partly methodological and partly analytical study focuses on identifying the links within TM, especially in a technology identification phase and between TM and other business processes that could ensure maximum synergies and benefits for a company. Its added value also lies in the bibliometrical statistics of the ScienceDirect and EBSCOhost databases (1960 – 2010) for the identification of trends in TM.

Keywords: Integrated technology management, strategic technology management, technology synergies, technology identification

JEL Classification: M11, O31, O32