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Integration of Technology Management and Selected Specifics of Best Technology-Integrated Companies

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Technological know-how is a very significant determinant of success that can primarily depend on a systemic, integrated approach to Technology management (TM), on a well-defined and implemented technology strategy, but also on adequate overall socio-environmental characteristics of the technological system. The main tasks of integrated TM are to ensure systematic monitoring, analysis, planning, organizing, controlling, assessment, and effective use of the technological system to more effectively integrate it into a functional entity and to support also other related business goals and processes. This article deals with the specification of key parts of the TM integration with the particular emphasis on the selected specifics of the best technology-integrated companies in the world.

Keywords: integrated technology management, integrated technology system, technology-integrated companies, efficiency

1 Introduction

Since the *1980s*, Technology management (TM) has become a part of managerial strategies and processes in many institutions (companies, research and financial organizations, government institutions, etc.) (Pelc, 2002). Later, the processes of more *radical technology innovation* stimulation caused the increasing importance of the TM development (Leifer, 2000) that meant better business opportunities in the long time, but required also more systematic managerial efforts. Another important determinant in the TM history has become the so-called *trade-offs* between making quick profits, through the technology imitation or transfer, and on the other side more intensive investment in technological R&D in a long period. Later, *efficient technology investment* became the foundation for the success of many companies and projects. Increasingly, there have been more successful many *technologically specialized companies* (IBM, Microsoft, Dell, Apple, later Intel, Cisco, Corning, Google, etc.) that have integrated their R&D with changing and emerging needs of customers. These technology oriented companies have been more and more using *venture capital*, and applying new *cooperative business models* (holdings, alliances, clusters, etc.) in order to maintain and improve their market positions. Since the *1990s*, approximately 25 of the most innovative companies in the world have had in about 3% higher the average profit margin than the first 1200 companies ranked by Standard&Poor's (Larson, 2007). For these reasons, many companies have started to develop a new business, i.e. *sale/lease of technology*. At the same time, there was a boom of *start-up science invention and intellectual ventures*, i.e. companies that were primarily focused on R&D of new technologies. In the last two decades, the expansion of *intelligent ICT* in many areas has caused increasing requirements also for TM. Classification, simulation and modeling of technological processes from development of a technological concept, zero series, and beta-testing to commercial production increasingly reduce innovation time, but also production and operating cost (Larson, 2007). So-called traditional in-door TM is being completed by cooperative TM within *open-innovation networks*, and *Living labs*. The important factors of business success have become the management of different stakeholders and capacities, or taking advantage of the higher openness of technology strategies. Thus, the development of integrated TM can be characterized by a gradual process of dissemination, updating, and an integrated use of new technology and related know-how.

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2 Integration of technology elements, processes, levels, and capacities

In accordance with the definition of the *European Institute of Technology and Innovation Management* (EITIM), we can define the processes of technology management (TM) as: *effective identification, selection, acquisition, research, use and protection of technologies (elements, processes and infrastructure) required to achieve and sustain market positions and business performance in conformity with business objectives* (EITIM, 2010). TM should enable an organization analyzing, planning, R&D, implementation, control and commercialization of its technology so that this organization becomes more flexible towards the implementation of new know-how, innovation, entering new markets, or better resistance to its competitors. These activities of TM, however, require adequate systemic integration, for more effective operations of the technology system. TM is not only a certain amount of managerial processes, objectives, rules and experience, but also a methodological and scientific discipline, which requires systematic identification, categorization, and integration of technological and related information and know-how. TM should systematically integrate technology elements, processes, TM levels and capacities in order to achieve strategic business objectives through the technology. *This integration and selected trends of technology-oriented companies are more specified in this article.*

2.1 Integration of key elements in technological system

Technology is an artificial process, set of related processes or synergies that have a particular purpose. This purpose may be from a simple production activity: drilling, cutting, joining to complex fully automated production technologies, for example in automotive, chemical, or ICT industry. These technologies should create an integrated technology system (TS) to accelerate, improve and to streamline the production and related business processes. At first, integration of the TS means an integrated use of *material elements of TS* (*hard technology*, i.e. machines, equipment, vehicles, hardware, tools, channels), *non-material elements of TS* (*soft technology*, i.e. technological procedures, methodologies, processes, rules, algorithms, models, concepts, norms, standards, software, databases, services, brands etc.), and *human elements of TS* (*human technology*, i.e. explicit and tacit know-how, employees' performance, attitudes, approaches, objectives, assessment, control, culture, ethics etc.). These last mentioned elements are often overlooked, respectively underestimated in TM, although they can characterize the quality of the TS. Other elements of the TS are all inputs (raw materials, semi products, information, energies, external services, legislative standards, etc., *Figure 1)*.

Though, *Soft technology* is generally older, *Hard technology* has been more systematically codified and understood in the history. Hard technology exists because of the invention process itself, but the use made it comes from the soft side. As an example, *Microsoft* has not achieved its success only by depending upon the advanced hard technology development, but just taking advantage of soft and human technologies. In fact, the company has developed an association with the prestigious *Cambridge University* to address specific needs in education and training of its personnel (Jin, 2005). Generally, the rule is that investment in hard and soft elements of technology should be balanced to some degree, but clear in their effectiveness and efficiency. But, it is also necessary to keep adapting human elements to this degree and all necessary inputs of TS - in terms of market changes, technology progress, new legislative norms, changes in strategy and higher business ethics.

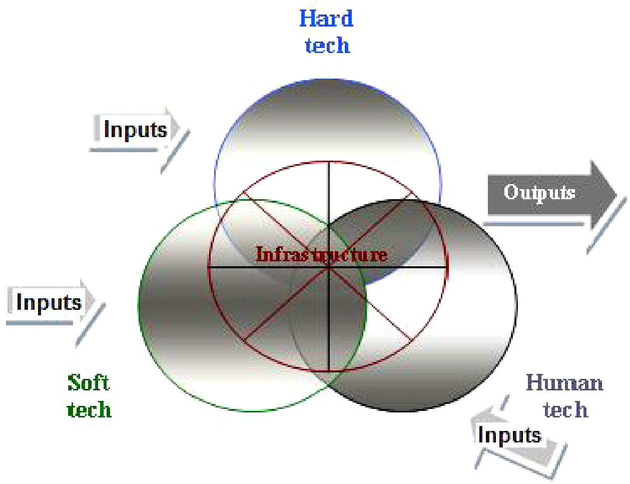

Figure 1: Integration of key elements in model technological system

Soft/human capital and services have become an object of business of many technology companies. *Cisco, Hewlett-Packard, Oracle, Yahoo*, and other tech companies have formed a new nonprofit consortium dedicated to the advancement of service innovation. Consortium members advance the state-of-the-art in customer service practices through a process of collective thinking and experience. The Consortium integrates academic research and emerging business trends with operational goals of its members in order to develop innovative strategies, models, and standards. As a member of the Consortium, a company can help influence the direction of support services, be on top of emerging trends, become an early adopter of innovation, and benefit from professional growth through a wide range of opportunities (CSI, 2012).

For another example, *IBM* reported a strategic shift in its technology strategy by focusing even more on supply chain consulting and computer services. It shifted about $1 billion for hard technology R&D to soft technology consulting services. The consulting and computer services make up nearly 50% of the IBM revenue. For this purpose, the company formed so called *On Demand Innovation Services* that employed about 200 scientists and analysts (Collier and Evans, 2007). *Microsoft, IBM, HP, Cisco, Corning* and many other technological companies provide customers with "*technology solutions looking for problems*". These companies develop and adopt perspective technologies and are looking out for applications of those technologies by offering a targeted array of products and services, but serving a broad spectrum of customers and market segments (Ramos-Aquino, 2003).

Each element of technology usually has its own specific input and role. Thus, a technological activity is a specific process of dynamic interactions between all elements in the technological system, which takes place in a particular *technological support infrastructure/integration/network* (technology support net). This technology infrastructure is a key area for technology integration, because it can directly affect other technology elements and processes. A form of this technological infrastructure primarily depends on whether it is a product or organizational technology. *Integration of a product technology usually requires greater demands on hard-tech elements synchronization. Organizational integration of technology requires better soft and human-tech elements synchronization.* For example, the *Cisco Network Foundation* integrates routers, switches, and wireless access points in the network managed by Cisco SW. This infrastructure is the integrated technology solution (product/service) in which network devices contain also some intelligence functions that support higher quality of services, availability, manageability, and multimedia wired and wireless communications capabilities of the network. By implementing this network, administrators get an integrated technology solution that can support critical business capabilities and provide a scalable platform for adding new applications, features, and capabilities as business needs evolve (Cisco, 2011). For an organizational example, *Oracle Technology Network* is the Oracle official organizational online community integrating Oracle technical experts and their experience, sources and know-how. It is reported that it is the world largest online network of developers, administrators, and architects using Oracle products and computer-industry-standard technologies such as Java, Linux, and PHP (OTN, 2011). So-called *right social infrastructure* should also create an important part of each technological system of an enterprise (Jones et al., 2000). Within this infrastructure, well defined objectives, procedures, performance standards, rules for internal communication, learning and innovation may create important determinants of TM integration and effectiveness.

Every technological infrastructure should be adequately planned and managed, so there is a need for appropriate decentralization of TM. *Functional and operational autonomy* may help to increase flexibility and effectiveness of various technological processes within a technological system. A *product technology infrastructure* requires adequate planning and management as well. For example, for high-tech characteristics are specific rapid changes just in technology infrastructure, which modify a purpose, performance, outputs, linkages, information flows and technological demands of the system (Chandra and Kumar, 2001), that imposes higher demands on the integration of such systems. Each technological infrastructure should be based on the *target driven integration* of technological elements and flows. These flows

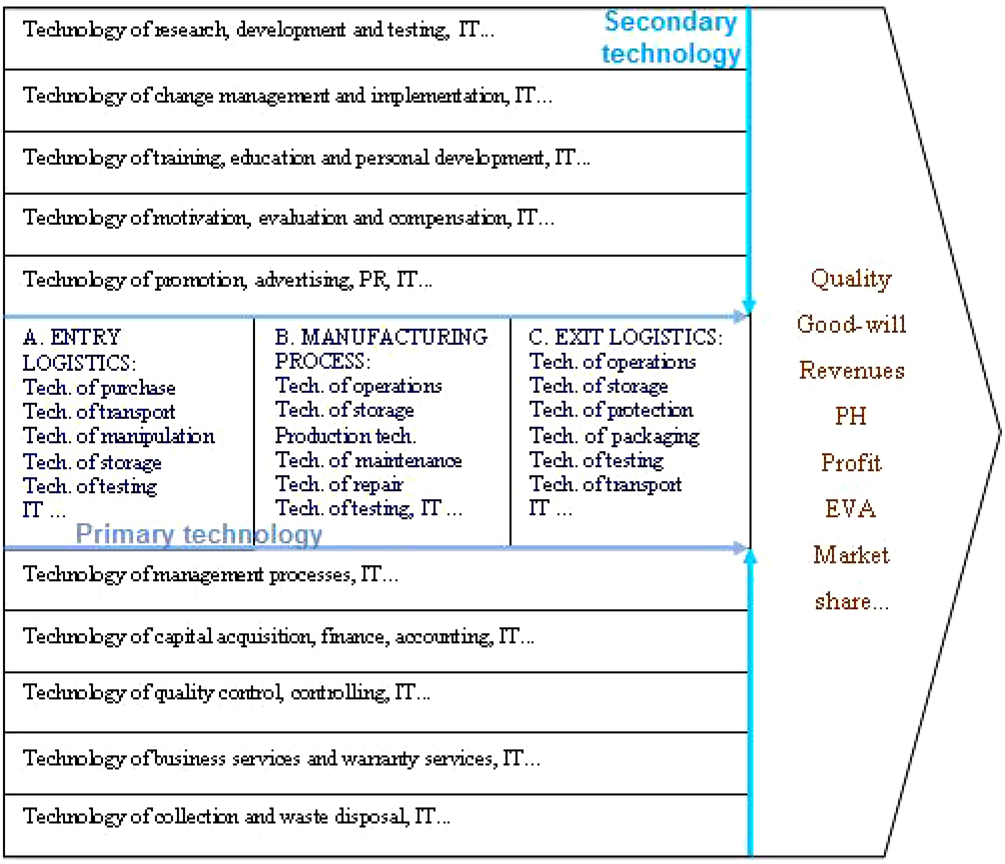

Figure 2: Integration of primary and secondary technological processes
Source: Modified according to (Porter, 2009).

can be material, information, flows of resources, know-how etc. And they create partial outcomes and subsequently inputs of specific technological processes, or a final output of the technology (finished product, service, network, information etc.). There is also a need here to adequately measure the value added of individual technological processes by systemic process analysis and controlling. Recently, there is a general rise in importance of research, which focuses on the relationship of effective technological infrastructure and TM processes.

2.2 Integration of primary and secondary technological processes

In general, technology can also be defined as know-how of business (Probert et al., 2000) or a set of goal-oriented business processes. But, this does not only mean the production know-how, but the *know-how of all guided business processes*. Integrated TM should be a process of guided technology changes and systemic integration in any type of organization. Therefore, TM should not only integrate technology elements and processes, but also adapt and integrate technology with strategy, multiple business capacities and technology processes, technology infrastructure and business organization, so that the company could adequately cope with new market challenges. Such integration should lead towards a unified interdisciplinary teamwork approach to TM at all levels and stages of the company (not only at the production level). This approach should mainly balance the tradeoffs between organizational stability and technology flexibility, process efficiency and production quality, increase in an absorption capacity and risks of external cooperation, as well as technology related decision-making competences (subsidiarity) and team responsibility for fulfilling business objectives.

Thus technology affects not only production activities (*primary technology*), but also processes in virtually every part of a company (*secondary technology*) in order to support strategic objectives of the company (profit, EVA, margin, goodwill, market value, etc.), *Figure 2*. And integrated TM should be a concept integrating the main, but also cross-enterprise processes, mainly those in connection with the main production process (R&D and testing, logistics, quality control, controlling, waste disposal, etc.). Thus TM has become a more interdisciplinary discipline, which requires more and more complex demands on managers. The selection and integration of primary and secondary technologies should be a systemic process, because the complexity of the technology context can imply a broad array of interactions between each technology process and level.

For example, *Intel*'s recent production equipment facilities cost about $3.5 billion, a third of which had not been used before. The requisite facilities were systemically combined to create a manufacturing process comprising about 6000 processing steps, each of which had to work in perfect coherence. But, in the early phase of the integration, no one had planned which primary and secondary technologies would function in the future plant environment, let alone produce reliably once combined to create the new technology system.

Microsoft faced the similar problem with its Windows. The basic product technology was based on the simple principle: *plug and play*. However, this goal implied the technology functioning with a number of other application software (SW) combinations, and each of the new functions included in Windows must have had to work seamlessly in any situation. The systemic integration must have had to include millions of precise technology instructions and number of technological standards and diverse approaches (Iansiti and Levien, 2004). Intel and Microsoft faced the challenge: how to integrate their technologies with a large number of technological processes and elements with an unclear system impact on a technology system, and come up with a product that would work coherently. Finally, for Intel and Microsoft only a proactive systemic integration approach was the most important for their results.

But, creating well integrated technology should not be the only goal of integrated TM. Better internal research and production facilities, external technology progress, and changing stakeholders' needs provide many other challenges and requirements for TM. In well-integrated organizations, when a technological path is unclear, integration can follow other well-established managerial processes. Thus the diversity and complexity of technological solutions also highlight the issue between integration efficiency within traditional internal TM versus TM outsourcing, as well as sharpening the need for a more proactive systemic TM approach.

2.3 Integration of different levels of technology management

On the level of internationalized companies, we can recognize *three levels of TM*, which also require appropriate integration. This integration should be primarily based on systematic implementation of strategic objectives through the technology tasks on different management levels, defining roles, responsibilities and competences for partial technological elements and processes, and the division of competences in an innovation process. But, this integration can also take place in the "opposite direction", where partial needs of individual business units are driving decisions at a higher level of TM:

Operative TM is generally mostly applied in small and medium sized enterprises (SMEs) and focuses on implementation and coordination of operational technology processes, projects, mainly production technologies, primarily in a connection with cost, efficiency and flexibility of specific technologies, current capacities and operational results. Operative TM should ensure implementation of strategic business objectives into technology and its outcomes. The managerial tasks here are mainly to ensure conditions related to a required level of efficiency, regular monitoring and daily optimization of technological projects, elements and processes. These require the determination of appropriate tools and criteria for technology monitoring, analyses and controlling, feasible operational solutions to technology collisions, and systematic optimization of downstream technology processes. Well selected tools, especially for collection and analyses of information are required for operative TM. Information and knowledge management systems create the bases for functioning of the technology infrastructure and are also used to properly plan and manage technological asset of the company (Sahlman and Haapasalo, 2009). Regarding the criteria for operative technology monitoring and analyses at this level, these are mostly quantitative, financial characteristics such as: technology expenditure, production cost, and volumes, VA of technology processes, and in-house prices, etc. Operative TM should provide strategic TM with actual information about the technology system for more realistic strategic decisions and investment.

Strategic corporate TM focuses mainly on the proper use of corporate resources/investment and capabilities in connection with a technology system, eventually resources and capabilities of specific business units with a technology strategy, so that they were in accordance with strategic business objectives. The link between effective technological activities and market demands is another important task of strategic TM, e.g. by an effective use of technology transfer, joint technology research and funding, outsourcing, entering a cluster, etc. Strategic TM should first and foremost define an organizational structure for TM processes, considering the size of business, path dependencies, traditions and principal decisions about the degree of TM centralization and decentralization. Strategic TM can also comprise functions like R&D or production management, although these are usually organized as separate units. Processes of strategic TM require corresponding personnel for appropriate planning and communication of strategic technology objectives (Sahlman and Haapasalo, 2009). Foresight and technology assessment within strategic TM are suggested to have a time horizon at least 5 years, depending on a technology and company. Strategic tools like Technology roadmapping or variant scenarios can be very valuable source of information also for operative and global TM. (*Figure 3*) As a positive example, every year the *Qualcomm* managers (similarly with Microsoft) must undergo intensive training at *Cambridge University* to learn about how to apply technology frameworks, new technology introduction tools, or strategic TM techniques. Topics of this course include: integration of technological considerations into business strategy and long-range planning processes; understanding and communicating the value of technology investment, or how to assess technology and TM processes (CTM, 2010).

Global TM is applied more in larger international companies that have several separate business units in different locations. Such global TM focuses mainly on the global use of resources and capacities, but also on a global transfer or sale of technologies (Probert et al., 2000). Usually, different types of alliances, coalitions and agreements form the basic structure of global TM, technology collaboration and networks. These networks consist of different institutes, sub-contractors, suppliers, industry analysts, regulatory bodies, customers and other stakeholders (Sahlman and Haapasalo, 2009). Global TM cooperation can be also realized between companies in different industries. For example, in 2000, *IBM and Nissan* announced the creation of the *global TM initiative* in which Nissan outsourced the information systems (IS) operations from IBM. These services included the operative TM activities within its IS, regular maintenance, and a part of the application development, but excluded the planning and design of new IS. IBM has taken over a portion of Nissan information technology (IT) operations that have enabled Nissan to use the latest IT know-how, adding them to their capabilities accumulated in providing advanced solutions in the automotive industry (IBM, 2000). Thus this Global TM has also enabled to manage and prioritize modern automotive IT, properly allocated technology investment, eliminate duplication in R&D, reduce launch times, improve business cooperation, and increase the effectiveness in both companies. But, the main issue within this global TM cooperation remained undisclosed, i.e. the increased demand for better technology coordination and communication within individual partners that could have improved the overall TM effectiveness.

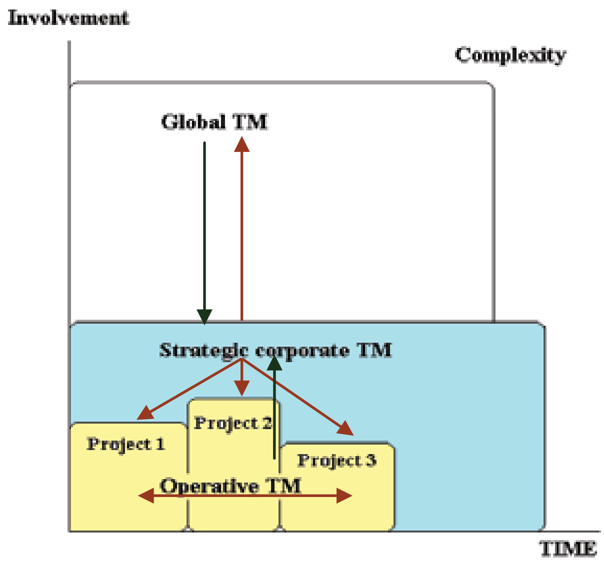

Figure 3: Model integration of different levels of TM

2.4 Integration of technology management capacities

Many technological systems such as a traditional client/server system or a cellular manufacturing system can be characterized by their possible *modularity, adaptability and reconfiguration*, which means that their physical design/platform may be separated from the technological system so that it is possible to individually use and replace various parts of this technology (Chandra - Kumar, 2001) and thus to improve overall technology capacities. The basic idea of so-called *Group technologies* (GT) is to divide a technological system into several subsystems/components that can be individually combined afterwards. This effective combination of GT within a given technology system can reduce production times, business cost, and increase technology capacities, because it allows *"work-in-process"* (changes during operations of technology). Among the key instruments for the division and integration of GT belong *technology classification* and *coding system*. These enable to categorize and assign codes to different parts of the technology according to its functions, individual capacities, or production requirements. Based on these codes, different technological parts and capacities can be integrated into specific groups. Thus the entire technology system consists of several technology groups with homogeneous technological parts and capacities, which enables TM to easier implement effective technology changes. The disadvantage of this classification is that considerable efforts and time should be paid to the distribution and subsequent effective integration of technology elements.

As an example, new *Cisco CleanAir Technology* (custom HW/SW technology solution) was developed to overcome the visibility limitations of standard Wi-Fi chipsets. Cisco created a new technology solution behind the Cisco Spectrum Expert Analysis, and integrated it directly into the current CleanAir Technology infrastructure within the group technologies solution. The new HW/SW solution is capable of detecting any interference that might be used in the future, and requires only a SW update. In the CleanAir technology integrated solution, the SI (The International System of Units) information is fully integrated into the network architecture and TM systems - to enable intelligent and dynamic operations (Cisco, 2011).

Dynamic technology capabilities can form the basis for new capacities in other business areas, and thus also the potential for a new competitive advantage. Targeted classification and integration of technological elements should allow its flexible modification if necessary. There are some important supporting techniques for this process like *Simulation and modeling of a technological change*, eventually *Technology roadmapping* within Strategic TM. Flexible technology capabilities create an important capacity of TM to continually adapt and integrate its technology resources, skills and other business capacities with market requirements. But, all *TM capacities should be adequately integrated within TM. These capacities can be divided into four basic groups*:

Social capacity - is a general TM ability to constantly adapt employees to changes in principles, know-how, requirements, or corporate culture. Social TM capacities form the basis for other capacities of TM.

Absorption capacity - is a TM ability to recognize and adapt new specific information, know-how, procedures, standards, or external help in a company, not only by employees, but by the whole company. An absorption capacity creates the basis for organizational and innovation capacities.

Organizational capacity - is a TM ability to adapt its technology infrastructure to new conditions, investment, markets, culture, acquired know-how, technology and business course, depending on changes in business strategy. This capacity creates the basis for innovation capacity.

Innovation capacity - is a TM ability to improve its technology system based on new current and expected market requirements and technology progress (Da Silveira, 2002), and to carry out purposeful and effective changes in related business processes. Innovative capacity requires the integration of all these TM capacities (*Figure 4*).

In a chronological view, integrated TM capacities and specific technology know-how many times create a certain

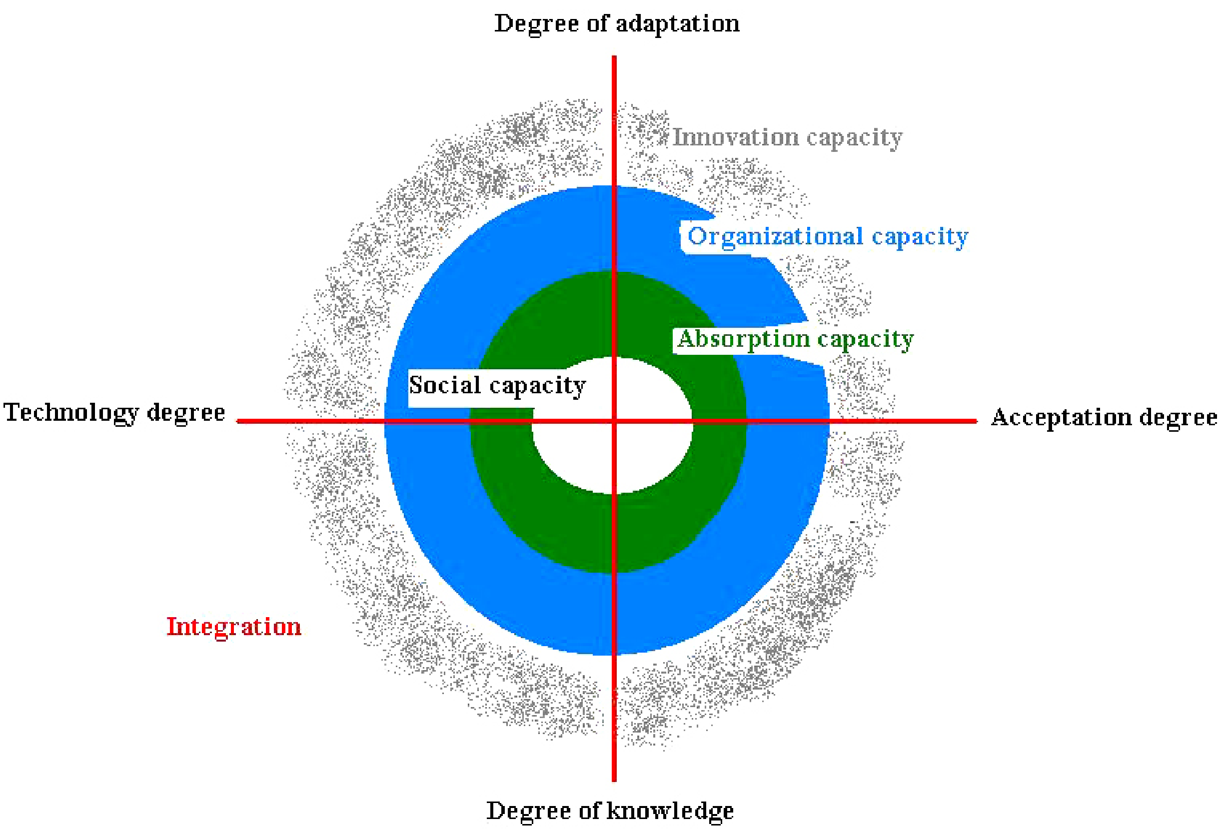

Figure 4: Model integration of TM capacities

kind of either negative or positive historical dependence of an enterprise (*Path dependence*) (Da Silveira, 2002). In a negative sense, this may affect development, acquisition, integration and implementation of new technology by an obsolete outdated way. In a positive sense, this dependence can save a lot of time, managerial activities and cost for new technology integration, automation and exploitation. Implementation of new technology can be thus influenced to a large extent by past and existing internal (also managerial) processes and corporate culture, although this often requires a new kind of leadership, organization, integration, motivation, control, or evidence. Improper innovation of new technology can bring many imbalances in different areas, from a decline in customer demand and higher demand on investment and operational resources, through increased laboriousness of technology processes, imbalances in logistics, more difficult coordination and control, to incorrect values and culture in the enterprise. Thus the path dependencies may also induce disintegration of TM capacities.

As an example, *IBM* products have not been performing as well as *Apple*, despite the longer business experience. In simplicity, it is difficult once a company is on a specific historical trajectory for a competing system to offer a better product and better price. Writers of IBM SW came up with the dominant operating system, which made dominant the IBM goodwill (Cerere, 2009). A little initial advantage has been changed into the significant cost differentiation. *Dell* is also successful because of its specializing in cost control, controlling the customer experience and being the first to the market. But where Apple more stands out is its perfect marketing and elegant design. The Apple "transformative changes" mean that technology has been integrated in a more creative way in different systems and applications, and this reflects the process of learning by doing (Consoli, 2005).

In general, increasing returns to innovation adoption of new technologies are necessary for evolving path dependencies in TM. Once the *higher adoption* appears, lock-in might emerge. Therefore, changing the past dependence for adopting new technologies also implies higher requirements on TM. Thus, a company can be locked in to its technology, while a competitor can be locked out, producing the result "winner takes all". At the same time past and existing purposeful TM processes, capacities and corporate culture can have a significant impact on new technology integration and adoption. But, TM must be also a more socio-cultural process (Hard and Knie, 2001). And new technology can also become a particular tool to socio-technological integration of an enterprise (especially its internal organization and communication), and thus also the mean for improvement of economic results.

Table 1: Most successful technology companies worldwide

10 most profitable tech companies in 2009 (2008)	2009				2008				2009/2008	
	Global 500 Rank	Best 50 R&D investors	Profit (bil. USD)	Revenues (bil. USD)	Global 500 Rank	R&D investment (bil. USD)	Profit (bil. USD)	Revenues (bil. USD)	Profit accrual (bil. USD)	Revenues accrual (bil. USD)
1. Microsoft (1.)	117.	2.	17,7	60,4	136.	9,0 (2.)	14,1	51,1	*3,6*	*9,3*
2. IBM (2.)	45.	15.	12,3	103,6	46.	6,0 (11.)	10,4	98,8	*1,9*	*4,8*
3. HP (4.)	32.	39.	8,3	118,4	41.	3,5 (26.)	7,3	104,3	*1*	*14,1*
4. Cisco (3.)	191.	21.	8	39,5	218.	5,2 (14.)	7,3	34,9	*0,7*	*4,6*
5. Oracle (6.)	408.	-	5,5	22	462.	2,8 (36.)	4,3	18,0	*1,2*	4
6. Intel (5.)	202.	17.	5,3	37,6	188.	5,7 (13.)	7,0	38,3	*–1,7*	*–0,7*
7. Corning (12.)	-	-	5,3	5,9	-	0,7 (132.)	2,2	5,9	*3,1*	*0*
8. Apple (8.)	253.	-	4,8	32,5	337.	1,1 (77.)	3,5	24,1	*1,3*	*8,4*
9. Qualcomm (9.)	-.	-	3,2	11,1	-	2,2 (38.)	3,3	8,9	*–0,1*	*2,2*
10. Dell (10.)	115.	-	2,5	61,1	106.	0,7 (122.)	2,9	61,1	*–0,4*	*0*

Source: (Fortune, 2009 and 2010; JRC, 2009.)

3 Selected specifics of most profitable technology companies

The most successful technology companies achieve their outstanding results by creating specific *technology teams* to systematically analyze new market opportunities and trends, technological infrastructures, and to innovate their integrated (written) technology strategies and programs, for better optimization of technology and related processes (Kepczyk, 2004). Among the most developed technological companies are: *Microsoft, IBM, HP, Cisco, Oracle* etc. (*Table 1*).

The largest increase in profit reported Microsoft, IBM and Corning, just at the time of the most intensive phase of the *Global economic crisis* in 2008 and 2009. The biggest change in revenues reported HP, Microsoft and Apple. Corning reported the biggest change within the ranking of the most profitable technology companies. And according to the ranking the 500 most successful companies of the world, Apple and Oracle experienced the biggest change. *Among the key specifics of the success of these best technology-based companies are:*

- *TM creates preconditions* for a proper application, implementation and realization of strategic objectives of an enterprise through a technological system and constantly monitors technological processes, as if it was the main strategic business asset. For example, before a company begins a technology implementation project with *Intel® AMT* (active management of technology), it must have a clear understanding of own technology capabilities, how they can be utilized within its environment, and it must review the scope of organizational impacts that the implementation will have. Having there identified also „opportunity areas", this will provide the basis for the technology implementation project and allow embracing the framework for creating technology teams, developing roadmaps for technology improvements, creating infrastructure augmentation, project schedule, and deploying the new technology (Intel, 2007).
- TM adequately *integrates strategic objectives and technological processes*, market requirements and R&D processes, technology innovation capacities and business opportunities, etc. An appropriate technology strategy is also an opportunity for organizational changes and improvement. From integration of technology processes; through customer insights that drive product and brand extensions; to spotting emerging trends that competitors miss; business and technology integration are of tremendous importance for an optimal growth and profit. E.g. with about 3500 strategy professionals, the *IBM technology strategy and change practice* is a part of IBM Global Business Services, one of the world's leading management consulting practices. Working across all major sectors, IBM has the technology expertise across more than a dozen industries: from communications, distribution, financial services, to industrial and public sectors. The IBM technology strategy services offer: establishing an overall IT strategy for a company, helping to establish/evaluate an overall business architecture or SOA (service-oriented architecture), and helping to improve IT processes to deliver higher quality and reduced technology costs to a company (IBM, 2011).
- The main tool that characterizes TM and its relevance to strategic business objectives should be a *well communicated technology strategy*, preferably formulated as the result of Foresight or broader technology cooperation. Technology strategy should form the basis for measuring TM efficiency and effectiveness, also for the alignment of operational plans and programs even in SMEs. Many companies look for partners to help them and their stakeholders to work up and implement more complex technology strategies. For example, *HP* works with thousands of clients (within the Strategic IT Advisory Services) to establish its technology strategy that adequately details the technology and capability requirements. But, HP also delivers more comprehensive technology strategies and transformation plans to their clients. HP widely maps relevant data associated with various technology processes and assigns a value to it that justifies introducing new technologies and changing the existing technology strategy. Clients can engage with HP to plan and implement new technology and realize technology synergy plans (ALTO, 2011).
- *Technological innovation* is often a long term incremental process that *requires a longer-term source of investment*. At the same time, the investment is often more risky than at product innovation. Therefore, a technology innovation process often requires an effective investment strategy and cooperation. As an example can be the *Qualcomm Ventures* (QCV) that was formed in 2000, with the $500 million fund commitment to make strategic investment in early-stage of high-technology ventures. Since then, QCV has also funded numerous other companies in the wireless sector, and set up several exclusive regional funds to spur development in key strategic markets, including the $100 million fund in China and the €100 million fund in Europe (QCV, 2011).
- An important factor in success and efficiency of TM operations is the so called Open technology strategy, which implies creation of the functional network with other institutions, not only from the technology industry, but also from R&D, education, finance, marketing sectors, etc. From a *resource based perspective of integrated TM*, a key advantage of such an open alliance or a network is that it enables a firm to use technological resources of cooperation partners. As a result, the partners' resources can be used without the need to transfer or lease them. Open networks thus enable to access to assets that are immobile or very costly to transfer (Markard and Worch, 2009). For example, *Oracle* is an open standards leader. Its IT solutions are based on the open industry standards so that the products could simplify customers' interoperability and security, and decrease the cost of deployment. Within its Open technology strategy, Oracle cooperates with about 100 standards-setting organizations, 320 technology managers, 590 technical working groups, and about 90 policy committees. This approach helps the company avoid vendors' lock-in, enables an open access to technical details and interfaces, lowers barriers to

innovation, and reduces the cost of technology investment (Oracle, 2011).

- Currently, a *significant IT support for TM* can be provided by complex information solutions (SAP, Oracle, Microsoft etc.) and Internet. In this context, it is also necessary to emphasize the need for *adequate protection of technological know-how* and information. For example, for SMEs, *Microsoft* offers *Windows Small Business Server* that is an affordable server solution providing networking, security, databasing, line-of-business support, and remote access, etc. Windows Small Business Server offers a server solution with appropriate complexity and increased manageability over traditional enterprise servers. The solution also enables to optimize technology processes and cost by using an intuitive management interface, one that presents relevant system information and matching set of tasks (Microsoft, 2011). Technology companies are concerned that legislation requiring the inclusion of specific intellectual property protection technologies poses serious threats to privacy, technical innovation, open source software development, and the fair use of copyrighted content. But, the widely discussed mandatory technical standards should result in user-unfriendly products and services. Development of such outputs can be a costly long-term process, but it can positively impact companies, consumers and technology industry.
- *Value-added of technological processes* mainly depends on systematic and systemic TM, clear technology vision and strategy, good internal and external relations, on corporate culture that accepts changes and creativity of employees, as well as on flexibility of technological solutions (Boomer, 2006). Many companies establish the so called value-added resellers to deliver their customers “hand-made” technology solutions. E.g. the independent *Apple Value Added Resellers* help associated companies to simplify and enhance their technology processes leading to improved business processes and economic results. Working with the Value Added Resellers, a company can obtain customized integrated multi-platform technology solutions, professional, industry experience, proficiency in Apple and complementary IT products, and additional services, such as: technology planning, system design, or training (Apple, 2011).
- And *effective integrated TM requires not only adequate management skills* (persuasion, good communication especially among engineers, managers and key stakeholders, capacity for flexible decision-making, empathy etc.), as it is at many other business processes, but also professional skills and technological know-how, where their “acquisition” is often a long term process. According to *Gartner*, a manager can save approximately 5 hours of work by 1 hour of technological education, or 20 hours of technological training can provide the manager with about 100 hours of an available capacity (Gartner, 2010).

4 Summary and conclusions

Approximately since the 1980s, TM has become a part of managerial processes and strategies in many companies and institutions (Pelc, 2002). Decentralization of R&D increased in the same time (Larson, 2007). Since the early 1990s, effective technology innovation has become essential for a success of many companies and projects. Increasingly more successful have become specific technological companies (Apple, Microsoft, IBM, Corning, Google, Intel etc.) that integrate their R&D with systematic marketing analyses, increasingly use venture capital for innovation processes, and create different broad cooperative business models. An important mean for formulating an integrated technology strategy has become an Open innovation approach.

TM has not only become a sum of particular managerial processes and experience, but also a methodological tool and scientific discipline, which requires systematic identification, categorization, and linking technological and related know-how. TM should systematically integrate technology elements, processes, TM levels and capacities in order to achieve partial strategic business objectives through the technology. This integration should lead towards an interdisciplinary team approach to MT at all levels of management, particularly as regards to the relationship of organizational stability and flexibility, process efficiency and product quality, or an increase in an absorption capacity and risks of external collaboration.

A technological activity is a specific process of dynamic interactions between all elements of a technological system, which takes place at a particular technological infrastructure. A general rule is that investment in hard and soft elements of technology should be balanced to some degree, but it is also necessary to keep adapting human elements to this degree and all necessary inputs. Integration of a product technology usually requires higher demands on hard-tech elements synchronization. Organizational integration of technology requires better soft and human-tech elements synchronization. The so-called right social infrastructure should also create an important part of each technological system.

On the level of internationalized companies, we can recognize three levels of TM, which require appropriate integration. Operative TM should ensure implementation of strategic business objectives into a technology and its outcomes. Strategic corporate TM should focus mainly on the proper use of corporate resources and capabilities in connection with a technology system. And global TM should focus mainly on the global use of resources and capacities, but also on a global transfer or sale of technologies. Dynamic technological capabilities can enable TM to form the basis for new capacities in other business areas.

Lack of an integrated approach to TM can prevent many managers to increase their technological efficiency. Companies often have well-developed processes of product innovation, but they have a problem, how to develop and integrate their technologies. Among the best technology-oriented companies are *Microsoft, IBM, HP, Cisco, and Oracle*. The main specificity of the success of technology-oriented businesses is the fact that *TM creates preconditions* for proper utilization, implementation and realization of strategic business objectives through the technology and constantly monitors technological processes, as if it was the main strategic business asset.

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Integracija managementa tehnologije in izbranih specifik v najboljših tehnološko integriranih podjetjih

Tehnološki know-how je pomemben dejavnik, ki je v prvi vrsti odvisen od sistemskega, integriranega pristopa k managementu tehnologije, na jasno opredeljeni in vpeljani strategiji tehnologije, pa tudi od celotnih sociološko-okoljskih značilnosti tehnološkega sistema. Glavne naloge integriranega managementa tehnologije so zagotoviti sistematično spremljanje, analizo, planiranje, organiziranje, nadzor, ocenjevanje in učinkovito rabo tehnološkega sistema, da bi se bolje integriral v funkcionalno entiteto in podpiral druge poslovno usmerjene cilje in procese. Članek obravnava opredelitev ključnih delov integracije tehnološkega managementa s posebnim poudarkom na izbranih specifikah najboljših tehnološko integriranih podjetjih na svetu.

Ključne besede: integrirani management tehnologije, integriran tehnološki sistem, tehnološko integrirano podjetje, učinkovitost