Chapter 2
Introduction to Innovation Management

2.1 Innovation Management Through Management of Knowledge and Education

'Until philosophers become kings or until kings and princes in this world acquire the spirit and power of philosophy .....states shall not be relieved from their demons-I believe the same is true for human race…'

[Plato]

Many authors have dwelled on the idea that innovation can become object of 'management'. For example, Burns and Stalker (1961) authored the book 'Management of Innovation' partly based on a previous study of a research and development laboratory of a local company.

In contrast to the past when innovations in enterprises appeared in a random and disorganized way, in the post-war period emphasis was placed on the idea that innovations could be systematized, even 'planned'. The development of organizational studies (e.g. Cyert and March 1963) and the study on management function (e.g. Barnard 1938; Drucker 1999) laid new foundations for the understanding of innovation process.

Therefore, a basis was created for a new sector of specialization and knowledge in technology and organizations. However, managers do not fully or duly comprehend the management of knowledge and in many cases, professionals and academics, when talking about knowledge management; they practically mean management of information and technologies.

In reality, knowledge management has to do more with the art of thoroughly understanding the potentials of an organizational context and with the evaluation, influence and the disclosure of tacit know how (Carayannis 2000).

A research by McKinsey in 40 companies in Europe, Japan and the USA showed that many executives believe that knowledge management starts and ends with the creation of specialized technological information systems.

E.G. Carayannis et al., *Innovation and Entrepreneurship*, Innovation, Technology, and Knowledge Management, DOI 10.1007/978-3-319-11242-8_2

Some companies even take a step further to connect all information available and construct models that would enhance performance thanks to improved processes, products and their relations to consumers. These companies realize that the actual knowledge requires companies themselves to develop ways whereby their employees shall understand previous connections, advancing beyond infrastructure touching upon all aspects of an enterprise (Hauschild et al. 2001).

2.1.1 The Role of Knowledge in Innovation

Given that innovations do not constitute a purely technological project, the knowledge required for their successful management cannot be solely covered by science and engineering. Innovations can be divided in two sectors:

- In technical knowledge and transfer of knowledge (Bohn 1994) and
- In learning regarding administrative methods offered for technology management (Jelinek 1979).

An organization needs access to two kinds of knowledge, i.e. technical and administrative in order to enhance systematic development of innovations.

For the benefit of the entire organization and not only of isolated individuals, learning and knowledge should be accessible not only by the one who discovered them but also by all parties involved, who should be in a position to use them, apply them, modify and adopt them. Learning needs to be generalized in an organization, if it wants to be real and not be downgraded to a ‘simple adjustment’. It needs to make the transition from a simple reproduction to application, change and improvement. ‘Learning rules’ should be included, changed and adjusted without repeating blindly older successful methods. Finally, if learning is to include innovations, it should also include an administrative system for the present and the future (Jelinek 1979).

The most demanding point in research regarding knowledge application in innovations is to sort out significant and information management-related information from the opposite. The attributes of knowledge involved in the process of innovations may present significant diversifications. Part of this knowledge will be clear and shall take the form of technical documents, drafts or other documents, it shall be codified and easy to determine; another part of knowledge shall be tacit, embedded in the established organizational projects and can only be carried over through socialization and cooperation. Therefore, the successful management of innovations may clearly benefit from the systematic approach to knowledge management. Knowledge, learning and their context of development constitute classical definitions having been redefined in the context of information technology progress and knowledge management. Knowledge management may be considered as a socio-technical system made of tacit and clear business policies and attitudes. Said attitudes and policies are facilitated through integration of information technology tools, business processes as well as of the intellectual, human and social capital. The capacity of individuals and of an organization to think rationally, to learn, express themselves/itself and have a vision on collective or individual basis can be considered as a capacity of management and cognition.

Organizational memory, intelligence and mindset are important and decisive factors for cognitive processes both at individual and organizational level. According to our opinion, the managerial and organizational part of cognitive process and knowledge management drive to superior levels of knowledge and meta-knowledge. What is knowledge really and how is it acquired?

2.1.2 Knowledge/Meta-Knowledge

> *'The biggest ancient-Greek breakthrough was the removal of explanations on what was happening to the world by the field of religion and magic and the creation of a new kind of explanations, i.e. rational ones being the object of a new kind of research.'*
>
> [Peter Checkland 1981, p. 32]

Many definitions have been advocated at times for knowledge and organizational knowledge. Beckman (1998) grouped a raft of remarks and drew up some useful definitions related to knowledge and organizational knowledge:

- **Knowledge** is organized information that can be utilized for problem solving (Carayannis 1999).
- **Knowledge** is information that has been organized and analyzed in order to be understood and utilized for problem solving or decision making (Turban 1992).
- **Knowledge** includes direct and indirect restrictions imposed on objects (units), functions and relations in combination with specific and general heuristic and reasoning processes that take part in the model under formation (Sowa 1999).
- **Knowledge consists of** truths and convictions, estimates and concepts, judgments and expectations, methodologies and know-how (Wiig 1993).
- **Knowledge** groups perceptions, experiences and processes considered sound and true, that direct thought, behavior and human communication (van der Spek and Spijkervet 1997).
- **Knowledge** is a rational thought on information in order to guide the implementation of projects, problem solving and decision making aimed at performance, learning and teaching (Beckman 1997).
- **Organizational knowledge** is the collective sum of human-centered assets, intellectual property assets, infrastructure assets and market assets (Brookings 1996).
- **Organizational knowledge** is processed information included in programs and processes facilitating action. Such knowledge has been acquired through systems, processes, products, regulations and the organizational context (Myers 1996).

Beckman (1997) suggests the method of **Hierarchization of Knowledge** that involves five levels and where knowledge can climb upwards from lower levels toward a superior level.

Nonaka and Takeuchi (1995) classified accessibility to knowledge in two categories, in inherent and clear, while Beckman (1997) identifies the following three stages of accessibility: tacit, implicit and explicit:

- Tacit (human mind, organization)—possibility of indirect access, always with difficulty, through knowledge elicitation and behavior observation.
- Implicit (human mind, organization)—accessible through querying and discussion, but informal knowledge must first be located and then communicated.
- Explicit (documents, computer)—directly accessible, documented into formal knowledge sources that are often well-organized.

2.1.3 Knowledge–Learning Relation

> *'Even if the first step in the course of a historic invention is the result of a conscientious decision, in this case as in any other case, the spontaneous idea-the instinct or the intuition-does play a significant role. In other words, the unconscious does take part, whose contribution is decisive. Therefore, conscious effort is not exclusively responsible for the result. The unconscious gets into the picture at some point with its almost invisible objectives and its intentions. Reason on its own is not enough'*
>
> [Carl Jung 1958]

First researches on organizational learning focused more on the effort to describe the learning process in the organizational-business environment without necessarily recognizing the regulatory role of learning (Cyert and March 1963; Nelson and Winter 1982; Levitt and March 1988). Learning, as an activity in an organization, in a business corresponds to the unification of individual efforts and of the interaction relationships in groups.

Organizational learning, therefore, is converted into a process governing the relations among individuals through mechanisms, such as disclosure of information, communication and the cognitive environment. Some authors utilize the version of 'cognitive learning', highlighting thus the actions to identify the pathways that would improve organizational learning through certain systems (Senge 1990; Ciborra and Schneider 1992). Based on this tenet, companies with better organizational learning are expected to have a better performance in the market compared to the rest of companies.

Other authors stress that learning is likely to mitigate an organization's performance. Huber (1991) reports that 'units may learn to do something right in the wrong way or may learn to do something wrong in the right way'.

Ineffective or unsuitable learning processes may deprive a company from its competitive advantage, if they contribute to the erroneous connection between management activities and company performance (Levitt and March 1988). Even the effective learning processes may be undermined by the market changes and the environmental conditions that render them non relevant or in the worst case dwindle the company's performance.

Learning activities, therefore, may turn into basic disadvantages from basic advantages. It is also probable that technological learning shall eliminate competition, inflict a short term blow on the organization's competitiveness but yield a higher performance long term, if the market adapts to new technologies (Christensen 1997). In this way, there is no linear relation between learning and an organization's performance. What is more likely happening is that improvement of performance depends on quality (and not on quantity) of cognitive learning.

2.1.3.1 Types of Learning

'Computo, ergo sum. Particeps sum, ergo sum. Cogito, ergo sum.'

[René Descartes]

We believe there are three levels of learning, taking the previous theory into consideration, regarding the impact of learning on formulating a company's potential and the change of its mode of operation (Carayannis 1994a, b, c; Carayannis and Kassicieh 1996). Three degrees of technological learning match this hierarchy:

- Functional learning
- Tactical learning
- Strategic learning

In **functional learning**, the accumulation of experience and learning takes place by learning new things (Carayannis 1994b). It is a short term to mid-term perception of learning that focuses on new or improved capabilities on the basis of knowledge offered by the organization. This type of learning contributes to managing basic organizational capacities, (Prahalad and Hamel 1990), competition strategies (Porter 1991) and resources allocation (Andrews et al. 1965).

In **tactical learning** we learn new tactics to apply the already accumulated experience and learning processes (we redefine the basic rules and the contingencies involved in our short term functional context): we create new models for eventual unexpected events pertaining to decision making, by modifying or improving the rules for decision making (Carayannis 1994b). This is the means to lead to a long term perception of learning, ending up in the company's re-establishment and re-planning. Tactical learning facilitates companies in exploring new opportunities for the organization in a more performing and effective way and to reinforce or combine the already existing basic capacities, creating innovative concepts for more competitive advantages.

With **strategic learning** we develop and learn (internalization and institutionalization) novel views in relation to the enterprise's–organization's functional environment or the view of the world (Hedberg 1981) and we therefore assimilate new learning strategies (Cole 1989). We redefine the fundamental characteristics (rules and contingencies) taken into account for decision making or the fundamental characteristics of our functional context. It is a very long term concept on learning that focuses on the reformulation of 'tools' (methods and processes) used for an organization's reestablishment and re-planning (Bartunek 1987; Bateson 1972, 1991; von Krogh and Vicari 1993; Nielsen 1993). The strategic learning degree involves the broadening and review of concepts regarding the limits and capabilities of a company's strategic environment. Strategic learning contributes to rapid progress towards a new competitive environment and to 'increasing the learning curve gradient and rate through improved and innovative projects adopted by organizations' (Carayannis 1994b, pp. 582–583). The result is what other authors call 'change of the rules of the game' (Brandenburger and Nalebuff 1996; D'Aveni 1994) or the 'creation of new ecologies for the enterprises' (Moore 1996). The company paves a new way towards a conceptual formulation of its operations, its market and the entire competitive environment, acquiring a greater strategic flexibility not only vis-à-vis the course of its works but also regarding the influence and mentoring of its remaining operations.

2.1.3.2 Learning/Meta-Learning

Learning is the first process used by companies to modify their capacities in order to better respond to the environment. In the case of learning, as it happens with the majority of basic concepts, there is no absolute matching as to what is being learned, how it happens and how it is being managed. In finance, learning refers to quantitative and measurable improvements in operations adding value. For the management, learning is the source of 'sustainable competitive performance' (Dodgson 1993) while in the literature on innovations, learning is considered a source of 'comparative innovative performance' (Dodgson 1993). According to Doz (1996), inside an organization there is a distinction between cognitive learning and behavioral learning. The process of cognitive learning arises in case the members of a company realize the need for change under certain conditions, while behavioral learning appears when the company's cognitive projects indeed change (application of cognitive learning). Broadening even more the concept of learning, we could say that the organizational learning involves a new form of behavior being reproduced in the entire company, driving towards a broad change within the organization (Teece et al. 1997).

2.1.3.3 Knowledge Management

Knowledge management is defined as the 'systematic, clear and premeditated creation, renewal and knowledge application in order to enhance as much as possible the knowledge-related company's performance and the revenues derived from the elements of knowledge' (Wiig 1993). Sveiby (1998) defines knowledge management as 'the art of creating value from an organization's intangible assets'. Sveiby (1998) distinguishes two basic kinds of activities regarding knowledge management:

- The first one refers to knowledge management as management of information and
- The second kind as management of people.

2.1.3.4 Cognitive/Meta-Cognitive Process

The cognitive capacity is people's ability to estimate, interpret and raise arguments on environmental, conceptual or organizational stimuli and the meta-cognitive capacity is the ability to 'make thought on their thoughts, just like meta-learning means learning things related to or for learning' (Carayannis 1994a).

The processes for the creation, transfer, selection, acquisition, storage and recovery of knowledge could be dealt with from an information technology (Shannon and Weaver 1949), meta-cognitive (Simon 1969; Sternberg and Frensch 1991; Halpern 1989) and linguistic perspective (Chomsky 1993).

In this context, the person who solves human problems and the manager of technologies is considered equally technician and worker (Schon 1983), at the same time 'synthetic' and 'divisive' (Mintzberg 1989). Persons, groups and organizations are based on multi-level learning and reverse learning (Carayannis 1992, 1993, 1994a, b, c; Dodgson 1993) to create, preserve and increase the ability of groups, persons and organizations to transfer and assimilate embedded and non-embedded (von Hippel 1988) technologies in the form of artifacts, convictions and evaluation programs (Garud and Rappa 1994) or in the form of inherent and explicit knowledge (Polanyi 1958, 1966; Nonaka 1988, 1994). It is also very important to understand that individual and organizational learning and knowledge are entities that complete and reinforce each other through the organizational memory. Moreover, the learning process should be supported by an accurate and specific organizational memory in order to create, preserve and constantly renew the company's stock in skills and capabilities: In case of an organization that is about to learn something new, memory allocation, memory accuracy and the conditions it is used constitute the basic characteristics of the organization (Weick 1979) (see Carayannis 1994b, 2001). It is important to remember that 'knowledge does not develop in a linear way, by collecting data and applying a method of assumptions and conclusions but it resembles more a spiral line with a rising course so that each time we reassess a previous position or opinion, it is done under a new perspective' (Carayannis 1994b). This conceptual perception lays the ground for the development of an Organizational Cognition Spiral—OCS (Carayannis 1998a, b, c), as part of a model to manage organizational knowledge. Intuition, defined by Weick as 'inherent expertise', relates to all these concepts (Davenport and Prusak 1998, p. 11) combined with meta-knowledge, which is knowledge (consciousness) over the knowledge one possesses (Carayannis 1998a, b, c).

2.1.4 The Model of Organizational Cognition Spiral

The model being suggested contributes to the comprehension of basic issues involved in organizational knowledge management. The model identifies different knowledge situations constituting the two-dimensional function: of knowledge (K) and of meta-knowledge (MK), as defined above, and includes successive 'cycles of

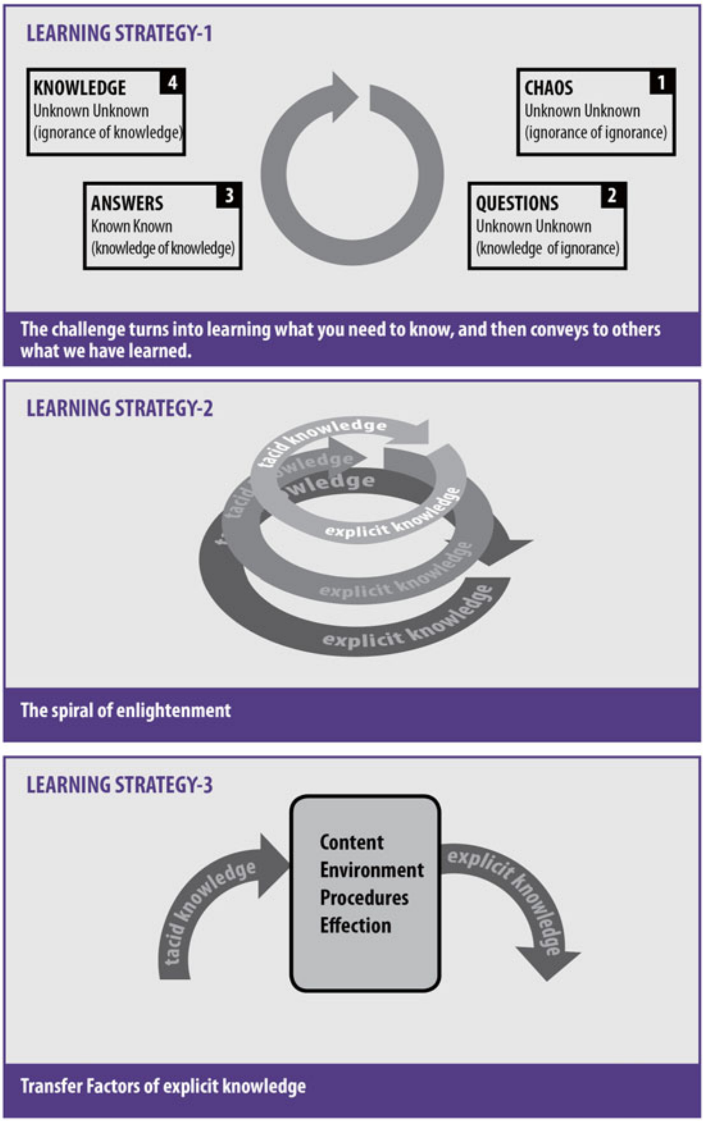


Fig. 2.1 Knowledge cycles (Carayannis, GWU lectures, 2000–2009)

knowledge' a person or organization can go through and pass from four stages of knowledge or ignorance. As we shift from one cycle to the next and to the following one, the overall level of knowledge and meta-knowledge increases (see Fig. 2.1) (Carayannis 1998a, b, c).

Usually, but not always, according to Tables 2.1 and 2.2 (end of paragraph), transition takes place from ignorance of ignorance (you do not know what you ignore) to knowledge of ignorance (you know what you do not know), to knowledge of

Table 2.1 Process and technology-available knowledge conversions

Conversion	Procedures available	Available technologies
A (III->I) From knowledge of Ignorance to knowledge from knowledge	Problem solving	Decision-making tools
	Internally motivated knowledge discovery	Interactive modeling
	Active learning	
	Focus on efficiency	
B (IV->III) From ignorance of ignorance to knowledge of ignorance	Cooperation procedures	Groupware
	Internally motivated discovery of after-knowledge	GDSS
	Value elicitation	Videoconfereding
	Target recognition	Brainstorming
	Facilitation	
	Active learning	
	Focus on efficiency	
C (IV->II) From ignorance of ignorance to ignorance of knowledge	Osmosis knowledge	Information infrastructure
	Externally motivated knowledge discovery	Access mechanisms—networks
	Knowledge creation	LANs
	Passive learning	WANs
	Focus on efficiency	Internet and Intranet
	Circumvention the paradox of knowledge and productivity of information technology	Data sources
		Data storage
		Distributed databases
D (II->I) From ignorance of knowledge to knowledge of knowledge	Protection of intellectual property	Intelligent Agent Technologies
	Outdoor motivated discovery of after-knowledge	Collaborative filters
	Management of intellectual capital	Data mining
	Passive learning	Neural networks
	Focus on efficiency	
E (III->II) From knowledge of ignorance to ignorance of knowledge	Implicit learning from top to bottom	Tools for decision making for technological infrastructure
	Internalization of knowledge/vertical planning	Access mechanisms: networks
	Externally and internally motivated emergence and crystallization of a theoretical example	LANs
	Transfer of focus from efficiency to effectiveness	WANs
	Circumvention the paradox of knowledge and productivity, technology, information	Internet and Intranet
		Data sources
		Data storage
		Distributed databases
		Groupware
		GDSS
		Videoconfereding
		Brainstorming
F (II->III) From ignorance of knowledge to knowledge of ignorance	Explicit learning from the bottom up	Groupware
	Obsolescence of knowledge/substitution	GDSS
	Externally and internally motivated theoretical examples shifts change sign reference standards ("gestalt switches")	Videoconfereding
	Cleavage of the paradox of knowledge and productivity of information technology	Brainstorming
	Transfer of focus from efficiency to effectiveness	Learning capable Intelligent agents or Interfaces

Table 2.2 Content and technology-enabled knowledge states

State	Enabling content	Enabling technologies
State I: K, MK Awareness of awareness	• Internally-driven knowledge discovery • Active learning • Focus on effectiveness	• Decision support tools • Interactive modeling
State II: K, $\underline{\text{MK}}$ Ignorance of awareness	• Collaborative processes • Internally-driven meta-knowledge discovery • Value elicitation • Objectives identification • Facilitation • Active learning • Focus on effectiveness	• Groupware • GDSS • Videoconferencing • Brainstorming
Stage III: $\underline{\text{K}}$, MK Awareness of ignorance	• Knowledge osmosis • Externally-driven knowledge discovery • Knowledge creation • Passive learning • Focus on efficiency • Bypassing of knowledge & IT productivity paradox	• Information infrastructure • Access mechanisms: networks – LANs – WANs – Internet and intranet • Data sources – Data warehouses – Distributed databases
Stage IV: $\underline{\text{K}}$, $\underline{\text{MK}}$ Awareness of ignorance	• Individual privacy protection • Externally-driven meta-knowledge discovery • Intellectual capital management • Passive learning • Focus on efficiency	• Intelligent Agent Technologies • Collaborative filters • Data mining • Neural networks
E (III→II) From Awareness of ignorance to Ignorance of awareness	• Top down tacit learning • Knowledge internalization/ routinization • Externally & internally-driven conceptual paradigm emergence and crystallization • Transition of focus from effectiveness to efficiency • Bypassing of knowledge & IT productivity paradox	• Tools form making technology infrastructure decisions • Access mechanisms: networks – LANs – WANs – Internet and intranet • Data sources – Data warehouses – Distributed databases • Groupware • GDSS • Videoconferencing • Brainstorming
F (II→III) From Ignorance of awareness to Awareness of ignorance	• Bottom up explicit learning • Knowledge obsolescence/ substitution • Internally & externally-driven conceptual 'gestalt switches'/ paradigm shifts • Transition of focus from efficiency to effectiveness • Resolution of knowledge & IT productivity paradox	• Groupware • GDSS • Videoconferencing • Brainstorming • Learning-capable intelligent agents or interfaces

knowledge (you know what you know: result of research, discovery and learning) and finally to ignorance of knowledge (you do not know what you know: as a result of continuing practice, knowledge become inherent (Carayannis 1998a, b, c).
For the sake of simplicity, we assume that the dimensions are at two levels and represent presence and absence of knowledge and meta-knowledge. Therefore, the levels of the two dimensions are represented as K/˜K and MK/˜MK. These two levels over the two dimensions end up in totally four states of knowledge:

1. ˜MK, ˜K (ignorance of ignorance)—[You do not know what you do not know]
2. MK, ˜K (knowledge of ignorance)—[You know what you do not know]
3. MK, K (knowledge of knowledge)—[You know what you know]
4. ˜MK, K (ignorance of knowledge)—[You do not know what you know]

Organizations may sustain any of the above situations including possibly current, desirable or intermediate levels. The situations can be represented as follows (Fig. **2.1**).

Knowledge management can be considered as the process of managing transitions between the aforementioned four situations (Carayannis 1998a, b, c).

The revolutionary transformation of knowledge is by nature **differential and thorough** (Carayannis 1992, 1993, 1994a, 1994b, 1996, 1997, 1998a, b, c, 1999, 2001, 2002), because it consists of **reverse knowledge**, **knowledge** and **meta-learning**, differentiates older from new experiences, selects and preserves the useful measures for knowledge and unifies the lessons taught (Carayannis 1998a, b, c).

This process reflects the dynamics of a complex progress, at individual and organizational level, from the information, knowledge, wisdom and intuition data. In this way, constantly broadening and increasingly deeper levels of **organizational knowledge** (Choo 1998) are attained and quantitative and qualitative modifications are in place in the stock and flow of knowledge of an organization and individuals.

2.2 Difference Between Innovation–Invention

There is a clear difference between the concepts of invention and innovation. The famous economist Joseph Schumpeter (1942) was the first to have observed and defined this difference: the ‘invention’ is the outflow of an applied research, while ‘innovation’ is the successful introduction of an invention in the market as a functional solution (product or service). Scientific discovery is also assessed on the basis of whether it has contributed to understanding natural phenomena. Due to the fact that innovation includes specialized knowledge and the latter’s main attribute is its being a public good, the state enshrines legally the intellectual rights of an inventor–innovator by awarding him/her a patent, safeguarding thus for the benefit of the inventor–innovator the economic exploitation of the new product in a specific geographical region and for a specific period of time.

It would be easier to understand innovation as an entrepreneurial process evolving into a connection with scientific research, learning, market conditions and economy, if we take into account the historic examples of inventors who took a step further and proceeded to the commercial promotion of their inventions, become i.e. innovative entrepreneurs. Such examples shed light on the true nature of innovation. Until the end of the nineteenth century, scientists were not generally interested in the practical application of their discoveries. One of the first scientists who proceeded to the technological application of his scientific discoveries was Justus Liebig, who, by the middle of nineteenth century developed the first artificial fertilizer as well as a significant meat extract which constituted the only means to preserve animal proteins until the discovery of the refrigerator in 1880s. Moreover, in 1856 the English scientist Sir William Perkin discovered the first synthetic dye and established later a chemical industry to economically capitalize on his discovery.

One of the most successful, innovative inventors was the American Thomas Alva Edison, who managed to be granted exclusive rights over more than 1,000 patents throughout his life. Three of them were the light bulb, the cinema tape-film of 35 mm and the electric chair. His capacity to innovate, and not simply invent, i.e. his capacity not only to have ideas but convert them into products being sold successively in the market, helped to create a large enterprise (General Electric), with its worth standing at circa 21.6 bn $ in 1920. In other words, Edison understood correctly the two-way character of innovation requiring mobilization and coordination of two forces, the technology promise and the market demand.

According to his biographer, Mathew Josephson, Edison had no intention to dwell on organized research. He was driven to this option because he failed to manufacture electric light that could be practically used. This failure made him more determined and he decided to work on scientific research systematically. He was aware of the scientific work conducted previously by other scientists and decided to work hard to achieve what he wanted. Edison's contribution to electricity is a very good example of the ability to convert a commercial opportunity included in an idea into a practical application. In case of inventing an electric bulb, Edison understood that without an electrification point, the light bulb would be simply an idea with no practical value. Therefore, he and his research team began the creation of an electricity generation and distribution infrastructure, including even the design of switches, cables and floor lamps. Edison's contribution proved that innovation is something more than having new ideas. It is the process whereby new ideas acquire practical application. Notwithstanding the diverging definitions of innovation as regards the wording, all of them agree nevertheless that innovation is the elaboration and exploitation of new ideas and not simply their fabrication and invention. The interested reader may skim through the specialists of innovation, such as Freeman, Rothwell & Gardiner, Drucker and M. Porter, Clayton Christensen, and others.

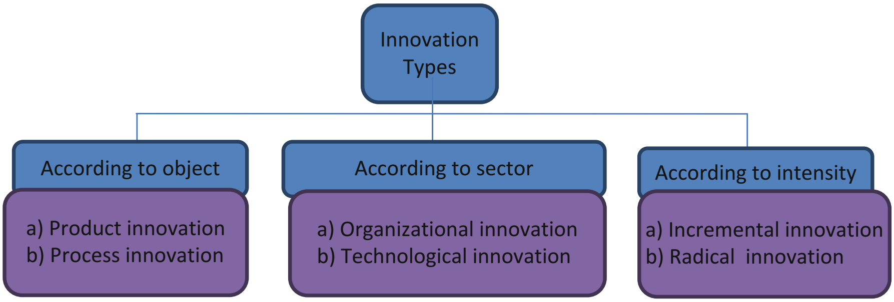
As regards invention in contrast to innovation, some of the most important inventions of the nineteenth century were invented by persons whose name was forgotten. The names we still remember are the names of entrepreneurs who transformed inventions into a commercial value. For example, the vacuum cleaner was invented by J. Murrey Spengler. However, it was W.H. Hoover, leatherwear manufacturer, who launched it in the market. Similarly, the sewing machine was invented by Elias Howe in Boston in 1846, who failed to promote it commercially, though he traveled to England for that purpose. Returning to the USA, he found Isaac Singer to have stolen his patent and having set up a thriving business of sewing machines.

Innovation is therefore the product of the nineteenth century, not of the twentieth century, while invention has existed since primitive times. The driving force was to envisage the opportunity to create new industries, such as the electric railway by Edison. In the twentieth century innovation became the heart of technological effort through systematic organization and institutionalization of applied research in laboratories of Research and Technological Development.

2.3 Types and Characteristics of Innovation

2.3.1 Types of Technological (and Non-technological) Innovation

The types of innovation vary depending on the object, the sector it refers to, the scope or its intensity. These types are not independent one from the other. There exist though some recognizable attributes, without having dividing lines. The types of innovation are classified in three groups.



In the **first group** the classification is based on the object innovation refers to:

- Product or Service Innovation and Process Innovation.

The **Product or Service Innovation** refers to the case when an enterprise introduces a new product in the market or provides a new service. **Process Innovation** is in place when an enterprise introduces new elements in its production process or its operation, being used for the production of a product or the provision of a process.

In some cases the dividing line between these two types is not clear. Separation depends on the organization involved. The emphasis placed by companies on every type of innovation differs depending on the company's stage of development. In the first stages, when the company is small, it adopts product innovations mainly. As the company grows and becomes more complex, it adopts process innovations too. The development of new products is a risky venture as it may inject big profits in an enterprise, if the venture succeeds, but it could also lead to failure.

On the contrary, process innovations, whereby higher production volume, low production cost and higher sales are sought after, are less radical, hence entailing lower risk for the enterprises adopting them.

In the **second group** the classification is based on the sector innovation refers to:

- Administrative or Organizational Innovation and Technological Innovation.

The **Administrative or Organizational Innovation** appears in the administration sector and affects the organizational system of an enterprise, consisting of business executives and the relations between them. In other words, the Administrative Innovation is the introduction of a new administrative system or a new administrative process; it does not introduce a new product or service but influences indirectly their introduction or the production process thereof.

The Technological Innovation pertains to the technological sectors of an enterprise, comprising the equipment and the procedures for raw materials and information transformation into products or services. Technological Innovation refers to the creation, improvement and expansion of the procedures sustained by the products. Technological innovation may refer to the adoption of a new idea relating to a new product or service, or the introduction of new elements in production processes or service provision of an enterprise.

Administrative Innovations are primarily adopted by large enterprises with more complex structures. These enterprises face bigger problems in auditing and coordinating various departments and try to solve such problems through administrative innovations. However, it seems that an increasing number of small enterprises implement Technological Innovations, striving in this way to gain a competitive advantage.

In the **third group** the classification is based on the intensity and scope of innovation:

- Incremental Innovation and Radical Innovation.

Incremental Innovation is the one leading to a relatively small deviation from current practices. It is introduced to improve old products or procedures, without intervening to the existing structure and strategy of the enterprise. **Radical Innovation** brings about fundamental changes in the activities of an enterprise and expresses a significant deviation from current practices. It gives momentum to new business activities, strategies and structures and introduces totally new products.

On average, Radical Innovations are adopted less frequently compared to gradual innovations. They constitute a bigger challenge for the existing structure, as regards determination of executives' duties and cause strong reactions upon the application thereof. They seem more complicated to the members of an enterprise because they are more original and they provoke a higher degree of uncertainty for their conditions of development and application. Usually large enterprises with higher success rates than smaller ones introduce Radical Innovations because the type of these innovations requires technical knowledge and stock of resources. Moreover, large enterprises possess the financial resources capable to absorb the largest part of the cost, in the event of failure and for this reason large enterprises act in a more decisive way.

2.3.2 Characteristics of Innovation

The characteristics of innovation are classified in three axes.

1. Product Axis: Product innovation is in place when a new or improved product is launched in the market.

   The parameters examined under this axis are the following:

- **Market demand:** Demand and acceptance of the product in the market is one of the key criteria for product innovation. It is directly linked to the company's market share and to profit margin.
- **Level of resonance:** It is the level of target-customers locally, nationally or internationally; it is the product acceptance and market penetration yardstick.
- **Optimal use of existing condition:** It is examined whether the existing technology is used in an optimal way relevant to the product and its production. It relates to updating procedures and technology forecast.
- **Price/Value:** The price and value of a product is compared with the prices of corresponding competitive products in the market.
- **Compliance with the regulations:** Compliance with the safety, health, environmental regulations, etc. It is a characteristic of innovation because compliance with the regulations could often lead to qualitative innovative changes on the product.
- **Originality:** It is examined whether the product is a new solution or encompasses changes compared to competitive products. These changes may concern the product, its package, the way it is distributed or its use. It is also a way to evaluate an enterprise's approach to innovation.
- **Offer of improvements:** The product as an evolution of an existing technology, in the sense of using new materials, the existence of new functions, the use of the product in new applications. It defines whether the product brings about changes on the basic design or its architecture.
- **Coverage of operational needs:** Coverage rate of specific operational needs, customer needs, including over-coverage offering additional functions not fully determined by customer demands. It relates to customer requirements analysis.
- **Aesthetic:** The product's outward appeal is a criterion of innovation often underestimated; it constitutes though a key success factor.
- Adherence to intellectual property rules.

2. Process Axis: Process innovation is the introduction of new processes in product development or the improvement thereof.

   The parameters examined under this axis are the following:

- **Market research:** Market research may disclose alternative solutions regarding design, price, distribution and product promotion and offers an estimate of product acceptance and image in the market.
- **Connection to target-customers:** Frequency of contact between the company and target-customers at local, national or international level. The main objective is to establish a long lasting relation mainly with large customers.

- **Access to new technology:** Frequency of the company's contact with the current technological evolutions regarding production of product. It relates directly with departments of R&D, design, cooperation with technological bodies, participation in exhibitions, etc.
- **Costing Methodology:** Costing methodology in all stages of the product development process. Analysis and accurate costing methodology is required to cut the total product production cost.
- **Compliance with the regulations:** Compliance of the product development process with the safety, health and environmental regulations, in parallel with the procedures to verify all the above. Compliance of the development process with the regulations often contributes to qualitative upgrading of the product.
- **Technique of ideas development:** The existence of specific techniques and approaches for the elaboration of new ideas is examined; such ideas affect significantly the development of a successful innovative product.
- **Improvement techniques:** The effort and the techniques to integrate new technologies and uses in the product are assessed.
- **Emphasis on fulfilling operational needs:** Focus of product development process on the specific operational need the product addresses. It involves conversion of requirements to product specifications and relates to the way the trade mark participates in product development process.
- **Focus on aesthetics in the design:** The success of products using a fixed technology and with fixed target-customers depends directly on their attractiveness and their visual diversification vis-à-vis competitive products. The aesthetic aspect of a product in combination with the analysis of its ergonomy is one of the main targets of industrial design. The use of systems and design engineers is assessed.
- **Formal procedures to protect copyright:** It is examined whether the required actions are taken to protect copyright. It is assessed whether an enterprise is geared towards protecting patents and designs and whether the above methodology constitutes its policy.

3. Management (organization) Axis: The introduction of changes in administration and organization constitutes the administrative innovation that completes the first axis.

   The parameters examined under this axis are the following:

- **Feasibility study:** It is the base (technical, economic, commercial) to decide upon an investment.
- **Formal procedures to ensure communication with target-customers:** Such procedures may include participation in exhibitions, sample distribution, meetings with groups of customers, etc.
- **Formal procedures to apply the best technology:** One of the key indications of innovation is systematic follow up of current technological evolution, the assessment of the technological level of competitors, the identification of new technologies and the correct selection of the best technology.
- **Cost control:** Control is a systematic review process applied during the design phase, in order to cut production cost, preserving at the same time the value and

the required operation specifications (value/price) and ensuring the product's sustainability and competitive price.

- **Quality control:** Formal control procedures during the design phase that include use of methods to analyze and improve innovation process quality and processes to safeguard rules applying to date.
- **Organizational culture:** Emphasis of organizational culture on innovation. It has been evidenced that organizational culture relates directly to a company's innovativeness. Some elements of organizational culture placing emphasis on innovation is the encouragement to create new ideas, the clarification of the enterprise's innovation policy to all employees, the determination of performance measurement systems, personnel training etc.
- **Quantitative controls with criteria to assess improvement of technology, new materials, functions and uses:** Introduction of controls with quantitative data and minimum acceptance values to assess improvement of technology, new materials, functions and uses. Processes for the integration and evaluation of new technologies and methods by the company.
- **Quantitative controls with criteria on the satisfaction rate of functional needs:** Introduction of controls with quantitative data and minimum acceptance values to fulfill specific functional needs.
- **Marketing and quality control processes for the aesthetic aspect of the product:** Introduction of marketing and quality control processes to assess and ensure good product aesthetic appeal. It relates directly to production and testing of originalities.
- **Formal control to protect copyright:** Formal control procedures to protect copyright are examined.

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