

KNOWLEDGE MANAGEMENT AT HIGH TECHNOLOGY BASED INDUSTRIES: A SOCIAL ORGANIZATION PERSPECTIVE IN THE BRAZILIAN AERONAUTICAL INDUSTRY

Isabel Cristina dos Santos
Faculty of Economics, Business Administration and Accounting,
TAUBATE UNIVERSITY – Taubaté - SP, Brazil

João Amato Neto
Production Engineering Department,
Polytechnical School – University of São Paulo USP, Brazil

Antonio Henriques de Araujo Junior
Production Engineering Department,
Rio de Janeiro State University – UERJ, Brazil

ABSTRACT

This paper aims to investigate the main social organization aspects that contribute to Knowledge Management in a high technology industry. Main matter questions “how can an industry manufacturing under customer orders, in long-term commitment and lead times, generate a state-of-art-knowledge, considering accelerated moves on technological boundaries based on human resources, organizational culture and leadership as enabling elements?” Methodological approach combined a single case study, supported by documental analysis, questionnaires and interviews. The research conclusions indicated innovative companies in Brazil which have to fulfill their own new knowledge needs due to the lack of a continuous governmental investment program in Research and Development. New technology and competitive requirements demand a cluster of human competencies which can be developed through an educational professional process and a development of people and leadership training since its organizational culture has been continuously nurtured to achieve superior performance in the business model and in the shareholders’ satisfaction.

Keywords: Knowledge Management, Technology and Competitive Arena, Social Organization.

INTRODUCTION

The aerospace industry creation in Brazil can be seen as part of a very comprehensive industrialization plan initialized in the beginning of 1930, when the focus on the national economy has changed from agriculture products to manufactured products. Under this transition scenario, the necessity of providing high qualified human resources has raised up towards attending the brand-new industrialization model. Therefore, a few of infra-structure industries and public services have been implemented aiming to provide raw material and a sort of essential services such as electricity, heated water among others. An agreement between Brazilian and the United States of America governments, in the early years of the Second World War, addressed funding enough to start the Brazilian Steel Company,

seeking to deliver steel to the USA defense industries, which includes the aeronautics segment. Besides the war demands for steel, the competitive arena was open for a new competitor which could have access to the Air Bases in the south of the American continent. To take advantage of this huge opportunity it was mandatory to develop a very comprehensive plan which would include from educational foundations to provide specialized technicians and engineers in Aeronautics field, up to implement laboratories practices, aiming to generate a consistent knowledge in all Aeronautics sciences which would be transferred, some years later, to the local industrial society. But the efforts to produce scientific knowledge locally took at least fifteen years to be applied in the local industries.

PAPER OBJECTIVES

The main objective of the paper is to contribute to the Knowledge Theory development, from analysis of a structured knowledge management model for technology based industries, having as a reference the model of the Brazilian aeronautical industry. To reach the main objective, secondary objectives have been defined, such as:

- a) Identify core business processes and competences seen as a core developing targets to the Knowledge Management Model; and,
- b) Identify the contributions made by Organizational Culture, Leadership and Human Resources to the Knowledge Management Model.

Besides these objectives, this research has been also guided by the analysis of the most influential factors related to technological and business environment to the knowledge management architecture.

The conceptual contribution to the Knowledge Management Model

According to Santos (2004), contemporary knowledge dimensions have been described in terms of: a) Knowledge Theory foundations that underlies the methodology as the main articulated tool to work with several theoretical statements; b) anthropological dimension refers to the human influencing factors to the knowledge creation process by aspects related to the cultural values of a group, their practices of knowledge transferring; and, c) praxis that refers to the use of organized knowledge to achieve a certain result, which requires to combine technical abilities, ethics and sensorial ability, as intuition industrial learning.

The workspace has been analyzed under different approaches such as: Industrial Psychology in 1910 which has given the first outlines to Organizational Development (BENNIS, 1976) in the sixties, to Learning Organization as a behavioral change process (ARGYRIS, 1969; SCHON, 1971; SENGE, 1990) in the seventies, and Organizational Culture (SCHEIN, 1992) in the eighties and nineties. One of the most relevant changes in the workspace refers to the technological innovation applied to Information Systems, Telecommunications and Transport. All these areas have transformed the way that individuals perceive existing reality and time and space relation. Santos (1998) discussed fast technology development as a phenomenon of contemporary acceleration which stuns the common sense of location of a certain society. This acceleration changes knowledge and technology before they are even considered old. Schon (1971) defined an organization as a great social and epistemological system, formed by organizational structure; technology applied; and also, Theory. Other concepts considered in this research includes:

Paradigm of the Complexity (Morin, 1990); chaos, unstable balance and dissolving structures debate initiated by Prigogine (1996) in the seventies.

In terms of business strategic based on knowledge, this research took into consideration some approaches such as: based on firm resources (Hamel and Prahalad, 1995) that fits with some contemporary conceptions regarding to flexible manufacturing systems (Harvey, 1996) strengthening organizational capacities through complementary competences obtained by alliances and industrial partnership (Kanter, 1997). Hamel and Prahalad (1995) have outlined the necessity of a strategic architecture towards to reach a required degree of organizational flexibility to respond promptly to new challenges. Hitt, Ireland and Hoskisson (2002) detach the knowledge levels that are indispensable to the competitiveness in three levels: a) information about resources and organizational infrastructure; b) intelligence based on external and competitive environment information; and, c) expertise that refers to organization capacity to implement innovation. According to Nonaka and Takeuchi (1997) states as insufficient to define organization as huge information processing unit to explain the organizational knowledge innovation creation phenomenon. In that way, the knowledge notion of these authors gives great emphasis to the insights, intuitions, values, emotions, images and symbols. As a consensus, knowledge should be a planned construction aiming to develop a differentiated set of abilities, beliefs, values, attitudes and behaviors, to build up unique organizational culture (Schein, 1992).

Reference model

This research takes into consideration the following concept developed by Fraunhofer Institute to define Organizational Knowledge, which is:

Knowledge Management includes all of the methods, instruments and tools that contribute to the promotion of an integrated process of essential knowledge - tends, in the minimum, the following four activities: to generate knowledge, to store knowledge, to distribute and to apply knowledge - in all of the areas and levels in the way of organization to include organizational performance, focusing on actions that create value to the business process. (Mertins, Heisig, Vorbeck, 2003, p.11).

According to the authors, knowledge is created in a specific cycle around designed field for knowledge management, as it is showed below

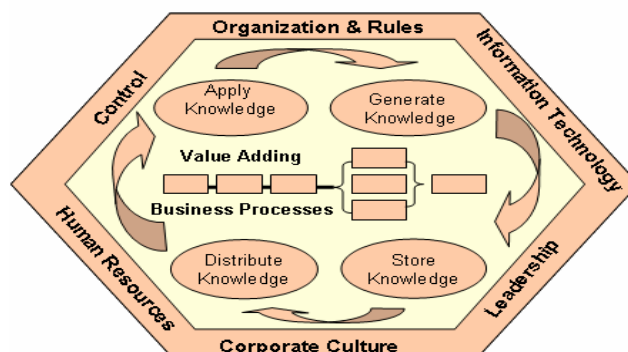


Figure 1: Knowledge Management Cycle (Mertins, Heisig, Vorbeck, 2003, p.11).

The Knowledge Management Model (KMM) above refers to three action levels. The first of them establishes that KMM should be focused permanently in value added to the

business process as they are those that define domains of the knowledge. The second level refers to the essential processes of KMM, which can be empirically divided into four groups of activities, i.e., knowledge creation, storage, distribution and new knowledge application. The third level is designated "Defined Areas for Knowledge Management" and it refers to specific aspects of the organization, such as organizational culture, leadership, human resources, information technology, organization and rules, and control systems. The sixth aspect – control systems- is considered a pre-requisite to measure the results obtained with the activities of KMM. Having as a basic reference the model developed by the Fraunhofer Institute, an initial Model has been formulated, and described below:

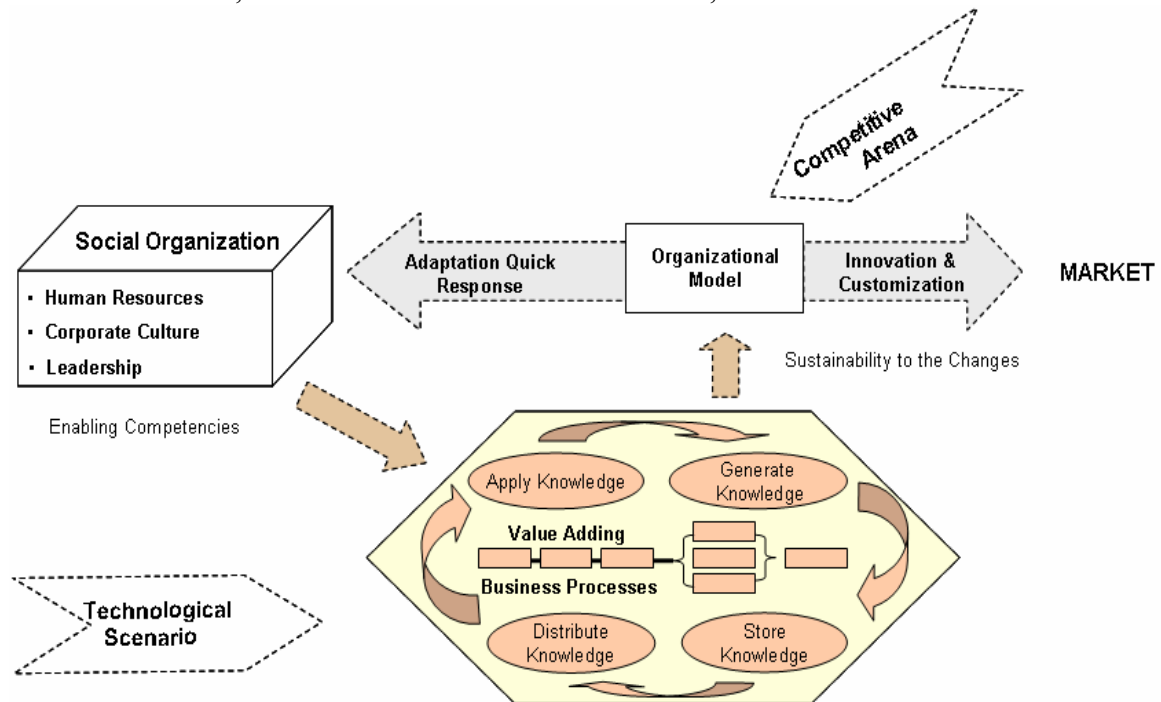


Figure 2 Knowledge Management in Aeronautics industries: Focus on social organization (inspired by Mertins, Heisig, Vorbeck, 2003)

Methodology and methods

The chosen methodology was based on a qualitative approach which has been supported by a documental analysis and an extensive bibliography research. The research strategy has considered a single case study, accomplished by a mix of data collection techniques which has combined these following collecting data methods:

- a) Non-structured interviews guided by an initial script applied to two experts aiming to provide adjustments in the collecting data tools;
- b) Non-structured interviews addressed to a team of nine experts who have been working over twenty years at the company, as executives and also a long term external consultants,
- c) Documental analysis gather from secondary sources combined with bibliographical and historical research, regarding to identify some success milestones in terms of the Knowledge Management Reference Model evolution.

Findings and Practical Implications

Organization for Economic Co-operation and Development - OECD – classifies as high technological intensity industries these sectors: aerospace, computers, electronic and office equipments and pharmaceutical industry. Inserted in the highest intensity class of technology, Brazilian aeronautical industry was considered a late comer in this field, but in the last years this industry has experienced to lead the global regional jet market, is characterized by the autonomy in the conception and project development; and an extensive and complex suppliers' chain management. To reach such performance three facilitative aspects were identified for the generation of the knowledge. The first regards the historical and political context when the industry was created under the involvement of the State in the choice of the industry for technological nationalization. The second aspect refers to the specific context of the sector, having in mind the great number of sciences involved and the formation of a national technological pole. The third aspect is related to the individuals' engagement around a common objective.

Research results

At the beginning of the formulation of the Model and for effect of orientating the research and for using the instruments, some questions were formulated in order to test some parameters and paradigms in the case studied company. Results are presented as follows:

- Which would be the main technological environment agents in the local Aeronautics field and what level of relationship they have with high technological innovation process in that industry? One of the main agents of the institutional areas is the government, mainly by volume of purchases, as no other agent would have enough resources to feed the process of R&D of the industry. All of the changes of orientation of economical politics consider relationship of the industry within the institutional sphere.
- During the industry's first steps, knowledge had a character of incremental growth, mobilized mainly for technological development of the sector, particularly guided by National Defense. This way, can it be affirmed that Knowledge Management emphasis was in technical matters? There is a consensus that, since the beginning, the company developed technological and market competences which are still effective in the current Model since the beginning of the industry.
- Is it correct to affirm that in that phase, was the company seen as a local "company with an international market", forming a strong culture of National Airplanes Manufacturing? Organizational culture traced two different groups. The first group, political leadership, with larger permeability in the political and technological institutional atmosphere, and strategic vision of the market; and the second group, formed by operational leadership, which recognizes the culture as clearly guided to be a National Airplane Factory.
- Due to the National Company Model, did the factors associated with Human Resources impose on local and national recruiting, and technical knowledge? Local sources used were the main providers of highly qualified professionals in Aeronautical Engineering and correlated areas, and in aviation, engineering and flight performance. Knowledge generation tool used was mainly based on Continuous Education and international exposure for professionals considered as key-people. The internal atmosphere promoted the cooperative work and the action

of Development of People was ruled in the premise of knowledge of "how to do" and of "reason to do" - know-how and know-why.

- Was the leadership profile guided technically, and did the career vision privilege the engineers' formation, and in specialist areas? At the beginning of the industry, technical profile, technological and marketing competences and business - with focus on the financial performance and strategic business management- marked an important change on leadership, prevailing until nowadays technical background in the aeronautical sciences and engineering, except for specialist areas.
- With the change of the business Model, from a National Company to a private enterprise, did Knowledge Management pass technical focus to the systemic focus, privileging the competitive positioning of the company? The Company since the beginning was focused in regional niche. In association with its business competence resulting from the change in the shareholders' profile as a propeller for entrance of organization in the niche above 50 seats, taking advantage of discontinuous conditions, i.e., tendencies of demand for the product in the market of medium load, the industrial infrastructure already installed and the low concentration of manufacture of great load and the good performance of risk partnerships. The change in the business management style was previously characterized by the shortage of resources and by low autonomy, as a private company it started to be oriented by the attendance of targets and the Return on the Investment of the Shareholders' expectations.
- Did knowledge generated along the development of the industry's competences allow a reduction in the level of high technology - systems, components, materials – international supplier's dependence? The sector had an initial level of 100% dependence on international suppliers. In the years that preceded the change of the management model, with the development of EMB 145, the level of internationalization of the product had been reduced by 75%. Nowadays, the product exhibits a level of nationalization around 50%.
- Business dynamics scenario in association with a cluster of conception and product development competences, and also, business focus changed from international market to a planetary perspective. Besides the discontinuous conditions on competitive niches, it highlighted the need for a new strategic orientation to cover organizational capacities for a new niche characterized by the medium load of aircrafts - 70 and 108 passenger seats. The mobilization of the resources for the entrance of the company into a new market niche elapsed, in fact, the need of the organization to look for competitiveness in more promising segments according to the industry tendencies. Information obtained during the interviews indicated that Knowledge Management reinforced competences in project development and product conception.

Questionnaires and Interviews

From these collecting data techniques applied to group of experts, aiming to reach an internal perspective on the Knowledge Management Model was to describe the following set of questions:

- Which are considered the most important functional and operational processes to the Knowledge Management Model? Research indicates two clusters of processes considered important to the KMM. They are:
 - Operational Processes
 - Technological Development: Including Research and Development, Project Management and Electronic Mock-up Implementation
 - Product Conception: Reducing time consuming through the Simultaneous Engineering Systems to integrate product Experts team.
 - Manufacturing Systems: Lean Manufacturing Implemented
 - Strategic Partnerships Management: Technology integration
 - Customers Management: Customization on Executive product line, financing source identification, delivering products as soon as possible, reducing lead time, new market and new services development
 - Management and Staff Processes
 - Continuous Education: Define special programmes to develop Human Resources and Leadership Style
 - Strategic Business Management and Business Performance Control: Managerial and capital market competencies development in association with performance control tools and systems.
 - Information Management: Implementing systems such as: Enterprise Resources Planning, Business Intelligence, Electronic Documentation Management
 - Continuous Improvement and Organizational Changing Management: Through a cluster of initiative to enhance workers suggestions, to share experiences and learned lessons and also, Improvement Committees.
- Is innovation possible due to the fast displacement of the technological boundaries? The expression “innovation technology” itself must be considered under the lead time perspective. The long term lead time is practically the same for all players in Aeronautic manufacturers. That why, even a simple time reduction in the production or conception cycle can become a strong competitive advantage no matter how fast the technology boundaries displaces.
- How could Knowledge Management Cycle include strategic suppliers into the process? Knowledge generate within a high technology based industry aims specifically new technology applicability, which will bring an appropriate Return on Investment, and benefits to be shared with strategic partners, customers and suppliers. Including strategic partner in the Knowledge Management Cycle, i.e., generate, store, distribute and apply new knowledge, means to establish long-term bonds what imply loyalty and risk sharing in a certain proportion. The analyzed company possesses some incentive programs and the partners' recognition awards which includes key suppliers. This incentive program involves the concession of prizes, granted in the form of means, as anticipation of payment part and others that support the construction of ethical and financial bonds with partners and suppliers. It has been a quite efficient formula in the interviewees' opinion.
- How can the company guarantee confidentiality and exclusivity into the productive chain, in case of technological innovation? There is a consensus among all experts interviewed about confidentiality and exclusivity on the technological innovation towards to the conclusion they are not possible to be guaranteed and two reasons

explain this constraint. First one refers to the investment made by the partners on a particular functionality or component they produce involved in the technological development. All the gains obtained through this learning process belong to the partners, including commercialization rights. Second reason is related to the communality aspect: the innovation tends to be appropriated to the others players products in certain point of the communality there was.

- How does new knowledge come to be a strategic asset to the company? Since the very beginning knowledge was considered a strategic asset not only for the company but also for the Nation. All Aeronautics knowledge was located abroad, in North America and Europe. To create a national aeronautic industry it was imperative to create the Aeronautics Sciences knowledge foundations, which was possible through Aeronautic Technical Center and its related institutes. Academic education has inaugurated the effort for nationalizing Aeronautical knowledge through CTA and its institutes. And educational approach has been kept along the industry implementation as a strategy, till nowadays.
- Knowledge Management Model in high technology based industry is more sensitive to the Technological Environment or to the Business Environment? According to the interviewed experts, the Knowledge Management Model would be more sensitive to the Technological Environment than the business. However, aeronautic industry provides itself financial resources for Research and Development. It means a tenuous tendency for Business Environment creates bigger impact than Technological Environment due to the dependency of a healthy financial management in order to provide capital enough for R&D activities to sustain its competitiveness.
- What are the most relevant change management initiatives to support transition from a National Company corporate culture into a private company? Company has experienced decreases in its financial performance before privatization process. To improve its performance a break-through process would be implemented. It calls a great number of fast changes which include headcount massive dismissal; cut off no lucrative products and services, and they also implemented a turn around business strategy towards to reach better results. All Sales effort was focused for selling the most promising product. According to the consultant interviewed, despite of the fact all leaders were suffering, since many of them were dismissed, they were committed with the change which was seen as the only manner to succeed. Some of them have been hired again.
- Which are considered perennial values in terms of Human Resources, Corporate Culture and Leadership? After privatization process a cluster of values has been defined considering the legacy from past virtues and future challenges. They can be summarized as:

Human Resources: Both Technical and Marketing Talent; recruiting globally when and if it is necessary; hire professional skilled in Market Analysis, Business Management and Technology, capacity to improve performance continuously, even under pressure; increase international exposure as a learning process such as: job rotation, fairs and missions, studies and international project team; develop new knowledge through Research and Development initiatives, consider Business Intelligence Systems as a must.

Corporate Culture: Follow the rules as a Global Player; integrate high technological systems for the product aiming to reach high technological customers services; keep focused on Stakeholders Satisfaction and Competitiveness.

Leadership: Oriented to reach global competitiveness, return on Investment is seen as the right way to provide business longevity, skilled to deal with political aspects, technological opportunities and technical constraints, autonomy for decision making based on Business Plan, agility in searching and applying resources.

Documental analysis from secondary sources, bibliographical and historical research

This topic will present some of the most remarkable aspects found along the during the whole research process aiming to lead documental analysis to finally respond investigation problems previously described.

Referring to the main question, there are three facilitative aspects were identified for knowledge generation. The first one is regarding to the political context Brazilian Aeronautics industry creation and National Government option for nationalizing such technology knowledge and manufacturing capacity to attend both Military and Civil jet markets. The second aspect refers to the specific context of the sector and its complexity to create a high technology national pole. The third aspect is related to the individuals' engagement around a common objective, along the development of the industry.

CONCLUSION

The articulation between elements from social organization to the company new technology requirements adaptation process, there was a consensus among interviewees: company strategy includes continuously updating their intellectual assets in Aeronautics innovation technology and in related Sciences. This target is achieved through Research and Development, Education process, personal development and leadership training. Regarding to the organizational culture, the main sustentation levers of technological competitiveness are ruled in continuous improvement, focusing on customers' satisfaction and, more recently, shareholders' satisfaction.

Some aspects in the proposed Knowledge Management Model must be highlighted. The first of them refers to the focus on the social organization aspects. Others elements like Information Technology, Control, Organization and Rules assume an instrumental relevance to the business processes and to the inherent stages of the Knowledge Management Cycle. The second aspect refers to the invigoration of social and technical competences related to the knowledge application, such as strategic orientation and vision, decision making and risk taking. These competences appear as a priority to the Knowledge Management Model in order to define autonomy levels needed to re-create an organizational culture characterized by innovation and continuous improvement. The third aspect pointed out by the model is leadership role which includes leading people to challenge existing knowledge regarding innovation and continuous improvement. Mentoring and coaching attitude are essential on the leader profile, considering high technology based industry. The fourth element refers to the influence of the Businesses Management Model in the Knowledge Management table of contents. It means businesses management model defines a cast of priorities to the Knowledge Management practices enabling the company to promptly respond to the new demands of the competitive scenario and put an adequate level of pressure on leadership for better performance and innovation.

It is possible to adopt effectiveness in the Knowledge Management Model as a process in continuous evolution that allows creating a critical community, with necessary emotional maturity to dare and to challenge paradigms in every technological, marketing or organizational matter. In the case of the aeronautical industry, the knowledge was built starting from the ideal of the creation of the Model of industrial development for the country, in the passage of the agrarian Model for the industry, for which the conditions of basic infrastructure were created. In that sense, a generalization should consider the limits of the historical and political base of the context of its installation.

This work hopes to have given some contribution to future studies concerning Knowledge Management Theory and also hopes to have called the attention of those researchers who are interested in the theme related to social organization as an effective factor to perform the Knowledge Management Cycle and generate innovation.

REFERENCES

- Bennis, W. (1976). *G. Organizações em Mudança*. São Paulo: Atlas.
- Harvey, D. (1996). *Condição Pós-Moderna*. São Paulo: Loyola.
- Hitt, M.A., Ireland, R.D., Hoskisson, R. E. (2002) *Administração Estratégica*. São Paulo: Pioneira Thomson Learning.
- Kanter, R. M. (1997) *Quando os Gigantes Aprendem a Dançar*. Rio De Janeiro: Campus.
- Mertins, K, Heisig, P, Vorbeck, J. (2003). *Knowledge Management: Concepts and Best Practices*. 2ª Ed. Berlin. Spring-Verlag.
- Morin, Edgard. (1990). *Introdução ao Pensamento Complexo*. Lisboa: Instituto Piaget.
- Nonaka, I, Takeuchi, H, (1997). *Criação de Conhecimento na Empresa*. Rio De Janeiro: Campus.
- Prigogine, I. (1996). *O Fim das Certezas*. São Paulo: Unesp.
- Santos, M. (1998). *Técnica, Espaço, Tempo*. São Paulo: Hucitec.
- Santos, I.C. (2004). *Um Modelo Estruturado de Gestão do Conhecimento em Indústrias de Base Tecnológica: Estudo de Caso de uma Empresa do Setor Aeronáutico*. 2004. 185 p. Tese (Doutorado) - Escola Politécnica da Universidade de São Paulo - Departamento de Engenharia de Produção.
- Schein, E. (1992). *Organizational Culture And Leadership*. San Francisco: Jossey-Bass Inc.
- Schon, D. (1971). *Beyond The Stable State*. Nova York: Norton Library, 1971.
- Senge, Peter. *A Quinta Disciplina*. São Paulo: Best Seller, 1990.