ACTION RESEARCH: THE FORMATION OF A MANUFACTURING VIRTUAL INDUSTRY CLUSTER

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Despite of the benefits that a virtual enterprise is supposed to provide to its partners, a prior task is to perform the competence matching and integration, in order to enhance the virtual enterprise's potential success. An appropriate approach for solving such task is the formation of Virtual Organizations, constituted of a Virtual Industry Cluster - the focus of this paper - and a Virtual Enterprise Broker. In this paper, it is shown and discussed how the task of creating a Virtual Industry Cluster was performed, by using the method of research action. Finally, an important result - the obtaining of a reference model - is discussed by the point of view of the Brazilian industry.

1. INTRODUCTION

Virtual Enterprises VE's are a response to the speed and globalization of the digital age Facing new requirements that are rapidly arising, companies find often that they do not own all the necessary competencies to fulfill those requirements (Jagdev & Browne, 1998). Thus, VE'S denote today a trend in globalized industry scenario, because of its potentiality in providing agility and flexibility associated to the capability in problem-solving of manufacturing issues, like new product development or production of ETO (Engineer to order) goods.

This is possible due to the concept of concentrating on core competencies of its partners, looking for achieving a synergic cooperation, using the "best of its class" skills, like business processes and technologies that embody a core competence.

Because the VE represents a market-oriented organizational form, according to Picot et al. (1997), the more the specificity of the tasks to be performed is, the higher the transaction costs are. By using Information Technology (IT) resources as integration tools, the partners face the possibility of lowering the transaction costs associated with the VE itself.

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This approach encompassed by VE's, of joining different parts to obtain competitiveness, is remarkably interesting for Small and Medium Enterprises (SME's), which very often miss the necessary resources to accomplish their tasks towards the established strategies. By participating in VE's, SME's have an efficient and cheap access to new resources, knowledge and also markets, with lower associated risks.

The more successful a VE is, the better is the identification and the integration of the required competencies, regarding issues like the availability of such competencies and the capability of each partner in providing the competence for the VE.

2.1 Competencies integration

Several authors proposed different definitions for what is called "competence", or "core competence" of a company. According to Reiss & Beck (1995), it is possible to establish an evolutionary path through time for business strategies formulation, starting from the product orientation, passing by market orientation until competence development and deployment. In this last case, a competence may be understood as a complex set of interdependent skills; among processes, organizational and interaction ones (Reiss & Beck, 1995).

In the MOTION project's final report, Teerhag et al. (1996) define core competence as the profitable usage of skills aiming at an objective oriented performing of a task. Österlund (1997) proposed that a core competence is not represented only by knowledge - tacit or explicit - but by a set of elements as skills, experience and values.

Hamel (1994) defined three levels of abstraction for competencies within a company, which are described below:

- *Meta-Core Competencies*: they represent the highest abstraction level for a competence. Meta-core competencies represent what makes a company recognized. Examples of Meta-core competencies are engineering excellence for Daimler-Chrysler, innovation for 3M;
- *Core Competencies*: at this level, a competence is considered an aggregation of constituent skills. Examples are culture of innovation in 3M, cross-functional engineering in Daimler-Chrysler;
- *Constituent Skills*: they are the basic capabilities of a company, which may compose a company's core competence. Examples: information technologies of Daimler-Benz, manufacturing systems of Toyota.

However the concept of core competence looks innovative and promising for competitive environments, the definitions offered in the literature focus on either the output of competencies (that they create value for the customers) or the attributes of competencies (they are difficult to imitate) (Drejer & Riis, 1999). There is a gap in showing how to evaluate companies' products, technologies and processes, considering them as constituent skills - building blocks - of the companies' core competencies.

The main reason to consider those "building blocks" instead of core competencies - like Prahalad & Hamel (1995) defined them - relies on the fact that when the integration of partners becomes real and necessary to set up a VE, it has to deal with tangible skills. These so-called "tangible skills" are the enterprises' core competencies' constituent skills, which are the products, business processes and technologies owned

by the companies (Figure 1). Once the constituent skills are integrated, the VE becomes able to operate the business it was created for.

Figure 1 - A representation for core competencies with different levels of abstraction

The capability of setting up a VE can be improved by an Internet-based information system (Bremer et al., 1999a). Independent *brokers* can operate these systems, although, the existence of communities dedicated to competence information sharing for the formation of VE's - may increase the capability of quickly setting up such networks.

3. VIRTUAL ORGANIZATIONS

The communities previously described have attributes of industry clusters (Anderson, 1994) and of virtual communities (Hagel & Armstrong, 1997). Common attributes are then the type of cooperation to be performed within the cluster (buyer-supplier, competitor-collaborator, and shared information) and issues like the capability of giving the cluster a defined focus, integration of content and communication and the brokering of the cluster's content. (Anderson, 1994; Hagel & Armstrong, 1997).

Within the Framework for Global Virtual Business (Bremer et al., 1999b), this community and the tasks it is supposed to perform, is represented by a business entity called Virtual Organization (VO). The Framework is composed by the Virtual Industry Cluster (VIC), the Virtual Enterprise Broker (VEB) and the Virtual Enterprise (Figure 2).

Figure 2 - The Framework for Global Virtual Business

The VIC is an aggregation of companies from diverse industries, with well-defined and focused competencies, looking for gaining access to new markets and business opportunities by leveraging their resources.

The VEB is the business entity is responsible for searching business opportunities and enabling the creation of VE's. The VEB performs the activities of partner search/selection, competence integration and the configuration of suitable infrastructures (information, physical, legal and cultural). The VEB is much a functionality that can be assumed by several different actors, like non-associated companies, people from the VIC companies, or even a system.

The VO will be itself defined when the VIC is able to assume or assumes the VEB functionality. Thus, like Kocian & Scheer (1996) have proposed, in the Framework for Global Virtual Business the Virtual ENTERPRISE and the Virtual ORGANIZATION have different meanings and purposes.

The VO is a stable cooperation basis, formed by different companies, which share information about their competencies for enabling the set up of VE's, through the VEB entity. The VE is a dynamic and temporary network, focused on exploiting a business opportunity, and it is a result of VEB's action. Common attributes are the infrastructures defined by the VEB, which are inherited by the VE from the VO.

The first necessary step to set up a VO like the Framework for Global Virtual Business proposes, is the creation of the VIC. The Framework is being used in applied research with industry partners, by members of the *COSME* project (*COSME* is the legend for *Cooperation of Small and Medium Enterprises*) (Bremer et al., 1999b) to create different VIC's.

The Brazilian case is related to the *VIRTEC - Virtual Organization of Technology* project, and it accounts today nine high-technology manufacturing SME's from the city of São Carlos, state of São Paulo. Despite the Framework defines the activities for all the business entities; it did not provide any model or method to implement the entities, even though all the desired results to be achieved are known (the business entities themselves and the capability in performing their related activities).

Based on the results to be achieved and the study of different approaches proposed by the discipline of research methodology, it was used the method of action research.

The main advantage of such method is that it made the enterprises active within the research process, improving their sense of commitment with the project.

4. THE USE OF ACTION-RESEARCH AND THE VIRTEC PROJECT

Action research is a research method. By itself, research methods do not determine the success of a project it is related with, but they do help the conducting of the activities with precision and focus.

According to Dick apud Thiollent (1999), action research is "... a research methodology that simultaneously looks for action (or change) and research (understanding) goals. The action research does it by means of a spiral process, alternating between critical action and reflection, looking for both action and understanding improvement in each cycle". The VIRTEC project was undertaken by NUMA - Nucleus of Advanced Manufacturing from the University of São Paulo at São Carlos. It is the NUMA performed a double role, as an agent (implementing the necessary steps and leading all the activities) and as an observer (evaluating the achieved results, during and after the related planned activities), assuming a strongly reflexive character.

According to Bremer et al. (1999b), the VIC must be able to:

- Search and select its members;
- Identify and evaluate the core competencies of its members;
- Perform its marketing;
- Manage the aggregated competencies.

The project's planning was conceived foreseeing 8 steps, encompassing the creation and/or the implementation of all the necessary methods and tools for the VIC activities, as described above.

The defined steps were:

1. Define the focus of the VIC and search the potential members;
2. Apply a profile questionnaire, in order to obtain a macro "portrait" of each potential member;
3. Pre-select the members and consolidate membership;
4. Create internal staff for the VIC/VO;
5. Apply and perform Benchmarking analysis;
6. Create and validate a competence evaluation method;
7. Implement infrastructures (information, legal, cultural, physical);
8. Create and validate a competence marketing strategy and
9. Compile the steps in a formal methodology.
 - Each step was evaluated during its occurrence and after that, giving place for interference with the research process. This dynamic character implied on the change of some of the initially proposed steps for the project. These steps were:
- *Create internal staff for the VIC/VO*: initially, only two types of role were expected. The first type, should be played by the partners of the VE's and by neutral agents defined inside the VIC. These agents were the general coordinator, the financial manager and the VIC council. Because the specificity of the tasks shown themselves greater than firstly expected, for

each business entity of the Framework for Global Virtual Business a set of business process was attributed, with respective key roles. In this paper, only those related to the VIC are shown (Table 1).

Table 1 – Business processes and key roles in the VIC

Business processes	Roles
<ul style="list-style-type: none"> - Create the VIC - Define the VIC focus (competence or region) - Define the VIC strategy - Search/select members for the VIC - Qualify potential members - Define members of the VIC - Consolidate VIC's strategy - Formalize the VIC's contract 	<ul style="list-style-type: none"> - These tasks are all performed by a <i>CATALYST</i>, who is a neutral entity that starts up the Framework.
<ul style="list-style-type: none"> - Manage the VIC - Perform VIC marketing - Generate trust culture in the VIC - Manage Conflicts - Perform continuous members evaluation 	<ul style="list-style-type: none"> - Operational manager - Operational manager - Network coach - Network coach - Network coach
<ul style="list-style-type: none"> - Manage information about core competencies - Identify and classify competencies - Manage information about VE 	<ul style="list-style-type: none"> - Network coach - <i>CATALYST</i>/Network coach - Network coach/Operational manager

- *Apply and perform Benchmarking analysis*: the chosen methodology initially considered well fitted with the project expectations, shown itself not so adequate. Attending to interference performed by the industry members of VIRTEC, a complementary qualitative analysis was developed and applied. This analysis should find out the processes and activities - in each company - that was demanding critical improvements.
- *Implement infrastructures (information, legal)*: initially, there was a discussion of "how much" IT should be necessary for the VIC and the influence it would have on the success of the project itself and of future VE's. Systems for telecooperation and an intranet site were foreseen, but because the VIRTEC members are geographically close and the investment on such resources was high and uncertain, the required information infrastructure became resumed to telephone/fax and Internet access, for asynchronous communication. About the legal infrastructure, initially only an ethics code would be used. No legal instruments - like contracts - should be used, aiming a bigger flexibility and the valorization of a trust culture. Also by the interference of the industry members, the ethic code gave birth a special kind of contract, the cluster contract.
- *Create and validate a competence marketing strategy*: initially, traditional advertisement (like folders, personal cards, announcements in newspapers,

and technical magazines) and also an Internet site were prepared. The marketing focus was driven to potential outer customers, but due to the new concepts the project brought with, it was noticed that the VIRTEC were also customers of the project. There was a gap with the industry members concerning the project goals, motivations and advantages. Also, there was a lack on mutual knowledge about competencies each one have. A small booklet was prepared, gathering theoretical references, other projects concerning VE's, the involved staff (from the companies and from NUMA) and basic information about each member's skills and attributes (like income, market segment, products, and so forth).

- *Compile the steps in a formal methodology*: the most important goal was to achieve a formal methodology. However, given the practical sense of the VIRTEC project, the methodology gave place to the achievement of a reference model, and, this reference model should not be a goal itself, but a result of the use of action research (there was no other reference model when the project started). Thus, after validating the proposed steps, a model should be formally designed, using the ARIS (*Architektur für integrierte Informationssysteme*) methodology and toolset.

5. FINAL COMMENTS

In developing countries like Brazil, the creation of VIC's and VO's enables a better business landscape. After the phenomena of globalization, local industries face foreign competitors that "arrive" ready to gain market-share.

By grouping in VIC's or VO's, SME's reinforce their local advantages of knowing their customers, markets and suppliers and diversify their portfolios of products, markets and competencies. Moreover, SME's acquire a new apparent size, they can look bigger then they really are. In the case of VIRTEC, the enterprises together have an income of US\$ 30,000,000.00 and 400 employees, actuating in machine-tools, engineering plastics, recyclable rubbers, castings, electronic instrumentation, house utilities and so forth.

There are already two products that were "born" inside the VIRTEC project (a recyclable polyurethane hammer and a drying-machine damper), and a third one that is being conceived (a power wheelchair) (Bremer et al., 1999a).

A second case of VO that is using the model developed during the VIRTEC project is the creation of a VO focused on the segment of dies for metal forming and plastic injection, on Southern Brazil. This case of VO groups 8 different competitors that identified the need of joining their resources and competencies to increase both internal and external competitiveness and it is called VIMAX.

When making part of research projects - like VIRTEC - the companies decided to contribute for the validation of a model of cooperation, having their counterpart in expecting the increase of their incomes. It is not an easy task, because the necessary involvement and commitment take time to be created and they are a key factor in finding out and exploring new business opportunities. The bigger the sensation of trust and mutual knowledge among its members the VO has, more business opportunities may appear. This issue is closely related to the cultural infrastructure, observed at the project occurrence and an important contribution for the Framework as well.

Finally, it possible to conclude that the use of action research in applied research has shown itself valid and of great valor, because it made possible the achievement of a reference model, a missing piece for the implementation and/or replication of the Framework for Global Virtual Business.

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7. REFERENCES

1. Anderson, G. . Industry clustering for economic development. *Economic Development Review*, v. 12, is. 2, p.26-32, Spring 1994.
2. Bremer, C. F.; Mundim, A. P. F.; Michilini, F. V. S.; Siqueira, J. E. M.; Ortega, L. O. A Brazilian case of VE coordination. PRO-VE - Pro Virtual Enterprise, Porto, Portugal 27-28 Oct. 1999a.
3. Bremer, C. F.; Eversheim, W.; Walz, M.; Molina, A. (). Global Virtual Business: A Systematic Approach for Exploiting Business Opportunities in Dynamic Markets. *International Journal of Agile Manufacturing*, 1999b, v.2, n.1, p.1-11, jan.-fev.
4. Drejer, A.; Riis, J. O. . Competence development and technology: How learning and technology can be meaningfully integrated. *Technovation*, 1999, n. 19, pp.631-644.
5. Hamel, G.; Heene, A. Competence Based Competition. Chichester, John Wiley & Sons., 1994
6. Hamel, G.; Prahalad, C.K. Competindo pelo Futuro. Rio de Janeiro, Campus, 1995.
7. Hagel III, J.; Armstrong, A. G.. Net gain - Expanding markets through virtual communities. Harvard Business School Press, 1997
8. Jagdev, H. S Browne, J. . The extended enterprise - a context for manufacturing. *Production Planning and Control*, 1998, v. 9, is.3, p.216-229.
9. Kocian, C.; Scheer, A. -W. . Kiesel - Das Virtuelle Umweltkompetenzzentrum – Theorie und Praxis der Virtuellen Unternehmung, M&C Management Sonderdruck, 1996.
10. Österlund, J. . Competence Management by Informatics in R & D: The Corporate Level. *IEEE Transactions on Engineering Management*, 1997, v.44, n.2, p.135-145, mai.
11. Picot, A.; Reichwald, R.; Wigand, R. Information, Organization and Management – Expanding Markets and Corporate Boundaries. London, John Wiley & Sons, 1997.
12. Reiss, M.; Beck, T. . Kernkompetenzen in virtuellen Unternehmen – Der ideale Strategie-Struktur-Fit für wettbewerbsfähige Wertschöpfungssysteme ?. 1995, Universität Stuttgart.
13. Teerhag, O.; Dresse, S.; Kölscheid, W.; Nieder, A. () Model for Transforming, Identifying and Optimizing Core Processes (MOTION). Rheinisch-Westfälische Technische Hochschule – Werkzeugmaschinenlabor, Final Report., 1996.
14. Thiollent, M. . Ergonomia no Processo Produtivo, Curso2 - Pesquisa Participativa. UFSCAR, mar., 1999