Chapter VI

Information Technology for Intelligent Metabusiness

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This article presents a framework to integrate effectively different Information Technologies in order to raise the intelligence and manage the knowledge of a metabusiness, an innovative business model. The concept of intelligence in a metabusiness is analyzed and the information technologies needed to create this new business environment are presented, as well as an integrated model based on a technology-service-process-production taxonomy. A case study addressing a major engineering company in Brazil, now playing the role of an integrator within a metabusiness is presented in order to validate the proposed model. The main obstacles and hurdles to accomplish an intelligent metabusiness are presented as well as the solutions to overcome them. Future trends and some conclusions in this realm are presented, mainly the ones regarding how to leverage the Human and Innovation Capital in a metabusiness.

OBJECTIVES

One of the greatest challenges of the new Knowledge Economy is to deal with several innovative business models, i.e., the ones that challenge traditional notions of structure, coordination and control. When all the tasks and processes of an enterprise are centralized in just one company, it is easier to organize and manage the knowledge accrued from a project. However, a lot of different players can now be involved in major projects in innovative business models. Hence, how is it possible to manage and store the knowledge generated during an enterprise, so as to use it during the current project and not to lose it at all for future projects?

A metabusiness or a relational company - also named virtual organization - is a quasi-firm created through digital links among several companies, in such a way that it is almost impossible to know exactly its boundaries (Keen, 1991). A
metabusiness – as an innovative business model - is also independent of its organizational structure, as each node has its own structure that can be changed without interfering in other nodes’ structures.

“The Organization is its Formal Structure” and “Structure follows Strategy” (Chandler, 1962) are two hypotheses challenged by metabusinesses that wisely use Information Technologies.

The main objective of this paper is to integrate effectively different Information Technologies to raise the intelligence of a metabusiness in charge of a major project or enterprise, through the creation, deployment, sharing, storage and retrieval of both tacit and explicit knowledge.

**THEORETICAL FRAMEWORK**


Notwithstanding being very important, this research just taps on how to create, deploy, transfer, store and retrieve the intelligence of an enterprise encompassing a lot of different companies, in different places, with different - although important - duties. Therefore, the next logical step includes expanding the research to ongoing and ad-hoc intraorganizational groups. In order to accomplish this, it is paramount to understand how Information Technology can leverage and strengthen the knowledge links among the players of a major project involving a lot of subcontractors, suppliers, and other firms.

This study analyzes the role and impact of the Information Technologies in three branches of a metabusiness: its degree of connectivity, its degree of sharing and its degree of structuring (Haeckel & Nolan 1993). These three parameters are considered vital to establish the intelligence of a metabusiness and its expertise to manage the involved knowledge.

The connectivity issue addresses the “degree of reach” of the metabusiness, i.e., if and how the involved companies are linked within the metabusiness in order to transmit data and information among themselves.

The sharing issue addresses the “degree of range” of the metabusiness, i.e., the type of transactions developed within the metabusiness, and the way the companies are working together, in order to set up a workgroup environment.

Finally, the structuring issue deals with the ability that the companies have to extract knowledge from the data and information retrieved and shared by them. As is known, knowledge - either tacit or explicit - is much more than data and information, and according to the Autopoiesis Theory (Maturana & Varela, 1980) is created when a “structural coupling” occurs with the workers. This research shows that this issue is a key point for the success of an enterprise, and the one where the major flaws and drawbacks occurred. People have great difficulty to transform raw data and information into knowledge, as well as tacit to explicit knowledge,
notwithstanding several frameworks explaining how this can be processed, as the Knowledge Spiral from Nonaka & Takeuchi (1995). The current educational system hinders workers to learn how to learn, making it difficult for them not to create standardized mental models to deal with new knowledge.

Hence, different technologies such as EDI (Electronic Data Interchange), EDMS (Electronic Document Management Systems), Workflow Systems, Internet/intranet/extranet and mainly WBI (Web-Based Instruction), just to name a few, are integrated to leverage the metabusiness’ intelligence.

In a metabusiness, the integrator keeps the core competency of the business, outsourcing most of the other productive processes. The integrator is in charge of managing dependencies and restraints among the players and their due processes, coordinating the transactions among the involved partners.

According to Prusak (1997) some trends are forcing companies to be engaged in a metabusiness, such as the globalization of the economy and the terrific pressure on firms for increased adaptability, innovation and process speed; the awareness of the value of specialized knowledge, as embedded in organizational processes and routines of the nodes of a metabusiness; the awareness of knowledge as a distinct factor of production; and cheap networked computing which is at last giving us a tool to work and learn with each other.

During the development of an enterprise, data and information are exchanged among the players compounding the metabusiness. Data and information are not knowledge, although often considered as such. There is great misunderstanding and confusion about the differences between data, information and knowledge.

**Data, Information and Knowledge**

Data means a set of discrete and objective facts concerning events. Therefore, it can be understood as a structured record of transactions within an organization (Davenport & Prusak, 1998).

Information is data that makes difference and is relevant, or as Peter Drucker says: “information is data with attributes of relevance and purpose”. Normally, information is understood as a message, usually having the format of a document or visual and/or audible messages. Information is, above all, context-based.

Knowledge is linked to the capacity of action (Sveiby, 1997). It is intuitive, therefore hard to be defined. It is linked to the user’s values and experience, being strongly connected to pattern recognition, analogies and implicit rules. Most of the time, knowledge within an organization is located both inside employees’ heads (tacit knowledge) and in documents (explicit knowledge). This can explain why too much confusion has arisen between Document Management and Knowledge Management.

Although it is a generally accepted distinction, doubts have been cast over the tacit-explicit dichotomy (Polanyi, 1958). According to the autopoietic epistemology school (Varela et al., 1992), knowledge is a private, personal thing, and so an organization cannot possess it. Hence, knowledge cannot be explicit, only tacit: explicit knowledge is actually data and/or information which help other people to create their own knowledge through what is known as “structural coupling”. However, this article will accept the tacit-explicit distinction, which will enable us to reach more interesting conclusions.
Then, assuming the tacit-explicit dichotomy, the following mathematical formulas depict what was said (Joia, 1999a):

\[
\text{INFORMATION} = \text{DATA} + \sum (\text{Attributes, Relevance, Context})
\]

\[
\text{KNOWLEDGE} = \text{INFORMATION} + \sum (\text{Experience, Values, Patterns, Implicit Rules})
\]

The main question is to know how knowledge can be transformed into corporate intelligence. Using the I.Q. metaphor (notwithstanding its flaws), it can be said that the Corporate I.Q. (Haeckel & Nolan, 1993) can be evaluated through the enterprise’s capability of connectivity (internal link and link with its partners), sharing (data and information shared among its personnel, and its partners) and structuring (ability to extract knowledge from information and raw data). The following exhibit 1 (Joia, 1995) depicts this concept.

**RESEARCH DESIGN**

We draw on organizational literature on knowledge creation, development and management to identify the challenges associated with dispersed and non-coordinated processes within the same enterprise. We then present an integrated information technology-based model with their associated processes, compare several variants of these processes, and explore criteria guiding managers in central process design activities. The model is based on the technology-service-process-production taxonomy (Joia, 1999b).

The information technologies are classified into connecting, sharing and structuring ones according to their characteristics. So, we manage to define the “Connecting Technologies”, “Sharing Technologies” and “Structuring Technologies”. The proposed framework allows us to deeply understand the linkage between the information technologies deployed, the services and processes associated with them, and the corporate intelligence. The corporate intelligence is a function of the speed the company creates its knowledge and manages it, allowing knowledge to be created from knowledge.

To validate the proposed model, a case study is analyzed and presented. In this case study, a process-based engineering company working currently as an integrator within a metabusiness is studied, so as to better understand the role the information technologies play in the development of the corporate I.Q. Using the data got from this example, it is possible to infer the hurdles a company faces to manage adequately its knowledge so as to increase its corporate intelligence.
INFORMATION TECHNOLOGIES

It is necessary to analyze the Information Technologies that must be deployed within a metabusiness to leverage its intelligence. As said previously, these technologies are divided into: connectivity, sharing and structuring, according to the I.Q. metaphor.

Connectivity Technologies

The “degree of reach” in a metabusiness is paramount. So, the first step to build an effective metabusiness is to choose the correct technologies to connect the players. According to Badaracco (1991):

“‘What is a computer?’ The old answer was: a solitary central-processing unit. The new answer: a computer is a network.”

Therefore, the ideal solution is an intranet-based infrastructure within each firm, linked to the integrator through extranets. The exhibit 2 depicts the necessary infrastructure:

To link all the nodes of the metabusiness, wide-area networks are needed to work as extranets, allowing the connection among the players’ intranets. Satellite channel, optical fibers, dedicated link etc, are just some ways of having the business ecosystem connected altogether.

A client-server platform supports the intranet-based infrastructure. However many problems must be overcome to achieve this degree of connectivity, as for most companies (specially smaller ones) this infrastructure is still expensive, and different protocols are frequently used which hinders correct communication among the companies; and the infrastructure to transmit the data through these technological links is still precarious and unreliable in the emerging markets.

All the data and information exchanged by two or more nodes of the metabusiness must go through the integrator, as otherwise frequent loss of coordination arises. This, of course, will lessen the flexibility, responsiveness and agility of the players, although keeping the main control of the fragmented processes (Volberda, 1999). The knowledge derived from these data and information, used solely by a node of the metabusiness, can be either document-to-person or person-to-person based. The former is important for a
“codification strategy” (Hansen et al., 1999), when the explicit knowledge is far more important than the tacit one as the product/service developed by the metabusiness is rather standardized. The latter is important for a “personalization strategy” (Hansen et al., 1999), when the tacit knowledge is far more important than the explicit one, as the product/service offered is tailor-made to the client.

Sharing Technologies

Currently, the networking boom, mainly based on Internet, intranet and extranet potentialities has changed the computer from a calculation machine into a communication device. This allows people to work together in a collaborative and integrated environment. As an example, several software have been developed to allow different persons working at the same time, on the same document; to allow the intelligent tracking of messages and documents within a productive process; and to help the employees, together, to view and manipulate information in a more efficient way. CSCW (Computer Supported Collaborative Work) is now a reality, and can be used in complex enterprises.

The first step to give intelligence to a metabusiness is to develop its connectivity, as was already shown above. The second one is to allow the nodes (or players) to work in a cooperative and collaborative way, sharing data and information on-line, at real time, in order to build knowledge for the enterprise altogether. In a broad sense, there is a range of technologies, from the simplest to the most complex that can be used to accomplish this target. The systems usually can be classified according to the number of professionals that use them and the number of tasks to be performed, as shown below in the exhibit 3.

Groupware and Workflow Systems, also called Workgroup Systems, compound the Sharing Technologies, as several professionals are performing one or more tasks. However, there is a great misunderstanding between the main concepts underlying these two technologies, as the former has its focus in the information, and the latter in the process. The exhibits 4 and 5 below present these very important differences.

Among the most important Groupware Technologies we can cite the Intranet/Internet-Based ones, such as Electronic Mail, Bulletin Board, NewsGroup, Chat and Video-Conferencing. The latter one is becoming very important for the effective sharing of the tacit knowledge, through the face-to-face socialization process (Skyrme, 1997). Other
very important groupware technologies are both the EDI (Electronic Data Interchange) - that allows companies to exchange forms, reports etc. in a standardized way -, and the Distributed Data Base that allows the partners to get and share records of a data base, as well as perform real-time transactions among them.

Surely, the most important Sharing Technology is the Workflow one. The Workflow systems belong to another more comprehensive technology: EDMS - Electronic Document Management System. EDMS is not one technology, but a set of technologies linked to accomplish a target: the full life-cycle control of a document in a project. The following technologies are normally embedded in an Electronic Document Management System: Imaging, that deals with the need of transforming documents on paper into digital ones, by using scanners; Full-Text Retrieval, that retrieves documents searching for words within them; Workflow, that allows the innovation of productive processes by reengineering them, making it possible to control a document route within a company; and Multimedia, the least developed EDMS technology that allows the storage and retrieval of frames of animation, sounds etc.

The evolution of the EDMS is very interesting, and can explain why BPR (Business Process Reengineering) leverages this technology and vice-versa. The earlier systems dealt only with the storage and retrieval of documents and images (scanned documents and images). They were called Document Filing Systems (Weizer et al., 1991). The more recent systems have begun to deal with the processes within a company, controlling the documents’ flow across the enterprise (tasks, recipients, due dates, etc.). This group, called Workflow Automation (Weizer et al., 1991), presents a great potentiality due to its capability of innovating processes such as (Korzeniowski, 1993):

- Administrative: Basically the relationship between two persons or groups. Most of the information flow can go through electronic mail.
- Production: Totally structured processes that can be easily depicted due to their high degree of repeatability. There are several Workflow Systems that can deal with this kind of process.
- Ad-Hoc: Unstructured processes, mainly related to creativity tasks. Their graphic modelling is almost impossible, therefore, there is no commercial system available for use.
Structuring Technologies

Notwithstanding the great advances in the Connectivity and Sharing Technologies, the same can not be said concerning the Structuring Technologies. Although great advances have been made lately, such as the development of the data mining technology, this realm is the bottleneck for the effective development of the metabusiness’s intelligence. Structuring, as said before, is about creating meaning (or knowledge) for lots of data and information. Some research shows that the overload of information does not necessarily convey to adequate knowledge creation (Joia, 1999a) and is the main cause of problems in complex enterprises developed in a metabusiness way. The metabusiness is intelligent if and only if their nodes and respective personnel are intelligent too.

There is a new reality today, when the Cartesian, Taylorist, fragmented and sequential thinking is being replaced, in a very fast way, by what can be named hereinafter as Digital Thinking (Joia, 1999a). Digital Thinking depends upon the creation of a new mental model that, far from what is preached by the analogic and Cartesian concepts, is based on an assynchronous mental model and on the ability of linking, combining and associating different, or even opposite ideas.

Digital Thinking has its rationale on the blending of some intelligences despised by most educators and managers for a long time. In 1983, at the Harvard University School of Education through a seminal work, research was presented describing seven different types of intelligence, and theorizing about a concept that had always seemed quite obvious for most of us: intelligence is multi-edged and multi-dimensional (Gardner, 1983). Later on, the emotional intelligence concept was gathered into this array of multiple intelligences (Goleman, 1995), and other authors have expanded this initial string of intelligences (Handy, 1997). The Digital Thinking concept has most of its features accruing to the following intelligences (Handy, 1997): Analytical - defined as the ability to rationalize and formulate concepts and questions; Numerical - defined as the ability to handle numbers; Spatial - defined as the ability to recognize patterns of action and behavior and Expositive - defined as the ability of having verbal and written communication skills.

The world is being submitted to a transition from the electro-mechanical to the digital era. The mental model of the ordinary worker is an analogic-based one, which generates great difficulties for most of them for handling informatized processes in this current digital era. Most foremen do not understand how a string of commands, launched from computer screens, can command a machine far from them that was formerly commanded directly through the manual contact of gears, levers and buttons. As they cannot understand this rationale, a mental routine is created by them, to memorize automatically the needed procedures. As a result, most of the technological innovations based on Information Technologies implemented in the companies are far from reaching the forecast productivity target, as people are not taking advantage of all the potentialities to which these innovations can lead.

The ability to learn new things - or learn to learn - is paramount today. Rather, the ability to unlearn what was learnt is necessary most of the time, which is not a very smooth process, unless well led. Learn to learn, ability to solve problems which were not faced before, to be creative and to use inductive thinking, instead of deductive that still forges the current educational process, among others, are the
workers’ current major challenges when working in a metabusiness that is supposed to be intelligent. In an intelligent metabusiness the integrator must rely on the other nodes’ capabilities and skills to solve correctly the problems turned up. Some integrators take it for granted. Experience has shown that if a metabusiness is to be intelligent, all the players must have reached a minimum level of expertise in their realm, and the integrator must be in charge of auditing the quality of the work done by their partners. More recently, the integrators are conscious that they must train the other companies, or at least deploy procedures, methods etc. that can be followed by the players to develop the project. This explicit knowledge can be stored mainly both on documents and databases and the main technologies to spread this knowledge among the nodes of a metabusiness are Expert Systems, Data Mining and Web-Based Instruction (WBI) Systems.

The Expert System is a very important structuring technology that leads the professional to a knowledge internalization process: from explicit to tacit knowledge (Nonaka & Takeuchi, 1995), as shown below in the exhibit 6:

The Expert Systems can convey the following benefits:
1. Acquisition, storage and deployment of the strategic knowledge;
2. Availability, full-time, of the specialist’s knowledge;
3. Liberation of the specialist to solving complex problems the expert system is not able to deal with;
4. New techniques training that depend on the basic knowledge of a problem;
5. More consistent and qualified solutions for a problem, spending less time;
6. Standardization of operational procedures.

The Expert System also called “Knowledge-Based Computer System” must be used cautiously. It is important not to fall into the trap of having an “intelligent machine”, but rather a system to augment human thinking (Sk Byrne, 1997).

Exhibit 6. Basic Structure of an Expert System
Data Mining Technology aims to develop intelligent ways to navigate a great amount of data and information, so as to extract what is actually relevant and to create recognition patterns that help the users not to suffer from unnecessary information overload. The purpose is to judge the relevance of the information for the one interested in it. Unfortunately this intelligence is still low, leading the user to waste time in making the necessary judgment.

WBI systems are engines developed to using the intranet/Internet capabilities, as distance learning can be deployed within a metabusiness in an interactive and hypertextual way. The user needs just a browser (Netscape, IExplorer etc) in his/her personal computer. The system with the respective course’s content is stored either in the intranet server of the integrator or in a generic Internet server. WBI systems are compounded of three distinct modules: Authoring Module: used to create automatically the course by the content’s author or another professional; Utilization Module: used to process the training; and Tracking Module: used by the course administrator to track and manage the performance of the pupils and the course as a whole, through the students’ grades, evaluations, drawbacks etc. that stay stored into the log of the system.

Using a WBI system based on Internet/intranet resources and, if possible, coupled with video-conference, video-multicasting and/or video-on-demand, a new modus-operandi can be defined that allows a just-in-time education, or an education anytime and anywhere. This new process is based on:

1. Definition and Generation of the programmatic content.
2. Content Modularization for hypertextual browsing in the WEB.
3. Definition and choosing of the following tools:
   a) Communication Tools: E-mail between the students and the teacher, Newsgroup, List server, chats, videoconferences.
   b) Coordination Tools: Diary, News, Assessments, Assignments, and Exercises.
4. Availability of the content through the Authoring Tool.
5. Use by the students of the system with its content inside.
6. Evaluation of the course and the students by the virtual mentor through the Tracking Module.

All of these tools can be integrated into one single system and made available via WEB as also with videoconference equipment. Most of the events are asynchronous, and just a few of them are synchronous, such as chats and videoconferences.

AN INTEGRATED MODEL FOR INTELLIGENT METABUSINESS

To integrate all the technologies presented before in a structured taxonomy for intelligent metabusinesses, it is taken for granted that technologies are important as they can allow services to be deployed, and services are important as they convey to productive processes, according to the following formula: TECHNOLOGIES => SERVICES => PROCESSES => PRODUCTION, as shown in the following exhibit 7:
Therefore, the table 1 can present more deeply the idea shown in the exhibit 7, relating the Connectivity, Sharing and Structuring issues - the three facets of an intelligent metabusiness - with the needed services and productive processes within a relational enterprise.

Table 1. Integrated Model for Intelligent Metabusiness

<table>
<thead>
<tr>
<th>TECHNOLOGIES</th>
<th>CONNECTING</th>
<th>SHARING</th>
<th>STRUCTURING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Client-Server Based Intranet, Extranets, LAN, WAN, Satellite Links, Dedicated Links, Fiber-Optics Network</td>
<td>Internet, Groupware, Electronic Data Interchange (EDI), EDMS, Workflow, Video-Conferencing and Distributed Data Base</td>
<td>Web-Based Instruction Systems, Data Mining, Expert System</td>
</tr>
<tr>
<td>SERVICES</td>
<td>Physical Link among the players (Star Topology with the Integrator as the Hub)</td>
<td>Data and Information Transactions, Forms Exchange, Documents Life-Cycle Control and Tracking</td>
<td>Education Anytime, Anywhere Just-in-Time Education, Knowledge Acquisition, Pattern Recognition</td>
</tr>
<tr>
<td>PROCESSES</td>
<td>PRODUCT INNOVATION; OPERATION MANAGEMENT; PLAYERS’ COORDINATION (management of restraints and dependencies); QUALITY CONTROL OF THE NODES OF THE METABUSINESS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A CASE STUDY

We are going to analyze the case of PROMON Engenharia, a major consultancy company in Brazil with revenues of more than US$ 800m in 1997, in charge, for instance, of Itaipu Dam design, the biggest hydroelectric power plant in the world. This company had to reinvent itself in order to survive in the Brazilian engineering consultancy industry. As the table 2 shows below, a stalemate has occurred in the engineering consultancy market, with loss of organizational memory and human capital (Joia, 1998).
Table 2. Brazilian Engineering Consultancy Industry Data

<table>
<thead>
<tr>
<th>YEAR</th>
<th>REVENUE (MUS$)</th>
<th>PERSONNEL (HIGHER EDUCATION)</th>
<th>PERSONNEL (TOTAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>1,000</td>
<td>10,900</td>
<td>42,500</td>
</tr>
<tr>
<td>1982</td>
<td>1,200</td>
<td>11,200</td>
<td>44,300</td>
</tr>
<tr>
<td>1983</td>
<td>800</td>
<td>10,200</td>
<td>39,600</td>
</tr>
<tr>
<td>1984</td>
<td>600</td>
<td>10,100</td>
<td>39,000</td>
</tr>
<tr>
<td>1985</td>
<td>700</td>
<td>10,900</td>
<td>42,400</td>
</tr>
<tr>
<td>1986</td>
<td>800</td>
<td>13,100</td>
<td>47,000</td>
</tr>
<tr>
<td>1987</td>
<td>1,100</td>
<td>15,500</td>
<td>56,400</td>
</tr>
<tr>
<td>1988</td>
<td>1,450</td>
<td>16,200</td>
<td>60,000</td>
</tr>
<tr>
<td>1989</td>
<td>1,000</td>
<td>12,800</td>
<td>45,300</td>
</tr>
<tr>
<td>1990</td>
<td>900</td>
<td>9,600</td>
<td>34,000</td>
</tr>
<tr>
<td>1991</td>
<td>870</td>
<td>8,200</td>
<td>28,000</td>
</tr>
<tr>
<td>1992</td>
<td>880</td>
<td>7,500</td>
<td>25,500</td>
</tr>
<tr>
<td>1993</td>
<td>1,030</td>
<td>7,400</td>
<td>24,400</td>
</tr>
<tr>
<td>1994</td>
<td>900</td>
<td>7,000</td>
<td>25,300</td>
</tr>
<tr>
<td>1995</td>
<td>1,090</td>
<td>6,100</td>
<td>21,300</td>
</tr>
<tr>
<td>1996</td>
<td>1,200</td>
<td>6,200</td>
<td>21,500</td>
</tr>
</tbody>
</table>

To avoid the impact of this situation, Promon became itself an integrator, looking for Turn-Key projects and BOOT (Build-Own-Operate-Transfer) ones (Joia, 1998), keeping some core competencies, such as the know-how of designing and managing civil enterprises, both explicitly - through procedures, codes, databases etc.- and tacitly - through informal employees’ networks (socialization process) (Nonaka & Takeuchi, 1995). It creates a strategic ecosystem (Moore, 1996) based on knowledge links (Badaracco, 1991) with construction and assembly companies, suppliers, banks, subcontractors etc. as shown in its virtual structure, depicted in the exhibit 8:

Exhibit 8. PROMON’s Relational Structure
PROMON has also included itself as a process-oriented structure that involves the major players of an engineering enterprise as depicted below in the exhibit 9:

Exhibit 9. PROMON’s Process-Oriented Structure

The Production Macro-Process, also called “Contract Accomplishment” was divided into the following processes:

a) Basic Design
   This is the enterprise conception. It is without doubt the most important phase of the enterprise. In this stage, the later a mistake is picked up, the more financial losses and delays there are in the project.

b) Detailing
   Also called executive design, as the name says, it is the detailing of the Basic Design. The basic design delivers information for this phase. The work now is much more repetitive, not always presenting an actual added value. Most of the detailing is done by subcontractors (small players) coordinated and managed by the integrator that is in charge of the quality assurance of the work done.

c) Construction and Assembling
   In this stage the builder and the assembler who have taken part in the Basic Design play their role. Once again all the work must be coordinated by the integrator that manages the dependencies and constraints.

d) Equipment Supply
   The equipment (if needed) is then delivered by other companies, according to the specifications of the integrator who is in charge of auditing them before they go to the site. They must arrive just in time for the builder and assembler to locate them in the field, according to the schedules, which shows, once again, a complex chain of dependencies and restrictions that must be managed by the integrator, using Information Technology and the necessary services.
e) Management

This is where the Enterprise Engineering (Liles et al., 1995) integrates all the former stages into just one - the Enterprise Workflow. Usually, PERT/CPM networks and Gantt charts are used. All the information of the enterprise should pass through the Integrator, the one in charge of all this complex workflow. The Integrator, without doubt, can be considered as an Information Factory.

PROMON invested heavily on Information Technologies to increase its “degree of reach” (connectivity) and “degree of range” (sharing) as shown in the exhibit 10 below. Therefore, some concepts and techniques such as Concurrent Engineering (Zangwill, 1992) could be implemented in its metabusiness, allowing the partners not to work in a sequential way, but rather simultaneously.

Unfortunately, no investment was made on Structuring Technologies, i.e., PROMON didn’t foresee that its main players should be trained on how to work together in a major enterprise and that it was paramount to manage, coordinate and equalize the needed knowledge among the several involved players. Hence, there were great difficulties for the nodes of the metabusiness to get knowledge from the data and information available. Due to that, several quality assurance problems arose, increasing the forecast costs of the enterprise. A Web-Based Instruction System would be absolutely necessary to fill this gap. Besides, some cultural and organizational problems, as well as technological ones, turned up, as this was a new *modus-operandi* for most of the players.

Another main problem was on the different technological platforms used by the players. Some of them did not even use Internet as a normal production tool. These inequalities lower heavily the intelligence of any metabusiness and must be solved in order to accomplish the targets forecast.

*Exhibit 10. PROMON’s Metabusiness IT Infrastructure*
After a deep analysis of PROMON’s case study it is possible to present a generic table (Table 3) with the main problems arisen to build and maintain an intelligent metabusiness, their causes and some possible solutions, as shown below:

<table>
<thead>
<tr>
<th>BARRIERS</th>
<th>CAUSES</th>
<th>SOLUTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus only on direct man-power and indexes</td>
<td>Obsolete decision criteria</td>
<td>Deep analysis of the costs and benefits involved</td>
</tr>
<tr>
<td>Failure to perceive the actual benefits</td>
<td>Lack of measures to intangible benefits</td>
<td>Intangible and tangible productive analysis</td>
</tr>
<tr>
<td>High risk for the managers</td>
<td>Reward system not considering innovation</td>
<td>Different reward systems for managers</td>
</tr>
<tr>
<td>Lack of coordination and cooperation</td>
<td>Organizational fragmentation</td>
<td>Systems to allow coordination/cooperation</td>
</tr>
<tr>
<td>High expectation and hidden costs</td>
<td>Selling of an unreal system</td>
<td>Planning strategic objectives</td>
</tr>
<tr>
<td>Human</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To avoid the risk</td>
<td>Fear of change and uncertainty</td>
<td>Communication and involvement</td>
</tr>
<tr>
<td>Resistance</td>
<td>Fear of loss of power and status</td>
<td>Board engaged in project implementation</td>
</tr>
<tr>
<td>Unplanned decisions and fear of being made redundant</td>
<td>Orientation and Action: lack of patience with planning</td>
<td>Pilot Project planning: long-range objectives</td>
</tr>
<tr>
<td>Technical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incompatibility of systems</td>
<td>Purchase of different hardware &amp; software platforms</td>
<td>Purchase of only one integrated system; write own system; neutral transfer files</td>
</tr>
</tbody>
</table>

After a deep analysis of PROMON’s case study it is possible to present a generic table (Table 3) with the main problems arisen to build and maintain an intelligent metabusiness, their causes and some possible solutions, as shown below:

So, Promon was very successful to get information as soon as needed, but unsuccessful in transforming information into knowledge. The very contempt of the necessary training of all the players involved in the endeavor, so as to be able to create and manage knowledge derived from the received information, along with technical incompatibilities among the players’ platforms hinder PROMON to take advantage of the intangible benefits the company might have accomplished. PROMON overlooked the importance of the Human and Innovation Capital in the knowledge creation and management process (Joia, 2000).

**FUTURE TRENDS**

As it was already said, the knowledge can be either explicit or tacit. Also, a metabusiness is intelligent if and only if its nodes also have intelligence. Intelligence is the ability of using knowledge to create new knowledge (Drucker, 1996). But if it is hard to convince the professionals within a company to externalize their knowledge, both because they do not know how to structure it and because of lack of confidence in the firm, what about a lot of professionals working together for the
first time and belonging to different companies, geographically dispersed, tied digitally?

Hence, the first trend is the need the companies have to create mechanisms that reward their professionals involved in metabusinesses to externalize their strategic knowledge, as is already done in some management consulting companies, as Bain and Mckinsey (Hansen et al., 1999). It is necessary to develop an environment of trust where this is possible. According to Venkatraman & Henderson (1998), it is important to develop new ways of managing knowledge workers, as the human resource policies are geared toward production and administrative workers. Hence it is necessary to create incentives and compensation practices to attract and keep knowledge workers.

A second trend is to have technology used in a more comprehensive way. As McKenney et al., 1992 realized:

“- managers use electronic mail for efficient communication in well-defined contexts - monitoring task status, coordinating efforts, exchanging factual information, sending alerts, and broadcasting information.

- managers use face-to-face interaction for defining and discussing problems and solutions, building a shared understanding of the situation, discussing shifting priorities and external pressures, interpreting ambiguous signals, and socialization of members.”

Once again, the solution passes through the overcoming of organizational and cultural barriers, rather than technical ones. Also, the technology must increase the employment of the tacit knowledge, as it has been used to leverage and deploy the explicit one.

The third trend is to homogenize the technological platform of all the nodes involved in a metabusiness, defining a “bottom-line” platform, as just one node with an inadequate platform can jeopardize the intelligence of the metabusiness altogether.

**CONCLUSIONS**

The metabusiness is an extreme case that challenges our general understanding of the management of knowledge development processes in virtual organizations through the use of technology. The intelligence of a metabusiness depends on its degree of “reach” and “range”, or in other words, on its degree of connectivity, sharing and structuring.

We can conclude that technology, itself, does not create either knowledge or intelligence. Technology is just an enabler to achieve this stage. Notwithstanding that a lot of information technologies are already available to be used to increase the connectivity, sharing and structuring issues of a metabusiness in order to make it intelligent and with a high degree of “reach” and “range”, the organizational and cultural obstacles are still very high to be smoothly overcome, and the causes and solutions must be analyzed.

The attitude is dangerous that drives management towards strong investments in Information Technology, possibly at the expense of investments in human capital. This is the second conclusion. The danger lies on an IT-driven knowledge management strategy that may end up objectifying and calcifying knowledge into static,
inert information, thus disregarding altogether the role of tacit knowledge. It can be mentioned that the major problem Volkswagen has faced in its newly built truck plant in Resende, Brazil - regarded as the most advanced automobile production process implemented in the world - has come from problems with the quality of the products/services delivered by its partners. As part of the enterprise, VW built a Training Center in Angra dos Reis, near Resende, close to the factory, where all the metabusiness’ nodes employees are trained before being engaged in the production network. However, the quality problems still remain, mainly due to the lack of employees’ structuring skills, which hinders them for creating their own knowledge through the training process. Notwithstanding that the main players of this metabusiness work in the same geographical place, without certain physical boundaries, this innovative project has shown the need of investing in the leverage of the human capital of all the companies, otherwise all the enterprise can be jeopardized.

Motivation, expertise and resources are the tripod where creativity and the respective innovation derived lay upon (Amabile,1997). These three items are usually addressed in different scales in the companies. The exhibit 11 below depicts better what happened in PROMON. Although having state-of-art information technologies, and motivated employees, insufficient expertise was the main obstacle PROMON and its partners in the metabusiness have to overcome, due to a lack of Human and Innovation Capital development policy and a correct and timely coordination process.

Finally, the last and more important conclusion, is the need to give the employees of an intelligent metabusiness a digital thinking in order they have their structuring skill effectively developed, i.e, to give them:

- ability to decodify and structure data and information, in order to transform them in knowledge;
- identify, enunciate and solve problems by themselves;
- have the fundamentals to research, evaluate, criticize and select information among complex knowledge networks;
- be creative;
- have the ability to work in teams, most of time geographically dispersed, and have the ability of self-management;
- ability to work in digital and, often, virtual environments.

To achieve this, investments must be made in the development of customized Web-Based Instruction Systems and in ongoing training initiatives, so as to allow the increasing of the human and innovation capital of the firms and, by consequence, the intellectual capital of the metabusiness. It is also necessary to invest in the development of a trust-based environment among the companies and the employees involved in the endeavor.

Exhibit 11. Creativity Forces

<table>
<thead>
<tr>
<th>MOTIVATION</th>
<th>CREATIVITY</th>
<th>EXPERTISE</th>
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</thead>
<tbody>
<tr>
<td>RESOURCES</td>
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</table>
The knowledge society with its knowledge workers demands new organizational forms, organic, flexible, seemingly almost anarchic, but coordinated enough to allow knowledge to be created, stored, retrieved and reused. Development and improvements in the newly created Coordination Science (Malone & Crowston, 1994) is paramount to spread intelligent metabusinesses as the “knowledge-based organizational structure”, along with a deeper understanding of the intangible benefits of the Human and Innovation Capital.

REFERENCES


