Agile Virtual Enterprises

Implementation and Management Support

Maria Manuela Cruz Cunha & Goran D. Putnik

Agile Virtual Enterprises:
Implementation and Management Support

Maria Manuela Cunha
Polytechnic Institute of Cávado and Ave, Portugal

Goran D. Putnik
University of Minho, Portugal

IDEA GROUP PUBLISHING
Hershey • London • Melbourne • Singapore

Acquisitions Editor:	Michelle Potter
Development Editor:	Kristin Roth
Senior Managing Editor:	Jennifer Neidig
Managing Editor:	Sara Reed
Copy Editor:	Bernard J. Kieklak, Jr.
Typesetter:	Marko Primorac
Cover Design:	Lisa Tosheff
Printed at:	Yurhcak Printing Inc.

Published in the United States of America by
Idea Group Publishing (an imprint of Idea Group Inc.)
701 E. Chocolate Avenue
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@idea-group.com
Web site: http://www.idea-group.com

and in the United Kingdom by
Idea Group Publishing (an imprint of Idea Group Inc.)
3 Henrietta Street
Covent Garden
London WC2E 8LU
Tel: 44 20 7240 0856
Fax: 44 20 7379 0609
Web site: http://www.eurospanonline.com

Library of Congress Cataloging-in-Publication Data

Cunha, Maria Manuela, 1964-
Agile virtual enterprises : implementation and management support / Maria Manuela Cunha, Bruno Conceicao Cortes, and Goran D. Putnik.
p. cm.
Summary: "The authors address Agile/Virtual Enterprises as a new organizational paradigm, highly dynamic reconfigurable agile networks of independent enterprises sharing all resources, including knowledge, market, customers, etc., and using specific organizational architectures that introduce the enterprises' true virtual environments"--Provided by publisher.
ISBN 1-59904-010-7 (hardcover) -- ISBN 1-59904-011-5 (softcover) -- ISBN 1-59904-012-3 (ebook)
1. Virtual reality in management. 2. Business networks. 3. Virtual corporations. I. Cortes, Bruno Conceicao, 1976- II. Putnik, Goran, 1954- III. Title.
HD30.2122.C86 2006
658.4'038--dc22
2006009295

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

Agile Virtual Enterprises: Implementation and Management Support

Table of Contents

Preface

This book addresses meta-enterprise organizations and infrastructures as emerging and (now we are positive) indispensable organizational models, concepts or approaches for assuring, or enabling, effective and efficient implementation and management of agile and virtual enterprises (or Agile/Virtual Enterprises). In particular, the concrete meta-enterprise organization and/or infrastructure model presented in the book is called, by the authors, the *Market of Resources* (MR).

An Agile/Virtual Enterprise (A/VE) is seen as a new organizational paradigm, virtually the most advanced enterprise organizational paradigm of today's, expected to serve as a "vehicle" towards, in the limit, a seamless "perfect" alignment of the enterprise with the market. A/VE is characterized in different ways, ranging from simple subcontracting networks to dynamic reconfigurable agile networks of independent enterprises sharing all resources, including knowledge, market, customers, and so forth, using specific architectures, not only of software and data systems, but primarily the organizational architectures that introduce the enterprise's true virtual environments, in order to be permanently aligned with the highly demanding and global dynamic market. Obviously, when we, the authors, address Agile/Virtual Enterprises as a new organizational paradigm, we consider primarily and exclusively, the Agile/Virtual Enterprises as *highly dynamic reconfigurable agile networks of independent enterprises sharing all resources, including knowledge, market, customers, etc., and* *using specific organizational architectures that introduce the enterprise's true virtual environments*.

Thus, in this book, the form of *agility* addressed is primarily the dynamic reconfiguration of the organization, or structure, of networks of independent enterprises, while the *virtuality* is addressed as specific organizational architectures.

However, despite the Agile/Virtual Enterprise as seen by many authors as one of the most promising organizational approaches, only the relatively most simple models, as simple subcontracting networks or supply chains (if we consider them as A/VE models), are implemented, while we could easily observe that, in fact, we do not have implemented Agile/Virtual Enterprise models that correspond to the earlier-mentioned definition which is considered in this book (and by many other authors).

Among several reasons for this situation, probably the most important is that the concept of A/VE as "*highly dynamic reconfigurable agile networks of independent enterprises sharing all resources, including knowledge, market, customers, etc., and using specific organizational architectures that introduce the enterprise's true virtual environments*" introduces several new features that the "traditional" approach to the implementation and management can not manage. These are, in fact, the reasons why we can talk about the new paradigm. Some of these features are:

1. the nature of inter-enterprise relations, in the context of sharing all resources, and
2. the dynamic reconfiguration of the enterprise, or new networked enterprise, organizational structure.

Concerning the nature of inter-enterprise relations, the context of sharing all resources introduces new factors to be managed not present in the "traditional" "self-centered" enterprise, which are trust assurance and management, knowledge and intellectual rights protection, legal issues, communication phenomena, among others.

Concerning the dynamic reconfiguration of the enterprise, or new networked enterprise, organizational structure, the new phenomena is that the production operation "chain" or "network" under the same (fixed) organizational structure, as it is in the "traditional" enterprise, becomes shorter and shorter as the (organizational structure) reconfiguration dynamics become higher and higher. In the limit, an organizational instance (fixed) structure is characterized by only one operation. The consequence is that the focus of management is moving from the (production) operations management to (organizational structure) reconfiguration management. In other words, we could say that while in the "traditional" enterprise the importance of (production) operations management is high, in A/VE the importance of (production) operations management is low. In this sense, for example, the role of operation scheduling in A/VE is no longer one of the most important functions for operations management but, rather, could be seen as a network design tool. Therefore, the A/VE management and design (reconfiguration is in fact a network, or enterprise, structure design, or, redesign, process) are coupled.

A/VE dynamic reconfiguration brings other important phenomena. If we could say that coupled network management and design just imply another operation management model, the new factor is transaction cost. Actually, each (organizational structure) reconfiguration implies some costs. These costs are called *transaction costs*. The problem is that if you have a high (organizational structure) reconfiguration dynamics you will have higher and higher *transaction costs*. This, in fact, makes A/VE agility (i.e., dynamics) not sustainable.

There are two main enterprise dynamic networking, or A/VE, implementation and management disabling factors that follow the theory of firm models:

1. transaction cost, and
2. preservation of firm's knowledge on organizational and management processes, as it is the firm's competitive factor when relating, or networking, with other firms.

To control these factors, it was necessary to have a completely different approach than the "traditional" one, as, the "traditional" approach to enterprise implementation and management cannot deal with these problems.

It is recognized that the new approach should imply special environments for network (re)configurations and operations, the role of which is exactly to control two main factors against dynamic networking. As the role of these environments is not the management or implementation of the A/VE themselves, as it is the task of the A/VE owners, but rather to support these processes (implementation and management), these environments represent a kind of *meta-enterprises*, as they, in fact, are managing the dynamic reconfiguration factors that manage the "production" of (A/VE) enterprises. In this sense, this book presents a model of *a meta-enterprise organizations and infrastructures as emerging and indispensable organizational models, concept or approach for assuring, enabling, or supporting effective and efficient implementation and management of Agile and Virtual Enterprises (or Agile/Virtual Enterprises), assuring low transaction costs and the partners' knowledge protection (or preservation). The model presented in the book is called, by the authors, the* Market of Resources (MR).

This approach (i.e., the need for such environments, as external meta-enterprise organizations and/or infrastructure) is getting more and more recognition in the last few years by the research and theoretician community. In the literature, we can find references to other *Market of Resources* alike concepts, services and products, for example: *the new generation of high value-added electronic marketplaces*, *e-alliances*, *breeding environments*, *electronic institutions*, *virtual clusters*, "*guilds*".[1]

However, this is the first book on the market, of the authors' best knowledge, that *presents comprehensively a model* of such a meta-enterprise organization, infrastructure or environment for A/VE as dynamically reconfigurable network of enterprises, that share virtually all resources.

Actually, it is expected that these environments will be the regular environments for A/VE integration, reconfiguration dynamics and operation. (This expectation has been already expressed within the EU FP6 project, Network of Excellence I*PROMS — *Innovative Production Machines and Systems*, http://www.iproms.org/, Nº NMP2-CT-2004-500273, whose partner is University of Minho, that considered the "*Meta-enterprise organizational structures*", with the *Market of Resources* as an example, as one of the "*Key Enabling Features*" for future developments of the Production Organization and Management area.)

The authors think that it would be useful to mention that this book is in a way a continuation of the authors' previous book (Putnik & Cunha, 2005a) in the sense that this book is a comprehensive presentation of the Market of Resources, already presented in a much shorter way, as one of the main tools for enabling A/VE as dynamically reconfigurable enterprise networks. The structure and philosophy of the previous book (Putnik & Cunha, 2005a) presented, besides its content, a number of valuable contributions on particular "object" topics, an example of a new view on A/VE integration (and operation), for which the *Market of Resources* is one of the fundamental tools, which is a view through the lens, or framework, of Organizational Semiotics, more precisely, the Virtual Enterprise Integration Semiotics [see the Preface and Chapter I of the book (Putnik & Cunha, 2005a; Putnik et al., 2005b, 2005c)].

Also, the authors think that it would be interesting to mention that this book is a result of the work developed within the larger project on Virtual Enterprises that is on course at the University of Minho, Centre for Production Systems Engineering. The project on Virtual Enterprises in the Centre for Production Systems Engineering of the University of Minho has started as early as 1994, and has resulted up to date in 4 PhD and 5 MSc Thesis concluded, while three PhD projects are on course (at the moment of writing this Preface). The project on *Market of Resources* has started as early as 1999 as a PhD project, which was concluded in 2003. After that period, the concept was regularly revised.

Organization of This Book

The book's 11 chapters are organized into three parts that addresses three global issues of the A/VE implementation and management support. These are:

1. **Section I:** Business Requirements and Virtual Enterprise Model Needs, Chapters I to IV.
2. **Section II:** Functional or Activity-Based Model of the Market of Resources, Chapters V to IX.
3. **Section III:** Market of Resources and Agile/Virtual Enterprise Implementation and Management Support: Validation and Potential, Chapters X and XI.

Section I of the book addresses *Business Requirements and Virtual Enterprise Model Needs*. Through four chapters, Section I contains a discussion on the actual enterprise environment (i.e., market, its characterization from the perspective of the needs for new organizational models, some constraints and directions to overcome these constraints).

When talking about the actual enterprise environment the book focuses on its dynamics and unpredictability as the major challenge to competitiveness. From the other side, the question is: which are the A/VE models for which we should develop the management and implementation models? Actually, what are specific functional characteristics that should be satisfied?

In other words, Section I aims at presenting an answer to the question: meta-enterprise organizations and infrastructures, in particular Market of Resources, why?

This section contains four chapters. They are:

Chapter I presents a business requirements' analysis to help understand the actual economical and organizational context we live in, and to justify the emergence of new organizational models, in particular the A/VE models. This chapter starts with a brief introduction of the role of enterprises and the market, followed by a characterization of the actual economic context of strong competition, and the evolution of product life cycle in this context, and concludes with the identification of the requirements for competitiveness and a business alignment requirements analysis.

Chapter II presents a discussion on the emergence of the virtual enterprise concept, as well as presents the most relevant and most frequently discussed virtual enterprise models, namely, Supply Chain, Extended Enterprise, Agile Enterprise/Manufacturing, Virtual Enterprise/Virtual Organization, the BM_Virtual Enterprise Architecture Reference Model (*BM_VEARM*) Agile/

Virtual Enterprise reference model and OPIM (One Product Integrated Manufacturing). At the end of the chapter, a discussion is presented.

Chapter III presents the BM_Virtual Enterprise (BM_VE) model, as an Agile/Virtual Enterprise, in total or partial conformance with the BM_Virtual Enterprise Architecture Reference Model (BM_VEARM) (i.e., as a dynamically reconfigurable network integrated over the global domain, satisfying the requirements for integrability, distributivity, agility and virtuality as the competitiveness factors). In other words, a virtual enterprise (VE), according to BM_VEARM, is "… an optimized enterprise, synthesized over a universal set of resources, with a real-time replaceable physical structure, and when the synthesis and control are performed in an abstract or virtual environment." The importance of presenting the BM_VE is in fact that Virtual Enterprise (VE), or Agile/Virtual Enterprise (A/VE), implementation and management is not possible without *Market of Resources* (MR), and similarly defined meta-enterprise structures and/or organizations. BM_Virtual Enterprise uses three main mechanisms, or tools: Broker, Virtuality, and Market of Resources.

As a consequence of the BM_VE model, an "inverse" definition (i.e., the *Resource centered Virtual Enterprise Definition)* of VE is presented. Because of this consequence, it follows that BM_VE is a ubiquitous enterprise, too. Ubiquitous enterprise, and VE as a ubiquitous enterprise, could be considered as the next generation (enterprise) organizations.

Chapter IV introduces the requirements for Agile/Virtual Enterprise (A/V E) integration, discuss reconfigurability dynamics and business alignment and propose a Virtual Enterprise Extended Life Cycle. The Virtual Enterprise Extended Life Cycle is the crucial result, as it introduces the fundamental process, or phase, to make an A/VE effective and efficient, and it is the phase of contractualization of a Market of Resources. This A/VE life cycle model actually makes a distinction between the A/VE models as relatively static organizations and A/VE models as dynamically reconfigurable organizations.

Section II addresses *Functional or Activity-Based Model of the Market of Resources*. It contains five chapters through which the model of a *Market of Resources*, as a meta-enterprise organizations and infrastructures, is presented in detail. The representation technique used is IDEF0. This representation technique is chosen because it presents the main elements of a system in general, that is, presents the system's inputs (I), outputs (O), processes or activities (P or A), tools or mechanisms (M) and control or management (C). IDEF0 represents a correctly defined semi-formal graphical language, with data associated, providing an easy way to understand complex organizational models and facilitate the model implementation and control. The particular chapters are dedicated to present the supporting IC technologies.

This part is innovative in terms of the existing literature as the authors did not find any detailed description of these kinds of A/VE environments or infrastructures. What is important to notice is that the model is not a purely ICT solution (e.g., a kind of a set of Web services or an electronic market solution), but a true organizational model that is human-based and ICT-supported.

In other words, Section II aims at presenting an answer to the question: meta-enterprise organizations and infrastructures, in particular Market of Resources, how?

Chapter V introduces the concept of a Market of Resources as an environment to cope with the A/V E model requirements (i.e., an environment for Agile/Virtual Enterprise integration and business alignment), identifying the relevant requisites related with A/V E design and integration, and defining its participants. Also, the technical requirements to support the Market of Resources are presented and how existing technologies support the main processes of the Market of Resources.

Chapter VI presents some of the main ICT and some of the most relevant technologies that can contribute to support the A/V E models. It addresses as well the impact of the new information and communication technologies and the issue of information integration, considering recent developments.

Chapter VII explains how "traditional" Internet-based tools (WWW search engines, WWW directories, electronic mail and e-marketplaces) can be used to support some of the functionalities required by the A/VE models. It introduces as well the costs of subcontracting analysis and a cost-and-effort model that traduces the activities of A/VE integration that can be undertaken with the support of these traditional tools.

Chapter VIII presents a complete specification of the Market of Resources, to allow a complete understanding of how this environment is able to support the implementation and management of Agile/Virtual Enterprises.

The model of the Market of Resources includes three views:

1. The functional specification of the service provided, its processes structure and data structure using IDEF0 and IDEF1x modeling techniques;
2. The definition of a regulation regarding the operation and management procedures of the Market of Resources; and
3. A cost-and-effort model to allow a further analysis of the model performance.

In addition to the model presentation, an overall data architecture to support the Market of Resources is presented, based on IDEF1x diagrams, and finally the cost-and-effort model developed are introduced, traducing the operation of the

Market of Resources, with the purpose to allow the comparison of performance between the Market of Resources and the traditional Internet-based technologies in the support of activities of A/V E integration.

Chapter IX introduces some technologies that can support the development of the Market of Resources and discusses its utilization, as well as presents a prototype developed to demonstrate the operation of some functions of the Market of Resources. This prototype is used later in Chapter IX in the analytical simulation of the Market of Resources performance.

Finally, **Section III** addresses *Market of Resources and Agile/Virtual Enterprise Implementation and Management Support: Validation and Potential*.

Chapter X presents a validation of the approach. As validation criteria, time and cost functions are used. The method of validation is a simulation. It is important to notice that the validation clearly shows that if we want to implement agility in the form of A/VE dynamic reconfiguration, then the meta-enterprise organizations and infrastructures, in particular Market of Resources, are indispensable in order to control the networking dynamics disabling/enabling factors. Actually, the conclusion is that without these kinds of meta-enterprise organizations and infrastructures the A/VE reconfiguration dynamics is not possible, and therefore, the required enterprise's (A/VE) alignment with the market, and consequently the enterprise's competitiveness, is not reachable. In other words, we would say, without these kinds of meta-enterprise organizations and infrastructures the A/VE, as a concept, is losing attractiveness as it is reduced to the variant of a "traditional" enterprise or a "traditional" subcontracting network. At the end, **Chapter XI** addresses some usability and implementation issues as well as some future work.

In other words, Section III aims at presenting an answer to the questions: meta-enterprise organizations and infrastructures, in particular the Market of Resources, *is it valid, when is it valid, how to use it, and what else*?

Chapter X discusses the ability of the Market of Resources to cope with the requirements of Agile/Virtual Enterprises and compares its performance with the performance of traditional Internet-based technologies. It starts with the explanation of the cost-and-effort analysis undertaken, based on the cost and effort models introduced in **Chapter VII** and **Chapter VIII**, followed by the parameterization of this models by identifying its time constants. Subsequently, it is presented as a comparative study of performance between the traditional Internet-based tools and the Market of Resources, based on the results of an analytical simulation of the cost-and-effort of the Market of Resources compared with the utilization of traditional tools in the support of A/V E integration. Finally, it is identified as a solution space where the Market of Resources presents more efficiency in A/VE integration.

Chapter XI analyzes the context in which the Market of Resources appears, identifying favorable existing conditions and reviewing forecasts by credible analysts and consultancy houses, presents a SWOT[2] analysis, presents some critical success factors associated to the exploitation of the Market of Resources, identifies the targeted users, and finally explores some potential opportunities and expected benefits. The opportunities for the Market of Resources are identified, and the e-marketplace's evolution, the failure of the first generation of e-marketplaces and some research forecasts for B2B Internet-based transactions are presented. The main strengths and weaknesses of the Market of Resources' ability to support the A/VE model requirements and the main opportunities and threats associated to its exploitation, using a SWOT analysis, are highlighted. Also, it presents the set of critical success factors for the Market of Resources, their definition or explanation and the competitive advantage that each critical success factor confers. Finally, the target users of the Market of Resources, expected benefits by the creation of the Market of Resources to its targeted users and some future trends are discussed.

Expectations

This book is expected to be read by academics (i.e., teachers, researchers and students), technology solutions developers and enterprise managers (including top-level managers).

This book is expected to give incentives for and guide the creation of indispensable environments, as well as the Market of Resources as a particular one proposed in this book, for enabling more advanced and emerging organizational models, namely A/VE, as their meta-organizational structures. Looking from a future perspective and more advanced social needs, this book is expected to give incentives for and guide the creation of the meta-organizational structures (or infrastructures) as a part of the paradigm shift in organizational sciences. As we have said, it is expected that these environments will be the regular environments for A/VE integration, reconfiguration dynamics and operation.

Related with the earlier-mentioned "global" expectations, this book is expected as well to raise awareness of the A/VE implementation and management needs for supporting environments. Actually, the awareness that is expected is about indispensability of these environments for implementation and management of emerging highly dynamic networked organizations. That is, the implementation and management of these highly dynamic networked organizations is practically impossible without Market of Resources or like environments.

On the other hand, the book is expected to raise awareness of the new business opportunities and new business approaches, namely the establishment of these environments (Market of Resources) as a new service that companies and managers could, and should, exploit.

This book is expected to help and support teachers of several graduate and post-graduate courses, from Management to Information Technology, and in particular the emerging new courses on Agile/Virtual Enterprise concept itself, for the topics of A/VE enablers, providing a basis for qualitative and quantitative analysis of concrete solutions (Section II and Section III).

Also, the book provides a base for further study and research definition as well as solutions development.

The authors are also expecting that the book will contribute to the diffusion of the A/VE concept in other parts of the world, not only in the most developed countries.

At the end, the authors will be grateful to the readers for any constructive criticisms and indication of errors, conceptual, omissions or in typing.

Maria Manuela Cunha

Goran D. Putnik

Guimarães, March 2006

References

Putnik, G., & Cunha, M. M. (Eds.). (2005a). *Virtual enterprise integration: Technological and organizational perspectives*. Hershey, PA: Idea Group Publishing.

Putnik, G. D., & Cunha, M. M. (2005b). Preface. In G. Putnik & M. M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives.* Hershey, PA: Idea Group Publishing.

Putnik, G. D., Cunha, M. M., Sousa, R., & Ávila, P. (2005c). Virtual enterprise integration: Challenges of a new paradigm. In G. Putnik & M. M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 1-30). Hershey, PA: Idea Group Publishing.

Endnotes

[1] "Guilds" is the MR-like concept identified as a possible scenario for the virtual organizations by the MIT 21st Century Manifesto Working Group in their discussion paper, "What we really want? A manifesto for the organizations of the 21st Century," within the "MIT Initiative on Inventing the Organizations of the 21st Century."

[2] Strengths, Weaknesses, Opportunities and Threats.

Acknowledgments

The task of writing a book cannot be accomplished without great help and support from many sources. The authors would like to acknowledge the help, support and belief of all who made possible this creation.

First of all, this book would not have been possible without the ongoing professional support of the team of professionals of Idea Group Inc. We are most grateful to Mehdi Khosrow-Pour, Senior Acquisitions Editor, and Jan Travers, Managing Director, for the opportunity. A special word of gratitude is due to Kristin Roth, Development Editor, for her guidance and friendly words of advice, encouragement and prompt help.

Special thanks go also to all the staff at Idea Group Inc., whose contributions throughout the process of making this book available all over the world was invaluable.

We are grateful to the anonymous referees, whose comments and suggestions, as well as critics, were a valuable and appreciated input for improving the final version of this book.

We are grateful to a number of our colleagues with whom we exchanged ideas, views and discussions on the book's topics, which helped to "shape" the version that is presented. In particular, we are very grateful to Prof. A. Gunasekaran, University of Massachusetts - Dartmouth, for his valuable contribution to the project in the years 1999 to 2003.

The authors would like to acknowledge the support of the Network of Excellence I*PROMS — *Innovative Production Machines and Systems*, http://www.iproms.org/, an EU FP6 project, Nº NMP2-CT-2004-500273, whose partner is University of Minho.

A special thank to our institutions, the University of Minho, Braga, and the Polytechnic Institute of Cávado and Ave, Portugal, for providing the material resources and all the necessary logistics.

Thank you.

Maria Manuela Cunha

Goran D. Putnik

Guimarães, March 2006

Section I

Business Requirements and Virtual Enterprise Model Needs

Chapter I

Business Requirements and Background

Introduction

Before introducing the Agile/Virtual Enterprise organizational model and all the concepts underlying the topic of Agile/Virtual Enterprise implementation and management support, we need to introduce a business requirements analysis to help understanding the actual economical and organizational context we live in, and to justify the emergence of new organisational models. This chapter starts with a brief introduction of the role of enterprises and the market, followed by a characterisation of the actual economic context of strong competition, and the evolution of product life cycle in this context, and concludes with a the identification of the requirements for competitiveness and a business alignment requirements analysis.

The Enterprises and the Market

As Adam Smith remarked in its classical *Wealth of Nations* (Smith, 1776, Book I, p. 145), "people of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices." Adam Smith analysed the way as markets organised the economical life and generated fast economical growth. He was the first to demonstrate that a system of prices and of markets is able to coordinate individuals and enterprises, without the need of any central direction (Samuelson & Nordhaus, 1985).

Right in the centre of economy is the unquestionable true called scarcity law. As we know, goods are scarce because there are not enough resources to produce all goods people wish to consume. The science of Economy studies how the society chooses, within the possible menu of goods and services, the way goods are produced and consumed, how different merchandises are produced and are given a price, and who can consume the goods the society produces.

In primitive societies, customs managed all the views of behaviour. To produce *what*, *how* and *for whom*, was decided by traditions, transmitted from the older to the younger. In a modern economy, however, customs cannot adapt themselves fast enough in order to be aligned with the evolutive patterns of production and consume (Samuelson & Nordhaus, 1985).

One of the main characteristics of a modern economy relies on an extensive network of commerce and on the specialisation of individuals and of enterprises. In this networked model, there are very few to offer a finished good. Specialisation is verified when the effort is concentrated in a given set of tasks – which allows each person, enterprise or organization to use with advantage any qualification or special resources. The paradigm of specialisation is the modern automobile assembly, with cars moving along an assembly line, where either workers or robots perform highly specialised functions, a concept that is explored by OPIM — One-Product-Integrated-Manufacturing model (Putnik, 1997), with a flat structure of primitive resources providers.[1]

In general, markets represent a mechanism through which buyers and sellers meet to exchange "things." Initially, the market was the place where goods were bought and sold. Today, the list of the most important markets includes Chicago Board of Trade, where petrol, wheat and other goods are negotiated, the New York Stock Exchange and the Hong Kong Stock Exchange, where property titles of major enterprises are traded, the Hong Kong Futures Exchange, etc.

A market can be centralised (as the one of shares, bonds or wheat) or decentralised (as the one of housing or second-hand automobiles), or can assume the format of an electronic market (as happens for several financial services, raw materials, consumables and many other products and services). Its main characteristic is to link buyers and sellers to define prices and quantities.

At every moment, several factors affect the economic activity. Some people buy while other sell. In the middle of this, markets keep solving the *what*, the *how* and the *to whom*. When balancing the forces that operate in the economy, markets try to find the equilibrium between *offer* and *demand* (Scherer & Ross, 1990).

This book is about a new dimension of market, a particular electronic marketplace. The electronic marketplace is a virtual place where business participants (buyers and sellers) meet to exchange goods and services or to cooperate in order to achieve a common business goal.

Inter-Firm Collaboration

Enterprises can enter the global market through a range of activities that reflect an increasing level of ownership, financial commitment, and risk. Exporting and importing, are the basic method; more risky formats include licensing, joint ventures and direct investment

Knowledge and physical resources associated with the development and production of most of today's products often exceed what a single firm is able to accomplish. Managers have to continually decide where to set the boundary between what work takes place inside versus outside a company, what kind of relations to build with suppliers, and how to manage the division of labour between them.

One of the most widely discussed area in recent business literature is that of organisational network structures that (supposedly) hold the promise of survival and growth in an environment of ever-increasing complexity (Bradley, Hausman, & Nolan, 1993; Byrne, 1993; Davidow & Malone, 1992; Naisbitt, 1982; Naisbitt & Aburdene, 1985; Toffler, 1985).

In a network structure, a leading firm identifies the most suitable suppliers and manages the interactions within the production network, interfacing between firms in order to minimise transaction costs. Transaction costs within a network are minimised through the selection of partners and the establishment of suitable contracts (Meyer, 1998).

Outsourcing or sub-contracting has become an important strategy for many firms, as recognised during the late eighties and nineties, partly due to an increased pressure towards downsizing and a growing recognition of possible advantages of cooperative inter-firm relations, as defended by many researchers, just to mention, Miles and Snow (1984, 1986), Naisbitt (1982), Naisbitt and

Aburdene (1985), Toffler (1985), Jarrilo (1988), Davidow and Malone (1992), Bradley, Hausman, and Nolan (1993), Byrne (1993), Kidd (1994, 1995), Handy (1995), Browne & Zhang (1999). Outsourcing some internal activities and building cooperative, interdependent and long-term relations with suppliers and alliance partners are considered to give the participating firms some benefits such as combining different competencies, sharing fixed costs and gaining economies of scale (Kanter & Myers, 1991).

Although the close relations a corporation can build with its partners, the firm still has to compete with other firms who are seeking similar relations with the same partners.

The Theory of the Firm

A firm is viewed as an entity able to produce (or sell) more efficiently than its constituent parts acting separately. Firms, as "cost-minimizing devices" (Tirole, 1988, p. 15), what are firms and how do they behave is the theme of this section.

The "Make-or-Buy" Decision

The evolution of the hierarchical firm, in the beginning of the Twentieth Century was the direct consequence of changes that were taking place in infrastructure and technology (Besanko, Dranove, & Shanley, 1996); no change was more important than the development of mass production technologies. These new technologies made it possible to produce goods at costs far below anything that could be achieved by firms using older technologies.

To fully exploit the production opportunities, these firms needed reliable supplies of inputs, as well as access to widespread distribution and retail outlets, to reach many customers at lower costs, integrating new functional responsibilities.

Every firm engages in many transactions as it goes about its business of producing a line of goods. According to its dimension and covered functions, the firm organises these transactions differently and have different relationships with its buyers and suppliers. It buys raw materials alternatively from long-time suppliers, from another division within the same organisation, or in the marketplace. And in the same way, firms sell their products in various ways: anonymously, in stores, through franchises, or even, in vertically integrated firms, directly through firm's own channels of distribution.

Firms take a set of strategic decisions that involve the decision on which transactions should be undertaken in-house and which should be outsourced.

This set of decisions is known as the “make-or-buy” decisions. In practice, firms can carry out their transactions wholly within the firm, outside the firm, or in the grey area between the firm and the marketplace (Oster, 1994).

The principles governing the decisions as to how to structure the organisation’s transactions or how deeply to vertically integrate were first articulated in 1937 by Ronald Coase (Coase, 1937), the father of *transaction costs economics*, in his pioneering work “The Nature of the Firm.”

> *The operation of a market costs something and by forming an organisation and allowing some authority (an “entrepreneur”) to direct the resources, certain market costs are saved. The entrepreneur has to carry out his function at less cost, taking into account the fact that he may get factors of production at a lower price than the market transactions which he superseeds, because it is always possible to revert to the open market if he fails to do this.* (Coase, 1937, p. 392)

To Coase, when vertically integrating, a firm opts to make its resource decisions internally using whatever management mechanisms are available, as opposed to using the market.

The core question of Coase’s theory, followed by the more recent work of Williamson (1975; 1985), is whether a set of transactions ought to take place in the marketplace or within the boundaries of a firm. The make or buy decision is hinged on the ability to achieve superior results at lower cost. As part of maximizing profit, a company strives to find the most inexpensive means of producing goods and servicing its customers. To resolve the associated make-or-buy decisions, the firm must compare the benefits and costs of using the market, as opposed to performing the activity in-house. The key insight is that markets and firms represent alternative ways of organising economic exchanges.

The author concluded that the distinguishing mark of a firm is the suppression on the price mechanism. Resource allocation in the market is normally guided through prices, but within the firm, the work/job is done through decisions and commands of management. Activities are collected in a firm when transaction costs incurred in using the price mechanism exceed the cost of organising those activities through direct managerial controls.

The lower cost available from external procurement drives the recommendation of increased reliance on markets (Malone, Yates, & Benjamin, 1987). But there are transactions costs associated with reliance on the market, including the explicit coordination cost and more complex contractual risks.

Since Coase's "The Nature of the Firm," both internal and external modes of organisation have been analysed in order to understand the nature of transaction costs and the nature of the growth of the firm. According to Hagedoorn and Schakenraad (1990) there are basically three alternatives available to any firm:

1. Control or internal organisation, where coordination takes place through the internal hierarchical system;
2. Competition or external organisation, where coordination is reached through market transactions;
3. Cooperation, where coordination is realised by means of company-to-company agreements.

Market transactions costs are usually of significant amount as a consequence of the time and effort associated with the communication of work specifications and contract negotiation, especially when goods or services would have to be contracted for repeatedly in small quantities, or when designs are changing in complex ways. In those circumstances, it may be cheaper to bring them under the firm's direct span of internal management and control.

As defended by Alchian, "resource owners increase productivity through cooperative specialisation," (Alchian & Demsetz, 1972, p. 777), quoted by Dyer (1997). The value chain in modern economies is characterised by interfirm specialisation, such that individual firms engage in a narrow range of activities that are embedded in a complex chain of input-output relations with other (Dyer, 1997).

Transaction Costs Economics

Coase (1937) and Williamson (1975), have distinguished four types of transaction costs, two of which occur at the contracting date and two of which occur later. These types are: (1) search costs, (2) contracting costs, (3) monitoring costs, and (4) enforcement costs. Search costs include the costs of gathering information to identify and evaluate potential trading partners; contracting costs refer to costs associated with negotiation and writing an agreement; costs of monitoring the contract may be high, as well as enforcing contracts may involve considerable legal costs. Coase and Williamson assert that the minimisation of transaction costs is a major concern of organisation design.

If a firm enters the market to purchase supplies, it must undertake the costs of searching for the best price and quality goods, arranging delivery in a prompt and reasonable way, and ensuring that all terms of the transaction be met. These are the transaction costs associated with using the market. If, instead, the firm internalises the transaction and buys and sells within the firm, it bears a quite different set of transaction costs, corresponding to the costs of coordinating buying and selling activities within the firm, organising and motivating workers. An optimal strategy will involve trading off the costs of using each of the available methods of organising transactions.

To protect against the hazards of opportunism, transactors may employ safeguards or governance structures — legal contracts — with the purpose of providing, at minimum cost, the control and trust that is necessary for transactors (Dyer, 1997). A legal contract specifies the obligations of each party and allows each to appeal to a third party (i.e., courts or state) to sanction an opportunistic trading partner.

For simple transactions, when asset specificity is low, a classical contract is typically employed, with relatively low costs. As asset specificity increases, transactors will attempt to write a more complex contract, with contingency clauses and increasing transaction costs (Williamson, 1985). Over some threshold, the costs of contracting become prohibitive and transactors move to unified governance /hierarchy (Williamson, 1985).

Contractualization

For Clemons, Hitt and Snir (2000), a critical aspect of outsourcing is to define the terms of the relationship. In an ideal world, a firm performs an informed assessment of the relevant costs, benefits and risks of outsourcing *versus* internal procurement. If there exists a profitable outsourcing opportunity, the client and the providers enter into a contract with a full knowledge of the nature of the work for the client and the capabilities of providers, and create an explicit written agreement that covers all aspects of the services to be delivered and payments to be made, including contingency plans for unforeseen events. During and after the engagement, both parties are fully aware of whether the terms of the contract were met, and if not, appropriate remedies can be enforced by a third party. In this ideal world, without contractual problems, clients benefit from using outside vendors, including economies of scale, scope or specialization in the form of improved quality, lower cost or faster time to market.

Unfortunately, and according to the same authors, in reality, most contractual relationships cannot meet these conditions, especially when subcontracting operations or services instead of procurement of commodities. There is a vast spectrum of available services, each with different characteristics leading to unique tradeoffs in the outsourcing decision. If some situations are well-defined and commonplace, such as hardware maintenance, involving minimal procurement risk, at the other extreme, companies may outsource a complex service, requiring providers to provide services that are yet undefined with unknown technologies. Standard contracts are hardly justified for ill-defined services.

The Outsourcing Decision

Clemons et al. (2000), based on Prahalad and Hamel (1990), suggests that a *core competence* should not be outsourced, and to expanding the scope of activities that should be made, not bought, to include areas that are important to maintaining a competitive advantage in a company's core competencies. There often are adjacent activities that are risky to outsource.

These concepts, however, provide little guidance in the outsourcing decision (Clemons et al., 2000). The authors suggest first examining what it means for an activity not to be a core competence. Second, understanding the risks of losing one's competitive advantage from outsourcing adjacent activities requires a thorough evaluation of possible risks. It appears straightforward to determine if an activity is a *competenc*e. Areas of competence are those where the firm has a comparative advantage over competitors. Here, the firm can continue to produce internally, at lower cost or better quality, than available in the outside market. If an activity is not a competence of the firm, then it can be done more cheaply outside the firm, for the usual reasons of economies of scale, scope and specialization.

This leads to the formulation of the economically rational outsourcing decision proposed by Clemons et al. (2000, p. 9): "A firm should keep an activity in-house if the size of the *expected* economic loss (transaction costs and contractual risks), given optimal contractual risk mitigation that can result from an outsourcing contract, exceeds the expected economic gains (difference in production costs)."

The Actual Economical Context

During the 1970s and 1980s we have assisted with changes in the world economic scene, particularly the failure of large corporations to adequately respond to new competition from Asia. Until the beginning of the eighties, price was the dominant factor that determined customers' preferences, while quality and speed were not of considerable significance as consumers were searching the available products on the offer side. This resulted in extensive mass production of goods at lower prices, until a moment with the industry pushing goods to a market that wanted to require, to pulling. To Boyer (1987), the problems posed by the contemporary society are the result of reaching the limits of *taylorism*, the extension of the labour organisation has become anti-productive, mass production was directed to global-dimensioned markets, and consuming has deviated from the model of standardised production.

Global competition throughout the last two decades has strengthened the significance of a company's ability to introduce new products, while responding to increasingly dynamic markets with customers rapidly changing needs, demanding for shorten the time required to design, develop and manufacture, as well as for cost reduction and increased quality.

As mentioned in the Iacocca Institute report *"21st Century Manufacturing Enterprise Strategy"* (Nagel & Dove, 1992), the main trends of the actual economical context are: (1) to meet the rapidly changing needs of the marketplace, (2) to shift quickly between product models or between product lines, in order (3) to respond in real-time to the customer demands.

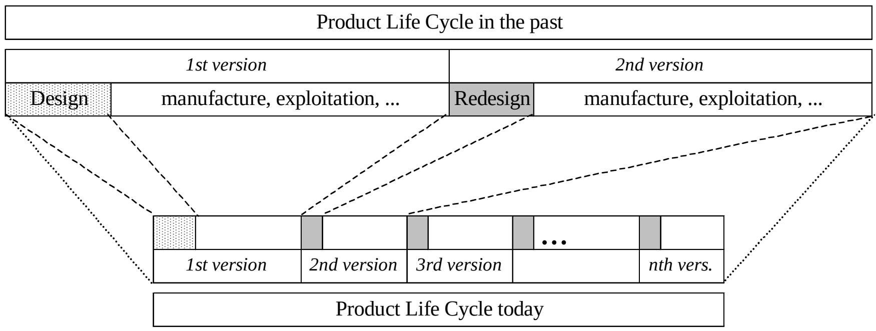
Today, the number of worldwide products and services is increasingly growing, together with the growing number of global enterprises and global brands (this happens also for the service sector). Major global manufacturers and suppliers internationalise, in order to give fast response at the best price, to the products required by the market. Most of current products integrate components originating from different parts in the world, while manufacturers (Original Equipment Manufacturers — OEM) get specialised in designing, assembly and marketing, and manage a network of suppliers.

The driving force of business is to fully satisfy customers each time more demanding, each time more global, with products each time more customised to their individual needs, at the right time, at the right price and with the required quality. At the same time, although the constant stream of innovations in the goods and services allows manufacturers and service providers to offer higher quality products, it increases customers' expectations, and thus requires higher levels of competition.

Evolution of Product Life Cycle

Decreasing product development cycle time has been an important issue for several years, according to a research by Griffin (1993), based on a number of citations of speed-to-market. Research in this domain also found evidence that product life cycles were shrinking, while product obsolescence occurs more quickly than in the past, companies are responding by bringing more products to market more frequently, and as a consequence, competition has intensified. In order to keep up with competition and continue to grow in face of shorter product life cycles, companies are driven to introduce more products to market faster and to submit the product to changes (redesigns) more frequently.

Figure 1. Evolution of product life cycle (Cunha & Putnik, 2002)



In the past a product could exist without great changes (adaptations, redesigns); faced with the challenges of today, besides the shorter duration of a product, it suffers several redesigns in order to be competitive (i.e., aligned with the market demands, see Figure 1).

Changes are usually measures undertaken to improve either products or processes. The main factors that can lead to product changes are: customer requirements, correction of detected errors, improvement of the production process, quality improvement, and cost reduction.

If the presence of an excessive number of changes in a product can reveal that it is not of good quality, a product without changes cannot offer credibility, as it reveals little attention concerning its improvement. The evolution of a product requires changes, so they must be understood as essential to the production process and production management, as the manufacturer or producer must be responsive in the answer to the market.

The Example of the Automotive Industry

The automobile industry has evolved from a handful of large vertically integrated firms serving primarily domestic markets (the "Big Three"[2] in the United States, Toyota and Honda in Japan, Volkswagen and Mercedes-Benz in Germany) to a weaving multi-tiered industry involving thousands of global suppliers.

Due to the complexity of new product-development projects, the development tasks cannot be accomplished by the auto manufacturer alone. Parts of the development tasks are delegated to external suppliers; the consequent problem is that those delegated tasks and their solutions must be coordinated and reintegrated into the overall project (Schrader & Göpfert, 1996). In a context of time-based competition and high performance, dynamically reconfigurable networked organizational models (e.g., the Agile/Virtual Enterprise model) seem to be the ones assuring enterprise integration and strategic alignment.

The automotive supply chain has become more complex. The U.S. automotive supply chain consists of four primary elements: original equipment manufacturers (OEMs), first-tier suppliers, sub-tier suppliers and infrastructure suppliers, as represented in Figure 2 (Brunnermeier & Martin, 1999). Those four elements are organized in networks to form the supply chain, as represented in.

The design and production of an automobile requires interaction and coordination among many functions and industry participants. The structure of an automobile consists of approximately 15,000 parts and accessories that must be designed to be compatible (Brunnermeier & Martin, 1999).

The degree of outsourcing from OEMs is expected to grow in this decade, from the actual 60-70% to 70-80% of vehicle value (Tiemann, Scholz, & Thies, 2000). Consequently, the cost and quality of a vehicle is a function of the productivity of a network of collaborating firms working in Figure 3.

Figure 2. U.S. automotive supply chain (Brunnermeier & Martin, 1999)

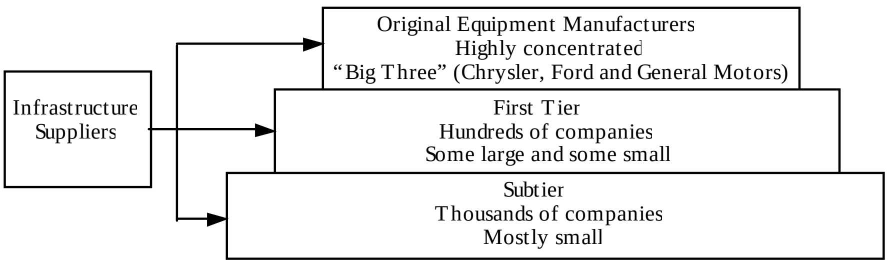
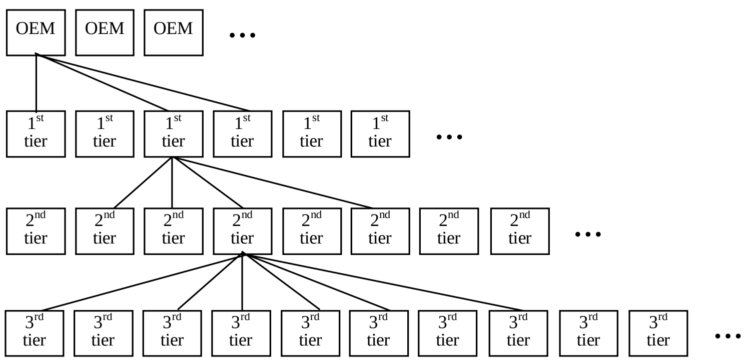


Figure 3. Subcontracting in automotive supply chain (Morel & Phelps, 2000)



The automotive industry structure is characterised by Morel and Phelps (2000) as follows:

1. There are only few OEMs and first-tier suppliers often do business with a few of them;
2. Because of the OEMs interest in outsourcing complex components, the number of first-tier suppliers is small;
3. First-tier suppliers do relatively little business outside of the automotive sector;
4. Moving to lower tiers, the total number of potential suppliers increases;
5. Lower-tier suppliers nearly always have a larger customer base than first-tiers;
6. Down the chain, automotive suppliers also tend to sell to other industrial sectors, thus decreasing their dependence on automotive business.

Items 1 to 3 demonstrate the low dynamics felt for complex resources[3] subcontracting, while items 4 to 6 reveal the potential for high reconfigurability dynamics, especially for basic or primitive resources (Cunha & Putnik, 2002).

Need for New Organizational Models and Need for Business Alignment

Every period of technological change is a period of opportunity. Indeed, risk taking and entrepreneurial activity feed on change, but also drive it.

The combination of the shorter life span of new products, increasing product diversity over time, rapid technological developments, increased technological complexity, market globalisation, as well as frequent changes in demand, increases the need for different approaches, consisting of more efficient manufacturing systems to keep competitiveness. Competitiveness is a main requisite of enterprises, whose satisfaction requires the definition of new organisational concepts, either of enterprises, or of production systems, with extremely high performances, strongly time-oriented while highly focused on cost and quality.

There are several factors determining the performance of the new organisational models. One of the most important factors is the organisation capability of fast adaptability or fast reconfigurability (i.e., flexibility[4]). In any case the reconfigurability, as a part of flexibility, implies the search and selection of new resources (substitute resources) to be allocated to the task to be performed, in order to satisfy the new circumstances (the new tasks, optimisation of old tasks, “deadlocks,” etc.). Another important factor of competitiveness is the ability of aligning the enterprise capabilities and performance with the market requirements, which means to put in the market the exact product that the market wishes, with the best possible return (financial and/or other).

Requirements for Competitiveness

Trends in the global competitive environment today suggest the need for new approaches, namely concerning Supply Chain integration, Next-Generation Manufacturing Processes, Extended and Virtual Enterprises, Agile Enterprises, Smart Organizations, etc.

For almost two decades, authors converged on the idea that the solution to the trends in the global competitive environment today relies on flexibility, the most important organisational innovation that the future deserves to enterprises, as Donovan and Wonder (1993) describe it.

Flexibility that, for example, to Miles & Snow (1984) or to Ohno (1988) could be found on a networked organisation; Womack expressed through the conceptualisation of lean systems (Womack & Jones, 1994; Womack, Roos, & Jones, 1990); corresponds to agile distributed systems to Nagel and Dove (1993); Staffend (1992) associates to virtual factories; Verpsalainen (1991) associates to the supply of teleservices; Warnecke (1995) associates to the Fractal Factory; can be found in the model of a learning organisation of Peter Senge (1990); to the IMS (Intelligent Manufacturing Systems) Programme is found in a Holonic Manufacturing System (IMS, 1995); according to Lehner (1991) is found in an anthropocentric production system; can be given by a Virtual Enterprise (Byrne, 1993) or by an Agile/Virtual Enterprise (Cunha & Putnik, 2004; Putnik, 2000); is found in an OPIM (One Product Integrated Manufacturing) system (Putnik, 2002); is given by a Virtual Value Chain (Rayport & Sviokla, 1999), just to mention some representative and comprising approaches over the last few years.

Flexibility is the ability a system exhibits during operation, that allows it to change processes easily and rapidly in a predefined set of possibilities, each one specified as a routine defined ahead of time so that when it is needed, it is put in place (Silva, 1998). In manufacturing, flexibility is related to physical flexible machinery; flexible in the sense that the machines or cells are able to execute several operations and that they can quickly change between different production plans at a given point in time.

However, if traditionally the goal of the enterprise was to fulfil the customer requirements using its internal limited set of resources, the knowledge and physical resources associated to the development and production of most of today's products often exceed what a single firm is able to accomplish.

For the problem of reconfigurability, the traditional organisational model uses the own resources existing within the organisation.[5] The set of the own resources of the company itself represents the resources selection domain. As this selection domain is relatively limited and of small size, it cannot, in general, provide the desired competitive performances neither for actual products nor for new products.

To solve the problem of the lack of resources that could bring to the company a competitive advantage, the company searches for cooperation with other companies simply buying components, subcontracting other companies or creating strategic or joint-venture associations. Inter-enterprise integration is the essential condition to make effective this cooperation.

This experience is already known for a long time. The growth of outsourcing in the eighties was the first signal that the traditional hierarchical corporate model (the mega enterprises that were vertically integrated) was breaking down (Skinner, 2001). Initially, outsourcing was generally used with relatively simple products and services, mostly because of transaction costs, where the costs of coordination of activities between organisations were significant.

The recent developments of ICT that allow organisations to be integrated electronically has significantly reduced the transaction costs, enabling organisations to focus on their core activities or core competencies and buy from the exterior non-core products and services. This gave rise to the opportunity for flexible and reconfigurable partnerships or networks, corresponding for example to the virtual enterprise model.

In the last few years, new factors have emerged that brought a different view on the enterprise organisation. A new requisite for extremely high dynamics of the company reconfigurability (i.e., in search for new resources, through companies' association creation, cooperation, etc.) has been introduced. The new production enterprise is a network that shares experience, knowledge and capabilities — it is critical in this new environment for a manufacturing company to be able to efficiently tap these knowledge and information networks.

A successful company must acquire the capability to achieve and explore the competitive advantage in synergy (Yusuf, Sarhadi, & Gunasekaran, 1999), that is, using the best resources available to an organisation (Cunha, Putnik, & Ávila, 2000), which requires a shift from "self-centred closed enterprises" (Browne & Zhang, 1999) to dynamically reconfigurable collaborative networked structures, corresponding to the recent approaches of the Extended Enterprise (Browne, Sacket, & Wortmann, 1995), the Virtual Enterprise (Byrne, 1993; Drucker, 1990; Goldman, Nagel, & Preiss, 1995), the Agile Enterprise (Nagel & Dove, 1992), the Virtual Value Chains (Benjamin & Wigand, 1995; Rayport & Sviokla, 1999), the Agile/Virtual Enterprise (Cunha et al., 2000; Cunha, Putnik, & Gunasekaran, 2002; Putnik, 2000), the Intelligent Enterprise (Quinn, 1990), the Smart Organisation (Filos & Banahan, 2001), the OPIM model (One Product Integrated Manufacturing) (Putnik, 1997; Putnik & Silva, 1995) and other models, each with its characterising nuances. Fast reconfigurability or fast adaptability is, hence, an essential characteristic of these global networked structures.

Several factors appear as supreme factors of competitiveness, namely: (1) the organisations' *capability to achieve and explore competitive advantages in synergy*, by using or integrating the optimal available resources for the functions that the organisation undertakes, (2) the capability of *fast adaptability to the market*, together with (3) the capability of *managing all business processes independently of distance*.

The models satisfying the requisite of fast reconfigurability are the Agile Enterprise and Virtual Enterprise ones[6] (Agile/Virtual Enterprise – A/VE) and Agile Manufacturing (Goldman et al., 1995; Kim, 1990; NIIIP, 1996; Onosata & Iwata, 1993; Putnik, 1997).

"Time-based competition"[7] makes companies try to be very fast in introducing new products and to have very short production lead times to manufacture and deliver products to customers (Blackburn, 1991; Stalk, Jr., 1988; Stalk, Jr., & Hout, 1990). Traditional centralized and sequential manufacturing, planning, scheduling and control mechanisms are being found insufficiently flexible to cope to highly dynamic variations in product requirements and changing production styles, as they limit the expandability and reconfiguration capabilities of the manufacturing systems (Shen & Norrie, 1998).

In this context, agility, scalability and integratibility are also essential requirements, besides complementary to flexibility. We can then present the new fundamental requirements for competitiveness as:

- **Agility**, considered in the present context of networked structure (providers of resources) as a capability for fast adaptability or fast *reconfigurability* of the entities in cooperation, in order to respond to market changes (Putnik, 2000). Adaptability is the manufacturing system's ability to be maintained easily and rapidly, in order to respond to manufacturing requirements, based on its shop-floor constraints. Adaptability refers to production facilities reconfiguration and scalability, workforce that has the incentive and flexibility to respond creatively to customer needs (Agility_Forum, 1995). A system is said to be adaptable if it can continue to operate in the face of disturbances changing its structure, properties and behaviour, accordingly to new situations it encounters, considering as disturbance any event not previously specified. Agility also includes the high responsiveness feature.

- **Distributiveness**, considering that today's competitive pressures are forcing companies to abandon the traditional approach of product development and manufacturing, conceived as a series of fairly discrete and centralised steps, and adopt new forms of sharing risks and taking profit from opportunities on a competitive basis, by an effective and efficient access and operation of spatially distributed objects (components or subsystems) (Putnik, 2000). This corresponds to the concepts of Distributed Enterprise and Distributed Manufacturing Systems, defined by Putnik et al. (1998) as enterprises or manufacturing systems which performance does not depend on the physical distance between the enterprise elements.
- **Virtuality**, besides agility, the competitiveness of the new organisational models requires the cooperation with the best resources to each function. This way, to each market or business opportunity, a new configuration of resources could be the most suitable answer, which determines a limited duration to the partnership. Venkatraman and Henderson (1996) state that virtualness is the ability of an organisation to consistently obtain and coordinate critical competencies through the design of value-adding business processes and governance mechanisms involving external and internal elements to deliver differential, superior value in the market place. Virtuality, in our work, implies the existence of a mediating service, supported by ICT (an electronic brokerage service), between the globally dispersed resources providers and the entities willing to build a partnership for some market opportunity.
- **Integratibility**, meaning that heterogeneous environments should interoperate efficiently. Defending the new organisational models as possibly integrating resources from the globally set of distributed resources, integrability means the capability for efficient access, negotiation and interoperation with the set of resources selected to cooperate with. Petrie (1992) defines enterprise integration as the task of improving the performance of large complex processes by managing the interactions among participants. Enterprise integration is both inter- and intra-organisational, where the goals and processes of functions or departments within an enterprise must be managed and integrated along with those of different enterprises in a customer supply chain.
- **Scalability and business dynamic alignment**, meaning that the structure of resources is not static, and can be permanently subject of alignment with business requirements. This requirement is intimately associated with the requirement for fast adaptability or reconfigurability.

- **Evolutionary capability** is the ability to learn with history, analysing the weaknesses and strengths of the past.

When competitiveness relies on the ability of dynamic reconfigurability and on a permanent alignment of the enterprise, partnership or network with the market environment, as happens today, the new organisational models must address the above set of requirements for competitiveness.

Business Alignment and Reconfigurability

The concept of alignment was initially introduced in the field of Information Systems and Technology. It is widely accepted that the effective use of Information and Communication Technology (ICT), to leverage the skill and knowledge base of the organization, can provide competitive advantage in the marketplace (McFarlan, 1984). The potential benefits to be gained from the effective deployment of ICT obliges organizations to consider the alignment of their ICT and their business (Shams & Wheeler, 2000). In this sense, alignment refers to actions by management to gain synergy between ICT and the enterprise's information systems, products, markets and business administration, by ensuring that internal policies match external policies in this area.

According to Henderson and Venkatraman (1993), quoted by Shams and Wheeler (2000), there are two definitions of alignment: traditional linkage, defined as, "ensuring that Information Systems activities are linked to business requirements," and strategic alignment, defined as "selecting the appropriate alignment perspectives for achieving business objectives." In this work, we adopt a perspective based on the second definition.

The concept of strategic alignment between any business policy or strategy and any kind of technology is an essential one. The driving force of business is to fully satisfy customers each time more demanding, each time more global, with products each time more customised to their individual needs, in an environment extremely competitive. At the same time, although the constant stream of innovations in goods and services allows manufacturers and service providers to offer better/higher quality products, it increases customers' expectations, and thus requires high levels of competition. In this framework, by aligning we mean the actions to be undertaken (situations to be verified) to gain synergy between the business, that is, the market opportunity[8] and the provision of the required product, with the required specifications, at the required time, with the lowest cost and with the best possible return (financial or other).

We believe that this concept can support the necessity of aligning business (market opportunities) with the most recent business models, namely the Agile/Virtual Enterprises (A/VE) model.

In Chapter IV, we propose alignment strategies between business (market opportunities) and the integration of resources in an A/VE, to answer to a market opportunity, supported by the environment of a Market of Resources.

Reconfigurability is a requirement the new organisational models must present to keep the enterprise aligned with the market opportunities. The new enterprise organisation models are not static, and the fast reconfigurability previously mentioned must happen within a minimum setup time, without disruption. It is required a high reconfigurability dynamics, which is function of reconfigurability request frequency and reconfiguration time.

Summary

This chapter introduced the main business requirements to help in understanding the economical and organizational context we live in, as a justification of the emergence of new organizational models. The new organizational models are required to by network, with a high adaptibility or reconfigurability dynamic, and permanently aligned with business. Agility, distributivity, virtuality, integrability, scalability and evolutionary capability are the requirements for competitiveness that the new organizational models must address.

References

Agility_Forum. (1995). *Creating the agile organization: Models, metrics and pilots*. Bethlehem, PA: Agility Forum.

Alchian, A. A., & Demsetz, H. (1972). Production, information costs and economic organisation. *American Economic Association, 62*(5), 777-795.

Benjamin, R., & Wigand, R. (1995). Electronic markets and virtual value chain on the information super highway. *Sloan Management Review, 36*, 62-72.

Besanko, D., Dranove, D., & Shanley, M. (1996). *Economics of strategy*. New York: John Wiley.

Blackburn, J. D. (1991). *Time-based competition: The next battleground in American manufacturing*. Homewood, IL: Business One-Irwin.

Boyer, R. (1987). *La flexibilité du travail en Europe.* Paris: La Découverte.

Bradley, S. P., Hausman, J. A., & Nolan, R. L. (1993). Global competition and technology. In S. P. Bradley, J. A. Hausman, & R. L. Nolan (Eds.), *Globalisation technology and competition: The fusion of computers and telecommunications in the 1990s* (pp. 3-31). Boston: Harvard Business School Press.

Browne, J., Sacket, P. J., & Wortmann, J. C. (1995). Future manufacturing systems: Towards the extended enterprise. *Computers in Industry, 25*, 235-254.

Browne, J., & Zhang, J. (1999). Extended and virtual enterprises: Similarities and differences. *International Journal of Agile Management Systems, 1/1*, 30-36.

Brunnermeier, S., & Martin, S. A. (1999). *Interoperability and cost analysis of the U.S. automotive supply chain* (RTI Project Number 7007-03 - Final Report). NC: Research Triangle Institute.

Byrne, J. A. (1993). The virtual corporation: The company of the future will be the ultimate in adaptability. *Business Week*, 98-103.

Clemons, E. K., Hitt, L. M., & Snir, E. (2000). *A risk analysis framework for information technology outsourcing* (Working Paper). Pennsylvania: University of Pensylvania.

Coase, R. (1937). The nature of the firm. *Economica, 4*, 386-405.

Cunha, M. M., & Putnik, G. D. (2002). Discussion on requirements for agile/virtual enterprises reconfigurability dynamics: The example of the automotive industry. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 527-534). Boston: Kluwer Academic Publishers.

Cunha, M. M., & Putnik, G. D. (2004). Trends and solutions in virtual enterprise integration. *Tekhné - Review of Politechnical Studies, 1*(1), 143-164.

Cunha, M. M., Putnik, G. D., & Ávila, P. (2000). Towards focused markets of resources for agile / virtual enterprise integration. In L. M. Camarinha-Matos, H. Afsarmanesh, & H. Erbe (Eds.), *Advances in networked enterprises: Virtual organisations, balanced automation, and systems integration* (pp. 15-24). Berlin: Kluwer Academic Publishers.

Cunha, M. M., Putnik, G. D., & Gunasekaran, A. (2002). Market of resources as an environment for agile / virtual enterprise dynamic integration and for business alignment. In A. Gunasekaran (Ed.), *Knowledge and information technology management in the 21st century organisations: Human and social perspectives* (pp. 169-190). Hershey, PA: Idea Group Publishing.

Davidow, W. H., & Malone, M. S. (1992). *The virtual corporation - Structuring and revitalising the corporation for the 21st century*. New York: HarperCollins.

Donovan, P., & Wonder, J. (1993). *The flexibility factor*. Montreal, Canada: Les Éditions de l'Homme.

Drucker, P. F. (1990, May/June). The emerging theory of manufacturing. *Harvard Business Review*,94-102.

Dyer, J. H. (1997). Effective interfirm collaboration: How firms maximize transaction costs and maximize transaction value. *Strategic Management Journal*, *18*(7), 535-556.

Filos, E., & Banahan, E. (2001). Towards the smart organization: An emerging organizational paradigm and the contribution of the European RTD programmes. *Journal of Intelligent Manufacturing, 12*(2), 101-119.

Goldman, S., Nagel, R., & Preiss, K. (1995). *Agile competitors and virtual organizations: Strategies for enriching the customer*. New York: van Nostrand Reinhold.

Griffin, A. (1993). Metrics for measuring product development cycle time. *Journal of Innovation Management, 10*, 112-125.

Hagedoorn, J., & Schakenraad, J. (1990). Strategic partnering and technological cooperation. In Dankbaar, Groenewegen, & Schenk (Eds.), *Perspectives in industrial organisation* (pp. 171-191). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Handy, C. (1995). Trust and virtual organization. *Harvard Business Review, 73*(3), 40-50.

Henderson, J. C., & Venkatraman, N. (1993). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Systems Journal*, *32*(1), 4-16.

IMS. (1995). *Holonic Concepts*. Holonic Manufacturing Systems, Intelligent Manufacturing Systems. Retrieved from http://www.ims.org.

Jarillo, J. C. (1988). On strategic networks. *Strategic Management Journal, 9*(31), 31-41.

Kanter, R. M., & Myers, P. (1991). Interorganizational bonds and interorganizational behaviour: How alliances and partnerships change the oOrganizations forming them. In A. Etzioni & P. Lawrence (Eds.), *Socio-economics: Toward a new synthesis* (pp. 329-344). New York: M.E. Sharpe.

Kidd, P. (1994). *Agile manufacturing: Forging new frontiers*. Reading, MA: Addison-Wesley.

Kidd, P. (1995). *Agile corporations: Business enterprises in the 21st Century - An executive guide*: Cheshire Henbury.

Kim, S. (1990). *Designing intelligence: A framework for smart systems.* Oxford: Oxford University Press.

Lehner, F. (1991). *Anthropocentric production systems - The European response to advanced manufacturing and globalisation*. Brussels: Fast - Forecasting and Assessment in Science and Technology, European Commission.

Malone, T. W., Yates, J., & Benjamin, R. (1987). Electronic markets and electronic hierarchies. *Communications ACM*, *30*(6), 484-497.

McFarlan, F. W. (1984). Information technology changes the way you compete. *Harvard Business Review*, *62*(3), 98-103.

Meyer, K. E. (1998). *Multinational enterprises and the emergence of markets and networks in transition economies* (Working Paper Nº 12). Copenhagen: Copenhagen Business School, Center for East European Studies.

Miles, R. E., & Snow, C. C. (1984). Fit, failure and the hall of fame. *California Management Review, 26,* 10-28.

Miles, R. E., & Snow, C. C. (1986). Organizations: New concepts for new forms. *California Management Review*, *28*, 62-73.

Morel, J., & Phelps, T. A. (2000). *A review of interoperability issues in the automotive industry* (A White Paper produced for the National Coalition for Advanced Manufacturing): ERIM - Centre for Electronic Commerce.

Nagel, R., & Dove, R. (1992). *21st Century manufacturing enterprise strategy*. Bethlehem, PA: Iacocca Institute, Lehigh University.

Nagel, R., & Dove, R. (1993). *21st Century manufacturing enterprise strategy*. Bethlehem, PA: Iacocca Institute, Lehigh University.

Naisbitt, J. (1982). *Megatrends: Ten new directions transforming our lives*. New York: Warner.

Naisbitt, J., & Aburdene, P. (1985). *Re-inventing corporation*. New York: Warner.

NIIIP. (1996). *The NIIIP reference architecture*. National Industrial Information Infrastructure Protocols. Retrieved from http://www.niiip.org

Ohno, T. (1988). *Just-in-time for today and tomorrow*. Cambridge, MA: Productivity.

Onosata, M., & Iwata, K. (1993). Developing of a virtual manufacturing system by integrating product models and factory models. *Cirp Annals Manufacturing Technology, 42*(1), 475-478.

Oster, S. M. (1994). *Modern competitive analysis* (2nd ed.). New York: Oxford University.

Petrie, C. (Ed.). (1992). *Enterprise integration modeling*. Boston: MIT Press.

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review, 68*(3), 79-91.

Putnik, G. D. (1997). Towards OPIM system. In M. A. Younis & S. Eid (Eds.), *Proceedings of the 22nd International Conference on Computers and Industrial Engineering* (pp. 675-678). Cairo.

Putnik, G. D. (2000). BM_Virtual enterprise architecture reference model. In A. Gunasekaran (Ed.), *Agile manufacturing: 21st century manufacturing strategy* (pp. 73-93). UK: Elsevier Science.

Putnik, G. D. (2002). Part I - Towards an OPIM system: Manufacturing SME organization for the future. *Int. J. Networking and Virtual Organizations, 1*(2), 125-150.

Putnik, G. D., & Silva, S. C. (1995). One-product-integrated-manufacturing. In L. M. Camarinha-Matos & H. Afsarmanesk (Eds.), *Balanced automation systems - Architectures and design methods* (pp. 45-52). New York: Chapman & Hall.

Putnik, G. D., Sousa, R. M., Moreira, J. F., Carvalho, J. D., Spasic, Z., & Babic, B. (1998). Distributed / virtual manufacturing system cell: An experimental installation, *Proceedings of the 4th International Seminar on Intelligent Manufacturing Systems*. Belgrade, Yuguslavia.

Quinn, J. B. (1990). *The intelligent enterprise*. New York: The Free Press.

Rayport, J. F., & Sviokla, J. J. (1999). Exploiting the virtual value chain. *Creating value in the networked economy* (pp. 35-51). Boston: Harvard Business School.

Samuelson, P., & Nordhaus, W. (1985). *Economics*. New York: McGraw-Hill.

Scherer, F. M., & Ross, D. (1990). *Industrial market structure and economic performance* (3rd ed.). Boston: Houghton Mifflin Company.

Schrader, S., & Göpfert, J. (1996). *Structuring manufacturing-supplier interaction in new product development teams: An empirical analysis* (Report prepared for the MIT International Motor Vehicle Program). Munchen: Ludwig-Maximilians-Universitat Munchen, Institut fur Innovationsforschung und Technologiemanagement.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. London: Century.

Shams, R. M., & Wheeler, F. P. (2000, 1-2 November). *On the strategic alignment of business and information systems: Defining informa-*

tional dimensions of alignment. Paper presented at the 10th Annual Business Information Technology Management Conference, BIT'2000, Manchester, UK.

Shen, W., & Norrie, D. H. (1998). An agent-based approach for manufacturing enterprise integration and supply chain management. In G. J. et al. (Eds.), *Globalization of manufacturing in digital communications era of the 21st century: Innovation, agility and the virtual enterprise* (pp. 579-590). Boston: Kluwer Academic Publishers.

Silva, N. (1998). *Sistemas holónicos de produção - Especificação e implementação.* Unpublished Master Thesis, Faculdade de Engenharia da Universidade do Porto, Porto, Portugal.

Skinner, S. (2001). *Business to business e-commerce: Investment perspective*. London, UK: Durlacher Research. Retrieved from http://www.durlacher.com

Smith, A. (1776). *The wealth of nations*. Oxford: Clarendon.

Staffend, G. S. (1992). *Making the virtual factory a reality.* Paper presented at the Autofact '92, Michigan.

Stalk Jr., G. (1988, July/August). Time: The next source of competitive advantage. *Harvard Business Review, 66*, 41-51.

Stalk Jr., G., & Hout, T. M. (1990). *Competing against time: How time-based competition is reshaping global markets*. New York: The Free Press.

Tiemann, R., Scholz, J., & Thies, C. (2000, June 12-15). Future trends in technical and strategical relations among OEMs and suppliers - Re-shaping the automotive industry. *Proceedings of the FISITA World Automotive Congress 2000*. Seoul, Korea.

Tirole, J. (1988). *The theory of industrial organisation*. Massachusetts Institute of Technology.

Toffler, A. (1985). *The adaptive corporation*. New York: McGraw Hill.

Venkatraman, N., & Henderson, J. C. (1996). *The architecture of virtual organising: Leveraging three independent vectors* (Discussion Paper). Boston: Systems Research Center, Boston University School of Management.

Verpsalainen, A. (1991). Systems that turn manufacturing into sService. In E. Eloranta (Ed.), *Advances in production management systems, IFIP 1991*. North-Holland: Elsevier Science Publishers.

Warnecke, H. J. (1995). *The fractal company*. Berlin: Springer-Verlag.

Williamson, O. (1975). *Markets and hierarchies: Analysis and antitrust implications*. New York: The Free Press.

Williamson, O. (Ed.). (1985). *The economic institutions of capitalism*. New York: The Free Press.

Womack, J. P., & Jones, D. T. (1994). From lean production to the lean enterprise. *Harvard Business Review, 2*.

Womack, J. P., Roos, D., & Jones, D. T. (1990). *The machine that changed the world*. New York: Rawson Associates.

Yusuf, Y. Y., Sarhadi, M., & Gunasekaran, A. (1999). Agile manufacturing: The drivers, concepts and attributes. *International Journal of Production Economics, 62,* 33-43.

Endnotes

[1] In fact, OPIM System explores the fact that an enterprise is able to show high performance (ideally, 100% performance) only in a reduced number of primitive resources (operations, functions). Providers of these primitive resources can be directly subcontracted by an "enterprise owner," in a flat organisational structure.

[2] Ford, General Motors and Chrysler.

[3] A resource can be a product, operation or service.

[4] In the concept of Flexible Manufacturing Systems, the flexibility is defined as a capability of the (manufacturing) system to adapt to the new tasks (i.e., to reconfigure, to reprogram itself in order to satisfy the demand in an optimal way) without interruption of the production (manufacturing) process. So "adaptability," or "reconfigurability," is necessary but not sufficient conditions for flexibility. Any system is possible to adapt but we seek for adaptation of the system so fast that the production process will be not affected. Based on this premise, "fast adaptability" or "fast reconfigurability" are synonyms for "flexibility."

[5] In traditional organisation the combined and/or integrated process planning (PP) and production planning and control (PPC) carry on the reconfigurability of the manufacturing system. The operation design, as the PP function, and the manufacturing operations scheduling, as the PPC function, both include a machine tool selection (i.e., resources selection, on the existing workshop as the resource selection domain). Similar processes are carried on for the business processes where the reconfigurability is termed as a company "re-organisation."

[6] Although we state that there is a difference between the Agile and Virtual enterprise concepts, in the context of the present work, we will not address it, as our main concern is the flexibility given by the characteristic of fast reconfigurability intrinsic to both models.

[7] This concept was first defined in a series of books and articles by consultants at the Boston Consulting Group.

[8] We will designate by market the environment where business takes place.

Chapter II

A Review on Virtual Enterprise Models

Introduction

In this chapter the most relevant and most discussed virtual enterprise models are introduced in a broader sense: the Supply Chain Management, Extended Enterprise, the Agile Enterprise/Manufacturing, the Virtual Enterprise/Virtual Organization, the *BM_VEARM* Agile/Virtual Enterprise and OPIM (One Product Integrated Manufacturing). At the end of the chapter a discussion is presented.

The Emergence of the Virtual Enterprise as an Organizational Concept

The eighties have seen the rise of a plethora of models and acronyms always used in conjunction with production and operations management and control, such as Just-in-Time (JIT), Total Quality Management (TQM), Zero Inventory (ZI), Efficient Consumer Response (ECR).

During the first half of the nineties, several criteria for competitiveness have emerged, including requirements such as quick response, high flexibility and quality, constrained by environmental concerns (Yusuf, Sarhadi, & Gunasekaran, 1999). The goal of the enterprise was to fulfill the customer requirements, traditionally, using the limited set of resources available within the walls of the organization. As during the nineties, the requirements for competitiveness of today remain the same, and the goal of the enterprise is still to fulfill the customers' wishes.

Several organizational approaches have emerged since then, some based on technology, others relying more on organizational or on human aspects. Holonic Manufacturing Systems Bionic Manufacturing Systems, Fractal Factory, Lean Production, Agile Manufacturing, Concurrent Engineering, Anthropocentric Production Systems, are examples of emerging organizational models whose main characteristic is flexibility, and all of them represent attempts to increase competitiveness and efficiency. Other recent models rely on more or less strong alliances, more or less dynamic partnerships, and more supported or less supported by ICT, some of which can be classified as agile and virtual enterprise models.

Williamson (1991) identified two distinct economic forms of governance: hierarchy and market. Hierarchy denotes common ownership of successive stages of the supply chain, whereas market represents the transactions between atomistic organizational units. Recent attention has focused on intermediate forms of economic organization, lying somewhere between a market and a hierarchy. Williamson refers to these as hybrid organizations, whereas more recently other authors use terms such as network, virtual organization, extended enterprise, etc.

It is recognized that the value chain in modern economies is characterized by inter-firm specialization such that individual firms engage in a narrow range of activities that are embedded in a complex chain (Dyer, 1997). As Browne et al. (1995) suggest, manufacturing systems can no longer be seen in isolation; they must be seen in the context of the total business and the linkages from the supplier chain forward into the distribution and customer chain. Browne and Zhang (1999) refer the shift from "self-centered" closed-enterprises to global open-enterprises.

A more dynamic theory of the firm would (...) view a firm as the capability to design and assemble assets, organizations, skill sets, and competencies for a series of temporary competitive advantages, rather than a set of activities held together by low transaction costs, for example. (Fine, 1996)

According to Wassenaar et al. (1998), by introducing quite new business transaction patterns between firms and their partners, ICT and electronic business enforces an ongoing reshaping of intra- and inter-organizational structures. At one side, organizations are internally broken up into small self-contained business units coordinated by quasi-horizontal market mechanisms. On the other hand, organizations are externally integrated in an interdependent network coordinated by quasi-vertical hierarchical mechanisms. These new emergent intra- and inter-organizational forms proposed and developed in the past few years, which consist of dynamically reconfigurable collaborative networked structures, are described in literature under labels like the network organization (Miles & Snow, 1986), the intelligent enterprise (Quinn, 1990), the electronic hierarchies (Malone, Yates, & Benjamin, 1987), the virtual value chains (Benjamin & Wigand, 1995; Rayport & Sviokla, 1999), the Extended Enterprise (Browne et al., 1995), the Virtual Enterprise (Byrne, 1993; Drucker, 1990; Goldman, Nagel, & Preiss, 1995), the virtual corporation (Davidow & Malone, 1992), the Agile Enterprise (Nagel & Dove, 1992), the Agile/Virtual Enterprise (Cunha, Putnik, & Ávila, 2000; Cunha, Putnik, & Gunasekaran, 2002; Putnik, 2001), the Smart Organization (Filos & Banahan, 2001), the OPIM model (One Product Integrated Manufacturing) (Putnik, 1997; Putnik & Silva, 1995) and other models, each with its characterizing nuances.

We can say that there exists a broad/extended terminology to this range of concepts, sharing similarities and sometimes overlapping, that we designate by Virtual Enterprise models or concepts.

All of them have in common ICT as a prerequisite and facilitator, or even the core. However, there is so far no unified definition of these concepts and a variety of definitions exist from different points of view in the literature (Camarinha-Matos, Afsarmanesh, Garita, & Lima, 1997).

Franke (2001) identifies two major driving forces towards these virtual organization or virtual enterprise concepts:

1. **The changing market conditions:** Consumers are demanding more specialized products, which leads to a broader product range that companies have to develop and produce; companies have to tailor their output according to individual customer wishes, with the effect that the complexity across all organizational functions increases; specialization and individualization of products leads to shorter production cycles, which in turn increases the investment and cost of R&D, production, and sales; another influential market change is the internationalization of markets and the globalization of competition.
2. **Fast development of ICT:** Within the last two decades has dramatically improved the speed, quantity and quality of communication, and especially the coordination of economic actions and transactions.

Both of these external forces lead to a changing business understanding and different business strategies that, in its consequences, originate organizational changes. In order to improve their flexibility and to decrease complexity, companies employ the core competence strategy, which means that the economic actors concentrate on what they can do best, specialize in certain areas, develop and constantly improve their core competencies. However, a core competency *de per si* does not create any value, and companies have to search for value chains where to integrate their core competencies, which are then flexibly configured in different value chains, leading to an optimum value creation process.

Box 1. Toward virtual enterprises (Putnik et al., 2005a)

"…companies must be able to form a **network** of reliable subcontractors, many of them large firms which have not worked together before. Some companies, therefore, have found it advantageous to focus only on the overall design, leaving the actual construction to their affiliates. . . . the functions of product design and development, manufacturing, and distribution, ordinarily integrated by a plan and controlled directly by managers, will instead be brought together by *brokers* and held in temporary alignment by a variety of *market mechanisms*." (Miles, Snow, 1984)

"...'flotilla', consisting of modules centred either around a stage of the production process or around the number of closely related operations. Though overall command and control will still exist, each module will have its own command and control. And each, like the ships in a flotilla, will be manoeuvrable, both in terms of its position in the entire process and its relationships to other modules. This organisation will give each module the benefits of standardisation and, at the same time, give the whole process greater flexibility. Thus it will allow rapid changes in design and product, rapid response to market demands, and low-cost production of 'options' or 'specials' in fairly small batches." (Drucker, 1990)

"**Agile Manufacturing System**: "… a manufacturing system with extraordinary capabilities … to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness). A system that shifts quickly (speed and responsiveness) among product models or between lines (flexibility), ideally in real-time response to customer demand (customer needs and wants)." (Nagel, Dove, 1993)

"**Extended Enterprise**: core product functionalities are provided separately by different companies who come together to provide a customer defined product" (Browne, 1995)

Supply Chain is "a system whose constituent parts include material suppliers, production facilities, distribution services and customer linked together via the feed-forward flow of materials and the feedback flow of information" (Stevens, 1998)

"**Smart organisations** are knowledge-driven, *inter-net*worked, and dynamically adaptive to new organisational forms and practices, learning as well as agile in their ability to create and exploit the opportunities offered by the digital economy." (Filos, Banahan, 2001; Filos, 2005)

"The **extended enterprise** is an expression of the market driven requirement to embrace external resources in the enterprise without owning them. Core business focus is the route to excellence but product/service delivery requires the amalgam of multiple world class capabilities. Changing markets require a fluctuating mix of resources. The extended enterprise, which can be likened to the ultimate in customisable, reconfigurable manufacturing resource, is the goal…
"The operation of the extended enterprise requires take up of communications and database technologies, which are near to the current state of the art. However, the main challenge is organisational rather than technological." (IMS International, 2003)

[*] – minor adaptations in the original text introduced by the authors

A selection of virtual enterprise model definitions, as well as related approaches, that do not refer explicitly the term "Virtual Enterprise" but could be considered as it, is presented in Box 1 (*Toward Virtual Enterprises*) (Putnik et al., 2005a), while the virtual enterprise model definitions that refer explicitly the term "Virtual Enterprise" will be presented in the "The Agile Enterprise/Manufacturing Model" section of this chapter.

We would consider the models presented in the Box 1, in a way, as "transitional" models towards the Agile/Virtual Enterprise.

Supply Chain Management

The concept of supply chain management has existed for several decades, but only since the last decade is gaining increased attention. Until the nineties, commercial innovations in products, processes and services typically were achieved within vertically integrated industrial corporations. During the nineties, however, the global competitive environment has shifted towards a horizontal on virtually integrated industry structure, involving close interaction among suppliers, manufacturers and customers — the supply chain (Huang, Wang, & Dismukes, 2000).

A Supply Chain is "an integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors and retailers) work together in an effort to: (1) acquire raw materials, (2) convert these raw materials into specified final products, and (3) deliver these final products to retailers" (Beamon, 1998, quoted by Huang et al., 2000).

The supply chain comprises the production and supply of materials and parts, and it serves both the manufacturing logistic chain and the distribution logistic chain (Huang et al., 2000), that is, it encompasses all the activities associated with the flow and transformation of goods, from the raw materials stage, through to the end user, as well as the associated information flows. Supply chain includes the management of information systems, sourcing and procurement, production scheduling, order processing, inventory management, warehousing, custom service, and after-market disposition of packaging and materials (Wu, Cobzaru, Ulieru, & Norrie, 2000). The term *Supply Chain Management* (SCM) seems to have its origins in the early 1980s to describe the potential benefits of integrating these activities through improved supply chain relationships, to achieve a sustainable competitive advantage (Shee, Tang, & Tzeng, 2000), when companies such as Procter and Gamble realized that many cost savings were possible if they could have at least some control over the customer's orders (Hinkkanen, Kalakota, Saengcharoenrat, Stallaert, & Whinston, 1997).

By monitoring the inventories at the customers, it is possible to predict when a stock out would occur at the earliest, and when a customer is ready for a new shipment. This flexibility for inventory replenishment makes it possible to smooth out the production and distribution peaks; so supply chain management not only involves the management of logistics functions as was done in the past (striving for internal efficiency of operations), but includes managing and coordinating activities upstream and downstream in the supply chain (Kalakota, Stallaert, & Whinston, 1996).

The objectives of SCM consist on coordinating and optimizing functions of supply-demand relationships that manage the flows of products/services and information that carries control and feedback mechanisms (Shee et al., 2000). In other words, SCM aims to provide advantages in customer satisfaction, cost reduction, quality improvement and flexibility enhancement (Jenkins & Wright, 1998).

Important academic work to understand and model supply chain activities dated to Forrester's pioneering industrial dynamics modeling (Forrester, 1958, 1961), describing amplification effects within the supply chain, and to the work of Clark & Scarf (1960), followed by the work of several researchers as (Burbidge, 1985; Burns & Sivazlian, 1978; Swaminathan, Smith, & Sadeh, 1998; Towill, 1982; Wilkner, Towill, & Naim, 1991). During the last decade, much effort has also been dedicated to the development of information technology to support SCM, namely to the application of multi-agent technology.

For years, most researchers were investigating centralized or hierarchical decision paradigm for the supply chain issues. Supply chain models have evolved from multi-echelon systems to more sophisticated network models, as presented in Huang et al. (2000). However, as a whole, the supply chain should have an overall optimal performance; the simple aggregation of all the separate optimal solutions does not necessarily lead to the optimal solution of the whole supply chain system, that is to say, entities should have some sort of coordination between them, as defended, for example, in Huang et al. (2000), Parunak and VanderBok (1998), and Swaminathan et al. (1998).

With increasing accessibility to global markets, many organizations are expanding beyond the boundaries of their own country. Not only do they expand through the sales of products to other countries, they also locate their facilities in other countries. Some organizations have realized improvements in their marketing efforts when development and manufacturing is located close to the target customers. Also, the higher level of global competition motivates organizations to focus on the potential economic benefits of locating in countries with lower labor costs or by locating close to suppliers who offer lower costs or higher quality material (Murray, Kotabe, & Wildt, 1995). The trend toward global organizations mandates more research in those areas that provide competitive advantages such as lower cost, high quality, and faster delivery. Global supply chain agility provides an organization with the ability to adapt in order to pursue or maintain these advantages. Goldman et al. (1995) state, "Agility is the competency that sustains world class performance over time."

The Extended Enterprise

According to Browne & Zhang (1999), individual companies work together to form inter-enterprise networks across the product value chain. The extended enterprise and the virtual enterprise can be seen in the context of enterprise partnerships, designed to facilitate co-operation and integration across the value chain, the first more concerned with long-term relationships and the second with more dynamic configuration.

The extended enterprise is a term frequently used in literature to represent the high level of interdependence that exists between organizations, not only in manufacturing industry, but also in other business areas (financial, transportation, etc.).

The extended enterprise extends beyond traditional organizational boundaries. It includes the relationships that an enterprise has with its customers, suppliers, business partners, even former competitors and so on (Browne et al., 1995). The extended enterprise is responsible for the whole product life cycle, from material procurement to component production and manufacturing, to final assembly, further to distribution and customer service, and in an increasing number of cases, to the dispositioning and, where possible, recycling of end-of-life products (Browne & Zhang, 1999). In this sense, the extended enterprise can be regarded as represented by all those organizations or parts of organizations, customers, suppliers and subcontractors, engaged collaboratively to design, develop, manufacture and deliver a product to its end user (Browne, Harhen, & Shivnan, 1996). It includes both the inbound supply chains and the outbound logistics chains.

Although the challenge of creating and operating an extended enterprise is primarily managerial and concerned with the design and implementation of appropriate business processes, the efficiency of the organization, once formed, is greatly determined by the speed and efficiency with which information can be exchanged and managed among business partners (Browne & Zhang, 1999). Based on collaborative engineering, production and logistics, it requires effective electronic management of engineering and production information, which is to say, the extended enterprise relies on advanced ICT, interoperability between partners' systems, information exchange protocols and standards.

Browne (1995) identifies the following major characteristics of the extended enterprise:

- The manufacturing enterprise focused on its core business and technical activities, and outsources non-core business activities to outside suppliers and service suppliers; outsourcing encourages both the manufacturer and its suppliers' competitive ability and enhances their mutual dependency.
- The manufacturer develops long-term relationships with key customers and treats them as important business partners.

The Agile Enterprise/ Manufacturing Model

The Agility concept was coined in 1991, by a group of scholars, lead by R. N. Nagel and Rick Dove, at Iacocca Institute of Lehigh University in Bethlehem, in a two-volume report entitled *21st Century Manufacturing Enterprise Strategy* (Nagel & Dove, 1993),[1] when an industry group observed that the increasing rate of change in the business environment was outpacing the adaptability of traditional manufacturing organizations. As Dove (1994) describes it, "though some of these organizations were simply late to wake up, many could see a need but were unable to institute internal change quick enough. Agility is the word that describes the missing characteristic in these organizations; they could not adapt at the same pace as their changing environment."

Agility is considered by most of literature as a competitive advantage. The Agility Forum (Agility_International, 2002) mentions several reasons, such as market fragmentation, shrinking product lifetimes, and true global competition, for an organization to increase its agility.

Numerous research and development programs are ongoing in this area (Agility_Forum, 1998). A few notable examples include: the Agile Manufacturing Initiative sponsored by the Defense Advanced Research Projects Agency (DARPA) and the National Science Foundation (NSF); the Technologies Enabling Agile Manufacturing (TEAM) program sponsored by the U.S. Department of Energy with the goal of demonstrating the benefits of integrating multiple software systems within an agile manufacturing enterprise; and the establishment of a series of Agile Manufacturing Research Institutes (AMRI's) which support the teaming of university and industry with the goal of developing the principles and practices that define agile manufacturing.

Despite this high level of interest in agility, the actual definition of the concept is vague and somewhat expansive. Even the Agility Forum (previously known as Agile Manufacturing Enterprise Forum) notes that the idea of agile manufacturing is not a specified technique with a clearly delineated list of components. As a result, researchers have adopted a wide range of approaches to agility.

Agility, according to the Agility Forum (Dove, 1996), is the ability of an organization to adapt proficiently (thrive) in continuously changing, unpredictable business environment. An Agile Enterprise is a broadly change-proficient enterprise; an enterprise that exhibits competency at causing and dealing with change in the important competitive business practices of its business sector. The Agile enterprise has been defined as one that is proficient at change and Agility defined as change proficiency (Dove, 1995). Webster defines Agility as "highly competent."

The original definition (Nagel & Dove, 1993) consists of "(…) a manufacturing system with extraordinary capabilities (…) to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness). A system that shifts quickly (speed and responsiveness) among product models or between lines (flexibility), ideally in real-time response to customer demand (customer needs and wants)."

Lee (1998) defines agility as, "…the ability of a manufacturing system to manufacture a variety of components at a low cost and in a short period of time." This approach focuses on interventions early in the design stage of a product, the reduction of lead times for a product, and an increased utilization of resources. On the other hand, deVor, Graves, & Mills (1997) observe that the agile concept is evolving from an initial localized implementation to become a strategic methodology that utilizes "proactive adaptability." This strategic view results in a more comprehensive, less specific perspective as can be seen in the definition of agility provided by Gunasekaran (1998). The author defines agility "(…) as the capability to survive and prosper in a competitive environment of continuous and unpredictable change by reacting quickly and effectively to changing markets, driven by customer-designed products and services (…)." Gunasekaran further notes that the concept embodies an inherent paradox as companies must compete and cooperate in the same market environment.

Another very complete and comprehensive definition of Agility is the one suggested by Yusuf et al. (1999, pp. 37): "Agility is the successful exploration of competitive bases (speed, flexibility, innovation, proactivity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment."

Agility has been defined in terms of outcomes by several researchers (Dove, 1994; Goldman et al., 1995; Nagel, 1993; Nagel & Dove, 1993), as dynamic, context specific, aggressively change embracing and growth-oriented envisaging succeeding, winning profits, market share and customers. For instance, the US Agility Forum defines Agility as "(...) the ability to thrive and prosper in a competitive environment of continuous and anticipated change, to respond quickly to rapidly changing markets driven by customer-based valuing of products or services" (Agility Forum, 1998). Meanwhile, Kidd (1994; 1995) advances with operational aspects of agility. Some of the aspects proposed by Kidd (1995) that we consider to be the most relevant include: (1) quick response to market opportunities, (2) adaptability or capability to change direction, (3) virtual corporations, and (4) reconfigurability of corporate resources in answer to unexpected market opportunities.

Dove (1995) proposes to define Agility along four change-proficiency inter-related metrics — time, cost, robustness and scope, defined as:

- Time required to complete a change in order to respond effectively to the environment;
- If cost is no object, everything can be changed, however, if the cost of change is too much in relation to the competitor's costs, there will be a low financial performance;
- The change process must be sufficiently robust; quick and economical change are not enough if the result "is balanced on the head of a pin" and does not remain functional; and finally,
- Something is considered Agile because it is prepared to thrive on unpredictable change, when to change or what to change is not known until it occurs, and the dimension of scope of Agility addresses this question. Scope is the principal difference between flexibility and agility; flexibility is a characteristic fixed at specification time, it is the planned response to anticipated contingencies, while agility, on the other hand, repostures the fundamental approach in order to minimize the inhibitions to change in any direction. The system must be designed not anticipating a defined range of requirements, but to be deconstructed and reconstructed as needed, designed with a "reusable, reconfigurable, scalable strategy" (Dove, 1995).

Gunasekaran (1999) presents a review on available literature on Agile Manufacturing, defining the expression as the ability of a producer of goods and services to thrive in the face of continuous change. Agile Manufacturing is supported by suitable alliances based on core-competencies, organizing to manage change and uncertainty, leveraging people and information (Gunasekaran, 1999). The author also views Agile Manufacturing as a natural development from the original concept of "lean manufacturing," which main concern was cost cutting.

In general, the fundamental tenet of Agile Manufacturing is the use of modern information technology to form virtual enterprises, which "agilely" respond to changing market demands. Electronic commerce, trust-based relationships, virtual enterprise are tactics, or strategies or enablers to improve change proficiency in today's business environment, and hence enablers, are not synonymous, with Agility (Dove, 1996). Change proficiency, fundamental in the Agile enterprise, "(…) can be as simple as a portfolio management company that constantly reshuffles the in-Agile resources it controls, or as complex as a vertically integrated organization concerned about the Agility of each of its operating units, which in turn are concerned about the Agility of each of their key business processes" (Dove, 1996).

The Virtual Enterprise/ Organization Approach

Davidow and Malone (1992) suggested that the virtual corporation is the industrial strategy for structuring and revitalizing the corporation for the twenty-first century.

There is not a universally accepted definition of the virtual enterprise (VE) concept (depending on application domain there are also referred terms or concepts as *virtual company*, *virtual corporation*, *virtual factory*, *virtual manufacturing*, etc.). According to Camarinha-Matos et al. (1997), the paradigm of Virtual Enterprise is a growing and multidisciplinary area of research and development, involving concepts such as extended enterprise, supply chain management, electronic commerce, virtual organizations, etc.

A review undertaken by Putnik (2000) highlighted the existence of at least two approaches in the virtual enterprise concept definition or specification:

1. By the first approach, the most important characteristic of the virtual enterprise concept is the dynamic networking of enterprises.
2. The second approach emphasizes the "virtuality" of the system as something "not physically existing as such but made by software to appear to do so" (Oxford Dictionary).

According to the first approach, networks are on the basis of the VE model. The idea of the virtual enterprise following the first approach (i.e., as a dynamic networking of enterprises) came from the works of Peter Drucker (1990) and the Iacocca Institute (Nagel & Dove, 1993). Nagel and Dove have defined the virtual enterprise concept as a part of a wider concept called Agile Manufacturing or Enterprise, and many institutions, researchers and authors followed that idea, as for example the IMS project (IMS, 1996) and the work of Goldman (Goldman et al., 1995).

The IMS project (IMS, 1996) defines the virtual enterprise as the next generation of manufacturing enterprise, which consists on a globally distributed assembly of autonomous work units linked primarily by the goal of profitably, serving specific customers and operating in an environment of abrupt and often unanticipated change.

In Goldman et al. (1995), the virtual enterprise concept is seen as a special case, or an implementation of the Agile Enterprise (or Manufacturing) concept. "A virtual organization structure is an opportunistic alliance of core competencies distributed among a number of distinct operating entities within a single large company or among a group of independent companies. While the virtual organization is opportunistic, its objective is to create solution products with lifetimes as long as the marketplace will allow. These products are expected to evolve, and as they do, so will the virtual organization's resource requirements. Some participants will leave to join other groups because their competencies no longer add enough value to be most profitably used in the virtual organization. For precisely the same reasons, others will join, because they can add value as the product evolves in one direction rather than another. The virtual organization is a dynamic organizational tool for agile competitors. It is at once neither temporary nor permanent."

The fundamental idea of the virtual corporation, for Franke (2001), is that it is a partnership created when it is needed.

A Virtual Enterprise is "virtual" to Parunak & VanderBok (1998) because it relaxes the conventional restrictions that an enterprise be a single legal entity, headquarted in a single place, with close synchronization among its various functions.

Forbairt (1996) defends the virtual enterprise as a response to the speed and globalization of the digital age. It is an enterprise that may have no physical head office, very few full-time workers and existing as a combination of specific skills from individuals or enterprises.

NIIIP (National Industrial Information Infrastructure Protocols) reference Architecture (NIIIP, 1996) defines a virtual enterprise as a temporary consortium or alliance of companies, which come together to exploit some fast changing market opportunity. Within the virtual enterprise, companies share costs, skills and access to global markets with each participant contributing with its core competence.

A similar definition is given in SME (1993), where a VE is a consortium subcontracting key processes to other suppliers.

Camarinha-Matos et al. (1997) introduce a new feature to the NIIIP definition, besides the partnership temporariness and sharing of competencies/costs: the cooperation based on ICT.

Similarly, Byrne (1993) stresses that the VE is a temporary network of independent companies — suppliers, customers, even rivals — linked by ICT to share skills, costs, and access to one another's markets. Each partner company contributes only what it regards as its core competencies. Once the market opportunity is met, the VE will disband. According to the author, the VE will have neither central office nor organization chart, nor hierarchy, nor vertical integration.

Taking a closer view at Byrne's definition, the organizational construct he describes features a number of distinct characteristics. The VE is a temporary network, which is neither set up for an agreed period of time, nor it is an open-ended cooperation such as a joint venture or a strategic alliance. The partnerships last as long as the market opportunities are beneficial for the cooperation partners. If the market has been exploited, the partnership dissolves and the independent companies will form new virtual corporations with the same or different partner companies depending on customer needs and market opportunities (Goldman et al., 1995). The VE model provides independent companies with the option to continue their day-to-day business in addition to the involvement in partnerships. The partnering companies may also be involved in several VEs at any one time.

Some authors use the term "Extended Enterprise" to refer what others classify as virtual enterprise. In the Extended Enterprise (Browne, 1995), core product functionalities are provided separately by different companies who came together to provide a customer defined product or service. Extended enterprise is a network of different companies along the supply, or value-added chain. Therefore, the competition is not anymore "company against company" but "supply chain against supply chain." Extended Enterprises "form, reform and dissolve over time." The extended enterprise could be seen as an interpretation of the virtual enterprise concept. But in Janowski and Guimenez (1998), extended and virtual enterprise differ in definitions and models.

Finally, Putnik (2001) highlights a very important characteristic of the virtual enterprise concept, that many authors do not point out. The virtual organization model expresses the need of agile competitors to create or assemble new productive resources *very quickly* and *frequently and concurrently* because of decreasing profitable lifetimes of individual products and services. In Kim (1990) is given an illustrative specification of the performances required for a new manufacturing system: an "ideal" manufacturing system or enterprise should: (1) manufacture from 1 to 1,000 products simultaneously, (2) accommodate lot sizes from 1 to 1,000,000, and (3) the system should reconfigure for a new product within 1 second (in order to satisfy (1) and (2)).

According to the second approach, enterprise networking is irrelevant. Terms used in this approach context are "virtual factory," "virtual manufacturing," "virtual reality in manufacturing," etc.

In Kim (1990) a set of abstract constructs, called virtual factories, is superimposed on the physical factory. A virtual factory is defined by a sequence of production operations implemented on the machinery of the physical plant. Each virtual factory supports the manufacture of exactly one product or output of the physical factory; its configuration is defined by the specification of the product to be manufactured. A virtual factory is defined by a sequence of processes rather than machines, therefore two consecutive products or units that are produced by some virtual factory may actually be treated on different machinery in the physical plant.

In Fujii, Kaihara, Morita, and Tanaka (1999), a (Distributed) Virtual Factory consists of several (distributed) simulation models.

Virtual Manufacturing is defined in Onosata and Iwata (1993) as a concept of executing manufacturing processes in computer as well as in the real world. The Institute for Systems Research (ISR, 1995) defines Virtual Manufacturing as the use of manufacturing-based simulation for product design and manufacturing system design and control.

It must be noted that the two approaches identified by Putnik (2000) to the virtual enterprise concept definition, in fact, exclude each other. The two approaches form two independent dimensions of the VE model space.

At the University of Minho, it was conceived a special model of the VE, called One-Product-Integrated-Manufacturing (OPIM). OPIM is conceived as an optimized manufacturing system for the purpose of a single product manufacturing, integrated over a universal set of primitive resources, in a real-time substitutable physical structure. The design (synthesis) and control of the system is performed in an abstract, or virtual, environment (Putnik, 1997; Putnik & Silva, 1995). The definition satisfies the requisites for enterprise networks (resources that integrate the system are independent companies or enterprises), for agility (real time configuration) and for virtuality. The particularity is that the system is integrated over primitive resources-companies (for example, a "single person," an individual machine/operation) and for a single product manufacturing.

In Camarinha-Matos and Afsarmanesh (1999), a Virtual Organization (VO) is a concept similar to the one of Virtual Enterprise, comprising a network of organizations that share resources to achieve its goal, but is not limited to an alliance of enterprises. A VO could be a virtual municipality, integrating the organizations of a municipality (e.g., city hall, water distribution services, cadastre services), being a VE a particular case of VO.

Bultje and Wijk (1998) note that the different interpretations of the virtual organization concept partly depends on the authors understanding of the term "virtual." They have identified four different sub-concepts of "virtual," used to define the essence of virtual organizations, which can be reduced into the above two approaches evidenced by Putnik (2000).

Bultje and Wijk (1998) make the following distinctions:

- **Virtual means "unreal, looking real":** Virtual reality is a good example of this sub-concept.
- **Virtual means "immaterial, supported by ICT":** means that something does not physically exist, it is only created by data, as for example the Virtual Shopping Mall, the Virtual Office or the Virtual Products.
- **Virtual means "potentially present":** an organization which does not exist but would have the possibility to exist; as soon as the need for a certain configuration of organizations is spotted, an operating unit will be configured.
- **Virtual means "existing but changing":** the dynamic network follows this meaning of virtual; the organizational unit exists, but the composition of partners is temporary, and the organization reconfigures itself permanently, it is dynamic and progressive.

According to Franke (2001), one of the major problems of virtual corporations is the search for suitable partner companies; companies which fit together in terms of mutual trust, organizational culture, business processes and ICT systems.

In contrast to hierarchical organizational structures, where the allocation of resources and their organizational fit is facilitated by its organizational boundaries (closed system), the search for suitable partners holding the needed resources and/or competencies, as well as to fit to the other partners, is rather difficult to achieve. The search for suitable partner companies with the required core competencies can be performed on a global scale (i.e., via the Internet). This search approach might be difficult and time consuming (as we will demonstrate later in Chapter X), but it certainly bears the risk that the allocated partners do not fit together (Franke & Hickmann, 1999). Therefore, Goldman et al. (1995) introduced the organizational concept of "Virtual Webs" to facilitate the partnering process of unfamiliar partner companies, which can be seen as the home base (hub) of virtual corporations. The virtual Web platform is an open-ended collection of pre-qualified partners that agree to form a pool of potential members of virtual corporations.

Sieber (1998) distinguishes two different views on virtual corporations: one the one hand there are rather institution-oriented definitions (e.g., the definition followed by Byrne, 1993), on the other hand there are definitions with a clear reference on effectiveness and efficiency of companies. The author defends the second, following the definition of Venkatraman and Henderson (1996): "Virtualness is the ability of an organization to consistently obtain and co-ordinate critical competencies through its design of value-adding business processes and governance mechanisms involving external and internal constituencies to deliver differential, superior value in the market place" (Venkatraman & Henderson, 1996, p. 4, quoted by Sieber, 1998).

Box 2a. Virtual enterprise (Putnik et al., 2005a)

"A **Virtual Enterprise** is an organization fundamentally customer-oriented which accomplish the customer needs in a particular way and which is extremely time and cost effective." (Davidow, Malone, 1992)

"A **virtual corporation** is a temporary network of independent companies – suppliers, customers, even rivals – linked by information technology (IT) to share skills, costs and access to one another's markets. It will have neither central office nor organization chart. It will have no hierarchy, no vertical integration." (Byrne, 1993)

"**'Virtual Enterprise'** with the key processes subcontracted to other suppliers" (SME, 1993)

"**Virtual corporates** are fluid, online partnerships comprised of the best practices from various companies that bring together their individual core competencies to create a new product or service during a market window of opportunity. Once the life cycle of the product or service ends, they will separate and go about their businesses." (Hormozi, 1994)

"The **virtual organization**, or more accurately, an organization with a virtual organizational structure, is only one of many forms that cooperation, both among companies and within a single company, can take. … A virtual organizational structure is an opportunistic alliance of core competencies distributed among a number of distinct operating entities within a single large company or among a group of independent companies. … While the virtual organization is opportunistic, its objective is to create solution products with lifetimes as long as the marketplace will allow. These products are expected to evolve, and as they do, so will the virtual organization's resource requirements. Some participants will leave to join other groups because their competencies no longer add enough value to be most profitably used in the virtual organization. For precisely the same reasons, others will join, because they can add value as the product evolves in one direction rather then another. … The virtual organization is a dynamic organizational tool for agile competitors. It is at once neither temporary nor permanent." (Goldman et al., 1995)

"A **Virtual Enterprise** is a temporary alliance of enterprises that come together to share skills or core competencies and resources in order to better respond to business opportunities, and whose cooperation is supported by computer networks" ESPRIT IV PRODNET (Camarinha-Matos et al., 1997)

"A **virtual enterprise** is not really different from a traditional enterprise other than the fact that it can append and shed processes quickly. There are more legal and regulatory issues than technical issues when removing barriers to virtual-enterprise operations." (Nell, 1998)

[*] – minor adaptations in the original text introduced by the authors

By Jägers, Jansen and Steenbalkkers (1998) a VE model is characterized by the following characteristics:

- Boundary crossing;
- Complementary core competencies;
- Geographical dispersion;
- Dynamic composition;
- Temporariness;
- Electronic communication and information sharing.

Box 2b. Virtual enterprise (Putnik et al., 2005a)

"A **Virtual Enterprise** is a temporary partnership of independent companies and/or individuals - suppliers of specific goods and services, customers - who are linked through modern telecommunications to exploit and profit from rapidly changing business opportunities. In a Virtual Enterprise, companies can share costs, skills, knowledge and access to specialized expertise, access to regional and global markets, with each partner supplying what it can do best - whether a product or a service. … This enterprise is called "virtual" because it is composed of partners of core competence and has neither central office nor hierarchy or vertical integration. This way of doing business in partnership is made possible by our Virtual Network Architecture (VNA). VNA will enable working groups based in different countries of the world to operate together, using multi-media (*voice, data and image*) to interact as if they shared an office. Teams will be able to work together in real time, regardless of geographical location. Partnerships will be less permanent, less formal, and based more on special opportunities. Companies will join together in strategic partnerships to seize an emerging market. They then are free to end their partnership after completion of the venture." (VEA, 1998)

"Virtual Enterprises are opportunistic aggregations of smaller units that come together and act as though they were a larger, long-lived enterprise. The *virtual* here is meant to convey that many of the advantages of a large enterprise are synthesized by its members. In most interesting cases, this synthesis is temporary, built around a specific opportunity. When the opportunity fades, the virtual enterprise vanishes into constituent parts to reassemble into other configurations. … A VE is agile only if it is formed with the intent of dissolving, or reconfiguring, so it is possible to have a VE without having an AVE." (Goranson, 1999)

"A **Virtual Enterprise** (VE) is an optimised enterprise synthesised over universal set of resources with the real-time substitutable physical structure. The design (synthesis) and control of the system is performed in an abstract, or virtual, environment." (Putnik, 2001)

"The ***virtual organization*** is a Multi-actor system consisting of humans and virtual actors. Human actors and virtual actors have different capabilities. Those actors communicate and cooperate based on the virtual domain." (Gazendam, 2001)

"**Advanced virtual enterprise** (AVE) is characterized by highly dynamic configuration, changing partners and roles, and evolving products and process well after start – also cheap, opportunistic formation, dissolving and transitions to other forms. A typical AVE might be characterized as the best configurations of smaller players quickly aggregating to address an opportunity." (Goranson, 2003)

"**Definition** (*Business, or product, centered*): Virtual Enterprise is a hierarchical structure, composed by elementary (hierarchical) structural patterns "*c-r-c*."

Definition (*Resource centered*): Virtual Enterprise is a hierarchical structure with three levels "*r-c-r*," or two levels, "*c-r*" or "*r-c*," as special cases.

Definition (*Business, or product, centered*): Virtual Enterprise is a hierarchical structure, composed by *Resource centered* VE.

(*c*) - control unit, agent, client, server *r*- resource manager, broker (Putnik et al., 2005b)

[*] – minor adaptations in the original text introduced by the authors

A selection of VE model definitions, which explicitly use the term "Virtual Enterprise," is presented in Box 2 *(Virtual Enterprise*, Putnik et al., 2005a). It is important to notice that many definitions in Box 2 are practically identical to the definitions of the VE models designated in the previous text as "toward VE" (Box 1) except in explicit use of the term "virtual enterprise."

One Product Integrated Manufacturing

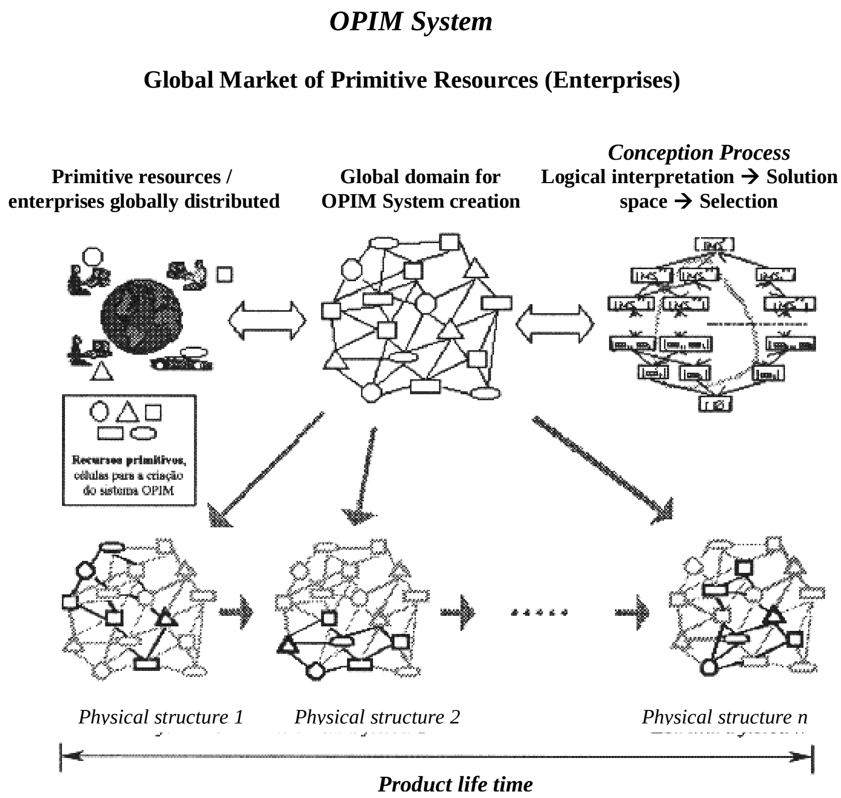
One Product Integrated Manufacturing (OPIM) is a recent organizational concept for manufacturing systems of a specific product (Putnik, 1997; Putnik & Silva, 1995). According to its authors, manufacturing systems conceived to produce several products are technically less efficient when compared with dedicated systems, and this level of efficiency or of performance reaches its maximum when manufacturing systems are dedicated to one single product, which corresponds to the existence of a productive structure for each new product. This way, this concept corresponds to a distributed manufacturing system at the highest level and to a highly dynamic structure.

The product conception and the respective productive processes can be decomposed in a set of particular tasks, being selected and allocated the most adequate resources to each task. The domain for resources selection is the set of all entities (machine-tools, transportation mechanisms, computers, production cells, etc.) that have capacity to perform the required productive tasks and that are connected by data transmission networks and telematics technology (Figure 1).

The domain for resources selection should be as broad as possible in order to allow the best choice. OPIM system defines an instantiation of a general model of a production system. The process of designing the productive system is undertaken through the negotiation between the leader enterprise, the one that initiates the process, and the entities candidate to the execution of the productive tasks, including conception, planning and production control (Putnik, 1997). The best structure for the enterprise is constituted from primitive entities, that is, from unitary resources specialized, corresponded to individual one person or one machine enterprises, in a type of service (conception, planning, management and production) and in a type of product.

The OPIM system generated should be the one that, from the market of potential productive entities, offers the best performance to the product production. All the

Figure 1. Selection of primitive resources from the global market for OPIM systems (Putnik, 1997)



functions of project, planning and production are based in information and independent of the distance between productive units, which can be geographically disperse, but connected by ICT.

Further research of the OPIM concept led to its later generalization in the *BM_Virtual Enterprise Architecture Reference Model* (BM_VEARM) and corresponded BM_VEARM based VE, called BM_Virtual Enterprise. Considering BM_VEARM and BM_VE, OPIM model is its special case.

(BM_VEARM and BM_VE are presented in more detail in the next section of this chapter and in the Chapter III).

BM_Virtual Enterprise Architecture Reference Model

In this section we introduce the *BM_Virtual Enterprise Architecture Reference Model* as an underlying concept of the Agile/Virtual Enterprise, proposed by Putnik (2000; 2001). It is conceived to cover all processes in an enterprise, from the macro to the micro level and for any type of production, and to support the requirements for the highest dynamic reconfiguration of Agile/Virtual Enterprises.

Reference Models

Several definitions of the reference model concept can be found in literature. In NIIIP (1996) a reference model is defined as "a software architecture that positions a collection of component technologies, identifying technologies needed to accomplish an objective as well as the interfaces between them." The reference model must be independent of application(s) and independent of implementation(s). In Schlechtendahl (1989), the reference model or "frame architecture," is defined as a kind of standard that set the framework and defines concepts and terminology for enabling the definition of well defined interfaces between interfacing layers, and thereby, the contents of each layer.

To Bernus et al. (2002), there are two types of reference model being developed:

1. **Functional Reference Models:** Models to establish the functional and information requirements that must be satisfied;
2. **ICT Reference Models:** Describe a generic composition of systems (ICT architecture) that can then be implemented in support of the requirements models.

Actually, there are identified only a few efforts on more rigorous definitions of the virtual enterprise concept. There are contributions on formalization of different topics of enterprise modeling and integration, for example, Bernus et al. (1996), Gruninger and Fox (1996), Menzel and Mayer (1996). There are significant efforts on building enterprise ontologies as a base for a formal approach to enterprise specification and engineering, both for generic enterprise models and virtual enterprises, for example, Fox, Barbuceanu, and Gruninger (1995), Presley and Rogers (1996), Presley (1997). Regarding Agile/Virtual Enterprises reference models, there do not exist too many, however we can mention NIIIP, (NIIIP, 1996), Prodenet project (Camarinha-Matos, Afsarmanesh, and Cardoso, 1999), Globemen (Globemen_Consortium, 1999), etc.; in most of the situations the VE definitions are presented but not the VE reference models.

VERA or VERAM — Virtual Enterprise Reference Architecture and Methodology is a VE specific architecture (Bernus et al., 2002; Zwegers, Hannus, & Tolle, 2001), which has been applied in Tolle, Bernus, and Vesterager (2002) as a structuring architecture for mapping applicable VE reference models.

Requirements for BM_VEARM

As we have seen, Virtual Enterprises are defined as enterprises with integration and reconfiguration capability in useful time (agility), integrated from independent enterprises, primitive or complex, with the aim of taking profit from a specific market opportunity. After the conclusion of that opportunity, the virtual enterprise either reconfigures itself or is dissolved and another virtual enterprise is integrated, due to new market opportunities. During the operation phase of the virtual enterprise, the configuration can change, as the need for readjustment or reconfiguration due to unexpected situations that can happen at any time, raising the importance of the reconfigurability dynamics (Cunha & Putnik, 2002), see also Chapter I and Chapter IV of this book.

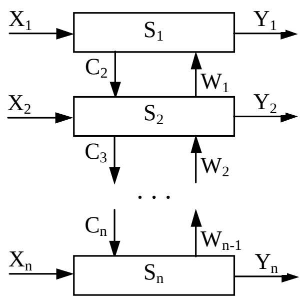
An Agile/Virtual Enterprise is defined by Parunak (1997) as a "… rapidly configured, multi-disciplinary network of firms organized to meet a window of opportunity to design and produce a specific product."

An important term to be used extensively is the term "resource." A resource represents an entity that can contribute or add value, providing either a product (component, assembly) or an operation. A resource is (a view of) an enterprise object, which is used to realize or to support the execution of, one or more processes and it is the subject of control (or management).

In terms of implementation, the resource is a physical support for the service realization or execution (e.g., machine tool, computer equipment, human operator, time money, and software). The resource is a recursive construct (i.e., resources can be made of resources), and so, we recognize *primitive* and *complex* resources. But, a process is not a resource. An enterprise or company is a resource provider, when the enterprise (server) is used (contracted) by other enterprise (client) to carry on some service or to provide some product required by that enterprise.

The basic properties (i.e., the basic requirements and functionalities) of the *BM_VEARM*, as an underlying architecture or reference model of an Agile/ Virtual Enterprise, include:

Figure 2. A hierarchical multilevel system



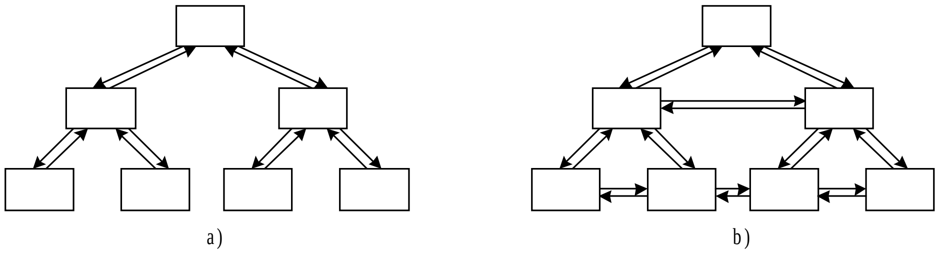
- Integrability,
- Distributivity,
- Agility, and
- Virtuality.

As the system architecture for specifying the BM_VEARM, to represent a global view of the enterprise, or (manufacturing) system, it is adopted a hierarchical, multilevel, system architecture (Figure 2). The underlying formalization is the theory of hierarchical multilevel systems by Mesarovic, Macko, and Takahara (1970). Putnik (2000) extended the model application to the higher-level processes of an enterprise and, in that sense, the BM_VEARM is a specialization of the general model of a hierarchical, multilevel, system, as used in Putnik (2000) to build the specific (reference) model of a virtual enterprise.

The pair of two control levels (S_i, S_{i+1}) is an *elementary structure* for specification of different functional systems, each one of two hierarchical levels, having different terms in different scientific areas, for example "controller — object of control" in the area of production control or devices control, "client — server" in communication and database, or "principal — agent" in economics and organizational sciences (Putnik, 2001). This pair will be used for representation of the organizational structures for implementation of four above-mentioned functionalities.

Additionally, by the application of sequential, parallel and feedback operators for system composition/decomposition it is possible to represent or model different engineering systems and especially, enterprise (and manufacturing) systems and its components (Figure 3).

Figure 3. (a) Model of the multilevel system with rigorous hierarchy of the processes; (b) model of the multilevel system with hierarchy and sequences of processes



(Actually, although in the context of this book the formalization capability and the underlying formal theory are not of major importance, the adoption of the underlying system theory will have a fundamental influence on the capacity of formalization of the VE models, as well as in drawing some conclusions about the nature of VE phenomena, and, consequently on learning process about VE).

Integratibility

According to the *BM_VEARM*, one of the most important requirements for the virtual enterprise is the capability for efficient access to heterogeneous candidate resources to be integrated in the enterprise, efficient negotiation between them and their efficient integration in the virtual enterprise.

By "heterogeneous" resources we mean that the resources work/operate internally in their own specific, proprietary language, but they do not conform to the same standard(s). Portability and interoperability among heterogeneous applications and devices (platforms), as well as extendibility, reconfigurability, longevity, are characteristics of the so-called *open system architecture*.

Integration is primarily the task of improving interactions among the system's components using computer-based technologies with the following goals (Vernadat, 1996):

1. To *hide underlying heterogeneity and distribution* of functions, data, knowledge and functional entities to business applications and users, therefore ensuring portability;
2. To *facilitate information exchange and/or sharing* among applications; and

3. To *provide an open environment* (i.e., an *interoperable "plug and play" environment)* in which new components can be easily added or connected, updated or removed, for integrated enterprise operations.

The Enterprise Integration (EI) model space is multidimensional, as well as there can be constructed many EI model spaces. The identification of the EI model space is necessary in order to position or to formally specify an enterprise model. Several different EI model space dimensions were identified by different contributors (Bonney, Barson, Head, & Huang, 1992; Goranson, 1992) and compiled in Petrie (1992), such as:

1. **Language dimension** (syntax vs. semantics): if two models are written in two different languages, then there must be some mechanism for translation between them.
2. **Location of connectivity dimension** (global vs. pair wise): given a group of models, the global approach provides some common intermediate model of linking all the models, while the pair wise approach provides links for each pair of models only as needed.
3. **Location of "intelligence" dimension** (wrappers vs. translators): translator is an intermediate language or mechanism, as a third model that translates between two models within a global or pairwise approach. The other approach is to envelop each model with a "wrapper" that corresponds to the interchange language.
4. **Types of technology dimension** (unification vs. federation): the unification approach assumes one central (meta) model to which all other models must translate. The federation approach assumes that some technology connects models as needed.
5. **Reconfigurability dimension** (dynamic vs. static): an enterprise could be modeled as a dynamic or as a static system; within a virtual and agile enterprise, it is required the highest flexibility.
6. **Resources integration** (intra-company vs. inter-company): intra-company integration is carried on over (a domain of) intra-company resources, within the company boundaries, while inter-company integration is carried on over (a domain of) inter-company resources, across company boundaries, among independent companies.

The open system architecture uses some integration mechanism determined by the values from the EI model space. The integration mechanism supports the open system architecture functionalities (interoperability, portability) in different ways.

In Computer Aided Design systems, one way to support open systems architecture is based on the "neutral file data transfer," a standard approach standardized through the ISO Standard for Exchange of Product model data (STEP).

Open systems are also applied in distributed computing systems or distributed software applications (or simply distributed systems). A distributed system is one that looks like an ordinary system to its users, but runs on a set of autonomous processing elements, each one having a separate physical memory space and the message transmission delay is insignificant (Wu, 1999).

Although the definition of distributed system refers the computer application domain (hardware and software), the same problems occur for enterprise components and processes integration. Obviously, there should exist some integration mechanism for the distributed systems (as well as for the enterprise integration). An example of the integration mechanism conceived for the integration of the object-oriented software components is the *Common Object Requester Broker Architecture (CORBA)*. *CORBA* is the "object bus" architecture, which lets objects transparently make requests to — and receive responses from — other objects located locally or remotely. The client is not aware of the mechanism used to communicate with, activate, or store the server object; it lets objects discover each other at run time and invoke each other's services (Orfali, Harkey, & Edwards, 1997).

Formally, in *BM_VEARM* the integration mechanism is presented through the "Integration Mechanism" (IM), represented in Figure 4. Conceptually, a different integration mechanism, which belongs to the integration semiotic framework, (shown in Table 4), are supported, including, translators (e.g., the file transfer mode, STEP), distributed systems (e.g., *CORBA*), brokering, and others. Furthermore, the IM level will play the role as a component of the *Normalized Virtual Enterprise (NVE) model*.

Distributivity

Distributivity has different views, of which one view of distributed systems has been already shortly discussed in the above text. Other views of distributivity, especially for the enterprise (and manufacturing) system or, are related to the *distributed control* of the (manufacturing) enterprise, based on *multi-agent system* model, and to the *spatial (or geographical) distribution* of the (manufacturing) enterprise functions and physical components.

The distributed control of the (manufacturing) enterprise, based on *multi-agent system* model consists of the distributed decision processes and decision centers (agents). The distributed control of the (manufacturing) enterprise as a function belongs to one of the (manufacturing) enterprise control level, as it provides a control of the (manufacturing) enterprise. It could be implemented as, or performed by, a logically distributed function over a single resource (processing element, agent), or it could be implemented over autonomous, physically (spatially) separated resources.

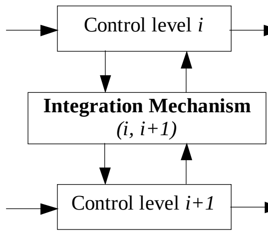
In the context of the VE reference model, the distributivity, as a VE required property, will be considered from the view of the VE components spatial distribution (as the other views of the distributivity are considered within other properties required by the VE concept).

The spatial distribution of the VE components is important from the following reasons.

- The VE requirement for reconfigurability, as a part of flexibility, implies the search of new resources, to be allocated to the task to be performed, in order to satisfy the new circumstances (the new tasks, optimization of old tasks, "deadlocks," etc.).
- The traditional organizational model, for the problem of reconfigurability, uses the own resources existing within the company boundaries (resources selection domain). As the selection domain is of relatively limited, in general, it can't provide the desired performances neither for actual products nor for new products. To solve the problem, the company tends to integrate independent resources across the company boundaries. To obtain the best experiences and competencies, it is desirable that as many as possible primitive or complex resources concur to the integration of the VE. The best case occurs if to the integration in the VE concur the independent resources from the universal or global domain. This requisite implies that the candidate resources to integrate an association, to fulfill a specific market opportunity (i.e., to integrate a virtual enterprise) are globally distributed and inter-connected using ICT, to enable the negotiation capability, (to integrate the association or virtual enterprise) and operation (of the virtual enterprise, as they got into it) in an efficient, effective and real-time way. The global distribution of candidate resources for integration on virtual enterprises implies the concept of "distributed" enterprises.[2]

The effective and efficient access and operation of spatially distributed objects is the main idea under the concept of Distributed Manufacturing Systems or Distributed Enterprise. We define a "distributed manufacturing system or enterprise" as a manufacturing system or enterprise which *performance does not depend on the physical distance between the enterprise elements* (Putnik et al., 1998).

Figure 4. Elementary structure for an integrated and open hierarchical multilevel system control (Putnik, 2000)

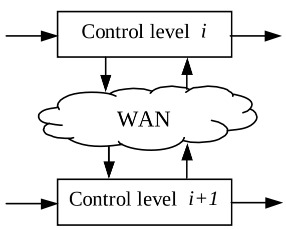


The condition "performance does not depend on the physical distance between the enterprise elements" makes the difference from other elements. Theoretically, it is possible to access and operate the system virtually at any distance, but the problem is with which performances. An increase of distances between machines, or human agents, in a traditional manufacturing system, affects negatively the system's performances. Also, the technology applied could be a limitation to increase the distance, for example the use of Local Area Network technology for computer communication limits the distances between computers.

The definition presented is oriented to a spatial distribution of enterprise's elements (components, subsystems) and not to distributed management or distributed software applications. The distributed enterprise does not imply virtual enterprise. We may say that distributed enterprises are an intermediate step on the development and implementation of the virtual enterprise concept. In the same way, we can imagine several cases where distributed enterprises take advantage when compared with virtual enterprises (i.e., cases where the application of the virtual enterprise concept does not apply).

In *BM_VEARM*, the distributivity of the VE is provided through the use of communication technology that enables efficient access to remote resources distributed geographically, all over the world (see Figure 5).

Figure 5. Elementary structure for a distributed hierarchical multilevel system control (Putnik, 2000)



Agility

The competitive foundations of the agile manufacturing or enterprise are continuous change, rapid response, quality improvement, social responsibility and total customer focus (Kidd, 1994). An agile company is one capable of operating profitably in a competitive environment of continually and unpredictable changing customer opportunities (Goldman et al., 1995).

Agility is a capability for *fast adaptability* or *fast reconfigurability* in order to respond rapidly to the market (or customer demand) changes. It implies the search of new resources, to be allocated to the task to be performed. If the enterprise searches for resources within its boundaries, we are talking about *intra-company agility*, otherwise, we are talking about *inter-company agility*. The concept of VE concerns this last one.

As the virtual enterprise or agile enterprise implies interactions between various independent companies, it will be required to control and manage inter-company organizational configuration, or reconfiguration. It is essential to be able to define domains of responsibility for configuration, or reconfiguration management, which reflect organizational policy and permit limited configuration management facilities to be offered, or to be contracted, across company boundaries. A domain (i.e., an environment for configuration management) could represent a set of enterprises, or companies, being managed by a particular manager, or a set of enterprises or companies, to which a particular access control policy applies. This domain for configuration management is designated as a market of resources (later it will be called the Market of Resources).

The management structuring needs to be flexible to reflect a wide range of organizational policies. The enterprises may be members of multiple domains to represent the fact that an enterprise is subject of multiple different management policies in different contexts. For example, an enterprise may be a member of a trading domain indicating it is offering a particular service while at the same time it is a member of the domain that is the responsibility of a particular manager. Subdomains are domains containing groups of enterprises that are members of other domains and provide the means of structuring management and partitioning responsibility. Some special subdomains for configuration management are designated as the *Focused Market of Resources* as we will see in Chapter VIII.

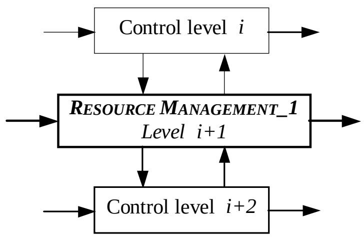
Also VE agility, to be more effective and efficient or to achieve the highest levels of effectiveness and efficiency, must be carried on by some "organization configuration manager," which will be designated as *resource manager* or *broker*.

The *resource manager* or *broker* performs different particular tasks within the global task of the organization configuration management. For example:

1. **Resource selection:** The process corresponds to visiting all the elements belonging to the resources management domain (i.e., the Market of Resources, identification of resources appropriateness for the service required, negotiation with the candidates and finally the selection of the best). Due to the complexity of the task, it is necessary to apply some search algorithm. The negotiation parameters are, for example, resources availability, time to complete the service, cost, etc., but it is also necessary to check several types of constraints, such as resource interdependencies, conflicting resources priorities, variable levels of resource availability, limitations on partial resource allocations, etc. The resources selection process is subjected to some common access, appropriateness identification and negotiation protocol (global or pair wise).
2. **Resource integration:** The task of integration of selected resources by passing integration mechanism parameters (e.g., client/server location, communication protocols, process plans, data formats, etc.). It includes also the task of contracting (i.e., to establish client/server commitments).
3. **Resource integration scheduling:** As the resource integration itself is a process and it implies various subprocesses, it is necessary to define their ordering (of the subprocesses) and their mapping onto time intervals in accordance with the resource integration process development.
4. **Resource (dynamic) reconfiguration:** The task of integration of new resources and removing old ones, as the enterprise has to integrate new functionalities, new technologies or new knowledge, to substitute failed resources, to substitute resources that are not necessary anymore, or to integrate more competitive ones.
5. **Resource monitoring and reliability analysis:** The task of monitoring resources performances in order to identify eventual failure and to define the resource properties evolution during the cooperation, and the resources performances control, in order to define negotiation policy in relation with the particular resource.
6. **Resource control:** The task of resources control within the responsibilities and organizational policy attributed by the manager, "principal," or "upper control level."

The resource management issues include also resource control and resource maintenance, but these issues are not considered as broker's functions. They belong to the "upper" control level (i.e., to the client – resource control) and to the "lower" control level (i.e., to the server – resource maintenance as well as resource control).

Figure 6. Elementary structure for an agile hierarchical multilevel system control (Putnik, 2000)



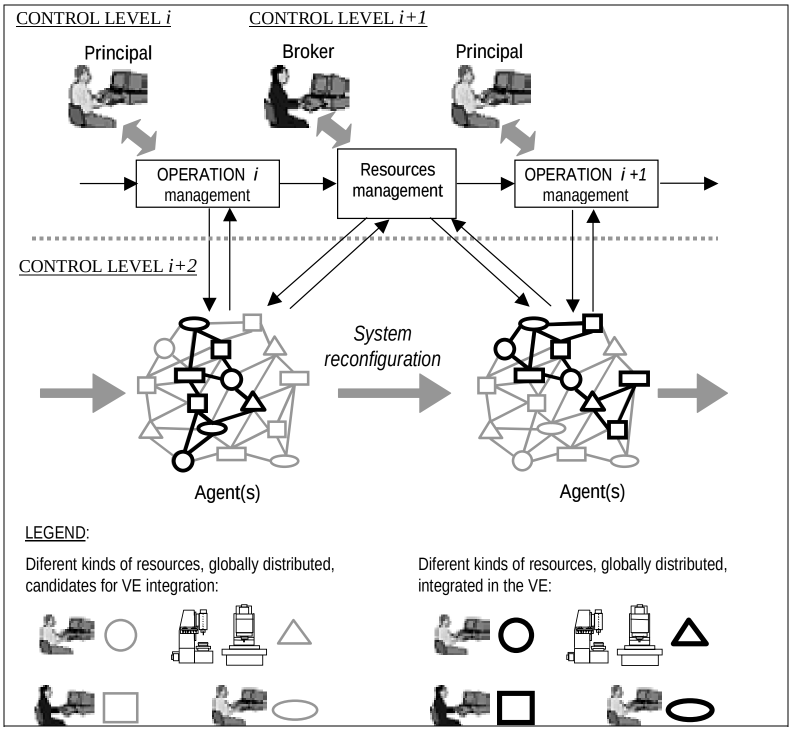
In *BM_VEARM* the "organization configuration management," the agility function is presented through the "*Resource Management_1*" level (Figure 6).

From the implementation point of view, the *Resource Management_1* level can be owned by the control level *i* or it can be independent. There are arguments that the *Resource Management_1* level should be a part of, or owned by, a control level *i*. This model is the classical "two-layer hierarchy" organizational model. Another expressions used for the model are "principal/agent" or "manager/worker" hierarchy. The "principal" is the owner of the vertical structure and the "agent" is responsible for production and affects the principal.

The independence of the resource management function in VE corresponds to the "three-layer hierarchy" organization model or, in other words, "principal/supervisor/agent" or "management/foreman/worker" hierarchy. The main motivation for the application the "principal/supervisor/agent" model is that "the principal, who is the owner of the vertical structure or the buyer of the good produced by the agent, or, more generally, the person who is affected by the agent's activity, lacks either the time or the knowledge required to supervise the agent" (Tirole, 1986). The direct implication of this approach is that the *resource management* function is carried on by an independent agent *resource manager* or *broker*.

Figure 7 represents an informal scheme of the agile enterprise elementary structure operation. It is important to notice that the structure proposed provides the enterprise reconfigurability between two operations, assuming that during one operation there is no change of the organizational structure (by the operation it is meant a set of processes carried on by the single agent, i.e., operator, machine tool, etc., performed over one piece or service, and without interruption). When the operation is finished the resource manager or broker can reconsider the organization structure and act with the objective to adapt it (to reconfigure it). The resource manager or broker is the principal agent of agility.

Figure 7. Agile enterprise operation scheme — Elementary structure (Putnik, 2001)



The model could be described as *operation off-line reconfigurability* of the enterprise. As a consequence of the "operation off-line reconfigurability" model is that the underlying physical structure of the enterprise is not hidden to the manager (i.e., to the "principal"), as the broker acts only between the operations. During the operation, the manager (the "principal") has direct contact with the worker (the operator or "agent"), who provides the service (or operation).

Although the model is represented as three-level hierarchical system, in practice the model can work as a rigorous hierarchy as well as a non-rigorous hierarchy. When it works as a rigorous hierarchy, during the operation the *Control level i* (principal, manager) and the *Control level i+2* (agent, worker) communicate through the *Resource management level* (resource manager). In this case, the function of the resource manager is to monitor the system performances in order to decide by itself about the system's reconfiguration. When the model works as a non-rigorous hierarchy then during the operation the *Control level i* and the *Control level i+2* communicate directly each with other. The *Resource management level* is passive and enter in function only between two operations when it receives the order from the *Control level i* to reconfigure the system.

Virtuality

The critic presented in this chapter to the definition of VE (see Virtual Enterprise definitions) as a dynamic (agile) networking of enterprises is that the definition does not present the original meaning of the word "virtual." "Virtual" means something not physically existing as such but made by software to appear to do so. Although the VE is interpreted as an agile enterprise integrated over "inter-company" domain, we would say that these enterprises are still only agile because they exist as real.

Within the "agile" enterprise concept, the "virtuality" is only in the design phase. During the design phase, hypothetical network structures are evaluated and the enterprise still does not exist. Once the enterprise is defined as a network, and the participants commit themselves to the enterprise organization and objectives, the enterprise becomes real; there is no room for the word "virtual." Another argument to keep the term "virtual" for the agile networked enterprise could be that although we work in a real enterprise at one moment, the actual real organization structure will be virtually changed in some future. Thus, the actual organizational structure is a virtual one.

The author of the BM_VEARM also criticizes the second VE definition, where VE is reduced to a simulation program, and hence the real enterprise in fact does not exist.

In conclusion, no one approach applied as a pure concept is acceptable by the *BM_VEARM* author requirements. And the requirements presented in (Putnik, 2001) are that it is needed the real, physical enterprise, which will produce real products (not simulated), and at the same time to keep the meaning of the word "virtual" (i.e., to keep some part of the enterprise that does not exist in reality). How it is possible to reconcile these two requirements? And if we need the real enterprise, why do we need some virtual part?

The author introduced the virtuality in the similar way as it is introduced in CAD systems and in distributed (software) systems.

In CAD systems it is conceived the *normalized device* (ND) as an abstract device that provides the independence between the application (i.e., the design process), and the underlying physical structure. The design process and physical structure communicate through the interface ND. Virtually the designer does not know anything about the specificity of the underlying hardware. If somebody would change the computer, but keeping the same CAD software and database installed, virtually the user would not detect the difference. We would say that he works in a virtual environment, as the underlying hardware is hidden from him. This concept is very important because it avoids the loss of the designer's time to learn about new hardware, changing of hardware does not interrupt the design process.

If the change of the underlying hardware occurs frequently, or at run time, we could talk about "agile CAD hardware management" and about "virtual CAD system."

The similar principle is implemented in distributed (software) systems. The client is not aware of the mechanisms used to communicate with, activate, or store the server object, lets objects discover each other at run time and invoke each other's services.

To implement the "virtuality" in the enterprise Putnik (2001) proposes the introduction of an interface layer between the *Control level i* (principal, manager) and the *Control level i+1* (agent, worker), which passes now to be *Control level i+2*. The role of this level is management of underlying physical structure (i.e., management of resources), which will carry on the process ordered by the upper level. Therefore, the VE agility must be carried on by some organization configuration manager (i.e., *resource manager* or *broker)*, similarly as for the concept of agility.

In *BM_VEARM* the *organization configuration management*, the function that provides virtuality is presented through the *Resource Management_2* in Figure 8.

The model is represented as a three-level hierarchical system with a rigorous hierarchy. During the operation the *Control level i* (principal, manager) and the *Control level i+2* (agent, worker) communicate through the *Resource Management level i+1* (i.e., through the *resource manager)*. During the operation,

Figure 8. Elementary structure for a virtual hierarchical multilevel system control (Putnik, 2000)

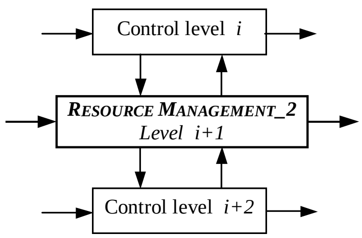
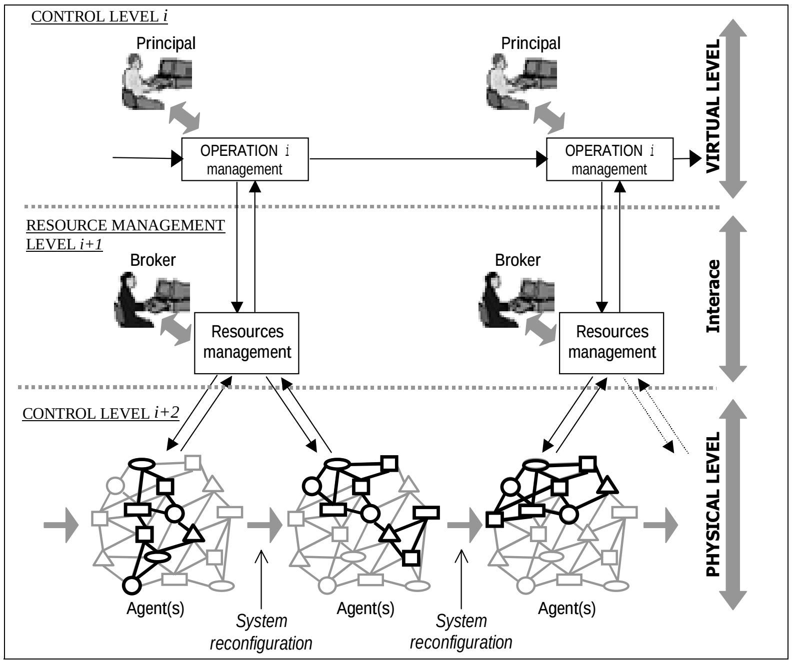


Figure 9. Virtual enterprise operation scheme — Elementary structure (Putnik, 2001)



the manager (the principal) does not have the direct contact with the worker (the operator or agent), who provides the service (or production).

In Figure 9 it is presented a scheme of the virtual enterprise elementary structure operation (includes agility as well). It is important to notice that the proposed structure provides the enterprise reconfigurability during the single operation, at run time. The resource manager or broker, can reconsider the organization structure during the operation at the run time, as well as between two operations, and act with the objective to adapt it (reconfigure it). The resource manager or broker is the principal agent of virtuality and agility.

The model could be described as *operation online reconfigurability* of the enterprise. As a consequence of the "operation on-line reconfigurability" model, *the underlying physical structure of the enterprise is hidden to the manager* (i.e., to the "principal"). The broker must provide the transition from one physical structure to another in a way that the "principal" cannot be affected by the system reconfiguration, in which case the operation would be interrupted and split in two implying some lost time. The lost time can have two components: by interruption of the operation itself (e.g., set-up time for restarting the operation), and the principal's adaptation time to the new specific organizational structure. Additionally, the three-level hierarchy model (principal/supervisor/agent) organization model, as it is conceived here, is in fact an application of the principle of "simultaneity" of the processes.

The main motivation for the application of the three-level hierarchy model is the principal's lack of time or of knowledge to supervise the agent. But even in the case the principal has both the required time and knowledge, in order to cut further processing time of the production operation and the enterprise reconfiguration time it is necessary to perform them in parallel[3]. In the agility scheme, as previously defined, the production operation and the enterprise reconfiguration are still performed in a sequence.

These are the reasons why virtuality is needed in *BM_VEARM*. Virtuality in this sense (the hidden underlying hardware structure) is actually present in the (open) CAD systems, in the OPEN NC concept, and distributed (software) applications. All these systems are virtually the models of a VE. In other words, the *Resources Management Level* together with the *Integration Mechanism Level* (e.g., the translator) *emulate* the underlying organizational (hardware) structure in a format that is understandable by the manager or principal. The principal does not see the real structure; he sees some "virtual" structure that does not exist.

BM_VEARM Structure

Thus, the reference model is defined as a hierarchical multilevel model of the enterprise/manufacturing system control, and satisfies the requirements for integrability (I), distributivity (D), agility (A) and virtuality (V).

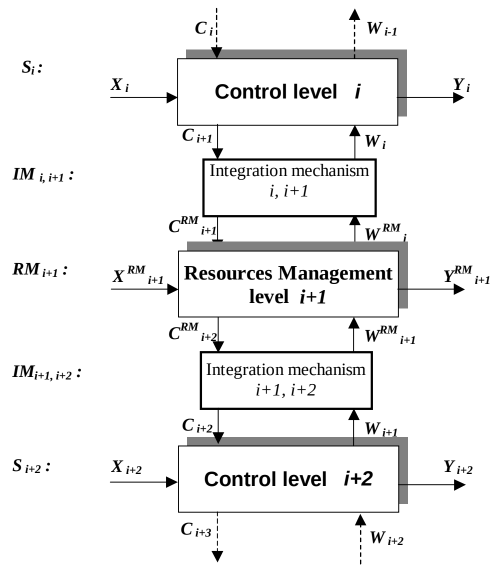
The *BM_VEARM* is built up on the *BM_Virtual Enterprise Architecture Reference Model elementary structures*, synthesized over elementary structures of the VE architecture, which provide I, D, A and V. So, I, D, A and V are the design parameters of the *BM_VEARM elementary structure* and of the model as a whole.

Recalling the general definition of the multilevel hierarchical system, Putnik (2001) specifies *BM_VEARM* as in Figure 10 and Figure 11.

The integration mechanism functions (i.e., the integration mechanism blocks from Figure 10) are not levels of the model. They only represent the interface (translation functions between control levels and resources management levels).

Additionally, the author proposes a concept of *Normalized Virtual Enterprise (NVE) Model* (Figure 11) similarly with the CAD systems. The *NVE* model is

Figure 10. BM_virtual enterprise architecture reference model elementary structure (Putnik, 2001)

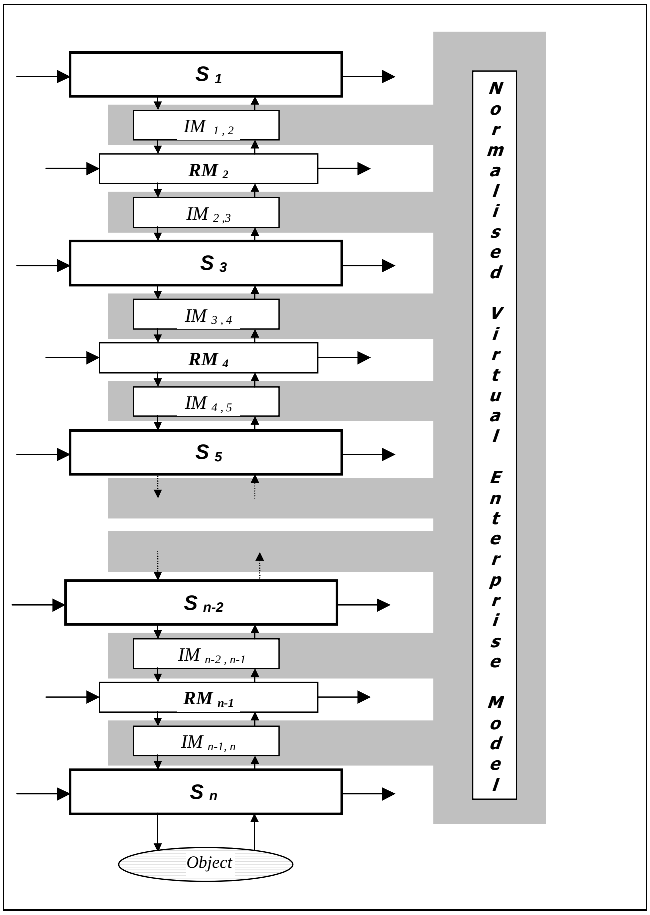


a synthesis of the translation functions that serve as an interface and integrating mechanism for the VE components. The expected advantage of the *NVE* definition is independence of the VE components (i.e., tools and technologies) development. Also an independent (of VE tools and technologies producers) organization or institution (for example ISO) could provide the specification of the *NVE* model.

According to the *BM_VEARM* the VE is seen as a general enterprise model from which all other enterprise models are special cases. For example, the agile, distributed, integrated and other enterprise models are special cases and can be derived from *BM_VEARM*.

Its objective is to contribute to the efficient development, implementation and operation of the VE concept as dynamically reconfigurable Agile/Virtual Enterprise. It sets the framework for modeling and integrating particular virtual enterprise models.

Figure 11. BM_Virtual enterprise architecture reference model and the corresponded normalized virtual enterprise (NVE) model (Putnik, 2001)



The Virtual Enterprise Laboratory Demonstrator Based on BM_VEARM

The validation of the reference model proposed is being carried on along with several research projects under development at the University of Minho, on VE theory and VE design and control tools and technologies and the corresponding environment. In particular, the reference model's practical objective is to serve as a framework for cooperation and coordination of this group of research projects.

In order to fulfill the requirements of the project validation, including the VE reference model, it is implemented a laboratory installation which will serve as a demonstrator for the VE design and control. The VE demonstrator based on *BM_VEARM* is installed at LABVE at University of Minho and is conceived as a Distributed/Virtual Manufacturing System (D/V MS) Cell, named *AURORA98* (Putnik et al., 1998).

In the first phase, the laboratory was used for research of distributed manufacturing system. In the second (present) phase the laboratory is extended with the components that are expected to provide the full demonstration of the VE concept based on the *BM_VEARM*, and includes projects such as:

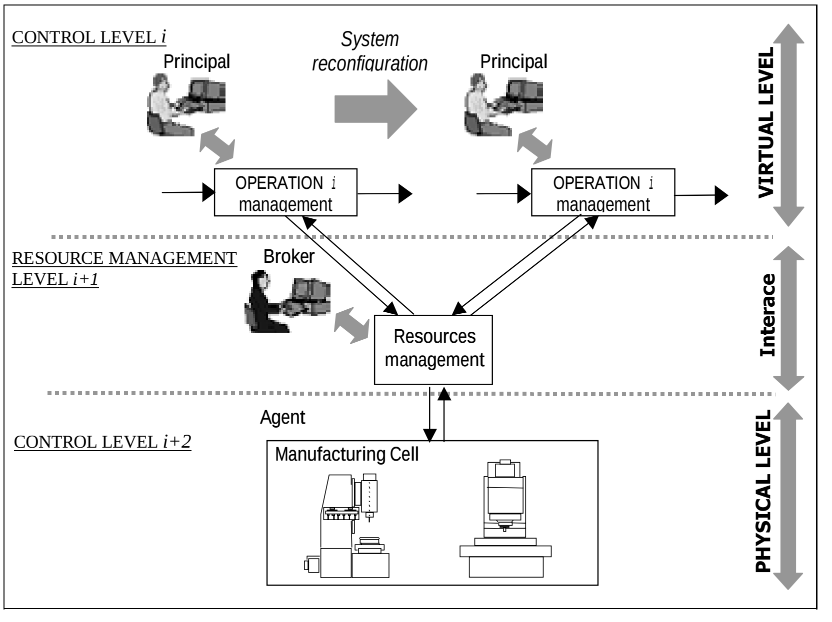
- Formal theory of the VE models, design and operation;
- Flexible manufacturing systems control within the VE framework;
- Market of Resources for VE integration;
- Distributed simulation of the VE;
- Concurrent engineering within the VE framework;
- One-Product-Integrated-Manufacturing;
- Marketing within the VE framework.

The D/V MS Cell structure used in the first phase for the VE model validation, based on the reference model, (Figure 12) is composed of:

1. **Machine cell:** 2 machine simulators, PLC, external sensors and actuators, robot, vision system, computer based local controller, etc.
2. **Broker:** remote resource manager, with computer aided tools and communication facilities.
3. **Control centre_1:** computer-based remote machine cell controller.
4. **Control centre_2:** computer-based remote machine cell controller.

The reconfiguration of the system consists of switching between two manufacturing cell controllers in accordance with their availability, service cost and quality. The broker performs the function of the system configuration management. Manufacturing cell controllers, as well as the broker, could be located at any point in the world.

Figure 12. An informal scheme of the virtual enterprise demonstrator based on the BM_VEARM (Putnik, 2001)



Summary

Many research projects are trying to discover the key success elements of planning and managing flexible and efficient organizations and company networks. Virtual paradigms are one of the approaches for managing distributed and flexible operating. The connective element of the several concepts under the umbrella designation of Virtual Enterprise (or Virtual Organization) models is distributed operating and the common goal to operate efficiently and flexibly through cooperation (Gnosis, 2001). The differences between them appear at the level of cooperation relationship between the involved enterprises and reconfigurability dynamics.

The move to agility requires the ability to respond to unanticipated change, as we have seen. It is built on a foundation leveraging on an enterprise's knowledge to meet the market requirements for quality, responsiveness, and customer satisfaction. Among the managerial and organizational changes required by the new competitive environment will be the foundation of the "virtual company," a form of joint venture, consisting on a temporary alliance of member companies which join to take advantage of a market opportunity, where each member company will provide its own core competencies.

As proposed by the report of Iacocca Institute (Nagel & Dove, 1993), only a small headquarters staff to deal with administrative and management is required, with the actual work being performed by geographically separated shareholder companies, subcontractors and partners joined through information and communication technologies and systems. When the market opportunity has passed, the virtual company is dissolved. A major issue in the formation of the virtual enterprise is the rapid integration of business processes of the participating companies (Barnett, Presley, Johnson, & Liles, 1994).

The VE differs from existing inter-organizational models by the degree of shared accountability and of responsibility of the participants and the structure by which companies contribute their competencies through "plug compatible" processes (Reid, Liles, Rogers, & Johnson, 1996). It is recognized that a major issue in the formation of the VE is the rapid integration of the business processes of the participating companies. While the integration of computer and communication technologies are no doubt critical issues, the successful attainment of the business goals of the VE often depends on the ability to align the business processes and practices of partner enterprises (Presley & Rogers, 1996).

Several authors consider Virtual Enterprise and Supply Chain Management to be two similar concepts. The supply chain of a manufacturing enterprise can be defined as a world-wide network of suppliers, factories, warehouses, distribution centers and retailers through which raw materials are acquired, transformed into products which are then delivered to customers; so, according to Shen and Norrie (1999), the Supply Chain Management a little more focuses on the chain level and is related with the life cycle of products, while the Virtual Enterprise focuses on the collaboration among the related factories and elements of the network. Camarinha-Matos et al. (1997) define the Extended Enterprise as an organization in which a dominant enterprise extends its boundaries to some suppliers.

Agile Manufacturing mainly focus on intra-enterprise performance, focusing more on procedural change with supporting organizational change, although also recognizing the necessity and the importance of partnerships with suppliers and customers. The Extended and the Virtual Enterprise models are fundamentally based on partnerships, designed to facilitate cooperation and integration across the value chain (Browne & Zhang, 1999). While the concept of Extended Enterprise focus on long-term enterprise relationships across the value chain, the concept of Virtual Enterprise suggests a more dynamic environment where individual enterprises work together for a relatively short time, to quick satisfy niche market demand, as compared by Browne & Zhang (1999).

In Table 1 we rate the six described VE models in terms of a set of features, in a scale 1 (irrelevant or very weak) to 5 (very important or very strong). All the

Table 1. Comparison of virtual enterprise models

	Extended Enterpr.ise	Virtual Enterprise	Agile Enterp /Manufact.	Sup.Chain Management	BM_VEARM (A/V E)	OPIM
- Importance of strategic alliances	5	4	4	5	3	3
- Partner relationships	5	4	4	5	3	3
- Organization stability	4	3	4	5	3	3
- Partnership coordination	5	5	5	4	5	5
- Utilization of ICT	4	4	4	4	5	5
- Virtuality (overcoming space barrier and hierarchy)	3	5	3	3	5	5
- Responsiveness	4	5	4	3	5	5
- Flexibility	4	5	5	3	5	5
- Integrability	4	5	4	3	5	5
- Distributivity (over-coming space barrier)	4	5	4	4	5	5
- Agility (partnership reconfiguration dynamics)	4	4	5	3	5	5

features included are at least relevant to the models, the reason why there are no "1's" or "2's" in the table.

An additional analysis, (Putnik et al., 2005a), Table 2 — *"Traditional" Enterprise vs. Virtual Enterprise potentials*, presents a comparison between the "traditional" enterprise and a virtual enterprise potentials, focusing on, by the authors, three fundamental virtual enterprise features (i.e., differences between the VE and the "traditional" enterprise) that make a paradigm "shift," which are:

1. dynamics of network reconfiguration,
2. virtuality, and
3. external entities (meta- (virtual) enterprise structures) as environment for enabling, or supporting, the VE integration itself as well as a reconfiguration dynamics.

Table 2.“Traditional” enterprise vs. virtual enterprise potentials (Putnik et al., 2005a)

Nº	Criteria	“Traditional” Enterprise	Virtual Enterprise
1	**Number of products by enterprise**	**Multi**	**One**
1.1	“Flow” of products through the enterprise	Yes	No
2	**Organizational reconfiguration dynamics**	**None**	**Yes**
2.1	Enterprise “life” time	Long	Short
2.2	Inter-enterprise networking	Low	High
2.3	Organization’s reconfiguration “transaction” cost (networking and dynamics disabler)	High	Low
2.4	Trust assurance and management (networking and dynamics disabler)	Low	High
2.5	Organization reconfiguration time (networking and dynamics disabler)	High	Low
2.6	“Flow” of enterprises through the product	No	Yes
2.7	Number of organizational structure instances	One/Low	Very high
2.8	Leanness	Medium	Maximum
2.9	Agility	Medium	Maximum
2.10	Operations management importance	High	Low
2.11	Organization design / integration complexity	Low	High
2.12	**Virtuality** (dynamics enabler)	No	Yes
2.13	Creativity	Medium	Medium
3	**External entities as organizational dynamics enablers**	**No**	**Yes**
3.1	“Meta-enterprise” as enterprise environment	No	Yes

(When “the potentials of VE” are compared, in fact there are referred the features of an “ideal” VE model. Naturally, in practice, the real VE models will be somewhere in between.)

(The following comments are practically compiled, with minor changes, from Putnik et al., 2005a.)

The first fundamental feature, dynamics of network reconfiguration (i.e., rapidness in reconfiguration) is the requirement *sine qua non*, for a competitive response to the turbulent and unpredictable market. It is called *flexibility*, or when it is in pro-activity too, it is called *agility*.

The degree the network dynamics desired is very high. Kim (1990) refers figuratively the requirement for the system reconfigurability within 1 second ("*the system, or enterprise, should reconfigure for a new product within 1 second*"), the performances required for a new, "ideally" agile (manufacturing) system or enterprise (actually this is our target, future system performance).

Considering the system reconfigurability, "'traditional' enterprise is considered as a "stable" organizational structure that tends to avoid organizational reconfiguration or networking because of the reconfiguration and/or networking costs (i.e., transaction costs) and to protect own knowledge on organization (management and technology) against the partners, which (the transaction cost and the knowledge protection) are the networking and network dynamics disablers. On contrary, for the VE the networking and reconfiguration are the opportunities to improve, or to keep the competitiveness. To achieve these objectives, VE should have the proper mechanisms, including the specific organizational structure, to minimize or to eliminate the dynamics and networking disablers.

A dynamically reconfigurable network could be described as "'Flow' of enterprises through the product," if each one organizational structure instance is considered as a new enterprise. Consequently, the number of organizational structure instances, integrated along the product/VE life time is very high, in comparison with the "traditional" enterprise where this number is one or at the best very, very low. In this way, the "'Flow' of enterprises through the product" metaphor means, in fact, the *inverse organizational model* in comparison with the "traditional" one — "'Flow' of products through the enterprise," contributing to the thesis that we are talking about VE as a new organizational paradigm. The inverse is manifested through various perspectives. For example, in the fact that in such enterprise (VE), through permanent reconfiguration, the leanness and agility can be maintained and promoted on the maximum level. Another example is production operations scheduling, which is not anymore one of the most important system's or enterprise's functions, but, rather, could be seen as a network design tool (entries 2.8-2.11, Table 2).

The second fundamental feature, *virtuality*, has basically two different approaches in the VE models. The first approach, widely used, interprets the virtuality as (1) "potentially present," and (2) "existing but changing" (Franke, 2000). This approach is criticized in Putnik (2001) as insufficient, arguing that there is a conflict with the etymology of the term "virtual" — "virtual" means something "not physically existing as such but made by software to appear to do so" (Oxford Dictionary). However, virtuality in VE should not be confused with the virtual reality (VR) based concept (e.g., "virtual manufacturing"), which is in fact a pure simulation. In Putnik (2001), the virtuality is interpreted as an architecture by which the operating unit, or partner does not see the real structure, it sees some "virtual" structure that does not exist. In this way the real enterprise exists but the unit, or partner, works in a "virtual" environment without knowing with whom cooperates. This is implemented through two "interface" layers, hierarchically "above" and "under" the operating unit or partner, which (layers) are performed by brokers, hiding the "client" and/or "server." This approach could be considered as the second approach to the virtuality in VE. This form, VE architecture, which provides a virtual environment for the VE agents operations, is introduced in order to minimize the "set-up" time when "switching" from one physical organizational structure to another one, and, important, in this way further minimize the "transaction costs." Actually, "virtuality," implemented in this form of the VE architecture, is a mechanism, or a tool, for further improvement of reconfiguration dynamics capability.

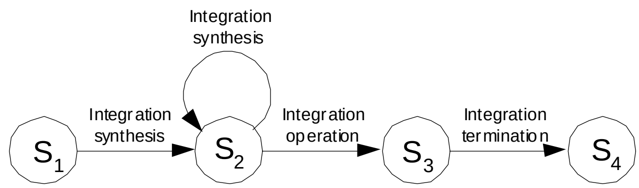
Finally, the third fundamental distinctive feature is the existence of "*external entities as organizational dynamics enablers*" (entry 3, Table 2). These entities are specific organizations, whose function is to serve as the environment for enabling, or supporting, the VE integration itself, as well as the reconfiguration dynamics assuring the low (reconfiguration) transaction costs and protection of the enterprise partners' knowledge. These organizations represent, in fact, the meta-enterprises for the operating VE enterprises (entry 3.1, in Table 2). These entities (organizations) are designated, by their authors, as *Market of Resources* (Cunha et al., 2000), (Cunha, 2003). In Cunha (2003) it is demonstrated that the VE reconfiguration dynamics is practically impossible without Market of Resources as the environment for the VE reconfiguration dynamics (i.e., the Market of Resources (MR)) is the condition *sine qua non*.

Actually, this book is exactly about the *Market of Resources* as the *sine qua non* condition, or enabler for effective and efficient implementation and management of VE. Or, in other words, the *Market of Resources* is the *sine qua non* support for the VE implementation and management.

One of the consequences of the Market of Resources is a different VE life-cycle model. The authors called it the "*Virtual Enterprises' Extended Lifecycle*" (Cunha, Putnik, & Ávila, 2004), Section 4.8 of this book, and it introduces, as main distinguished characteristic difference from the usual VE life-cycle, the phase of contractualization with the Market of Resources by the enterprises that want to make their resources available to integrate VE.

The needs for the existence of external entities as environments for VE reconfiguration dynamics is recognized as well by other authors, although it is not introduced in the VE definitions (yet). Other Market of Resources alike concepts, services and products, include the new generation of *high value-added electronic marketplaces*, *e-alliances*, *breeding environments*, *electronic institutions*, *virtual clusters* and "*guilds*" ("Guilds" is the MR alike concept identified as a possible scenario for the virtual organizations by the MIT

Figure 13. Integration process life cycle basic model (Putnik et al., 2005a)



21st Century Manifesto Working Group in their discussion paper "What we really want? A manifesto for the organizations of the 21st Century", within the "MIT Initiative on Inventing the Organizations of the 21st Century.") However, the authors of this book did not find more detailed description of these Market of Resources-like environments except their broad descriptions or the only recognition that they should exist.

It is expected that these environments will be the regular environments for VE integration, reconfiguration dynamics and operation.

Concerning VE integration (VEI – Virtual Enterprise Integration), in Putnik et al. (2005a), effective and efficient VE integration is consider as the main VE enabler. If VE is seen as the new organizational paradigm, and considering the complexity of VEI problem, in Putnik et al. (2005a) it is proposed a new VE integration paradigm based on organizational semiotics perspective. In concrete, instead on relying on syntactical/semantic approach to the integration it is proposed a wider approach based that includes as well pragmatics and social issues. These, actually, generated a new model of VE integration called *Generative Integration* could serve as an underlying model for organization integration and interoperability for organizations of other types then VE. Generative Integration is characterized by its development life-cycle, Figure 13, with communication as the main integrative process rather then (data) transaction process.

In Table 3, presented is a comparison of "traditional" and Virtual Enterprise concerning integration, and in Table 4 the VE integration life-cycle semiotics framework is presented.

[The reference (Putnik & Cunha, 2005c) is completely dedicated to the VEI as the VE key enabling factor.]

Table 3. A comparison of "traditional" and virtual enterprise concerning integration (Putnik et al., 2005a)

		"Traditional" Enterprise	Virtual Enterprise
1	Location of the Integration focus	Intra-enterprise	Inter-enterprise
2	Organizational structure (design) vs. integration (design)	Decoupled	Coupled
3	Structural complexity (of organization)	Low	High
4	Volume of integration relations	Low	High
5	Dynamics of establishment of integration relations	Low	High
6	Dynamics of integration processes	Low	High
7	Dynamics of needs for new integration mechanism	Low	High
8	Generative integration(*)	No	Yes
9	Life cycle	No	Yes
10	Language complexity	Low	High
11	Integration base	Transaction	Communication
12	Needs for multidimensional /multilevel approach	Low	High

(*) includes "self-integration" as a model

Table 4. VE integration life-cycle semiotics (Putnik et al., 2005a)

<table>
<tr><th colspan="5">Virtual Enterprise Integration</th></tr>
<tr><th rowspan="2">Semiotic Levels</th><th colspan="3">Integration Life-Cycle</th><th rowspan="2">Perspectives</th></tr>
<tr><th>type</th><th>processes</th><th>tools</th></tr>
<tr><td>Social</td><td rowspan="2">Generative integration (communication-based integration)</td><td rowspan="2">1) VE/VEI synthesis (coupled design and integration),
2) operation (transactions)
3) termination</td><td rowspan="2">social and cultural requirements identification, meta-enterprise environments,
VE architectures, VE/VEI synthesis, negotiation, brokering, cooperation, coordination, trust, integration management, VE design algorithms, learning, law, regulations, cost management, …</td><td rowspan="2">Organization</td></tr>
<tr><td>Pragmatic</td></tr>
<tr><td>Semantic</td><td rowspan="2">Transaction-based integration (information-based integration)</td><td rowspan="2">transactions</td><td rowspan="2">data-file transfer, shared databases, procedure call, standards, ontologies, meta-data, …</td><td rowspan="4">Technology</td></tr>
<tr><td>Syntactic</td></tr>
<tr><td>Empirical</td><td rowspan="2"></td><td rowspan="2">transfers</td><td rowspan="2">Hardware and physical processes</td></tr>
<tr><td>Physical</td></tr>
</table>

References

Ávila, P., Putnik, G. D., & Cunha, M. M. (2005). Broker performance for agile/virtual enterprise integration. In G. Putnik & M.M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 166-185). Hershey, PA: Idea Group Publishing.

Agility_Forum. (1998). *Agility Forum web site*. Agility Forum. Retrieved from http://www.agilityforum.org

Agility_International. (2002). *Agility international briefing on agility and business agility*. Agility International. Retrieved 2002, from the World Wide Web at: http://www.agility.co.uk/ab1.html

Barnett, W., Presley, A., Johnson, M. E., & Liles, D. (1994). *An architecture for virtual enterprise*. Paper presented at the IEEE — International Conference on Systems, Manufacturing and Cybernetics, San Antonio, USA.

Beamon, B. M. (1998). Supply chain design and analysis: Models and methods. *International Journal of Production Economics*, *55*, 281-294.

Benjamin, R., & Wigand, R. (1995). Electronic markets and virtual value chain on the information super highway. *Sloan Management Review, 36*, 62-72.

Bernus, P. et al. (1996). The meaning of an enterprise model. In P. Bernus & L. Nemes (Eds.), *Modelling and methodologies for enterprise integration.* Chapman & Hall.

Bernus, P., Baltrusch, R., Vesterager, J., & Tolle, M. (2002). Fast tracking ICT infrastructure requirements and design, based on enterprise reference architecture and matching reference models. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 293-302). Boston, MA: Kluwer Academic Publishers.

Bonney, M. C., Barson, R. J., Head, M. A., & Huang, N. (1992). UNISON — A tool for for enterprise integration. In C. Petrie (Ed.), *Enterprise integration modelling* (pp. 237-248). Boston: The MIT Press.

Browne, J. (1995). The extended enterprise - Manufacturing and the value chain. In L. M. Camarinha-Matos & H. Afsarmanesh (Eds.), *Balanced Automation Systems — Architectures and design methodologies* (pp. 5-17). Chapman & Hall.

Browne, J., Harhen, J., & Shivnan, J. (1996). *Production management systems: An integrated perspective* (2nd ed.). New York: Addison-Wesley.

Browne, J., Sacket, P. J., & Wortmann, J. C. (1995). Future manufacturing systems — Towards the extended enterprise. *Computers in Industry*, *25*, 235-254.

Browne, J., & Zhang, J. (1999). Extended and virtual enterprises: Similarities and differences. *International Journal of Agile Management Systems, 1/1*, 30-36.

Bultje, R., & Wijk, J. (1998). Taxonomy of virtual organisations, based on definitions, characteristics and typology. *VoNet: The Newsletter@http://www.virtual-organisation.net, 2*(3), 7-20.

Burbidge, J. L. (1985). Automated production control with a dimulation vapacity. In P. Falster & R. B. Mazumder (Eds.), *Modelling production management systems*. North-Holland: Elsevier Science.

Burns, J. F., & Sivazlian, B. D. (1978). Dynamic analysis of multi-echelon supply systems. *Computers and Industrial Engineering, 2*, 181-193.

Byrne, J. A. (1993). The Virtual Corporation: The company of the future will be the ultimate in adaptability. *Business Week*, 98-103.

Camarinha-Matos, L. M., & Afsarmanesh, H. (1999). The virtual enterprise concept. In L. M. Camarinha-Matos & H. Afsarmanesh (Eds.), *Infrastructures for virtual enterprises* (pp. 3-14). Porto, Portugal: Kluwer Academic Publishers.

Camarinha-Matos, L. M., Afsarmanesh, H., & Cardoso, T. (1999). Partners search and quality-related information exchange in a virtual enterprise. In K. Mertins (Ed.), *Global production management* (pp. 3-14). Berlin: Kluwer Academic Publishers.

Camarinha-Matos, L. M., Afsarmanesh, H., Garita, C., & Lima, C. (1997). Towards an architecture for virtual enterprises. *Journal of Intelligent Manufacturing, 9*(2), 189-199.

Clark, A. J., & Scarf, H. (1960). Optimal policies for a multi-echelon inventory problem. *Management Science, 6*, 475-490.

Cunha, M. M., & Putnik, G. D. (2002). Discussion on requirements for agile/virtual enterprises reconfigurability dynamics: The example of the automotive industry. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 527-534). Boston, MA: Kluwer Academic Publishers.

Cunha, M. M., Putnik, G. D., & Ávila, P. (2000). Towards focused markets of resources for agile / virtual enterprise integration. In L. M. Camarinha-Matos, H. Afsarmanesh, & H. Erbe (Eds.), *Advances in networked enterprises: Virtual organisations, balanced automation, and systems integration* (pp. 15-24). Berlin: Kluwer Academic Publishers.

Cunha, M. M., Putnik, G. D., & Gunasekaran, A. (2002). Market of resources as an environment for agile / virtual enterprise dynamic integration and for business alignment. In A. Gunasekaran (Ed.), *Knowledge and informa-*

tion technology management in the 21st century organisations: Human and social perspectives (pp. 169-190). Hershey, PA: Idea Group Publishing.

Cunha, M. M., Putnik, G. D., Gunasekaran, A., & Ávila, P. (2005). Market of resources as a virtual enterprise integration enabler. In G. D. Putnik & M. M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 145-165). London: Idea Group Publishing.

Davidow, W. H., & Malone, M. S. (1992). *The virtual corporation — Structuring and revitalising the corporation for the 21st century*. New York: HarperCollins.

deVor, R., Graves, R., & Mills, J. J. (1997). Agile manufacturing research: Accomplishments and opportunities. *IIE Trans., 29*(10), 813-823.

Dove, R. (1994, November). The meaning of life and the meaning of agile. *Production Magazine*.

Dove, R. (1995). *Metrics and measures for agility* (Production Magazine, Essays on Change Proficiency: The Dollars and Sense of Agility). Paradigm Shift.

Dove, R. (1996). *Agile supply-chain management.* Paradigm Shift.

Drucker, P. F. (1990, May/June). The emerging theory of manufacturing. *Harvard Business Review,* 94-102.

Dyer, J. H. (1997). Effective interfirm collaboration: How firms maximize transaction costs and maximize transaction value. *Strategic Management Journal, 18*(7), 535-556.

Filos, E. (2005) Virtuality and the future of organisations. In G. Putnik & M.M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives.* Hershey, PA: Idea Group Publishing.

Filos, E., & Banahan, E. (2001). Towards the smart organization. An emerging organizational paradigm and the contribution of the European RTD programmes. *Journal of Intelligent Manufacturing, 12*(2), 101-119.

Fine, C. (1996). Industry clockspeed and competency chain design: An introductory essay, *Proceedings of the 1996 Manufacturing and Service Operation Management Conference*. New Hampshire.

Forbairt. (1996). *Virtual Corporation Defined* (Summary Section for Forbairt Internet Report). Ireland: Forbairt.

Forrester, J. W. (1958). Industrial dynamics: A major breakthrough for decision makers. *Harvard Business Review, 36,* 37-66.

Forrester, J. W. (1961). *Industrial dynamics*. Cambridge, MA: The MIT Press.

Fox, M. S., Barbuceanu, M., & Gruninger, M. (1995). An organisation ontology for enterprise modelling: Preliminary concepts for linking structure and behaviour. *Computers in Industry, 29*, 123-134.

Franke, U. (2001). The concept of virtual Web organisations and its implications on changing market conditions. *Electronic Journal of Organizational Virtualness — EJOV, 3*(4), 43-64.

Franke, U., & Hickmann, B. (1999). Is the net-broker an entrepreneur? What role does the net-broker play in virtual webs and virtual corporations? In Sieber & Griese (Eds.), *Proceedings of the 2nd International VoNet Workshop*. Zurich.

Fujii, S., Kaihara, T., Morita, H., & Tanaka, M. (1999). A distributed virtual factory in agile manufacturing environment. *Proceedings of ICPR '99.*

Gazendam H. W.M. (2001). Semiotics, virtual organizations, and information systems. In K. Liu, R.J. Clarke, P.B. Andersen, & R.K. Stamper (Eds.), *Information, organisation and technology: studies in organisational semiotics.* Boston: Kluwer Academic Publishers.

Globemen_Consortium. (1999). *GLOBEMEN — Global engineering and manufacturing in enterprise networks*. IMS 99004/IST-1999-60002. Retrieved from http://globemen.vtt.fi

Goldman, S., Nagel, R., & Preiss, K. (1995). *Agile competitors and virtual organizations: Strategies for enriching the customer*. New York: van Nostrand Reinhold.

Goranson, H. T. (1992). Dimensions of enterprise integration. In C. Petrie (Ed.), *Enterprise integration modelling*. Boston: The MIT Press.

Goranson, T. (1999). *The agile virtual enterprises — Cases, metrics, tools.* Westport, CT: Quorum Books.

Goranson, T. (2003). Architectural support for the advanced virtual enterprise. *Computers in Industry, 51,* 113-125.

Gruninger, M., & Fox, M. S. (1996). The logic of enterprise modelling. In P. Bernus & L. Nemes (Eds.), *Modelling and methodologies for enterprise integration* (pp. 83-98). London: Chapman & Hall.

Gunasekaran, A. (1999). Agile manufacturing: A framework for research and development. *International Journal of Production Economics, 62*, 87-105.

Hinkkanen, A., Kalakota, R., Saengcharoenrat, Stallaert, J., & Whinston, A. B. (1997). *Distributed decision support systems for real time supply chain management using agent technologies* (Technical Report). USA: Office of Naval Research.

Hormozi, A. M. (1994). Agile manufacturing. *Proceedings of the 37th International Conference*, American Production and Inventory Control Society, San Diego.

Huang, S. H., Wang, G., & Dismukes, J. P. (2000). A manufacturing engineering perspective on supply chain integration. *Proceedings of the 10th International Conference on Flexible Automation and Intelligent Manufacturing* (Vol. 1, pp. 201-214). College Park.

IMS. (1996). *IMS Project*. Intelligent Manufacturing Systems. Retrieved from http://www.ims.org

IMS International. (2003). Intelligent manufacturing systems (IMS) program. Retrieved from http://www.ims.org/index_tor.html

ISR. (1995). What virtual manufacturing is. *Virtual Manufacturing User Workshop Report*. Lawrence Associates Inc. Retrieved from http://www.isr.umd.edu/Labs/CIM/vm/vmdesc.html

Jägers, H., Jansen, W., & Steenbalkkers, W. (1998, April 27-28). Characteristics of Virtual Organisations, *Proceedings of the VoNet Workshop* (pp. 65-76). Bern.

Jenkins, G. P., & Wright, D. S. (1998). Managing inflexible supply chains. *International Journal of Logistics Management*, *9*(2), 83-90.

Kalakota, R., Stallaert, J., & Whinston, A. (1996). *Real-time optimization in a fynamic supply chain environment* (Working Paper). University of Texas at Austin.

Kidd, P. (1994). *Agile manufacturing: Forging new frontiers*. Reading, MA: Addison-Wesley.

Kidd, P. (1995). *Agile corporations: Business enterprises in the 21st century — An executive guide*. Cheshire Henbury.

Kim, S. (1990). *Designing intelligence: A framework for smart systems*. Oxford: Oxford University Press.

Lee, G. H. (1998). Designs of components and manufacturing systems for agile manufacturing. *International Journal of Production Research, 36*(4), 1023-1044.

Malone, T. W., Yates, J., & Benjamin, R. (1987). Electronic markets and electronic hierarchies. *Communications ACM, 30*(6), 484-497.

Menzel, C. P., & Mayer, R. J. (1996). A situation theoretic approach to the representation of processes. In P. Bernus & L. Nemes (Eds.), *Modelling and methodologies for enterprise integration*. London: Chapman & Hall.

Mesarovic, M. D., Macko, D., & Takahara, Y. (1970). *Theory of hierarchical multilevel systems*. New York: Academic.

Miles, R. E., & Snow, C. C. (1984). Fit, failure and the hall of fame. *California Management Review, 26,* 10-28.

Miles, R. E., & Snow, C. C. (1986). Organizations: New concepts for new forms. *California Management Review, 28*, 62-73.

Murray, J. Y., Kotabe, M., & Wildt, A. R. (1995, First Quarter). Strategic and financial performance implications of global sourcing strategy: A contingency analysis. *Journal of International Business Studies*, 181-202.

Nagel, R. (1993). *Understanding agile competition, a quick look at how to make your company agile*. Bethlehem, PA: Iacocca Institute, Lehigh University.

Nagel, R., & Dove, R. (1992). *21st century manufacturing enterprise strategy*. Bethlehem, PA: Iacocca Institute, Lehigh University.

Nagel, R., & Dove, R. (1993). *21st century manufacturing enterprise strategy*. Bethlehem, PA: Iacocca Institute, Lehigh University.

Nell, J. G. (1998). *Enterprise representation: An analysis of standards issues*. Retrieved from http://www.mel.nist.gov/msidlibrary/doc/jimnell95.pdf

NIIIP. (1996). *The NIIIP reference architecture*. National Industrial Information Infrastructure Protocols. Retrieved from http://www.niiip.org

Onosata, M., & Iwata, K. (1993) Development of a virtual manufacturing system by integrating product models and factory models. *Annals of the CIRP*, *42*(1), 475-478.

Orfali, R., Harkey, D., & Edwards, J. (1997). *Instant CORBA.* New York: John Wiley & Sons.

Parunak, R., & VanderBok, R. (1998). *Modelling the extended supply network* (Working Paper). Ann Arbor, MI: Industrial Technology Institute.

Parunak, V. D. (1997). *Technologies for virtual enterprises* (Report). Ann Arbor, MI: Industrial Technology Institute.

Petrie, C. (Ed.). (1992). *Enterprise integration modeling*. Boston: MIT Press.

Presley, A. (1997). *A representation method to support enterprise engineering.* Unpublished doctoral dissertation, The University of Texas at Arlington.

Presley, A., & Rogers, K. J. (1996, August). *Process modelling to support integration of business practices and processes in virtual enterprises.* Paper presented at the International Engineering Management Conference, Vancouver.

Putnik, G. D. (1997). Towards OPIM system. In M. A. Younis & S. Eid (Eds.), *Proceedings of the 22nd International Conference on Computers and Industrial Engineering* (pp. 675-678). Cairo.

Putnik, G. D. (2000). *BM_Virtual enterprise architecture reference model* (Technical Report RT-CESP-GIS-2000-<GP-01>). Portugal: University of Minho.

Putnik, G. D. (2001). BM_virtual enterprise architecture reference model. In A. Gunasekaran (Ed.), *Agile manufacturing: 21st century manufacturing strategy* (pp. 73-93). UK: Elsevier Science.

Putnik, G. D. (2002). Part I — Towards an OPIM system: Manufacturing SME organization for the future. *Int. J. Networking and Virtual Organizations, 1*(2), 125-150.

Putnik, G., & Cunha, M. M. (Eds.). (2005c). *Virtual enterprise integration: Technological and organizational perspectives* (pp. xvii - 455). Hershey, PA: Idea Group Publishing.

Putnik, G. D., Cunha, M. M., Sousa, R., & Ávila, P. (2005a). Virtual enterprise integration: challenges of a new paradigm. In G. Putnik & M.M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 1-30). Hershey, PA: Idea Group Publishing.

Putnik, G. D., Cunha, M. M., Sousa, R., & Ávila, P. (2005b). BM_ Virtual enterprise: A model for dynamics and virtuality. In G. Putnik & M.M. Cunha (Eds.), *Virtual enterprise integration: technological and organizational perspectives* (pp. 124-143). Hershey, PA: Idea Group Publishing.

Putnik, G. D., & Silva, S. C. (1995). One-product-integrated-manufacturing. In L. M. Camarinha-Matos & H. Afsarmanesk (Eds.), *Balanced automation systems — Architectures and design methods* (pp. 45-52). Chapman & Hall.

Putnik, G. D., & da Silva, A. (2002). Part II — Towards an OPIM system: Results of the OPIM system design simulation and an applicability analysis. *Int. J. Networking and Virtual Organizations, 1*(2), 151-169.

Putnik, G. D., Sousa, R. M., Moreira, J. F., Carvalho, J. D., Spasic, Z., & Babic, B. (1998). Distributed/virtual manufacturing cell: An experimental installation, in *Proceedings of 4th International Seminar on Intelligent Manufacturing Systems*, Belgrade.

Quinn, J. B. (1990). *The intelligent enterprise*. New York: The Free Press.

Rayport, J. F., & Sviokla, J. J. (1999). *Exploiting the virtual value chain, creating value in the networked economy*. Boston: Harvard Business School Press.

Reid, L., Liles, D., Rogers, K., & Johnson. (1996). *A methodology for engineering the virtual enterprise.* Paper presented at the Agility Forum Conference, Boston.

Schlechtendahl, E. G. (Ed.). (1989). *CAD Data transfer for solid models.* Berlin: Springer-Verlag.

Shee, D. Y., Tang, T. I., & Tzeng, G. H. (2000). Modelling the supply-demand interaction in electronic commerce: A bi-level programming approach. *Journal of Electronic Commerce Research, 2.*

Shen, W., & Norrie, D. H. (1998). An agent-based approach for manufacturing enterprise integration and supply chain management. In G. J. et. al (Ed.), *Globalization of manufacturing in digital communications era of the 21st century: Innovation, agility and the virtual enterprise* (pp. 579-590). Boston: Kluwer Academic Publishers.

Sieber, P. (1998). Organisation virtualness: The case of small IT companies. In P. Sieber & J. Griese (Eds.), *Proceedings of the VoNet Workshop* (pp. 107-122). Bern: Simowa Verlag.

SME. (1993). *The new manufacturing enterprise wheel.* Dearborne, MI: Society of Manufacturing Engineers.

Swaminathan, J. M., Smith, S. F., & Sadeh, M. (1998). Modeling supply chain dynamics: A multiagent approach. *Decision Sciences, 29*(3), 607-632.

Tolle, M., Bernus, P., & Vesterager, J. (2002). Reference models for virtual enterprises. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 3-10). Boston: Kluwer Academic Publishers.

Towill, D. R. (1982). Dynamic analysis of an inventory and order based production control system. *Int'l Journal of Production Research, 20*(6), 671-687.

VEA. (1998). *The virtual enterprise concept. The virtual enterprises association.* Retrieved from http://www.vea.org

Venkatraman, N., & Henderson, J. C. (1996). *The architecture of virtual organising: Leveraging three independent vectors* (Discussion Paper). Boston: Systems Research Center, Boston University School of Management.

Vernadat, F. (1996). *Enterprise modeling and integration.* New York: Chapman & Hall.

Wassenaar, A., Govindaraju, R., Bragado, E. M., Meijer, A., Ribbers, P., & Swagerman, D. (1998). Lessons from managerial theories for improving virtualness in electronic business. In P. Sieber & J. Griese (Eds.), *Proceedings of the VoNet workshop* (pp. 107-122). Bern: Simowa Verlag.

Wilkner, J., Towill, D. R., & Naim, M. (1991). Smoothing supply chain dynamics. *Int'l Journal of Production Economics, 22*, 231-248.

Williamson, O. (1991). Comparative economic organisation: The analysis of discrete structural alternatives. *Administrative Science Quarterly, 36*(1), 269-296.

Wu, J. (1999). *Distributed system design.* CRC Press.

Wu, J., Cobzaru, M., Ulieru, M., & Norrie, D. H. (2000, July). *SC-Web-SC: Supply chain web-centric systems.* Paper presented at the IASTED — International Conference on Artificial Intelligence and Soft Computing, ASC-2000, Banff, Canada.

Yusuf, Y. Y., Sarhadi, M., & Gunasekaran, A. (1999). Agile manufacturing: The drivers, concepts and attributes. *International Journal of Production Economics, 62*, 33-43.

Zwegers, A., Hannus, M., & Tolle, M. (2001). Integration issues in virtual enterprises supported by architectural framework. *Proceedings of the IMS Forum 2001.*

Endnotes

[1] The report also introduced the expression “Agile Manufacturing”.

[2] Distributed enterprises do not imply virtual enterprises. We may say that distributed enterprises are an intermediate step in the development and implementation of the virtual enterprise concept. In the same way, we can imagine several cases where distributed enterprises take advantage when compared with virtual enterprises, i.e., cases where the application of the virtual enterprise concept does not apply. But, from the other side, the virtual enterprise will have the largest advantage if it includes the distributed enterprise features.

[3] This is the main principle of the concurrent or simultaneous engineering.

Chapter III

BM_Virtual Enterprise as an Agile/Virtual Enterprise Model

Introduction

Chapter III presents the BM_Virtual Enterprise (BM_VE) model, as an Agile/Virtual Enterprise, in total or partial conformance with the BM_Virtual Enterprise Architecture Reference Model (BM_VEARM) (i.e., as a dynamically reconfigurable network integrated over the global domain, satisfying the requirements for integrability, distributivity, agility and virtuality as the competitiveness factors). According to BM_VEARM, a virtual enterprise (VE) is "… an optimized enterprise, synthesized over a universal set of resources, with a real-time replaceable physical structure, and when the synthesis and control are performed in an abstract or virtual environment." The importance of presenting the BM_VE is in the fact that VE, or Agile/Virtual Enterprise (A/VE), implementation and management is not possible without *Market of Resources* (MR), and similarly defined structures and/or organizations, as an external independent institution that would serve as an environment to support the VE dynamic integration, operation and reconfiguration, as well as "boost" to the networking (VE) dynamics, providing overcoming (i.e., minimizing) of the two fundamental networking disablers: (1) "transaction" (i.e., reconfigurability) costs, and (2) the VE partners' knowledge and rights protection. Market of Resources is the third mechanism, or tool, that BM_VE, or any VE conceived as a dynamically reconfigurable enterprise network uses. It is an institution, or enterprise, operating as a *meta-enterprise* of the operating VE.

BM_Virtual Enterprise uses three main mechanisms, or tools: Broker, Virtuality and Market of Resources. Broker is the agent of agility and virtuality. Virtuality as a tool is a specific organizational structure pattern that contributes to further improvement of agility/reconfiguration dynamics.

The consequences of virtuality, as defined in BM_VE model (i.e., in BM_VEARM), are: (1) the hierarchical structure of VE, or A/VE, organization, (2) the *Resource-centered Virtual Enterprise Definition* (in a way the inverse definition of the "traditional" VE definitions), and (3) the virtualization process.

The consequences of virtuality in BM_VE, following BM_VEARM, the *Resource centered Virtual Enterprise Definition*, and the process of virtualization, following BM_VE and BM_VEARM, directly implied by the *(BM_VE) VE Extended Life Cycle*, characterized by the "contractualization of the Market of Resources" environment, or a meta-enterprise for its (VE) implementation and management.

BM_VE is a ubiquitous enterprise too. This is exactly because ubiquitousness is necessarily based on the *Resource-centered Virtual Enterprise Definition*. Market of Resources, and similarly defined environments, enable VE, or A/VE, to operate as a ubiquitous enterprise too. Ubiquitous enterprise, and VE as a ubiquitous enterprise, could be considered as the next generation (enterprise) organizations.

BM_VE Organization

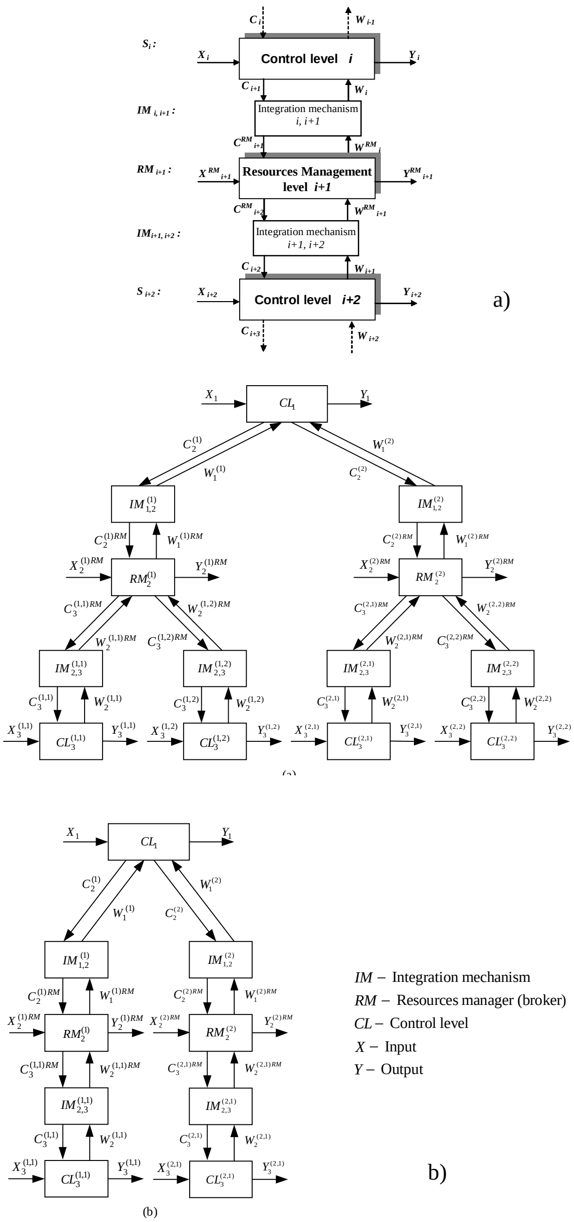
BM_Virtual Enterprise (BM_VE) is a Virtual Enterprise (VE) whose organizational structure is in a total or partial conformance with the BM_Virtual Enterprise Architecture Reference Model (BM_VEARM) presented in the previous chapter. Using the BM_VEARM elementary structure, or structural pattern, as the organizational structure's building block, BM_VE provides capability to effectively and efficiently manage the competitiveness factors integrability, distributivity, agility and virtuality (see Chapter II). Actually, BM_VEARM directly provides two main mechanisms to manage the above-mentioned competitiveness factors, (i.e., to achieve the highest levels of the VE (organizationl) structure dynamic reconfigurability, or agility), which are: (1) *Broker* and (2) *Virtuality*.

As already discussed in Chapter II, the *Broker* is the agent of agility seen as the organization reconfiguration dynamics, acting as the "third" entity between the main "actors" — the "client" and the "server" VE partners — and its contribution to the VE agility, the organization reconfiguration dynamics, is based on its supposed expert knowledge, more effective and more efficient than the "client's" knowledge on search and integration of the VE partners ("servers") and the VE reconfiguration management, which the highest efficiency is absolutely necessary to achieve the highest levels of the reconfiguration dynamics, or agility. This is the first broker's fundamental role in BM_VE model as a dynamically reconfigurable VE model.

Virtuality as a tool is a specific organizational structure pattern that contributes to further improvement of agility/reconfiguration dynamics reducing further the organizational structure reconfiguration "*set-up*" time. It is implemented through the Broker (again) that provides the intermediation services "online" with the operations of the "client" and the "server" and in a way that the operating agents, the "client" and the "server," are not aware of each other, implying that "client" and "server" communicate through the Broker (see Chapter II). The Broker should provide the transition from one physical structure, or organizational structure instance, to the another one in a way that the "client" can't be affected by the system reconfiguration, in which case the operation would be interrupted and split in two, implying immediately some time loss because of set-up time needed. During the operation the "client" does not have the direct contact with the "server" who provides the service (or production) (Putnik et al., 2005). This is the second Broker's fundamental role in BM_VE model as a dynamically reconfigurable VE model.

The structure proposed allows the enterprise reconfigurability during the (single) operation (i.e., the organisational structure may change during the operation) *at the run time*. The resource manager, or Broker, can reconsider the organisation structure during the operation, "at the run time," as well as between two operations, and act with the objective to adapt it (to reconfigure it) in order to achieve the best alignment with the environment (i.e., the market) (Putnik et al., 2005). The model could be described by the *operation online reconfigurability* of the enterprise. As a consequence of the "operation online reconfigurability" model, *the underlying physical structure of the enterprise is hidden to the "client."* In other words, the "client" doesn't see the real structure, he sees some "virtual" structure that does not exist. The Broker (i.e., "Resources Management Level"), together with the "Integration Mechanism Levels" (see the next section) (e.g., the translators), *emulate* the underlying organisational (hardware) structure in a format that is understandable by the "client." By this structure, a VE, in this case the BM_VE, could be seen as a homomorphism of Distributed (software) System Architecture (e.g., *Common Object Request Broker Architecture* (*CORBA*) (Putnik et al., 2005).

Figure 1. (a) BM_VEARM elementary structure or structural pattern; (b) BM_VEARM or BM_VE hierarchical structure instances (Sousa, 2003; Putnik et al., 2005)



The ideal goal to be achieved, in terms of time, is the capability of the VE "reconfiguration within 1 second."

This is a base for achieving the maximum levels of leanness and/or agility (see Table 2).

In this way, BM_Virtual Enterprise is the VE as a dynamically reconfigurable network integrated over the global domain, satisfying the requirements for integrability, distributivity, agility and virtuality as the competitiveness factors, or, in other words, a virtual enterprise (VE). A VE is, according to the BM_VEARM, "… an optimized enterprise, synthesized over a universal set of resources, with a real-time replaceable physical structure. The synthesis and control are performed in an abstract or virtual environment" (Putnik et al., 2005).

Canonical Structure

The BM_VE structural specification shows clearly the position of the Broker in the BM_VE overall structure, which is a hierarchical structure, as well as the structural patterns as VE structure building blocks, conceived for agility (i.e., for reconfiguration dynamics) and virtuality, and used during the EV structure synthesis process).

In the further analysis, in order to make the discussion and diagrams simpler, the integration mechanism will be omitted in the further consideration, without losing validity of the discussion or diagrams, because, as an interface between adjacent levels, from the implementation viewpoint, it (integration mechanism) is usually included within those levels. Therefore, the BM_VE organizational structure deals practically with only two types of elementary structure's building blocks: control-level block (represented by the terminal symbol c_i, representing client or server, dependently of the position) and resource-management block, or broker, (represented by the terminal symbol r_j) (Figure 2).

Figure 2. Building blocks used by G_{BM} (a) control level, (b) resources management (Sousa, 2003; Putnik et al., 2005)

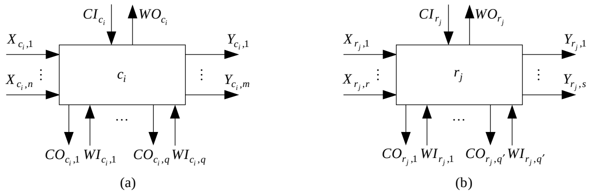
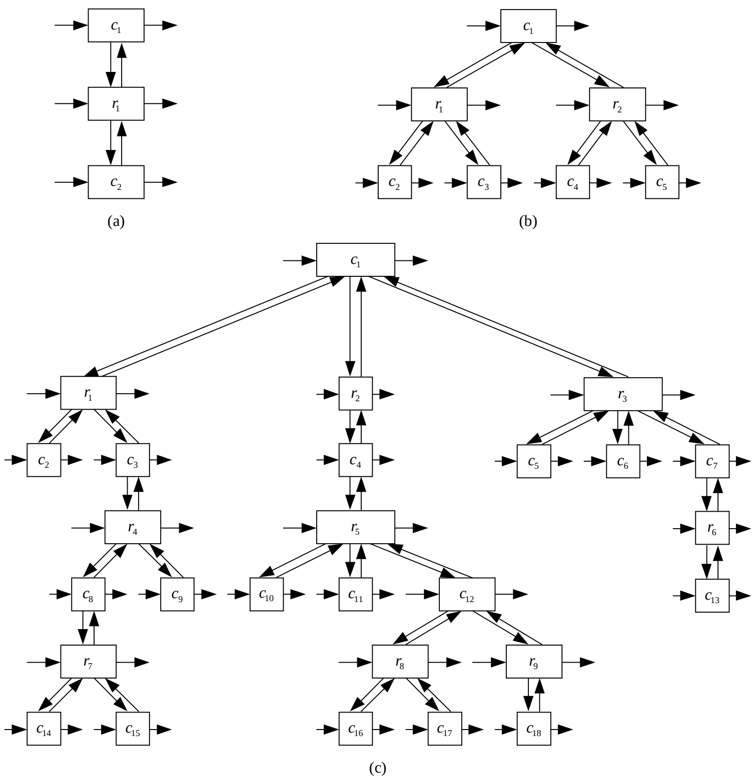


Figure 3. BM_VE system canonical instances generated by G_{BM} grammar, (Sousa, 2003; Putnik et al., 2005)



To represent rigorously or formally, the BM_VE organizational structure, in compliance with BM_VEARM, an attributed context-free formal grammar, denoted G_{BM}[1], was developed in Sousa (2003) and Putnik et al. (2005).

Some examples of BM_VE structures synthesized by are represented in Figure 3 (Sousa, 2003; Putnik et al., 2005).

These system structure instances are BM_VE *canonical structures* since they are full compliant to the BM_VEARM architecture.

In general, the components of a BM_VE may have their own internal composition, as in Figure 4.

When the components of the BM_VE are primitive resources (i.e., from unitary resources specialized, corresponded to individual one person or one machine enterprises), then the BM_VE is an OPIM system, or OPIM VE (see Chapter II).

Figure 4. Possible internal composition of a virtual enterprise instance (Sousa, 2003; Putnik et al., 2005)

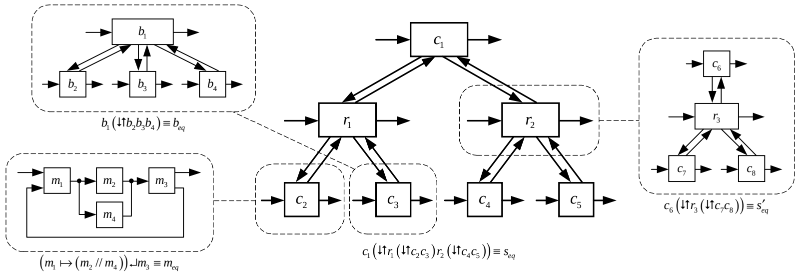
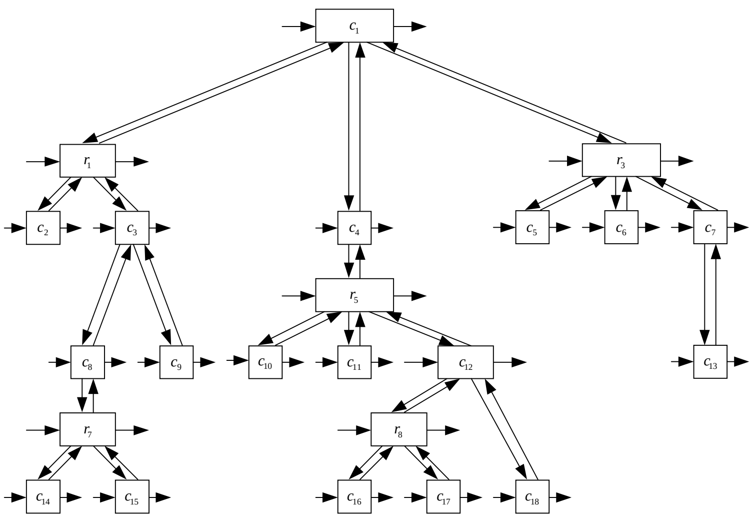


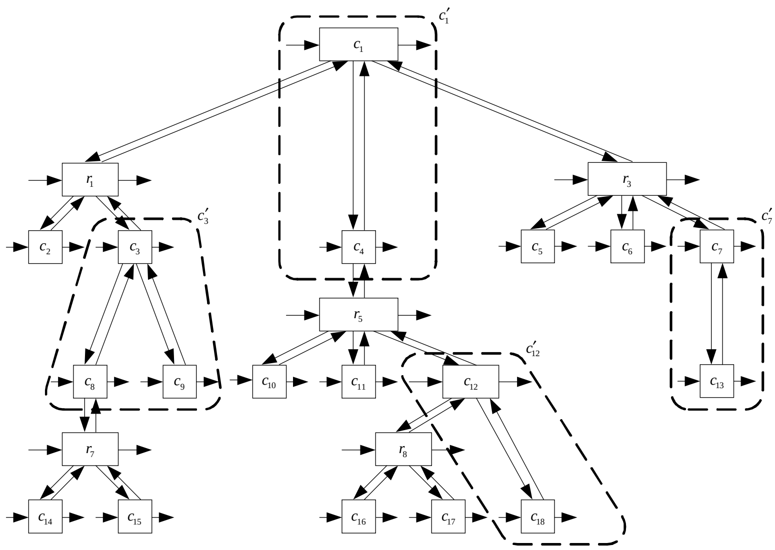
Figure 5. Potential BM_VE non-canonical structure instance (Putnik et al., 2005)



Non-Canonical Structure

Some structures can be BM_VE non-canonical structures. An example of a potential BM_VE non-canonical system instance is represented in Figure 5. For example, the control blocks c_1 and c_4, c_3 and c_8, etc., are directly connected, that is, there is no broker between them as the BM_VE canonical structure requires (Sousa, 2003; Putnik et al., 2005).

Figure 6. Transformation into BM_VE canonical structure (Putnik et al., 2005)



However, applying a composition, or synthesis, operator, it is possible to transform the structure in Figure 5 into a BM_VE canonical structure assuming the aggregations represented in Figure 6.

Thus the structure in Figure 5 is in fact a BM_VE non-canonical structure and its corresponding BM_VE canonical structure is represented in Figure 7. As a consequence we can state that any non-canonical BM_VE structure can be transformed into a BM_VE canonical structure. It is thus possible to determine if a given enterprise is or is not a BM_VE (Putnik et al., 2005).

Structural Dynamics or Reconfigurability

An example of a possible BM_VE system dynamics, that considers three operations, performed by different BM_VE configurations each one determined by the brokerage function as the most adequate for that moment, is presented on Figure 8. To formalize the structural dynamics or reconfiguration process in (Sousa, 2003), for its representation on the highest hierarchical level, it is

Figure 7. BM_VE equivalent canonical structure (Putnik et al., 2005)

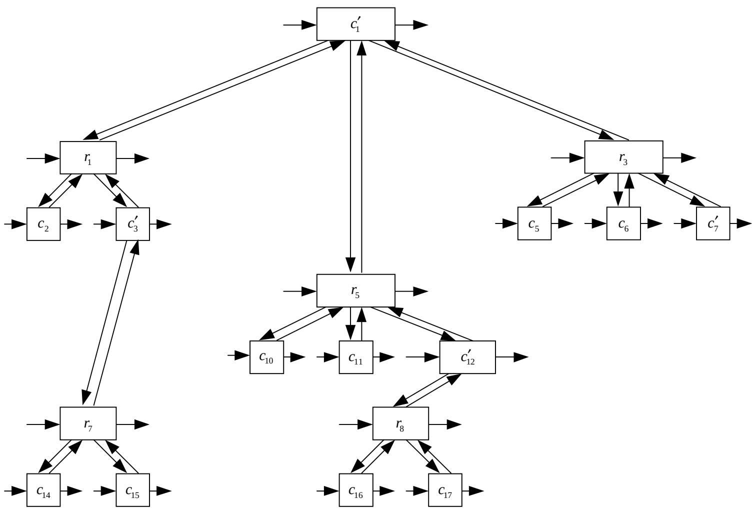
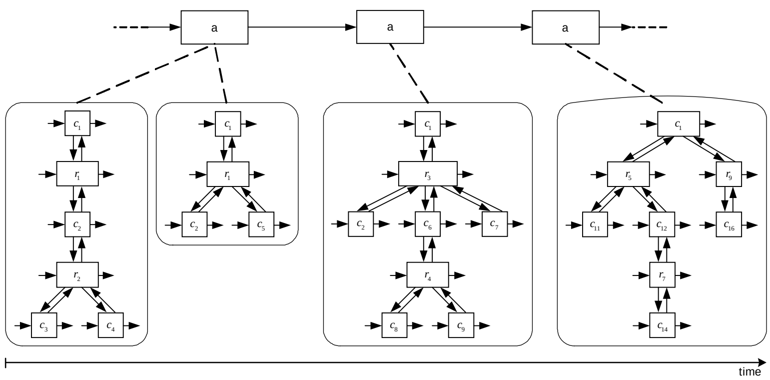


Figure 8. BM_VE reconfigurability dynamics (Sousa, 2003; Putnik et al., 2005)



developed by a trivial regular grammar denoted by G_1. If the VE operation is denoted by *a* then the sequence of BM_VE operations is described as *aaa*. Naturally, as the grammar is an attributed grammar, the attribute values determine the concrete underlying organizational structure.

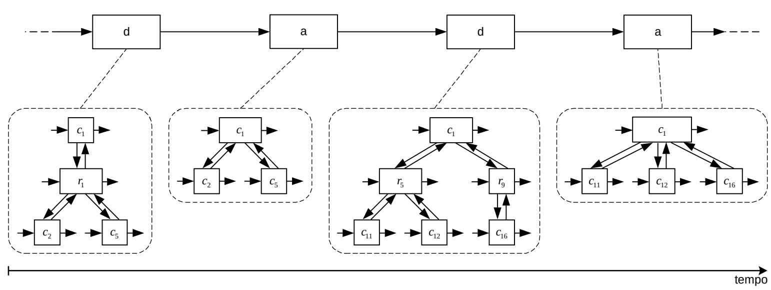
It is important to note that in the example given the “control block” c_1 at the highest level, which is in fact the VE owner and initiator, operate the underlying structure always through the Broker, the block r_j. In this way, the Figure 8 presents a BM_VE operation in a pure virtual way (i.e., as the pure VE, fully employing *virtuality* according to BM_VEARM). Thus, as seen before, BM_VE reconfiguration can occur not only between operations but also during an operation, without knowledge of the upper hierarchical level. In fact, from the VE owner and initiator point of view, the “control block” at the highest level, there are no three operations but only one.

Figure 9 in Chapter II represents an operational informal diagram of a BM_VE.

Relaxing the conditions of BM_VEARM, we could “permit” that VE can operate in a different way. During the production operations, represented by the symbol *a*, Figure 9, the VE operates as a traditional (networked) enterprise, without virtuality. But, during the configuration/reconfiguration process, or operation, the business, or VE, “owner” employs a broker and at that moment the enterprise operates with virtuality, as a BM_VE instance. It means that we have alternations of the “traditional” structures (without virtuality/brokers) and BM_VE structures. The first structure should be necessarily a BM_VE structure as it is the moment of initial configuration of the enterprise. Enterprises that operate in this way we will call Agile Enterprise (AE) or Agile/Virtual Enterprise (A/VE) (Sousa, 2003; Putnik et al., 2005).

To formalize the structural dynamics or reconfiguration process of a VE as a pure Agile (AE) or A/VEs operation, in Sousa (2003), for its representation on the highest hierarchical level, it is developed a trivial regular grammar denoted by G_2. If the VE operation is denoted by *a* and brokerage operation by *d*, then the sequence of BM_VE operations as AE or A/VE is described as *da*, *dada*, *dadada*, etc. Naturally, as the grammar is an attributed grammar, the attribute values determine the concrete underlying organizational structure. Example of

Figure 9. AE or A/VE operation



the VE, or A/VE operation and reconfiguration sequence generated is presented on Figure 9.

Figure 7 in Chapter II represents an operational informal diagram of an AE or A/VE.

External Environment as BM_VE Implementation and Management Enabler: The Market of Resources

Although BM_VE model provides potential for the highest levels of structural dynamics or reconfiguration, the structural and operational solutions by themselves are not capable to overcome two main dynamic or reconfiguration disablers. These are: (1) the transaction, or reconfigurability, cost, and (2) the VE partners' knowledge and rights protection. To overcome them it is necessary further *support*, *external* to the VE, as internally, due to their nature, it is not possible, or it is extremely difficult and time consuming, to overcome. In other words, we need an external independent institution that would serve as an environment to support the VE dynamic integration, operation and reconfiguration, as well as "boost" to the networking (VE) dynamics, providing overcoming (i.e., minimizing) of the two fundamental networking disablers: (1) "transaction" (i.e., reconfigurability) costs, and (2) the VE partners' knowledge and rights protection.

This environment we call *Market of Resources*.

Market of Resources (MR) is the third mechanism, or tool, that BM_VE, or any VE conceived as a dynamically reconfigurable enterprise network uses. It is an institution, or enterprise, operating as a *meta-enterprise* of the operating VE.

On the first view, MR looks like a common marketplace, that offers marketplace functionalities like searching partners for integration in the VE, or searching goods, filtering information or helping negotiation, that might use simple tools as well as advanced tools as electronic brokerage and/or intelligent agents technology. However, the MR does not rely just on the basic information and communication infrastructure. This is absolutely necessary, but the added value comes from the higher-level functions, necessary for the support to VE dynamic reconfiguration (networking): (1) to *shorten the transaction time* (search time, contracting time, monitoring time and enforcement time), as well as to *lower transaction costs* (search costs, contracting costs, monitoring costs and enforcement costs), in the process of resources integration (i.e., in the process of networking); (2) to *build, to assure and manage the trust*, knowledge/

technology transfer protection, as well as *the legal framework*, between the partners in the network through the trust assurance mechanisms, intellectual property protection, security between partners and against third parties; (3) to provide specialized services for *decision making support*; (4) to provide the *data/knowledge base on resources and transactions*; (5) to *mediate offer and demand of resources* to dynamically integrate in an A/VE and "Brokers"; (6) to *manage the environment for networking.*

These MR's functions led to definition of the (BM_VE) VE Extended Life Cycle model, presented in the later text.

Actually, the (BM_VE) VE Extended Life Cycle model reflects the fact that VE as a dynamically reconfigurable enterprise network is not feasible without MR like VE operation environments.

In other words, the *Market of Resources*, and similarly defined environments, are *the main enabler, or support to VE, or A/VE, implementation and management*.

Consequences of Virtuality in BM_VE

There are some important consequences of the virtuality in VEs as it is conceived within the BM_VEARM reference model, (Putnik et al., 2005).

These consequences further confirm the nature of VE, or A/VE, implementation and management enabler or support in terms of the Market of Resources.

Consequence 1

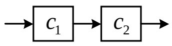
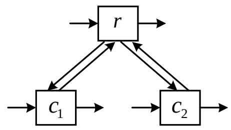
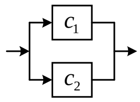
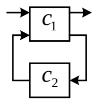
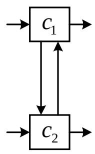
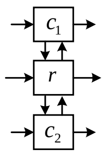
In any BM_VE, hierarchy is always present. Actually, the hierarchy is one of the conditions for virtuality, in terms of BM_VEARM's definition

Table 1 reflects the correspondence between typical inter-process relations inside traditional enterprises and BM_VEs.

Consequence 2

As mentioned before, the "agent" doesn't see the above and the below structure. Actually, for him, the enterprise finishes with the Broker above and below. From his point of view, the enterprise, that is, the VE, is bounded by the Brokers. The consequence for VE definition is radical. Now, we can say that the VE is a

Table 1. Inter-process relations substitutions (Putnik et al., 2005)

Inter-process Relation Type	**Traditional Enterprise**	**Virtual Enterprise**
Sequential		
Parallel		
Feedback		
Hierarchical		

structure "r-c-r", Figure 10, or its special cases, structures "c-r" and "r-c", Figure 11 (b) and (c). The general VE structure "r-c-r" means that the agent ("c") receives the task/job from the Broker (in which case the agent acts as a "server") and can ask the Broker hierarchically "below" for some other resources that can do part of the job he received (assumed), in which case the agent acts as a "client." The special case "c-r" is the case when agent acts only as a "client." This is, actually, the case when the agent is the VE initiator or entrepreneur. The special case "r-c" is the case when agent acts only as a "server" and does by himself the whole task he received.

From this viewpoint a BM_VE instance can be seen as a structure composed by "r-c-r" patterns and its special cases (Figure 12).

The above described consequence of virtuality has other implication: we can now define the VE in two ways. The first one, which is in conformity with the first part of this text, will be designated as "*business, or product-centered definition.*" This definition considers the whole structure which is formally defined by the grammar G_{BM}. Looking at the whole structure, we can easily notice that is composed regularly (canonically) from the patterns "c-r-c", which ("c-r-c") is, in fact, the minimal BM_VE structure (see Figure 3(a)).

Figure 10. The "r-c-r" pattern within a BM_VE (Putnik et al., 2005)

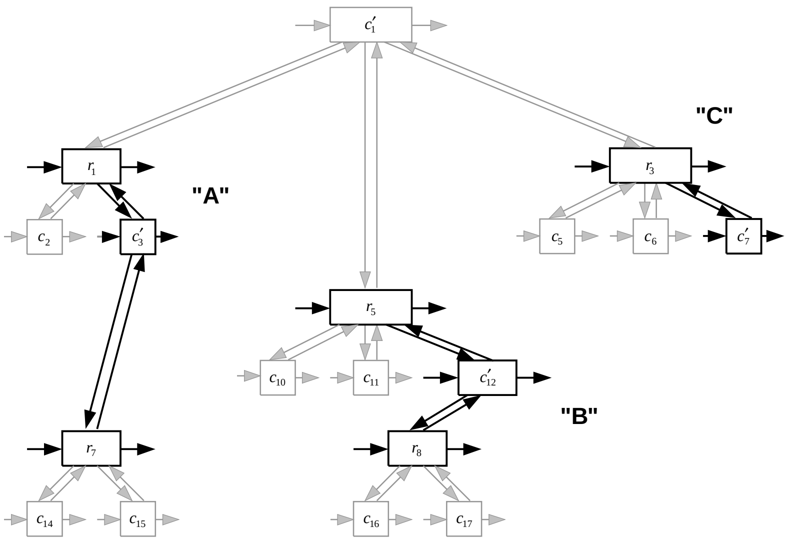
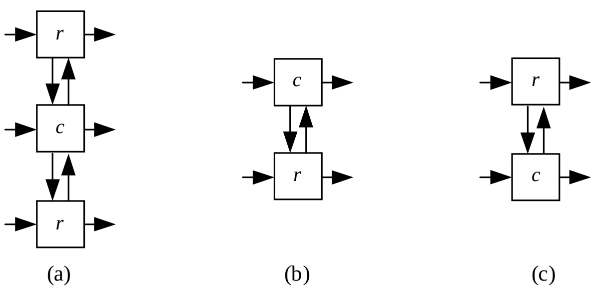


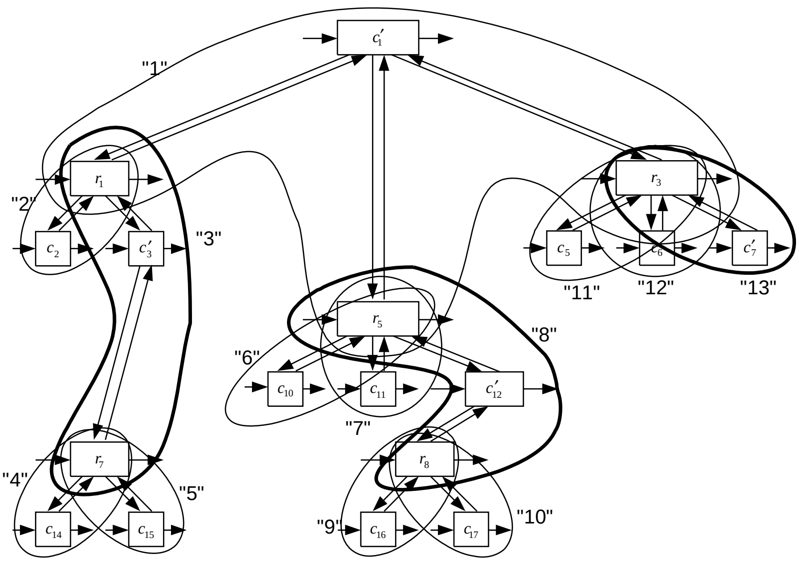
Figure 11. The "r-c-r" pattern and its special cases (Putnik et al., 2005)



Definition (*Business, or product-centered*): Virtual Enterprise is a hierarchical structure, composed by elementary (hierarchical) structural patterns "c-r-c".

As mentioned before, the second definition arises from the second consequence of virtuality and will be designated as "Resource centered definition".

Figure 12. A BM_VE from the "r-c-r" pattern viewpoint (Putnik et al., 2005)



Definition (*Resource-centered*): Virtual Enterprise is a hierarchical structure with three levels "r-c-r", or two levels, "c-r" or "r-c", as special cases.

Furthermore, the first VE definition — "business-, or product-centered" — can be expressed in terms of the second VE definition — "resource centered" as follows:

Definition (*Business, or product-centered*): Virtual Enterprise is a hierarchical structure, composed by *Resource-centered* VE.

In terms of Market of Resources as VE, or A/VE, implementation and management enabler or support, the *Resource centered* Virtual Enterprise Definition implies clearly that the VE as the hierarchical structure "r-c-r" most probably is not possible at all. It is hard to believe that this kind of operation, only through the brokers, is possible. In other words, it is hard to believe that there would be enough trust in brokers, not only in general case but in particular cases too (when brokers and the agent know each other sufficiently to fully trust each other), without an external independent and impartial trusting entity.

Consequence 3

The third consequence is a better understanding of the virtualization process (i.e., the transition process of traditional enterprises to VEs). The virtualization of a traditional enterprise c can be achieved by two ways.

1. Enterprise includes two external brokers, keeping its internal organization (Table 2);
2. Enterprise decomposes itself in a number of independent enterprises and connects them using brokers in order to continue its business. Some examples of virtualizations are represented in Figure 13.

Similarly as above, in terms of Market of Resources as VE, or A/VE, implementation and management enabler or support, most probably the virtualization process is not possible at all without an external independent and impartial trusting entity as the environment for making trusty relations with brokers (i.e., to create the structures “r-c-r” or its special cases).

Table 2. Virtualization of a traditional enterprise c employing external brokers (Putnik et al., 2005)

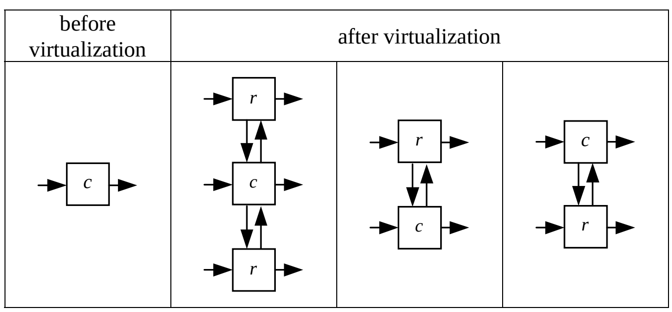
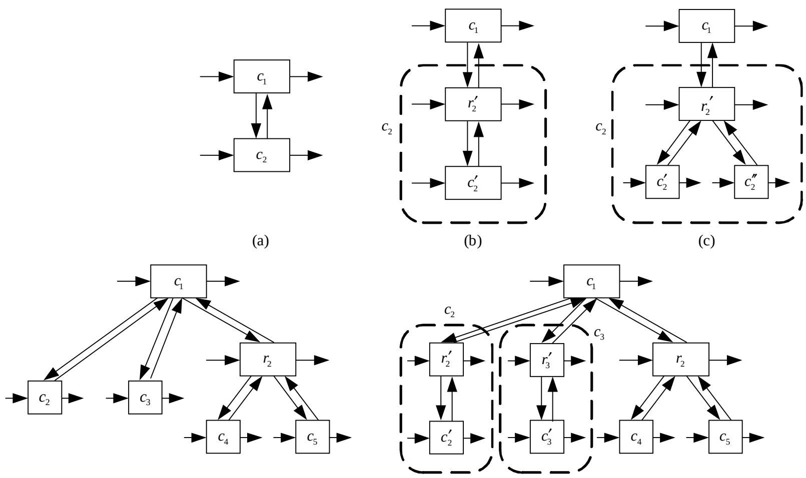


Figure 13. Virtualization of a traditional enterprise c *decomposing its own structure (Putnik et al., 2005)*



Summary

Market of Resources, and similarly defined environments, as VE, or A/VE, implementation and management enabler or support, is indispensable, when VE, or A/VE, is conceived as dynamically reconfigurable network integrated over the global domain, satisfying the requirements for integrability, distributivity, agility and virtuality as the competitiveness factors, or, in other words, a virtual enterprise (VE). According to BM_VEARM, a VE is "… an optimized enterprise, synthesized over a universal set of resources, with a real-time replaceable physical structure, and when the synthesis and control are performed in an abstract or virtual environment".

The consequences of virtuality in BM_VE, following BM_VEARM, namely, the *Resource centered Virtual Enterprise Definition*, and the process of virtualization, following BM_VE and BM_VEARM, directly implied the (BM_VE) VE Extended Life Cycle. VE Extended Life Cycle differs from the "traditional" VE Life Cycle exactly in the phase of "contractualization of the Market of Resources" environment, or a meta-enterprise for its (VE) implementation and management.

BM_VE is a ubiquitous enterprise too. This is exactly because ubiquitousness is necessarily based on the *Resource-centered Virtual Enterprise Definition*, implying a trusting environment for operation, which should be Market of Resources, and similarly defined environments. Further, considering the necessity to operate in such environment, a ubiquitous (VE, or A/VE) enterprise should follow the VE Extended Life Cycle.

The issue of VE integration (VEI) is the key success factor for VE, or A/VE, implementation and management, when VE, or A/VE, is conceived as dynamically reconfigurable network (e.g., BM_VE). As the main inter-enterprise integration issues, and particularly the integration dynamics, are transaction costs and the partners' knowledge and rights protection, then traditional syntactically and semantically based integration is not sufficient but it is needed integration considering pragmatic and societal dimensions, that includes the organizational perspective of VE, or A/VE, the Market of Resources is exactly a VE, or A/VE, integration organizational environment, belonging to the pragmatic and societal dimensions of integration, within the integration semiotic framework.

References

Orfali, R., Harkey, D., & Edwards, J. (1997). *Instant CORBA.* New York: John Wiley.

Putnik, G. D., Cunha, M. M., Sousa, R., & Ávila, P. (2005b). BM_ Virtual enterprise: A model for dynamics and virtuality. In G. Putnik & M.M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 124-143). Hershey, PA: Idea Group Publishing.

Sousa, R. (2003). *Contribuição para uma teoria formal de sistemas de produção*. Tese de Doutoramento, Universidade do Minho, Braga, Portugal.

Endnote

[1] The G_{BM} grammar is a representational class of a formal theory of BM_VE structures (Sousa, 2003), that is, the grammar describes, or represents, a formal theory of BM_VE canonical structures.

Chapter IV

Requirements for Agile/Virtual Enterprise Integration

Introduction

This chapter introduces the requirements for Agile/Virtual Enterprise (A/VE) integration, discusses reconfigurability dynamics and business alignment and proposes a virtual enterprise extended life cycle. The requirement of dynamic reconfigurability of the A/VE model is introduced in and the causes of reconfiguration needs are presented. This chapter also clarifies the concepts of basic resources and complex resources, and discusses concepts related with selection complexity, selection models and solution space dimension. It gives examples of reconfigurability dynamics, and introduces three dynamics parameters. The need of keeping the A/VE aligned with business requirements results in A/VE reconfiguration. The permanent business alignment of the A/VE requires a high reconfiguration dynamics. This chapter introduces a referential for A/VE alignment, involving the market opportunity (or the product required by the market), the A/VE project and the resources providers. It also presents the main functionalities that must be assured to support the implementation of the A/VE model. Finally, this chapter presents a new VE lifecycle, the Agile/Virtual Enterprise extended life cycle.

Requirements for the Agile/Virtual Enterprise Model

In the *BM_Virtual Enterprise Architecture Reference Model* Putnik (2000) presents "fast adaptability" or "fast reconfigurability" as the main characteristic for the competitive enterprise, considering that the concepts of "Agile Enterprise" and "Virtual Enterprise" are the new organizational paradigms that incorporate that characteristic. Other models presenting this feature of fast reconfigurability are the concepts of Virtual Factory and Agile Manufacturing (Goldman, Nagel, & Preiss, 1995; Kim, 1990; NIIIP, 1996; Onosata & Iwata, 1993; Putnik, 1997; Putnik, Guimarães, & Silva, 1996).

As presented earlier, the requirements for competitiveness include: agility, virtuality, distributivity and integrability, which are the characteristics of the A/VE organizational model.

In the A/VE model, agility means the ability of fast and active adaptation of the integrated resources in face of erratic and unpredictable changes in the environment / market, implying substitution of resources (reconfiguration, transition to a new A/VE instantiation or physical structure) to keep permanent alignment with the market. The efficient implementation of the A/VE model must assure *a high reconfigurability dynamics*, as a requirement to be permanently aligned with the market (i.e., to be competitive in delivery time, quality and cost, and to yield satisfactory profit margins).

This requirement of the A/VE model claim for an extended life cycle of the VE, which should integrate a new dimension of *enterprise dynamic integration*, to assure the most suitable configuration of the A/VE.

To respond to the A/VE requirement for reconfigurability dynamics, it is essential to assure the ability of:

1. Flexible and almost instantaneous access to the optimal *resources* to integrate in the enterprise, negotiation process between them, selection of the optimal combination and its integration;
2. Design, negotiation, business management and manufacturing management functions, performed independently from the physical barrier of space; and
3. Minimization of the reconfiguration or integration time.

As we will see, this requirement can only be assured by *an adequate environment to support A/VE dynamic integration and business alignment*. The organizational challenge of partitioning tasks among partners, selecting resources providers, integration of the same in useful time, coordination and reconfigurability dynamics in order to keep alignment with the market requirements, is of main concern, and can determine the success or failure of an A/VE project.

In the next sections we discuss reconfigurability dynamics and business alignment, and the required supporting environment.

Reconfigurability Dynamics in Agile/Virtual Enterprise Integration

The ability of dynamic reconfigurability is a requirement that the enterprises corresponding to the A/VE model must satisfy to strive. Reconfiguration in A/VE happen mainly for three reasons:

1. Reconfiguration during an A/VE life cycle as a consequence of the product redesign (a new instance of the A/VE is to be considered) in the product life cycle, to keep the A/VE aligned with the market requirements.
2. Reconfiguration as a consequence of the nature of the particular product life cycle phase (evolutionary phases).
3. Reconfiguration as a consequence of the evaluation of the performance of the A/VE participants during an A/VE instance, or is a consequence of participants that voluntarily disentail the partnership, originating another instance, due to their substitution.

Product life cycles tend to be shortening, time to market also, products suffer more frequent redesigns, and thus, virtual enterprises tend to last shorter time. Responsiveness and permanent alignment with market demands implies the requirement for increased dynamics to the A/VE model.

As Webster (*Merriam-Webster Online)* defines it, dynamics consists of “a pattern or process of change, growth, or activity.” In our context, dynamics means precisely the intensity of change that an A/VE is subject of.

Changes are usually measures undertaken to improve either products or processes. The main factors that can lead to product changes are: customer requirements, correction of detected errors, improvement of the production process, quality improvement, and cost reduction. If the product is to be developed and produced by an A/VE, each of these possible changes can cause an A/VE reconfiguration. Even a substitution of a resources provider or of a supplier within an A/VE can give rise to a product change. Besides the reconfigurations that can happen within each product version, the A/VE can suffer changes (reconfiguration) for each product change.

Cunha and Putnik (2005b) define organizational dynamics (structural dynamics) as changes in an organization's structure along the time, when time as a parameter is indispensable for the organization, or some aspect of organization, description and analysis. The organization's state changes frequency, state change time, and intensity are examples of an organization's dynamics features and performance measures.

Basic and Complex Resources

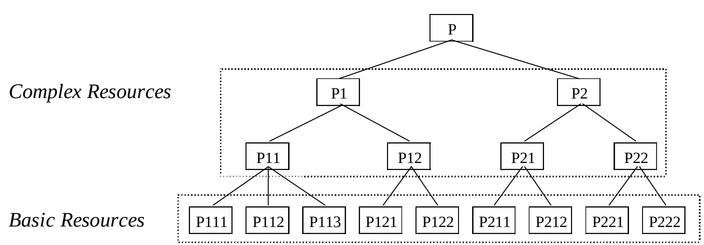
According to Coase (1937), activities are collected in a firm when transaction costs incurred in using the price mechanism exceed the cost of organizing those activities through direct managerial controls, otherwise activities could be outsourced. Outsourcing allows firms to concentrate on their core competencies, and increasing flexibility in face of unknown economic or market conditions.

The supply chain of a manufacturing enterprise is a worldwide network of suppliers, factories, warehouses, distribution centers and retailers through which raw materials are acquired, transformed and delivered to customers (Fox, Chionglo, & Barbuceanu, 1993).

The resources (services/products/operations/services) to be outsourced can be classified into *basic resources* or *complex resources*, as represented in Figure 1.

Basic resources are task-specific and do not require detailed contracts or specifications, are usually of fixed and short duration, and support lower-level organizational tasks. Examples are: payroll services, word processing, CAD

Figure 1. Product processes and corresponding basic and complex resources (Cunha & Putnik, 2002)



drawing services, testing /measuring services, cleaning services, and maintenance services.

Complex resources require detailed and complex contracts, detailed specifications, are usually of long duration, and involve high costs and risks. Its search is time consuming and costly, as well as its selection, negotiation, monitoring and enforcement. Examples include: product development, software development and turn-key manufacturing services.

As *Complex Resources* outsourcing is complex, time consuming and risky, it is expected that complex resources providers do not change much, that is, the partnership at higher levels of the process tree (top levels) are expected to be lasting (less dynamics), while for the provision of *basic resources* (lower levels of the process tree) there exists a larger pool of potential resources providers and links within partnerships are weaker. Reconfiguration dynamics for *basic resources* outsourcing is higher than for *complex resources,* as we will discuss later in this chapter.

A possible instantiation of an A/VE to produce a product P could involve outsourcing of parts P1 and P2 to resources providers R1 and R2, as represented in Figure 2 (*complex resources outsourcing*), or could involve outsourcing primitive parts (*basic resources outsourcing*), to resources providers also able to supply *complex resources*, as represented in Figure 2, or able to supply only *basic resources* as represented in Figure 3.

Figure 2. Outsourcing basic and complex resources (Cunha & Putnik, 2002)

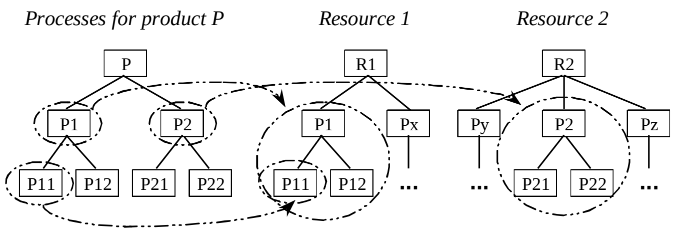
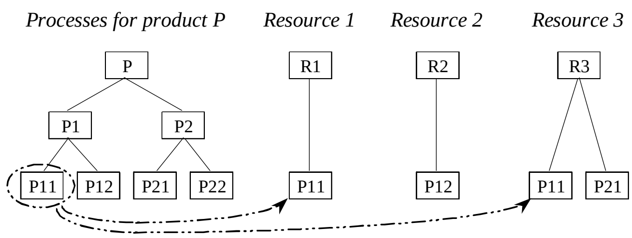


Figure 3. Outsourcing basic resources (Cunha & Putnik, 2002)



Subcontracting Space and Reconfigurability Dynamics

The analysis and comprehension of the complexity inherent to the problem of searching and selecting resources to create or reconfigure an A/VE is essential in the project of A/VE systems, as the efficiency of the selection process is critical to assure the real functionality of the system.

Selection Complexity and Solution Space Dimension

We propose that the complexity of the search-and-selection problem is a function of: the *solution space* dimension and of the *selection algorithm*.

Selection Complexity = f(solution space size; selection algorithm)

The *solution space dimension* corresponds to the number of possible combinations of eligible resources providers, verifying the requisites of the searched resource, which must be evaluated in order to find the optimal solution for the selection problem.

The *solution space dimension* is, in turn, a function of the *selection model* used, as the evaluation of the performance of the eligible resources to integrate in an A/VE instance (physical structure) can be performed under two approaches:

1. **Independently**, that is, analyzing the $\underline{n}$ resources providers' eligible to provide a certain resource, one by one, and independent of the other resources they are able to provide within the A/VE reconfiguration under analysis;
2. **Dependently**, considering all the possible combinations of the required resources, being provided by all the possible combinations of the $\underline{n}$ eligible resources providers, that is, considering different negotiation processes to the supply of more than one resource by each resources provider.

Solution space dimension = f(selection model)

Selection of Resources Providers to Supply 1 Resource

If we are evaluating the performance of ***n*** resources providers to supply ***1*** resource, the solution space dimension is ***n***. There is no distinction between *dependent* or *independent* selection models.

If there are required X units of the resource, which could be supplied independently by more that one provider, we should consider a dependent selection model. If, for instance, one resources provider is able to supply part of the required units but at very attractive conditions, it could be advantageous to consider another resources provider to supply the remaining units.

Selection of Resources Providers to Supply k Resources

Assuming that the number of required resources is ***k***, we can identify several situations, concerning the ability of the eligible resources providers to provide more than one resource, up to the ability of a provider to provide all the ***k*** resources under analysis, and including the application of a *dependent* or *independent* selection model.

If each of the ***n*** resources providers is able to provide only one resource, we have only the possibility to apply an *independent* selection model, and we are faced with the lower limit of the solution space size. Our solution space would be ***n***, the sum of the resources providers able to provide each of the ***k*** resources.

We are faced with the upper limit of the *solution space size* when all the ***n*** resources providers are able to provide all the ***k*** resources, that is, the ***k*** resources can be performed by any combination of resources providers. In this situation, according to the selection model, we have:

- A *solution space dimension* of ***n.k*** if the ***n*** resources providers able to provide the ***k*** resources are selected under an *independent* basis. The selection complexity is ($O(n.k)$).
- A *solution space dimension* of $\boldsymbol{n^k}$ if the ***n*** resources providers able to provide the ***k*** resources are selected under a *dependent* basis. The associated selection complexity is ($O(n^k)$).

In practice, not all the resources providers are able to provide all the resources under analysis to an A/VE instance and, depending on the selection model adopted, the *solution space dimension* is situated within the two intervals:

$$\boldsymbol{n \leq solution\ space\ dimension}_{\text{independent selection}} \boldsymbol{\leq n.k}$$
$$\boldsymbol{n \leq solution\ space\ dimension}_{\text{dependent selection}} \boldsymbol{\leq n^k}$$

We are not considering the possibility of X units of a given resource being supplied by more than one resources provider. We are only considering the selection of one resources provider for each required resource, independently of the quantity X, which would introduce increased complexity. In this situation, for X units of one resource, the solution space for one single resource could be on the limit n^X.

Analyzing the Solution Space Dimensions for Basic and Complex Resources

We are now making the analysis on the several levels of the process plan of the product to be produced by an instantiation of an A/VE.

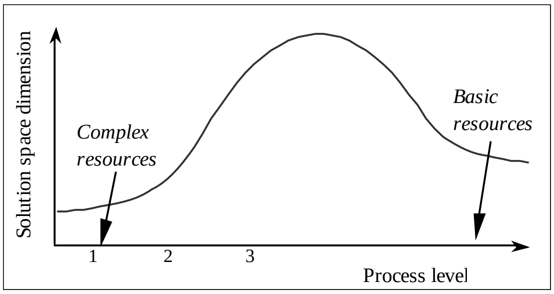
Concerning *complex resources* (the higher level of product process plan), the general situation is that usually the number of eligible resources providers is low and, depending on the product, the selection method can be a *dependent* or *independent* one. However, the number of *complex resources* to be subcontracted at once (k) is not supposed to be high, so even if we reach $\boldsymbol{n^k}$ complexity, the problem is tractable. (But *complex resources* selection corresponds in general to an *independent selection*. At the level of *complex resources,* reconfigurability dynamics is low.)

Performing the same reasoning for *basic resources*, namely at the lower levels of product process plan where reconfigurability dynamics is very high, the number of eligible providers is high and it is possible sometimes a *dependent* selection, but most of the eligible suppliers are of small size and much specialized, so the selection is, in general*, independent,* conducting to a *O(n.k)* complexity.

At the intermediate level, the possibility of performing a *dependent* evaluation increases, and it is likely to find an $O(n^k)$ complexity.

Independently of the selection algorithm, Cunha (2003) demonstrates that the complexity associated with the selection of resources providers to create/ reconfigure an A/VE depends of the *solution space dimension*, which is represented in Figure 4, in function of the level of the product process plan.

Figure 4. Representation of the solution space dimension in function of the process level



Examples of Reconfigurability Dynamics

In this section we present two examples of the frequency of reconfiguration requests in two industrial sectors: the automotive industry and the electronics (Hi-fi) industry.

An Example in the Automotive Industry

A study prepared by the Research Triangle Institute for the Manufacturing Laboratory of the National Institute for Standards and Technology (Brunnermeier & Martin, 1999) on interoperability cost analysis of the U.S. Automotive Supply Chain, refers that one OEM estimates as many as 453,000 exchanges of product data occur each year within the company and among the company and its suppliers. This figure could lead to the possibility of 453,000 different A/VE instances, or at least to the possibility of 453,000 evaluations of the A/VE performance, in order to determine the need of reconfiguration. (It is important also to remark that this is not the only justification to reconfiguration, as the performance during an instance could also determine the need to substitute resources.) Those 453,000 annual instantiations would mean an interval of 49.6 seconds between alteration requests, supposing a continuous operating industry (24 hours per day), 260 days per year, or an interval of 16.5 seconds supposing a one-turn operating industry (8 hours per day) (see Table 1).

Table 1. Example of reconfiguration requests frequency in the automotive industry

Number of evaluations of A/V E performance or number of annual instantiations: 453.000		
Supposing:	Time between Evaluation / Reconfiguration Request (seconds)	Evaluation/Reconfiguration Request Frequency (# per hour)
- Continuous operation (24 hours/day, 260 days/month)	49,6	72,6
- Only one turn operating (8 hours/day, 260 days/month)	16,5	217,8

An Example in the Electronics / Hi-Fi Industry

High-fidelity products integrate a high variety of small components of mechanical and electronic nature, which makes this kind of product particularly susceptible to changes along the life cycle.

A study undertaken in a Hi-Fi manufacturer in Portugal in 2003 indicated near 280 changes in a radio during the first three years of its life cycle, from the preventive series until the effective production. The preventive series period, lasting almost one year, registered 215 changes. The pilot series, for three months, registered 15 changes. During the four months of the production start-up, 15 changes were registered and during the first one-and-a-half year of production, around 35 changes were required.

If we consider the production to be subcontracted since the preventive series phase, the number of changes occurred in each phase of the product life cycle, can lead to reconfiguration of the partnership, and as such traduce the dynamics of the A/VE for that particular product. Table 2 presents the number of reconfiguration requests per month.

Dynamics Parameters

We can identify two parameters of reconfigurability dynamics: (1) the number of requested reconfigurations per unit of time and (2) the time to reconfigure. Reconfigurability dynamics is directly proportional to the number of requests and inversely proportional to the time to make operational the reconfiguration (search, negotiation, selection and integration).

Table 2. Example of reconfiguration requests frequency in Hi-Fi industry

Life cycle phase	Period (months)	Number of Changes	Reconf. request frequency (changes/month)
Preventive Series	12	215	17,9
Pilot Series	3	15	5,0
Production start-up	4	15	3,8
Production	18	35	1,9
Total	37	280	7,6

A/VE reconfigurability dynamics can be measured by a *ratio* between the frequency of reconfiguration requests and the reconfiguration time.

Reconfiguration Request Frequency

The example introduced in the previous section concerning the number of expected requests of data exchange in an automotive OEM, highlights the high frequency at which reconfiguration can happen. Alignment between the A/VE and the market implies the permanent evaluation of opportunities of reconfiguring the partnership.

By the definition of *basic* and *complex resources*, we are expecting to have a low reconfiguration request frequency for *complex resources* and high frequency for *basic resources*. The reason is not only the duration of contracts or the nature of the resources integrated in an A/VE instance, but also the number of subcontracts at each level of the product process plan, which makes reconfiguration request frequency to grow exponentially along the level of the product process plan (from complex to basic resources).

Reconfiguration Time

Selection complexity depends also on the *selection algorithm* to be used, which should be dependent of the level of the function to be integrated. The *solution space size* implies selection complexity (computational complexity), which can be dealt automatically, but at high levels (complex resources) it is not only a computational complexity.

Selection at high levels of product process plan involves the identification of candidate resources, negotiation with these and the final selection of the optimal combination of resources to integrate the A/VE. At high levels, the processes of performance evaluation and negotiation can be highly time-consuming.

$$t_{Selection} = t_{Search\ of\ candidate\ resources} + t_{Negotiation} + t_{Identif\ Optimal\ Comb}$$

Time to create/reconfigure an A/VE (reconfiguration time) includes, besides the selection time, the contracting time and integration time, and reflects the importance of the function to be integrated (this importance can be stated in terms of contract value, dependability of other functions on that one, etc.). Complex services also usually correspond to increased contracting time, which decreases with the product level.

$$T_{Reconfiguration\ .} = t_{Selection} + t_{Contracting} + t_{Integration}$$

Time to reconfigure an A/VE at high-level processes highly surpasses the time required to identify candidate/eligible resources, which is a computational effort. Stability (low reconfigurability dynamics) at a high level is a consequence of the high reconfiguration time required.

Selection time and contracting time have behaviors inversely proportional in function of the level of the searched function.

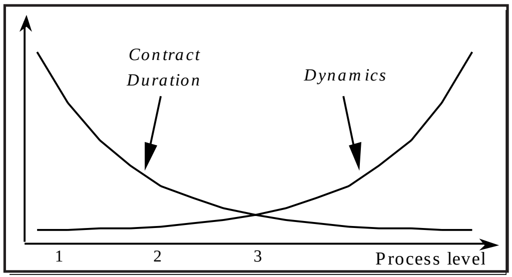
Reconfigurability Dynamics

Attending on the definitions of *basic* and *complex resources*, contract duration decreases along with the process level, as well as selection, contract and integration time. When considering an A/VE, *basic resources* are usually contracted for well-defined periods, usually short, and reconfiguration time is reduced. The opposite situation is verified for *complex resources*.

At the level of *complex resources*, dynamics is low, according to the two parameters of dynamics: a low reconfiguration requests frequency and a high reconfiguration time, while dynamics increases along with the product process level, growing reconfiguration requests frequency and decreasing reconfiguration time.

If the utilization of a low-level function is very high, possibly the function could be internalized, otherwise it is outsourced.

Figure 5. Representation of the reconfiguration dynamics and contract duration as function of the process level



A study undertaken on the USA automotive industry in 2000 of around 100 suppliers (73 first- and 30 second-tiers) suggested that first-tiers are likely to have closer and longer relationships with their customers than second-tiers (Iskandar, Kurokawa, & LeBlanc, 2001).

In Figure 5 we present reconfiguration dynamics and contract duration in function of the process level. Reconfiguration requests frequency has the same behavior as dynamics, and thus has been omitted from the figure.

Given the costs of evaluating the need to reconfigure the A/VE and given the complexity of the process of selection and integration, in many cases the reconfiguration is overtaken, with the sacrifice of the A/VE performance. The reason for the fact is that dynamics is not as high as it should be expected, and that partnerships do not achieve so high performances as should be expected, unless there exists an environment to support dynamic reconfiguration and integration.

The concept of Market of Resources is conceived exactly as an organized environment with the objective to “boost” the dynamics, as well as to support the high dynamics of the A/VE model, reducing reconfiguration and integration time.

Business Alignment in Agile/Virtual Enterprise Integration

Business alignment in Agile/Virtual Enterprise integration is complex and challenging, as alignment has to incorporate immaterial components in the relationships within the integration of resources. It is not just an internal strategy, but a set of integrated and inter-related integration strategies, that must be verified so that the integrated A/VE is able to meet the objective giving rise to the A/VE itself, that is, to meet the market requirements (or customer requirements).

Strategic alignment between business and A/VE integration involves a mix of dependencies between *market* requirements, *resources* requirements (product/service/operation) and *resources providers* requirements (Cunha & Putnik, 2005a). It is important to mention that *process* requirements must also be considered. We opted to include them in resources providers requirements.

We will designate by *Client* the entity looking for resources to create/reconfigure an A/VE. The *Client* is the one that wants to answer to a market opportunity, by capturing the corresponding market requirements, and asks the Market of Resources for optimal A/VE design, selection and integration, traducing the market requirements into resources providers' requirements, process requirements and resources requirements.

The Client, intermediated by the service provided by the Market of Resources, needs to assure the alignment between the market and the resources providers to be selected and integrated in the A/VE. Also the Market of Resources must assure that the Client has correctly captured the market requirements. This way, the process must align the Client with the market (business) and then align the resources providers (by the search, selection and integration processes) with the Client and with business.

Integrating an A/VE corresponds to aligning the entities *Client*, *A/VE*, *Resources Providers* and *Resources* with business. The Market of Resources is expected to guide the Client in aligning the A/VE with the market (customer) opportunity. The process consists of pushing downstream the market requirements.

The proposed referential for alignment must consider:

- **Market Alignment** (alignment with Customer or Market Requirements): Before the creation of the A/VE, the Client traduces the Customer Requirements into product specifications and designs the system of resources for the A/VE. The A/VE project consists of the generic identification of the characteristics of the resources that will accomplish the execution of the process plan to the required product (i.e., the process plan that will allow the production of the product verifying the market requirements).

- **Resources Alignment:** Aligning the Product with the specifications (i.e., with the market requirements). Resources provided by the selected resources providers must conduct to the desired product.
- **Resources Providers Alignment:** Aligning Resources Providers with the Market Requirements represents which characteristics resources providers must assure, so that the Client can trust that the selected set of resources providers is able to be integrated in an A/VE to efficiently produce the product that meets the requirements that have been captured by the Client (Market requirements). Resources providers' requirements include economical, managerial and organizational aspects.

These three sets of requirements for alignment are grouped in Table 3 and detailed in the following sections. Table 4 to Table 6 present the items of the checklist of Table 3, followed by operational analysis questions. They are not exhaustive listings, but the main aspects are included.

The Market of Resources will use algorithms for search and selection, as we will see later. The aspects conducting to *resources alignment* and some aspects of *resources providers alignment* are implemented through the *algorithm for search over the focused market* (addressed in Chapter VIII). The *algorithm for optimal search* checks the other aspects of *resources providers alignment* that are not verified by the *algorithm for Search over the focused market*.

Table 3. Checklist of requirements to be considered in alignment (Cunha & Putnik, 2005a)

Market Alignment	Resources Alignment	Resources Providers Alignment
✓ Price, Cost and Profit ✓ Quality ✓ Quick Response: the desired product, on time, in the required conditions ✓ Transparency and legality ✓ Trust and confidence ✓ Correct capture of market or customer requirements	✓ Cost ✓ Quality ✓ Integrability ✓ Interoperability between different providers ✓ Standards	✓ Availability ✓ Ability to meet Product/Service/Operation requirements ✓ Certification ✓ Dependability ✓ Flexibility ✓ Responsiveness ✓ Competitiveness and Proactiveness ✓ Past information of previous A/V E integrations

Market Alignment

The Client must have a correct capture of the business opportunity and must traduce it into resources requirements and int the A/VE project according to the rules/instructions provided by the Market of Resources in order to start the process. The A/VE project must be clear and consistent with the application of the *client search constraints* and *negotiation parameters*, as will be detailed later.

The success of the A/VE depends of the satisfaction of the Market Requirements. Resources alignment and Resources Providers alignment should be assured, so that the final product is able to meet the Market Requirements. They will determine the *requirements for resources selection*, an input for the A/VE project (or design) and integration process.

The Client must show a transparency and legality image to the integrated resources and, at the same time, win trust and confidence from the market. All of his behavior must be driven by these aspects.

Table 4. Market alignment (Cunha & Putnik, 2005a)

Requirements for Alignment	Analysis Questions
Price, Cost and Profit	- Is the Client aware of the financial flows of the business? - Is he confident to meet the budget? - Does he have management and control mechanisms?
Quality	- Is the Client aware of the level of quality required by the market or customer? - Is he sure to answer in conformity with it? - What mechanisms will be used for control and recovery?
Quick Response	- Is the Client aware of the timings to produce the product? - Is the Client convinced that the timings can be satisfied? - Does he make realistic previsions for the phases of selection, integration and start operation of an A/V E?
Transparency and legality	- Is the Client committed to follow the rules and procedures proposed by the Market of Resources, assuming a transparent position face to the market and to the resources providers to be integrated?
Trust and confidence	- Is the Client a serious enterprise? Is he known from previous participations? - Can the resources providers trust him? Does he inspire confidence? And concerning the market (customer)?
Correct capture of market/ customer requirements	- Is the product correctly specified?

Before proceeding with the search and selection of resources providers to be integrated in the Client's project of A/VE, the service provided by the Market of Resources must assure that the requirements of Table 4 are met by the Client in order to minimize the risk of failure.

Resources Alignment

Some requirements are organizational — cost, quality, time to output/answer — while others are related with technology — integrability (interoperability, portability and other dimensions of integrability) of different providers of resources, standards. Technology is an enabler but can also represent a barrier. Table 5 includes Resources Alignment concerns.

Resources Providers Alignment

To assure competitiveness, the client (A/VE owner) must have from the resources providers to be integrated in the A/VE: quick response in providing the resource; quality adjusted to the price; flexibility (intra-flexibility); and historical information of previous A/VE integrations. This last item of information (an intangible element) must be kept by the Market of Resources and is the result of the management/evaluation process that the Market performs during an A/VE operation, quantified under specific performance metrics.

Table 5. Resources alignment (Cunha & Putnik, 2005a)

Requirements for Alignment	Analysis Questions
Cost	- Is it possible to control costs over the partnership? Is it possible to individualize costs per operation? - Can volume discounts be negotiated in a global A/V E?
Integratability	- Can resources be fully integrated? In what phases? - In what dimensions is integratability possible?
Interoperability between different providers	- Is there complete compatibility between resources providers to be integrated? - Can an operation started by a partner (resources provider) be finished by another resources provider, due to a change in the A/V E project?
Quality	- Is it possible to identify the source of a defective part (traceability)? - Is it possible to conduct competitive benchmarking on a globally disperse A/V E?
Standards	- Are all resources providers using the same or compatible standards?

Table 6. Resources providers alignment (Cunha & Putnik, 2005a)

Requirements for Alignment	Analysis Questions
Availability	- Is the enterprise available to participate in the A/V E by the dates proposed?
Ability to meet resources requirements	- Can the enterprise assure the supply of the required product/part, service or operation according to the specifications?
Certification	- Is the enterprise certified to supply the required resource?
Dependability	- Is it a primitive or a complex resource? Does it depend on other resources? - Are the resources dependent on other projects that may affect the present project? - What is the degree of dependence of the final product on the resource under evaluation?
Flexibility	- What is the intra-flexibility of the enterprise offering the resource (primitive or complex) and set-up times?
Responsiveness	- Is the enterprise able to answer in the proposed time? - What is the estimated time to produce the product/part or to perform the operation?
Competitiveness and Proactiveness	- Is it possible to have information concerning the enterprise's benchmarking? What are the rankings?
Past information of previous A/V E integrations (successes and failures)	- Are there records of results of performance in other integrations? If so, they must be taken into consideration.

Functionalities for Agile/Virtual Enterprise Integration

Several aspects are crucial in the implementation of an environment to support A/VE integration: the implementation of the brokerage service, trust assuring, electronic contractualization, contract management, etc.

In this section we present the main functionalities that any environment to support A/VE integration must assure.

Virtual Enterprise Brokerage

One of the first attempts to address the concept of electronic broker (at the time network coordinator) as the support to the implementation of the model of *Dynamic Network Organization* (the former version of the Virtual Enterprise concept), goes back to Miles and Snow (1984, 1986). The network coordination or management functions, meaning coordination between partners, to maximize integration benefits were defended as essential, although at that time these functions were constrained by the limitation of the information and communication technology.

Virtual enterprises, as partnerships, need coordination mechanisms, such as rules, procedures and leadership, functions which organized environment is assured by the Market of Resources.

Dictionaries (Porto Editora, Webster) define *Broker* as funds or stocks corrector; intermediary, dealer of second hand good; agent. However, the set of attributed functions is more convenient to understand what in fact is the broker, than its several definitions (Ávila, Putnik, & Cunha, 2002). Other expressions associated to the broker designation are *cybermediaries*, which means organizations that perform mediation tasks in the world of electronic commerce (Sarkar, Butler, & Steinfield, 1995) or *Resources Manager*, which means the *A/VE Configuration Manager* (Putnik, 2000). Attending to the functions attributed to the broker under the several VE models, he is a necessary agent, but assuming different functions according to the frameworking model.

With the elimination of the client/supplier barriers for which the electronic market is responsible, the elimination of the traditional intermediaries, as the wholesalers and retailers could be predicted, allowing price reductions that, in some cases, could reach 60% (Sarkar et al., 1995). However, the emergence of the brokerage service can be justified with the answer to questions such as: how does the consumer locate the supplier; perform a purchase; find the required products and services at a fair price, and in which supplier can he trust. Mediation between suppliers and clients, introduced by the broker, is, according to Hands et al. (2000), the ideal solution to overcome this kind of problem. Also in the understanding of Resnick and Avery (1994), the importance of the broker is justified by cost reduction, privacy increase either client or supplier, more information available to the client, namely about product quality and market satisfaction, decrease risks from nonfulfilment involved parts, and improving the price efficiency creating mechanisms that induce only the adequate sales.

Eversheim et al. (1998) define *Virtual Enterprise Brokerage* as the exploitation of business opportunities through the creation of VE. Core processes of *Virtual Enterprise Brokerage* (Eversheim et al., 1998) are related to the organization and deployment of competencies of a set of potential partners, in order to integrate selected partners into a VE. Besides partner search and formation of the partnership, the Broker is also responsible by configuring the adequate infrastructure for the successful operation and dissolution of virtual enterprises (i.e., physical, information, legal, and socio/cultural infrastructure). Dignum (2000) refers that the function of a market broker, is to provide knowledge for those phases of a transaction where it is not economical for the parties to obtain knowledge themselves, and to provide economies of scale in those cases where that is profitable for both suppliers and customers.

Several authors have expressed the functions that the broker should assume within VE models, and several software platforms already exist to support brokerage performance. However, the comparison between the broker models proposed by different authors cannot be explicit unless it is created taxonomy for its functions, creating a referential model to the evaluation and comparison of several proposed broker models, which is proposed in Ávila et al. (2002).

In Putnik (2000), the broker is an essential and distinguishing component and feature of A/VE that provides high agility and especially virtuality to the enterprise by the fact that the physical structure of the enterprise could be hidden to the project manager. That, in fact, only is obtained with the broker intermediation between control levels.

The brokerage function is essential, as defended in the literature, as well as it is integrating part of the BM_VEARM model. The proposed Market of Resources should include the implementation of brokerage.

Trust in the Agile/Virtual Enterprise Model

As Davidow and Malone (1992) point out, trust is the defining feature of a virtual organization. Trust refers to the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action, important to the trustor, irrespective of the ability to monitor or control that other party (Mayer, Davis, & Schoorman, 1995, p. 712, quoted by Jarvenpaa and Shaw, 1998).

Jarvenpaa and Shaw (1998) review forms of trust in virtual teams and explore implications for virtual organizations. To the authors, the virtual organization idea promises responsiveness, but working in such a form is far from socially rewarding, particularly if it is not supplemented with face-to-face interaction. "Trust is the heartbeat" of the virtual organization (Jarvenpaa & Shaw, 1998, p. 47). Only through trust can members be assured of others' willingness and ability to deliver on their obligations.

The interactions between the separate organizational units participating in an A/VE cannot be regulated completely by contracts that characterize market style transactions and similarly are not governed by common ownership, as is the case with hierarchies (Williamson, 1991). The high level of investments inherent in the creation of a virtual organization means that there is a significant level of risk associated with the outcome. Based on contemporary examples of virtual organizations, businesses are obviously willing to take such risks, and organizational trust has been hypothesized to be an explanatory variable for the development of such cooperative behavior.

A study undertaken in 1998 by Sieber (1998) on organizational virtualness revealed four roles for trust:

1. Trust compensates for uncertainty with the partners and with the customer: the actions of players generate an expectation, which can either be fulfilled or disappointed.
2. Trust ensures variety and thus encourages innovation. This seems particularly significant between customers and suppliers. If there is trust between sales partners and a supplier, the partners will tend to inform the supplier of opportunities and risks in the marketplace.
3. Trust ensures access to the customer. There are many situations where a relationship based on trust leads to one company being given the role of prime contractor.
4. Trust also compensates for the fact that discrete work packages cannot be defined. This comes about through the ability to anticipate decisions in the operative sphere, based on a shared understanding of how a task is structured.

However, the same author stresses that trust does not replace written, legal contracts. Both forms of agreement are necessary, not always to the same extent, but one is not a substitute for the other.

Hence, trust is a major concern that an environment to suppt A/VE must assure.

Electronic Contractualization

The negotiation and management of contracts in virtual organizations is a challenging task. All the internal contractual agreements between the participants of a virtual enterprise have to be defined, as well as the dependencies between these internal and external rights and obligations must be synchronized.

The required functionalities for an electronic contracting system to support the A/VE model must include:

- Legal background information: a complete and updated regulation and set of recommendations to support the parties in the negotiation of a contract to participate in an A/VE.

- Contract preparation tools, including functions of contract drafting, discussion and contract management.
- Decision support to manage legal and business decision in the contracting process, previewing and simulating situations of unaccomplishment of a party, assuring optimized risk management, etc. (Burgwinkel, 2002).

Electronic contracting can provide benefits for virtual enterprises (Burgwinkel, 2002). Time-to-contract can be reduced, because the efforts for negotiation, validation of legal aspects and controlling the contract performance are optimized. Furthermore, electronic contracting systems can help to prepare contracts that are acceptable for both partners from a legal as well as from a business perspective.

Transaction costs can be minimized through the establishment of suitable contracts. The agreed contracts have to be not only enforceable, but they must be designed to be self-enforcing, such that each partner, at all stages of the relationship, has more to gain from a continuation of the relationship that from its cancellation (Meyer, 1998). The specialization that the Market is expected to develop can improve the contracts quality, comparing to the contracts developed by an SME, or by a firm without specialized resources in this field.

While the contract should not be used as the only management vehicle, it should be used to set the limits. It helps communication, defining a clear statement of the requirements at the start, and a framework for establishing a common sense of purpose among the A/VE participants. This is where the effective collaboration (intrinsic to the A/VE model) must start, which means that the purpose of the development effort is the delivery of the best/ideal product — not the exercise of the contract.

The reduction of the time-to-contract and risk minimization in a contractual agreement is a prerequisite for the A/VE model implementation. To reduce the contractualization time, the Market of Resources must be empowered to represent the parties in the contract formalization.

Enterprise (Dynamic) Integration and Information Integration

Integration is primarily the task of improving interactions among the system's components using computer-based technologies, with the goals of ensuring portability, information sharing and interoperability (Putnik, 2000).

Webster defines integration as "a combination of separate and diverse elements or units into a more complete or harmonious whole." Inter-enterprise integration is the essential condition to make effective the cooperation between resources collaborating in an A/VE.

Enterprise Integration means the establishment of effective and efficient interactions between the elements of an organization, and the concept of A*/VE Dynamic Integration*, means that the integrated elements must be permanently aligned to business, passing by as many instances of combination of resources as necessary, to accomplish the objectives of the A/VE. An A/VE can have as many instantiations as required either by product or process changes or as a requirement of quality and A/VE competitiveness improvement.

Integration also claims for distributed systems integration protocols (CORBA), standard inter-business communication and data exchange standards (such as STEP), as well as standardized product and process specification. Information integration refers to the sharing of information among members of the A/VE. This includes both any type of data that could influence the actions and performance of the integrated and cooperating resources providers, as well as management and coordination information. Such information should be accessible by the appropriate parties on a real-time, online basis without significant effort.

Finding the Right Resources Providers

Finding matching providers is essential for any dynamic e-business or VE solution. From the technological perspective, it requires standardized resources and business processes specification, as the XML-based RosettaNet and other developments.

Any attempts to make Web services technically and commercially viable require powerful and sophisticated ways to describe such services and to advertise and search for them (Field & Hoffner, 2002). Emerging standards such as such as the Universal Description, Discovery and Integration (UDDI) standard (UDDI, 2001) provides the basis for an online directory for finding such services. Web services are components with a description of their functional aspects and access protocols in Web Services Description Language (WSDL) that can be invoked over the Internet.

RosettaNet provides an open platform for e-business process standards allowing trading partners to exchange business information via Internet, recognizing the definition if B2B processes and data standards. In particular its building blocks such as the *Business Dictionary Structure & Content*, the *Universal Technical Dictionary Structure* and the *Supply Chain Technical Dictionary Content* represent a powerful contribution to the feasibility of the Market of Resources.

Extensive implementation experience within the Information Technology, Electronic Components and Semiconductor Manufacturing industries is reported by this independent industry consortium, in its white papers and press releases available at their official homepage (http://www.rosettanet.org).

Besides the technological aspects, VE integration relies on efficient access to the potential resources providers, negotiation between them and sophisticated and effective algorithms for selection of the optimal solution between the providers verifying the selection requirements. The importance of the broker consists also on the guidance of this process, which besides automated in some phases (automated negotiation, automatic contractualization), is mostly knowledge-driven.

The Broker Knowledge Base

A major problem in the VE area is to search among many resources providers and find the appropriate one to be integrated in the partnership. According to our A/VE model, the Broker will be responsible for seeking the appropriate partners and taking decisions concerning the formation of the project's alliance. We currently focus on this phase but the role of the Broker can be extended through the whole life cycle of a Virtual Enterprise. According to Harbilas, Dragios, and Karetsos (2002), the Broker can also make the rules of the partnership, control the partnership's operation, evaluate the partnership members, maintain trust between members and finally dissolve the partnership when the project is over. We can say that in general, the function of the Broker is to provide a knowledge support system for A/VE integration, reconfiguration and management.

Since the Broker has to represent knowledge about the activity of the A/VE, historic information, monitoring and control information, the existence of a global knowledge base is an essential component of the environment supporting A/VE integration.

Broker performance should be considered by the utilization of special selection algorithms, in particular for dependent selection processes, algorithms to evaluate bids in combinatorial auctions and/or dependent selection. Data-mining tools to organize the Market of Resources' knowledge based in focused markets, according to identified patterns of search and selection and negotiation constraints should be of major interest to allow a more efficient answer to the client requests for A/VE creation/reconfiguration. Decision-support systems using the results of the Market knowledge base organization and historic of participants' performance, as well as expert systems to guide the tasks of validation and selection should also be of great interest.

Electronic Negotiation

The ability to find resources providers matching the A/VE project resources requirements towards A/VE integration is fundamental. The aim of negotiations is to reach a mutually satisfactory agreement, which is in line with the goals of all parties.

Besides the existence of technologies supporting negotiation (automated negotiation, agent-based techniques, auctions and reverse auctions, etc.) to give a negotiation process any chance of success, it is necessary to agree on a considerable number of issues and ensure that they are adhered to. For example, the use of a negotiation intermediary, the attributes that are to be negotiated (a normalized representation of them), the language used in the process, the negotiation procedure details such as initiation and turn taking, termination conditions, and many others. Furthermore, the process of negotiation requires the establishment of a well-defined procedure and known points of interaction with agreed interfaces.

When dealing with the integration of an A/VE, we are referring to not single but combined negotiations as the Client is interested in several resources (or combinations of primitive/complex resources) and consequently engages in many interrelated negotiations at the same time.

Because contracts are awarded to only one contractor, under normal circumstances, bidders have to recover the costs associated with every unsuccessful bid through the increase of subsequent bid prices and consequently the entire cost of bidding is ultimately supported by the clients (Ng & Skitmore, 2001). To prevent wasted effort in preparing and tendering bids and to avoid the consequent escalation in bid prices, a pre-selection should be made and invitation to a smaller number of candidates for negotiation. This pre-qualification (which should be based on an efficient organization of the Market of Resources in *Focused Markets* as above-mentioned) aims to reduce the costs of negotiation, not only the bidders cost, but also the negotiation costs and the time required. This pre-qualification also reduces the search time, contributing to an increased dynamics (provided that the domain to perform the search contains the optimal or nearly optimal solutions).

Historic Information on Participants Performance

Keeping historical information on participants' performance and on A/VE results is indispensable to allow a safer solution to the A/VE integration, while simultaneously brings a deeper co-responsibility within the A/VE, as all the resources providers know that their performance is being monitored and registered to be used in later situations.

Historic data will be used in resources providers' qualification or later in negotiation and contractualization.

The Agile/Virtual Enterprise Extended Life Cycle

One of the major value-added aspects of the Market of Resources is intended to be the improvement of the A/VE reconfigurability dynamics. This way, a corresponding A/VE life cycle must be updated. In this section we present the actual VE life cycle proposed by several authors to conclude that it does not correspond to the characteristics of the VE defended in the BM_VEARM (the A/VE model), and present an extended life cycle, which integrates the new dimensions introduced by the Market of Resources concept.

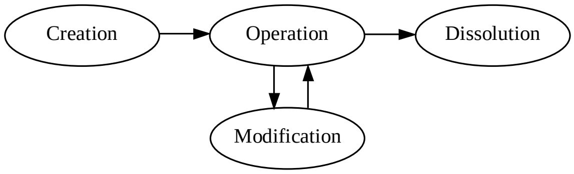
The Virtual Enterprise Life Cycle

The life cycle of a Virtual Enterprise can be interpreted as the period between its creation/integration until its dissolution. Several authors present their proposals for a Virtual Enterprise life cycle, as for example Camarinha-Matos and Afsarmanesh (1997), Faisst (1997), Fuchs (1997), Kanet et al. (1999), Merkle (1997), and Zimmermman (2000).

According to the literature, we can identify several phases in the life cycle of a Virtual Enterprise and we propose to distinguish two classes of VE life cycles: those considering reconfiguration or modification of the partnership and those not considering that.

In the first class of life cycles, Camarinha-Matos and Afsarmanesh (1997, 1999) propose as major phases of a Virtual Enterprise life cycle: *creation*, *operation*, *modification* and *dissolution* (Figure 6). To these authors, *Creation*, the initial phase of the VE involves its creation and configuration, requires as functionalities search and selection of partners, negotiation of the participation, contract definition, and definition of procedures regarding the partnership operation, configuration and dissolution. *Operation* is the phase where the VE performs its business process to achieve its objectives, requires safe mechanisms for information exchange, order management, order processing, distributed task

Figure 6. VE life cycle (Camarinha-Matos & Afsarmanesh, 1997)



management, etc. During the *Operation* phase, the partnership may require the addition or substitution of a partner, due to incapability to perform a task or any other event. Functionalities associated with *Modification* are the same as that for *Creation*. Finally, the VE concludes its existence, *Dissolution* phase, because it had achieved its objectives, or because it is decided by the partnership to do so.

An equivalent life cycle is proposed by Faisst (1997) with four phases: *Identification of Needs*, which guides the VE conceptual design, followed by an automated process of *Partner Selection*. *Operation* of the VE, including control and monitoring of the participants activities, and possible reconfiguration due to partial failures. At the end, the *Dissolution* phase.

In the second class of VE life cycle we refer the model by Kanet et al. (1999), which does not address the reconfiguration requirement. The authors propose the following phases: *Identification*, with the recognition of the opportunity, *Formation*, consisting on partner selection, *Design*, corresponding to the legal framework and systems integration, *Operation*, and *Dissolution*. Also the proposal of Fucks (1997) does not prevent the need of reconfiguration.

Both classes of life-cycle definitions do not regard the aspect of reconfigurability dynamics. *Modification* is an eventual phase for Camarinha-Matos and Afsarmanesh (1997), however, it is not regarded as an essential phase, as our A/VE model defends. For Faisst (1997), reconfiguration it is not even a phase, it is only a possibility within *Operation*.

The literature offers more definitions, but not too different from these.

The Agile/Virtual Enterprise Extended Life Cycle

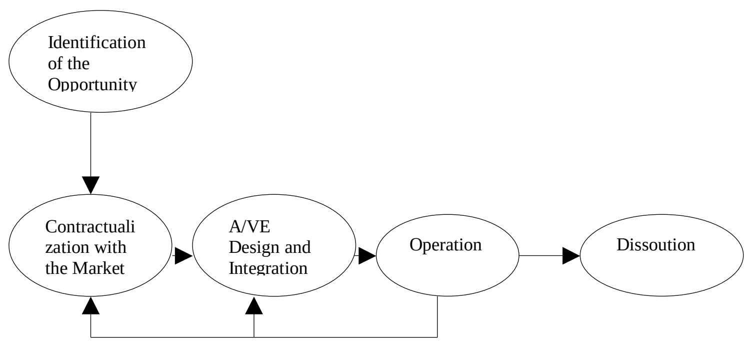
The existing VE life cycle cannot be limited to the phases of creation, operation and dissolution, where reconfiguration is only a possibility to happen during operation. The A/VE model requires dynamic integration, to support a high reconfigurability dynamics and permanent business alignment, as mentioned. Besides, a life cycle involves a project definition (in our case, an A/VE design phase), which should be an integrating part of it.

The extended life cycle we are proposing (see Figure 7) is directly tied with the *BM_VEARM* and the supporting environment — the Market of Resources — giving rise to the evolution of the reference model itself into an *extended BM_Virtual Enterprise Architecture Reference Model*.

The extended life cycle starts with the *Identification of the Opportunity* to create an A/VE, followed by the selection (by the Client or A/VE Owner) of a Market of Resources where he can find support to its creation. After the *contractualization* between the A/VE Owner and a Market of Resources, the process of designing the A/VE, and the search and selection of resources providers towards the A/VE integration takes place. During the *Operation* phase, the A/VE can suffer reconfiguration, represented by the arrow to the phase of A/VE design and integration, or the A/VE owner can even decide to contractualize with another market in alternative or complementarily, represented by the arrow from Operation to Contractualization with the Market. And finally, the *Dissolution* phase (*Dissolution* is a special case of *Reconfiguration*).

A/VE Design and Integration phase is possible only with the Market of Resources support, one of the main differences face to the traditional VE life cycle. Another major difference is the support the Market of Resources gives to reconfigurability. But the major characteristic of this proposed VE life cycle is the connection or dependability on the Market of Resources life cycle (its extension into the Market of Resources life cycle, which becomes part of the VE life cycle). At the same time, this proposed extended life cycle highlights the fact that the Market of Resources itself (brokers, servers and clients) is a factor of competitiveness.

Figure 7. A/VE extended life cycle



Summary

The first sections of this chapter introduced the main essential concepts concerning basic and complex resources, reconfigurability, reconfiguration dynamics, selection models (dependent and independent selection) and solution space, selection complexity, and introduced three dynamic parameters.

Fast adaptability or reconfigurability is a requirement of the A/VE model, in order to assure the maximum performance of the partnership. A/VE reconfigurations can happen as consequence of: (1) changes in the product, (2) the nature of the particular product life cycle, or (3) weak performance of a partner or its wish to voluntarily disentail the partnership. Search and selection of resources can be performed under two approaches: (1) independently (i.e., analyzing each eligible resources provider to contribute to an A/VE with a resource independently of the other resources it is able to provide) or (2) dependently (i.e., considering all the possible combinations of resources providers to provide all the combinations of the required resources for a given A/VE). Solution space corresponds to the set of possible combinations of eligible resources providers to contribute with a resource (product/service/operation) to an A/VE, and the complexity associated with the selection of resources providers to create/reconfigure an A/VE depends of the solution space dimension. Three fundamental reconfigurability dynamics parameters introduced in the chapter are: reconfiguration request frequency, reconfiguration time and reconfigurability dynamics.

The rest of the chapter discussed business alignment in A/VE integration, introduced the fundamental functionalities required by an environment to support A/VE integration (such as the Market of Resources) and proposed a life-cycle for the A/VE model (the A/VE extended life cycle).

The permanent alignment of the A/VE structure with business is essential to assure the maximum A/VE performance in meeting the market requirements and to keep competitiveness. Reconfiguration as fast as possible is a requirement to keep business alignment. The implementation of an environment able to support the A/VE model must assure a set of functionalities, such as brokerage, trust, electronic contractualization, electronic automated negotiation, enterprise dynamic integration, ability to find the right resources providers and a knowledge base of resources providers and historic information, functionalities implemented by the Market of Resources. Finally, as the Market of Resources intends to improve A/VE reconfigurability dynamics and the traditional VE life cycle does not consider this dimension brought in by this new environment, the VE life cycle need to be updated. The chapter ends with the proposal of an Agile/Virtual Enterprise Extended Life Cycle.

This chapter is fundamental to understand reconfigurability as a main requirement of the A/VE model and to prepare the reader for the discussion to take place in Chapters VII, VIII and X on A/VE integration and performance of A/VE enablers.

References

Ávila, P., Putnik, G. D., & Cunha, M. M. (2002). Brokerage function in agile/virtual enterprise integration: A literature review. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 65-72). Boston: Kluwer Academic Publishers.

Brunnermeier, S., & Martin, S. A. (1999). *Interoperability and cost analysis of the U.S. automotive supply chain* (RTI Project Number 7007-03 - Final Report). NC: Research Triangle Institute.

Burgwinkel, D. (2002). Managing contractual relationships in virtual organisations with electronic contracting. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 101-108). Boston: Kluwer Academic Publishers.

Camarinha-Matos, L. M., & Afsarmanesh, H. (1997). Virtual enterprises: Life cycle supporting tools and technologies. In A. Molina, J. Sanchez, & A. Kusiak (Eds.), *Handbook of life cycle engineering: concepts, models and technologies* (pp. 535-571). Boston: Kluwer Academic Publishers.

Camarinha-Matos, L. M., & Afsarmanesh, H. (1999). The virtual enterprise concept. In L. M. Camarinha-Matos & H. Afsarmanesh (Eds.), *Infrastructures for virtual enterprises* (pp. 3-14). Porto, Portugal: Kluwer Academic Publishers.

Coase, R. (1937). The nature of the firm. *Economica, 4*, 386-405.

Cunha, M. M. (2003). *Organisation of a market of resources for agile and virtual enterprises integration*. Doctoral thesis, University of Minho, Guimarães, Portugal.

Cunha, M. M., & Putnik, G. D. (2002). Discussion on requirements for agile/virtual enterprises reconfigurability dynamics: The example of the automotive industry. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 527-534). Boston: Kluwer Academic Publishers.

Cunha, M. M., & Putnik, G. D. (2005a). Business alignment in agile/virtual enterprise integration. In M. Khosrow-Pour (Ed.), *Advanced topics in information resources management* (Vol. 4, pp. 26-54). Hershey, PA: Idea Group Publishing.

Cunha, M. M., & Putnik, G. D. (2005b). Market of resources for agile/virtual enterprise integration. In M. Khosrow-Pour (Ed.), *Encyclopedia of information science and technology* (pp. 1891-1898). Hershey, PA: Idea Group Publishing.

Davidow, W. H., & Malone, M. S. (1992). *The virtual corporation — Structuring and revitalising the corporation for the 21st century*. New York: HarperCollins.

Dignum, F. (2000). Agents, markets, institutions and protocols. *European perspectives on agent mediated electronic commerce* (pp. 98-114). Springer Verlag.

Eversheim, W., Bauernhansl, T., Bremer, T., Molina, A., Achuth, S., & Walz, M. (1998). Configuration of virtual enterprises based on a framework for global virtual business. In P. Sieber & J. Griese (Eds.), *Proceedings of the 1st VoNet Workshop*. Simowa Verlag Bern.

Faisst, W. (1997). Information technology as an enabler of virtual enterprises: A life-cycle-oriented description. *Proceedings of the European Conference on Virtual Enterprises and Networked Solutions*. Paderborn, Germany.

Field, S., & Hoffner, Y. (2002). In search of the right partner. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 55-62). Boston: Kluwer Academic Publishers.

Fox, M. S., Chionglo, J. F., & Barbuceanu, M. (1993). *The integrated supply chain management system* (Internal Report). Toronto: Dep. of Industrial Engineering, University of Toronto.

Fuchs, M. (1997). *Design and implementation of value systems:The lifecycle perspective TELEflow*. Switerland: Institute for Techonology Management, University of St. Gallen. Deliverable 7.1. Retrieved from http://nectar.org/update/proceedings/97082101/fuchs/index.html

Goldman, S., Nagel, R., & Preiss, K. (1995). *Agile competitors and virtual organizations: Strategies for enriching the customer*. New York: van Nostrand Reinhold.

Hands, J., Bessonov, M., Blinov, M., Patel, A., & Smith, R. (2000). An inclusive and extensible architecture for electronic brokerage. *Decision support systems, 29*, 305-321.

Harbilas, C., Dragios, N., & Karetsos, G. T. (2002). A framework for broker assisted virtual enterprises. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 73-80). Boston: Kluwer Academic Publishers.

Iskandar, B. Y., Kurokawa, S., & LeBlanc, L. J. (2001). Adoption of electronic data interchange: The role of buyer-supplier relationships. *IEEE Trans. on Engineering Management, 48*(4), 505-517.

Jarvenpaa, S. L., & Shaw, T. R. (1998). Global virtual teams: Integrating models of trust. In P. Sieber & J. Griese (Eds.), *Proceedings of the VoNet Workshop* (pp. 35-51). Bern: Simowa Verlag Bern.

Kanet, J., Faisst, W., & Mertens, P. (1999). Application of information technology to a virtual enterprise Bbroker: The case of Bill Epstein. *International Journal of Production Economics, 62*, 23-32.

Kim, S. (1990). *Designing intelligence: A framework for smart systems.* Oxford: Oxford University Press.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of Management Review, 20*, 709-734.

Merkle, M. (1997). *Virtual organizations: How quality management paves the way for it*. Switerland: Institute for Technology Management, University of St. Gallen.

Meyer, K. E. (1998). *Multinational enterprises and the emergence of markets and networks in transition economies* (Working Paper Nº 12). Copenhagen: Copenhagen Business School, Center for East European Studies.

Miles, R. E., & Snow, C. C. (1984). Fit, failure and the hall of fame. *California Management Review, 26*, 10-28.

Miles, R. E., & Snow, C. C. (1986). Organizations: New concepts for new forms. *California Management Review, 28*, 62-73.

Ng, S. T., & Skitmore, R. M. (2001). Contractor selection criteria: A cost-benefit analysis. *IEEE Trans. on Engineering Management, 48*(1), 96-106.

NIIIP. (1996). *The NIIIP reference architecture*. National Industrial Information Infrastructure Protocols. Retrieved from http://www.niiip.org

Onosata, M., & Iwata, K. (1993). Developing of a virtual manufacturing system by integrating product models and factory models. *Cirp Annals Manufacturing Technology, 42*(1), 475-478.

Putnik, G. D. (1997). Towards OPIM System. In M. A. Younis & S. Eid (Eds.), *Proceedings of the 22nd International Conference on Computers and Industrial Engineering* (pp. 675-678). Cairo.

Putnik, G. D. (2000). BM_Virtual enterprise architecture reference model. In A. Gunasekaran (Ed.), *Agile manufacturing: 21st century manufacturing strategy* (pp. 73-93). UK: Elsevier Science.

Putnik, G. D., Guimarães, P. F., & Silva, S. C. (1996). Virtual enterprise / OPIM concepts: An institutionalization framework. In L. M. Camarinha-Matos &

H. Afsarmanesk (Eds.), *Proceedings of the 2nd IEEE/ECLA/IFIP International Conference on Architectures and Design Methods for Balanced Automation Systems* (pp. 391-400). Portugal: Chapman & Hall.

Resnick, P., & Avery, R. (1994). Retrieved from http://ccs.mit.edu/papers/ccswp179.html

Sarkar, M., Butler, B., & Steinfield, C. (1995). Intermediaries and cybermediaries: A continuing role for mediating players in the electronic commerce marketplace. *Journal of Computer Mediated Communication, 1*(3).

Sieber, P. (1998). Organisation virtualness: The case of Ssmall IT companies. In P. Sieber & J. Griese (Eds.), *Proceedings of the VoNet Workshop* (pp. 107-122). Bern: Simowa Verlag Bern.

UDDI. (2001). *The universal description, discovery and integration (UDDI) specification*. UDDI. Retrieved from http://www.uddi.org/

Williamson, O. (1991). Comparative economic organisation: The analysis of discrete structural alternatives. *Administrative Science Quartely, 36*(1), 269-296.

Zimmermman, F. (2000). *Structural and managerial aspects of virtual enterprises*. University of Bamberg, Business Information Systems Department. Retrieved from http://www.seda.sowi.uni-bamberg.de/persons/zimmermann.html

Section II

Functional or Activity-Based Model of the Market of Resources

Chapter V

The Proposal of a Market of Resources

Introduction

A review of VE integration-related literature reveals that although considerable research has been undertaken focusing on selection of cooperation partners, development of infrastructures (mechanisms and tools) to support VE management and coordination, insufficient attention has been devoted to the problem of creating the environment where these processes take place (i.e., the environment to enable an efficient and effective dynamic integration, offering strategies for dynamically align the virtual enterprise with business to support dynamic reconfiguration).

The concept of A/VE we are addressing is broader, more embracing and more dynamic than the concepts of Virtual Enterprise or Extended Enterprise found in the literature, as these do not require the dynamic integration we defend for agility, and for which we propose the implementation of a Market of Resources. This chapter introduces the concept of a Market of Resources as an environment to cope with the A/VE model requirements (i.e., an environment for Agile/Virtual Enterprise integration and business alignment) identifying the relevant requisites related with A/VE design and integration, and defining its participants. It also illustrates the technical requirements to support the Market of Resources and how exiting technologies support the main processes of the Market of Resources.

The Market of Resources Concept

As mentioned earlier, a virtual enterprise is a temporary and dynamic association of independent resources, primitive or complex, that brings to the virtual enterprise its best practices and core competencies to achieve the highest competitiveness of the whole. On the other side, to obtain the best experiences and competencies, it is desirable that as many as possible primitive or complex resources concur to the integration in the (virtual) enterprise.

Offer and demand are usually matched under several different circumstances, from unregulated search to oriented search, from simple intermediation mechanisms to the market mechanism, all of them with the possibility of being either manually performed or automated. A marketplace of resource providers will provide the matching between firms looking for potential partners for integration and firms offering their resources, facilitating A/VE integration, and offering to participants a larger number of business opportunities.

Three relevant requisites are identified in relation with the process of A/VE design and integration:

- Flexible and almost instantaneous access to the independent candidate resources providers to integrate a virtual enterprise, negotiation process between them, selection of the optimal combination and its integration;
- Design, negotiation, business management and manufacturing management functions independently from the physical barrier of space; and
- Minimization of the reconfiguration and integration time.

The first characteristic implies the existence of a market of independent candidate resources for integrating a virtual enterprise. This market role is:

a) To provide the environment and technology and the corresponding procedure protocols (i.e., an open system architecture) for the efficient access to resources, efficient negotiation between them and its efficient integration;

b) To provide a domain for selection of participant resources providers in a virtual enterprise, large enough to assure the best, or near the best options[1] (i.e., to provide the global domain to competitive access to any potential resources provider).

The second characteristic implies the utilization of the advanced information and communication technologies to the operation of the independent resources market (i.e., technologies providing technical conditions to efficiently accede to the globally distributed resources providers, efficient negotiation between them and its efficient integration).

The third characteristic is necessary in order to provide flexibility, as high as possible (i.e., reconfigurability as fast as possible).

In order to achieve the highest performance (productivity, costs, response time, quality, etc.) of the A/VE design and operation processes, it is of the highest interest to consider their automation, total or partial (Computer Aided). The process automation of systems integrating heterogeneous elements (resources) is based on technologies that provide interoperability (i.e., "open" systems architectures), which is an additional requirement for the operation of this Market of Resources and for A/VE design and operation as well.

As this market is intensively based in high-level information technologies (distributed software applications, information systems and databases, telematics applications, and Wide Area Networks), we are referring to an electronic and virtual market. This market provides information about the candidate resources to integrate a virtual enterprise, about products and about clients. In the same way, the electronic and virtual market provides:

- Access procedures,
- Remote negotiation and utilization of services, and
- Interaction with existing networks and markets of suppliers and users of information, services and products.

In business-to-business, e-commerce relations, the Internet provides more information, more choice opportunities and more opportunities to establish networks, lowering the cost of information and reducing information asymmetries. However, the new models of Agile/Virtual Enterprises, or the new forms of value creation, where market information concerns information about resources providers to integrate, although reinforced by the ability to use more globally distributed resources providers and by lower transaction costs provided by ICT and Internet usage, claim for a wider support environment, assuring better quality and better response at lower time. This corresponds to the concept of Market of Resources previously introduced (Cunha & Putnik, 2005; Cunha, Putnik, & Ávila, 2000; Cunha, Putnik, Gunasekaran, & Ávila, 2005) as an electronic market, subscribed by a subset of the universe of independent resources providers. To this subscription corresponds the formal description of the resources providers using a Resources Representation Language and its integration in a knowledge base.

It is proposed as an institutionalized organizational framework assuring the accomplishment of the competitiveness requirements for A/VE dynamic design, integration and business alignment. The operational aspect of the Market of Resources consists of an Internet-based intermediation service (with different degrees of automation), mediating offer and demand of resources to dynamically integrate in an A/VE (i.e., mediating between resources providers and clients — or A/VE owners) to answer to a market opportunity. Brokers act within the Market of Resources as intermediation agents for agility and virtuality.

In this "virtual" environment, offer corresponds to participants or resources providers (enterprises or resources providers integrating the Market of Resources knowledge base) that make their resources available, as potential servers /partners for A/VE integration, and demand corresponds to clients (A/VE owners), organizations looking for resources to create/reconfigure an A/VE to satisfy the Customer, and to assure business alignment. Customer is the entity giving rise to a business opportunity and is considered outside the Market of Resources. The Market of Resources intends to provide individual firms with access to a larger pool of business opportunities (both offer and demand sides) and remove barriers to reallocating and leveraging resources across multiple partners.

The Market of Resources appears as an alternative to the disperse solutions that can be used in A/VE integration, and aims at contributing to the solution of issues as reconfigurability dynamics, quality assurance, trust, negotiation, contractualization, selection of the optimal resources and integration, optimization in resources utilization and quick response.

Also the uncertainty, concerning the behavior of the resources to integrate increases the risks associated with the ability to answer to the production of an ordered product (the motive that led to the integration of the virtual enterprise) and therefore must be taken into consideration. The Market of Resources offers also procedures to manage the performance of every integrated resource, can support negotiation, contracts and commitments, and can act as the "face" of the entities in interaction or in negotiation. An essential aspect is the evaluation of the result of previous situations (i.e., the behavior of the enterprises in previous integrations) and to use this historical information in the search processes.

The cost associated to the integration of an A/VE surpasses the sum of costs of making contacts, with the cost of overcoming distance, etc., it is also the opportunity cost, the cost of losing an opportunity because of taking a few more hours or days to locate resources (specially for low-level processes, where dynamics are higher) or to reconfigure the virtual enterprise. Speed is a fundamental characteristic that should be considered, as one instantaneous physical structure (or one instance) of a virtual enterprise may last (on the limit) only for a few days or even hours, so there it is necessary to act almost on real time. Our contribution integrates this concern.

If the resources selection domain, to satisfy the tasks of the enterprise, within the same enterprise, represents the lower limit of the *resources selection domain* space, the global resources selection domain, to satisfy the tasks of the enterprise, implying the other enterprises sub-contracting, represents the upper limit of the *resources selection domain* space. The global domain provides virtually, and from a practical point of view, an almost infinite resources selection domain size for the optimal organization structure synthesis providing the highest level of competitiveness, however, the search in the global domain is prohibitive, because of the infinite effort required.

The selection problem is by nature a very complex problem (NP class) and if manually performed, it is not possible to assure high performance. The search of resources in the universal /global domain to integrate a Virtual Enterprise, even using agent technologies is extremely time consuming, and the lack of standardization and uniformity in the description of the resources cannot assure an efficient selection in useful time. We propose that all the entities in interaction in a selection process must be described in a normalized format to allow automatic selection and decision-making. The second way to assure efficient selection is to limit the search domain to a subset of the universal domain, registering the resources and describing them in a normalized basis, to enable the application of the automated brokerage mechanisms (later on the text, those brokerage mechanisms will be designated as *algorithms for search*).

Chapter VIII introduces the functional specification corresponding to this proposal.

Technical Requirements for the Market of Resources

All the technologies and techniques required to help A/VE integration, which were introduced in earlier chapters of this book, already exist, most of them dispersedly developed, as well as many valuable applications are already in operation. However, there is missing what we designate as an adequate *environment* to support the inherent need of dynamics required by the emerging paradigm of A/VE. The Market of Resources was conceived precisely to support the high dynamics of the A/VE integration and reconfiguration.

Table 1 summarizes the contribution of some technologies and environments, to the main VE models: Virtual Enterprise, Extended Enterprise, Agile Enterprise/ Manufacturing, Supply Chain Management, *BM_VEARM* and OPIM (One Product Integrated Manufacturing). It is also referred the importance of reconfigurability dynamics for each model.

The technologies included in Table 1 are able to contribute to activities of all the VE models, but do not to support them, as the purpose of their development was not the creation of an environment to support the VE models. The Market of Resources is proposed as an ideal environment to support the requirement of fast adaptability of the most dynamic VE models life cycle (*BM_VEARM* and OPIM), while e-marketplaces are designed to cope only with supply chains and e-business models that do not require a high reconfigurability dynamics. The functionalities of the Market of Resources are not indispensable for the Extended Enterprise, Agile Enterprise/Manufacturing or Supply Chain Management as are for the other models.

The technical requirements to support the Market of Resources can be grouped under three heads, and are bounded by a reference model (the BM_Virtual

Table 1. Techniques and environments contributing to VE models

	Techniques			**Environments**		Importance of reconfigurability dynamics
	WWW *searches*	*Electronic auctions*	*Agent-based brokerage*	*eMarket places*	*Market of Resources*	
VE models						
Extended Enterprise	x	x	x	x		medium
Virtual Enterprise	x	x	x		x	high
Agile Enterprise / Manufacturing	x	x	x	x		medium
Supply Chain Management	x	x	x	x		medium
BM_VEARM A/V E	x	x	x		x	high
OPIM	x	x	x		x	high
Ability to support fast reconfigurability				low	high	

Enterprise Architecture Reference Model) to guide the implementation and operation of the Market of Resources, and to manage the participation of the elements (providers, clients and brokers) (Cunha, Putnik, & Silva, 2005).

An information infrastructure:The information infrastructure must provide information exchange, security, access, monitoring, recovery and emergency handling and contingency operations. Technology elements include functional engines (file servers, network servers, distributed database engines, search engines and security mechanisms), distributed information resources built upon these engines (such as catalogues, distributed databases) and services to access these resources (building on the existing techniques as HTML, File Transfer Protocol, messaging, collaboration techniques, etc.). It is also essential to have a normalized representation language.

Appropriate support mechanisms and tools for the supra infrastructure: An information infrastructure *de per si* is not enough; participants require mechanisms and tools to operate within the infrastructure, namely integratibility support, coordination and performance evaluation, electronic negotiation systems, payments, electronic signature and other supporting tools. A shared information infrastructure is valuable only if it can support the accomplishment of the several dimensions of integrability already referred. Participants (clients and providers) need supporting tools to quantify service levels and to evaluate the performance, assess targets, etc., as well as collaborative and information exchange tools. Brokers need also specific management tools (search algorithm, expert systems, and artificial intelligence applications).

Coverage of the A/VE extended life cycle: The coverage of the extended life cycle is mainly assured by the support to the A/VE need for reconfigurability dynamics and by the existence of a brokerage function. Technical and procedural support is required to identify potential partners (including a wide variety of mechanisms, as auctions, bidding), qualify partners (in terms of technical capability, quality and previous history) and integrate into the A/VE (including conformity testing, contract conditions, payment, etc.). The Market must also provide coordination and performance evaluation mechanisms, during all the life-cycle phases; just to mention two examples: (1) the substitution of resources due to weak performance is a delicate process as it can implicate indemnities, and (2) the dissolution of an A/VE, if not properly managed, can generate tremendous costs (e.g., issues concerning corporate intellectual property).

Table 2 presents the core technologies/tools that correspond to the three classes of technical requirements above identified. The table intends merely to be illustrative, not to be seen as an exhaustive list.

In Table 3 we summarize some of the components required for the Market of Resources and the existing technologies able to support them.

Table 2. Technologies for the implementation of the Market of Resources technical requirements (Cunha, Putnik, & Silva, 2005)

	Technical Requirements		
	Information infrastructure	**Support mechanisms and tools**	**Coverage of the A/V E extended life cycle**
Technologies / Tools	- Servers - Distributed database systems - E-Marketplaces development platforms - Search engines - Electronic catalogues - Information exchange tools - Communication technologies - Messaging and collaboration techniques - Standards and protocols regarding information exchange, teleoperation, distributed manufacturing, (CORBA, HTTP, STEP…) - Interpreter for a normalized resources representation language or the support of a standard.	- Benchmarking and metrics - Modeling and analysis tools (distributed and virtual simulation) - Integration tools (translation tools) - Electronic negotiation mechanisms - Agent technology - Payments, ordering - Electronic contracting - Algorithms or protocols - Market regulation - Intelligent decision making systems - Computer-aided tools	- Market organization - Management procedures - Business models - Performance evaluation - Reconfigurability management - Contract management - Environment management (maintenance, control, coordination, enforcement, etc.)
	A/V E Reference Model (BM_VEARM)		

In Chapter IX we discuss the functionalities that some commercially available software platforms for e-marketplace development are able to support.

Summary

The implementation of the A/VE model requires the support of an environment able to match between firms offering their resources and demand of resources providers to create or reconfigure an A/V E instance, a functionality that is given by a market. This market should facilitate A/VE integration and offer participants a larger number of business opportunities. The Market of Resources, defined in the chapter, consists of an Internet-based intermediation service (with different degrees of automation), mediating offer and demand of resources to dynamically integrate in an A/VE (i.e., mediating between resources providers

Table 3. Technologies to support the main components and processes of the Market of Resources

Market of Resources components /processes	Support technologies and tools
- Market contents: user/buyer profile, catalogues, historic, database of resources	- Database management systems - Distributed database management systems - e-business development platforms - Portals
- Negotiation: request for quotes, auction/reverse auction, optimal selection	- Intelligent agent technology - Electronic negotiation tools - Algorithms or protocols - Regulation of negotiation - Intelligent decision making systems
- Transactions: payment, contractualization	- Electronic payment - Digital signature - Certification - Other security mechanisms
- Management: monitoring, performance evaluation, analysis of operation results, decision-making	- Simulation tools - Workflow technology and collaboration techniques - Regulation
- Brokerage: expert advise, monitoring and coordination	- Messaging and conferencing - Database management systems - Algorithms - Management procedures
- Integration: file translation, collaboration,	- Standards for product/services description - Collaboration tools, - Data translation standards and tools - Communication protocols
- Resources final selection (optimal combination)	- Algorithms, heuristics and computer-aided tools - Intelligent decision-making systems - Artificial intelligence

and clients — A/VE owners) to answer to a market opportunity. Brokers act within the Market of Resources as intermediation agents for agility and virtuality.

World Wide Web search engines, electronic auctions and agent-based brokerage are examples of techniques able to contribute to activities of the VE models in broad sense. Environments as the electronic marketplaces can contribute to VE models with less reconfiguration dynamics (Extended Enterprise, Agile Enterprise/Manufacturing and Supply Chain Management), while the VE model corresponding to highly dynamic reconfiguration require an environment as the Market of Resources.

References

Cunha, M. M., & Putnik, G. D. (2005). Market of resources for agile/virtual enterprise integration. In M. Khosrow-Pour (Ed.), *Encyclopedia of information science and technology* (pp. 1891-1898). Hershey, PA: Idea Group Reference.

Cunha, M. M., Putnik, G. D., & Ávila, P. (2000). Towards focused markets of resources for agile / virtual enterprise integration. In L. M. Camarinha-Matos, H. Afsarmanesh, & H. Erbe (Eds.), *Advances in networked enterprises: Virtual organisations, balanced automation, and systems integration* (pp. 15-24). Berlin: Kluwer Academic Publishers.

Cunha, M. M., Putnik, G. D., Gunasekaran, A., & Ávila, P. (2005). Market of resources as a virtual enterprise integration enabler. In G. D. Putnik & M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 145-165). Hershey, PA: Idea Group Publishing.

Cunha, M. M., Putnik, G. D., & Silva, J. P. (2005). Information technology infrastructure and solutions. In G. D. Putnik & M. M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 351-165). Hershey, PA: Idea Group Publishing.

Endnote

[1] "Near the best" means optimised, not necessarily optimal, implying an optimisation process.

Chapter VI

Information and Communication Technologies: Current Developments

Introduction

"The introduction of reliable, low-cost electronic computers into the economy was the most revolutionary technical innovation of the twentieth century" (Freeman & Soete, 1997, p. 158). "The fact that a new technology has many potential applications does not mean that all of these will occur simultaneously, or even over a short period. On the contrary, the assimilation of a major new technology into the economic and social system is a matter of decades, not years, and is related to the phenomenon of long cycles in the economy" (Freeman & Soete, 1997, p. 184). This was what, in fact, Schumpeter (1939) suggested. The focus of information technology within organizations has shifted over the last thirty years, from improving the efficiency of business processes within organizations, to improving the effectiveness of the whole value chain. During the sixties and seventies, businesses focused on the use of mainframes to process large quantities of data. In the 80s, businesses focused on using personal desktop computers to improve personal efficiency. The last decade has seen the use of information and communication technologies to create electronic networks within and between organizations.

The information and communication technologies (ICT) of today consist on advanced communication systems that, combined with advanced information technologies, allow the overcoming of time and space conditionings, by means of: (1) communication networks (telephonically, satellite, cable, etc.) that transport information, (2) basic services (electronic mail, interactive video) that allow the utilization of networks, and (3) applications (electronic commerce, electronic marketplaces, teleoperation, electronic business) offering specialized solutions for groups of users.

Information and communication technologies and systems are the support of concepts as distributed systems, computer-supported cooperative work, electronic commerce, electronic marketplaces, teleoperation, virtual prototyping, concurrent engineering, telemedicine, telework, etc., most of which, more deeply or less deeply, are connected with the implementation of some of the emerging ICT-based organizational models, to which the present book is a contribution.

In this chapter we present some of the main ICT and some ICT-based techniques and applications that can support and enable the new organizational models, in particular, that can support Agile/Virtual Enterprise integration.

Addressed is the impact of the new information and communication technologies. This chapter also reviews some of the most relevant technologies that can contribute to support the A/VE model, and introduces relevant applications of these information and communication technologies, some of then considered of relevance to the implementation of the Market of Resources. Finally, this chapter addresses the issue of information integration, presenting recent developments.

Impact of the New Information and Communication Technologies

"Described as an economy in transition to an economy of knowledge or an Information Society, where knowledge is a critical factor, the global economy of today brings not only uncertainty, but challenges and opportunities, and therefore must be faced with determination," to quote the Portuguese Information Society task force (MSI, 1997).

Enterprises are becoming global businesses, organized in networks of several formats. The advances in ICT allowed the process to be extended through continents, creating markets and systems not just global and distributed, but virtual. The absolute dimension of globalization corresponds to the extrapolation from the idea of global markets, to the one of global networks, in a global economy, using the full potential of the information and communication technologies.

The convergence between ICT, electronic industries and the legal framework, together with the liberalization of the communication sector, created new opportunities to the establishment of new applications, new services and new products, based on information, and thus allowing:

- To eliminate or to reduce time and distance dimensions (e.g., electronic commerce, collaborative work, teleservices, teleoperation and telework applications);
- To modify and make flexible the organizational structures, allowing the implementation of virtual and distributed enterprises, networked organizations and world-scale subcontracting;
- To actualize the management procedures based on the computer-aided decision-making, information services and other;
- To revolutionize work, with the alteration of the nature of work, appearing of new professions, more flexible and less hierarchic management;
- To modify the ways of learning, flexible and distance learning applications and computer-based distributed learning environments.

A report undertaken by the Working Party on the Information Economy prepared for the OECD (Organization for Economic Cooperation and Development) in 2004 (OECD, 2004) highlighted the following as main policy directions considered by governments:

- **Business environment:** a healthy business environment is fundamental for firms to thrive and benefit from ICTs. This includes: (1) a transparent, open and competitive business framework, (2) an independent rule of law for all firms, and (3) a stable legal treatment for national and cross-border transactions.
- **Network infrastructure:** encouraging the rollout and use of quality infrastructure at affordable prices.
- **Trust infrastructure:** developing the regulatory infrastructure right for trust, security, privacy and consumer protection. Combat cyber-crime, enforcement of privacy and consumer protection, effective dispute resolution mechanisms are essential aspects.

- **Skill upgrading:** lack of ICT skills and business skills are impediments to effective uptake.
- **Intellectual property**.

The impact of ICT addresses fundamentally three domains:

- **Impact on the organizations:** it is expected, with the rise of new ICT applications, an organizational evolution towards a vertical disintegration and decentralization, externalization of functions, establishment of networks and partnerships, distributed and virtual organizations, etc., envisaging the increase of flexibility, the capability of answering to market demands in a high competitive and concurrent environment and the ability of exploiting innovation. Simultaneously, enterprises should concentrate efforts in the development of economical intelligence to allow the anticipation of market challenges. The implementation of emerging concepts such as the networked, collaborative and dynamic organizational models is totally dependent of ICT.
- **Impact on employment:** as in every period of economical, social and technological change, it is expected a loss of employment, counterbalanced by the creation of new professions and new jobs. During the nineties, the demand for "knowledge-intensive" employment rose considerably in the OECD countries (OECD, 2001); the rise in the number of knowledge workers (scientists, engineers and others, e.g., ICT specialists and technicians that generate knowledge), accounted for nearly 30 percent of the net employment gains recorded during this period; wages have followed a similar pattern. For example in the United States, the wage of knowledge workers has risen much faster than wages of other occupations. Some sectors showing potential for job creation during the present decade include: content development, software development, enterprise information systems (ERP, CRM), electronic commerce, electronic business, and information and brokerage services.
- **Impact on the information infrastructure:** already in 1994, the *Bangemann Report* (Bangemann, 1994) referred to two fundamental characteristics in the implantation of the information infrastructure that the information society requires: one is the interconnection of networks without disruption, and the other is the interoperability, or the possibility of services and applications based on these networks to interoperate. The new information infrastructure will not be a simple network substituting everything that already exists, but a network of interconnected networks, assuring end-to-end digital connection and broad access. A main challenge

is still full business integration and information integration, besides all the recent developments on standards, protocols, business models and applications.

Information and Communication Technologies and Techniques

Advances in communications are now one of the major driving forces of change. ICT are an important industry sector, but its significance is far greater. They are an essential infrastructure for competitiveness of other economic sectors, and the basis for trade, provision of services, production, transport, education and entertainment, as well as present the necessary potential to meet the challenges of sustainable economic growth and new job creation (ACTS, 1998).

The Internet has evolved from an information space to a market space in the past few years. Electronic Commerce has become a very active research area within a short period, with agent technology being recognized as a promising approach for its implementation (Guttman, Moukas, & Maes, 1998). Several new technologies have emerged that allow the implementation of new applications that potentially contribute to achieve the requirements for competitiveness of the present/future times.

In this section we review some of the most relevant technologies that can contribute to support the Agile/Virtual Enterprise model, such as: the Internet, Agent technologies and Collaboration technologies.

Internet

The concepts of distributed computation that formed the basis for the Internet existed since the 60s. However, only in 1969 the North American Department of Defense decided to build a network, the Arpanet, mainly for academic and military purposes. During the 70s, there were established the links to academic sites and in 1982 appeared the TCP/IP protocol for data transmission.

In the 90s started the use of the Internet for commercial purposes. In 1992 the USA Government recognized its potential and the CERN (*Centre for European Nuclear Research*) developed the first World Wide Web (WWW) program (an information system over the Internet). Simultaneously other networks were created, mainly at academic level, but Internet came to be what we all know.

The Internet has been seen under different perspectives; for some, it represents an important learning and educational tool, for other, a democracy pier, a cultural enabler given the possibility of communicating without restrictions, and for many it represents an important medium to conduct business.

The main factors responsible by the success of the Internet are:

- Business, entertainment and academic utilization: integrating a wide range of applications in business, education and training, research, entertainment, etc.
- Software for navigation and browsing: the software tools that support the users in the browsing and the location of information resources.
- Development of broadband networks.
- Development of standards and protocols to improve portability and interoperability.
- The liberalization of communications and reduction of communication costs.
- The regulation of electronic transactions, intellectual property rights, security, encryption, etc.

Internet and Web-based systems provide support for activities such as:

- **Search engines** help users find items in the vast space of the Internet by using keywords, in particular to find sources of information.
- **Internet-based catalogues**, allow buying companies to browse, search, and/or place orders using the World Wide Web.
- **Electronic commerce**, in the forms business-to-consumer, business-to-business and business-to-administration.
- **Electronic business** applications that help supply chain integration, collaboration.
- **Internet-based marketplaces** that provide support for supplier/client relationship, including activities such as information exchange, negotiation, collaboration, settlement, payments, etc.

Agent Technologies

Agents consists of software than can travel over networks, activate and control remote programs, and return back to the source with information. According to a commonly used definition proposed by Wooldridge (1997), agents are software systems capable of flexible and autonomous action in some environment in order to meet its design objectives. Agents (Wooldridge, 1999) should be autonomous, pro-active, reactive and sociable[1]. A software agent acts independently on behalf of its user, in furtherance of its interests. Moreover, some of these agents are capable of copying themselves over the Internet, of interrogating host *Web* sites and of interacting with other agents.

Although, agents can act separately to solve a particular problem, when it is necessary to cope with a complex problem involving either distributed data, knowledge or control, a complete system made of several different agents has to be designed — a multi-agent system (Oliveira, 1999). An interesting application of this technology consists of its application to implement distributed systems as a set of agents, where the overall behavior of such distributed systems depends on the interaction and coordination of distributed elements.

In a multi-agent system, according to Barbuceanu and Fox (1995b; 1996), the environment is populated by other agents, each pursuing their own goals and each endowed with their own capabilities for action; in this case, the actions performed by one agent constrain and are constrained by the actions of other agents, so to achieve their goals agents will have to manage these constraints by coordination (Barbuceanu & Fox, 1995a; Nwana, Lee, & Jennings, 1996).

Some specific domains, where the intelligent agent-based solution proved to be appropriate, include:

- **Virtual organizations**, where agents can search for partners to integrate a supply chain or a virtual organization, promote negotiation between partners and negotiate contracts.
- **Electronic commerce**, where agents can search for products/services, negotiate and manage the transaction, and organise bids, in an electronic marketplace.

Other applications could be referred, but are not of interest for the scope of our work (such as entertainment, traffic management, network management).

For detailed descriptions of these technologies (agents theory, architectures and languages, and agents applications) we suggest Jennings, Farantin, Johnson, O'Brien, and Wiegand (1996a, 1996b); Jennings, Sycara, and Wooldridge (1998); Jennings and Wooldridge (1998); Oliveira (1999); Wooldridge and Jennings (1995a, 1995b), among many other valuable sources of information. The MIT Media Lab site provides interesting and valuable information on underway research projects at MIT's Software Agents Research Group (MIT_Media_Lab, 2001).

Expert Systems and Agent Technology are also defended as very important enablers of the emerging Virtual Enterprise model providing the increasing levels of system intelligence required by today's virtual organizations (Waldo, 2002). Researches in agent-based supply chain management can be divided into three types: agent-based architecture for coordination, agent-based simulation of supply chains, and dynamic formation of supply chains by agents (Ahn, Lee, & Park, 2003). Details can be found in Ahn et al. (2003) and Fox, Barbuceanu, and Teigen (2000). The third type above-mentioned refers to how supply chains can be formed dynamically, meeting environmental constraints that may change over time (Ahn et al., 2003). Agent systems that represent each partner in a supply chain perform negotiations with other agents to form a virtual supply chain (Ahn et al., 2003; Shen, Ulieru, Norrie & Kremer, 1999).

Collaboration Technologies

Collaboration technologies support the ability of people to work any time, any place, with others, in their own organization or in different organizations, sharing a common object and common information.

These systems support collaboration among people by providing functions such as: electronic mail, voice mail, discussion forums, brainstorming, voting, audio conferencing (teleconferencing), video conferencing, shared whiteboards (where people at different sites can work simultaneously on a document, presentation or other object), group scheduling (e.g., for multiple individuals to find a common time slot available for a meeting), computer-aided collaborative design, WorkFlow management systems, and others. Such systems may use proprietary communication protocols or the Internet or both.

Computer-aided tools for collaborative design together with virtual prototyping tools and distributed simulation tools allow distributed product development and integration, and virtual testing.

Information and Communication Technology Applications

The new ICT enable a multitude of new applications. Their common denominator will be, according to a European Directive (European_Commission, 1996), the role to be played by the final user. The existing and planned services and applications cover domains from education and training, business, health care, scientific and technical, to tourism and leisure.

The available ICT applications include, for example: Electronic marketplaces, Electronic dynamic negotiation (auctions and reverse auctions), Electronic commerce, Applications to support supply chain integration, Tele-operation, Telemedicine, Collaborative environments, Distributed manufacturing, Information services, Brokerage services, Teleservices, Distant education and training, Home banking, Entertainment, and many other.

Some of the applications we consider of most relevance to the implementation of the Market of Resources, and hence will deserve our dedication, are: electronic commerce, Internet-based marketplaces (electronic marketplaces), electronic negotiation, electronic contracting and tele-operation.

Electronic Commerce and Electronic Business

The online glossary whatis.com (Whatis) defines electronic commerce (e-commerce) as "the buying and selling of goods and services on the Internet, especially, the World Wide Web." In contrast, they define electronic business (e-business) using a much broader construct that incorporates "the conduct of business on the Internet, not only for buying and selling, but also servicing customers, and collaborating with business partners."

Electronic Commerce is a wide concept, defined by OECD (Organization for Economic Cooperation and Development) (OECD, 1996) as referring to all forms of commercial transactions involving either organisations or individuals and that are based on electronic processing and transmission of data, including text, sound and image, between enterprises (Business-to-Business or B2B), between enterprises and consumers (Business-to-Consumer or B2C) or between enterprises and Public Administration (Business-to-Administration or B2A). It refers also to the effects that the electronic exchange of commercial information can have in institutions and on the processes that support and regulate the activities of commercial nature; here are included the organizational management, contracts and commercial negotiation, the legal framework and regulation, financial agreements, taxes, as well as any other issues concerning the mentioned transactions.

Electronic Commerce relies on the combination of technologies, applications, processes and business strategies that support the reliable and secure exchange of information between customers and suppliers, viewing the realisation of commercial transactions and the way enterprises promote and sell its products and services. It involves products (goods for consumers) and services (information services, knowledge), traditional activities (health care, education and training), new activities (malls) and electronic material (software, images, multimedia, etc.).

It includes diverse activities, such as the electronic commerce of goods and services, the online delivery of digital contents, the financial electronic transactions, electronic commerce of shares, commerce of knowledge, commercial auctions, collaborative project and engineering, sourcing, public contracts and direct commercialisation to consumer (European_Commission, 1997). The activities upstream and downstream of those transactions that are publicity and promotion of goods and services, the provision of contracts between traders, the supply of market intelligence, support *pre* and *post*-sales, electronic procurement and support to distributed business processes are also considered to integrate the concept of e-commerce, as defended by OECD (2000) and by the Esprit Programme (ESPRIT, 1997).

Electronic business (e-business) is here considered as a general comprehensive term and is defined based on Wassenaar et al. (1998), quoting Wingand, Picot, & Reichwald (1997) as the application of information and communication technology to enhance or redefine any form of resource exchange between firms and their customers, suppliers or other business partners governed by dedicated intra and inter-organisational structures and general (inter)national agreed institutional arrangements.

Electronic Marketplaces

Recent years have seen a dramatic increase in the role of information technology in markets, both in traditional markets, and in the emerging electronic marketplaces, with a multitude of Internet-based online auctions. The expression Electronic Marketplace (e-marketplace) describes a platform commercially supported by ICT, to establish commercial relations between clients and suppliers.

E-marketplaces are, in essence, a real-time open marketplace where a buyer can evaluate all the potential suppliers for a particular product or service. The buyers need not to depend on one supplier, which helps to create a healthy price competition amongst the suppliers who can offer their products to multiple buyers.

As e-business transforms the market for goods and services globally, it is redefining the way companies manage their supply chains.

In this section we introduce the e-marketplaces concept, its typologies, present their functionalities, trading functions and introduce some examples of relevant e-marketplaces.

Electronic Marketplaces Definition

An electronic marketplace is a technological, Internet-based platform that allows a community of buyers to meet a community of sellers, with the objective of exchanging goods and services, exchange information, or to collaborate in order to achieve a common business goal.

It allows buyers, suppliers, distributors and sellers to find and share information, negotiate and collaborate. Who buys, benefits from an unique entry point to reach a community who sells (a global source of suppliers), and who sells hopes to reach to the largest number of potential clients (more than it would be possible independently). The main idea is to put together in a common infrastructure a wide range of enterprises that perform the role of client or of supplier, in order to facilitate procurement, for example.

E-marketplaces use Internet technologies and standards to distribute data and to facilitate online transactions (Bakos, 1998). They are often initiated by either the buying or the selling side, and frequently involve vendors of e-commerce software.

As a consequence, the economic benefits to firms are participation and value creation in wider market-like relationships organised electronically, while reducing costs through automation of a higher volume of transactions.

Whatever the roles a participant plays in an e-marketplace (e.g., consumer, customer, retailer, provider), he has to deal with information and to play the roles of information provider and information consumer. Information consumers need to search, gather, filter information; information providers need to deliver and route information.

According to the business models proposed by Dai and Kauffman (2001), there are three major market functions: (1) matching demand and supply, (2) facilitating transactions (information, goods, services and payment corresponding to market transactions), and (3) providing an institutional infrastructure (such as a legal and regulatory framework, that enables the efficient functioning of the market).

Idealy, markets should be characterised by an infinite number of anonymous participants, perfect information transparency, and instant competition based on price alone. Although such a scenario promises maximum economic welfare, via optimal allocation of resources, it is as the same time highly unrealistic as it results in a situation where corporate profit margins are approaching zero. Concerning electronic marketplaces, it is not possible to establish perfect marketplaces, linking large numbers of anonymous buyers with large numbers of equally anonymous sellers. Most inter-business systems, however, resemble online trading communities rather than true marketplaces and include only a limited set of buyers and/or sellers.

In addition to aggregating and disseminating data about supply and demand, such communities provide value to their members by increasing the transparency of market information, leveraging buying and selling power, improving trust between the participants and reducing transaction costs. Transaction support through supplementary information and services provides additional value and also helps to reach a critical mass of participants.

When e-marketplaces extend their activity besides offering transaction facilities, and also offer solutions for integration with other internal processes, we are in front of an e-business tool, not just an e-commerce tool. The functionalities that today are being offered by e-marketplaces are extending from e-commerce to e-business.

E-marketplaces open new opportunities of trade by providing new tools and services (Wang, Cheng, and Zhao, 2004) such as:

- Catalogues and sourcing directories to help buyers and sellers to increase their visibility, shorten transaction costs and order time, and to locate business partners (Baron, Shaw, & Bailey, 2000).
- Dynamic pricing tools (auctions and reverse auctions).
- Increased trust and confidence between business participants, when e-markets are concerned with participants performance and behaviour monitoring and evaluation.
- Process integration, through the utilization of process collaboration tools.

Electronic Marketplaces Classification

It is commonly accepted that e-marketplaces[2] can be organised either horizontally or vertically and as buyer-centric, seller-centric or neutral.

A horizontal e-marketplace addresses a specific function and serves a wide range of industries, typically providing a common service, such as financial services, benefits management, and MRO (maintenance, repair and operating) equipment procurement process management. Here, processes are transacted for several industry segments that share common traits. Horizontal e-marketplaces span a number of different product categories; rather than simply being a textile, chemicals or steel marketplace, they bring together retailers, manufacturers, technology companies, financial partners, etc.

A vertical e-marketplace focuses on a wide range of functionalities in a specific industry (e.g., chemicals, plastics, food and beverage, electronics) and seek to provide all of the services needed by that industry. For example, from liquidated merchandise, overstocks or requests for proposals (RFPs) to online auctions.

While buyers benefit from the single point of entry to an entire industry community (a purchasing catalogue of goods in the specific market segment and a global source of suppliers and merchandise), sellers hope to expand sales by reaching a larger number of potential customers than is possible through individual efforts (Segev, Gebauer, & Frank, 1999).

Vertical e-marketplace operators focus on specific industry verticals, such as life sciences (Biosupplies.com[3]), electronic components (AlliedElectronics[4]), telecommunications (Telezoo[5], Simplexity.com[6]), automobile industry (Covisint[7]), chemicals (Chemconnect[8]), steel (Newview Technologies[9]), manufacturing and plastics industries (PlasticNet[10]) and textile (AsianSources[11]). Vertical e-marketplace operators, in most instances, are acting as Internet-based intermediaries by setting up industry-specific, electronic marketplaces based on a variety of formats to bring buyers and sellers together. These companies also may provide technology solutions, such as Web storefront applications, to access these marketplaces, procurement software as well as industry-specific community/content features such as news, information, and other value-added services.

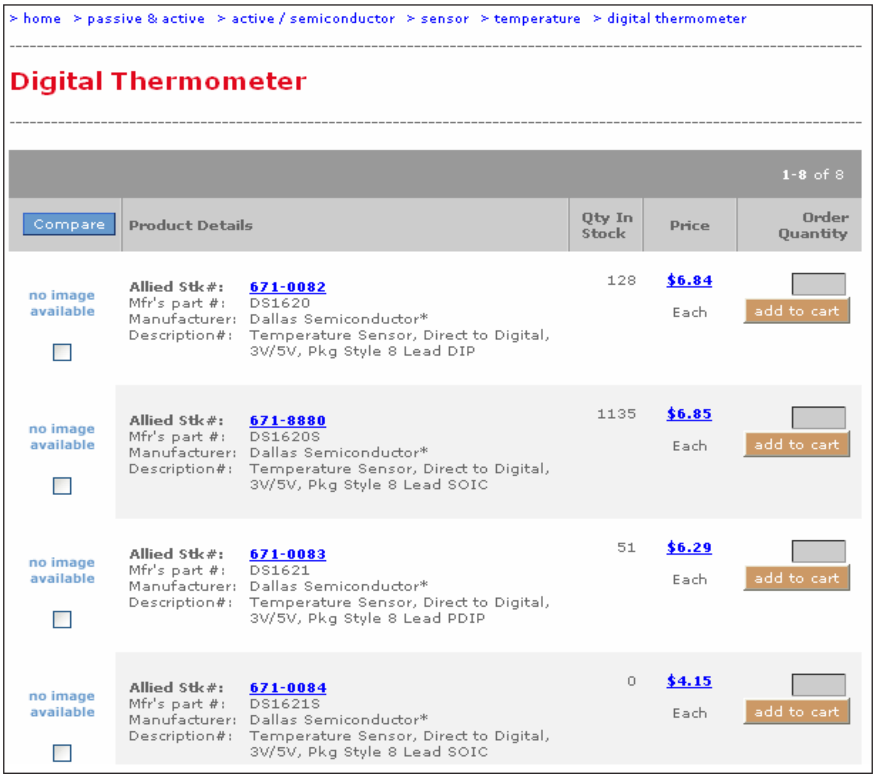
A buy-side (or buyer-centric) e-marketplace is focused on procurement, supply chain management and development, while a sell-side (or seller-centric) one is focused on the demand chain (i.e., processes by which the goods reach the customer) (Archer & Gebauer, 2000; Baldi & Borgman, 2001).

A buyer-centric e-marketplace exists when a few big buyers join forces to build a marketplace where small fragmented sellers can sell their goods. This benefits buyers since it permits quick and easy price comparison shopping. One or few large buyers come together to build and manage the hub in order to drive the waste out and diminish procurement costs, and generate revenue from transaction fees. The buyer centric approach disregards principals of trust and value within the supply chain (Archer & Gebauer, 2000).

Seller-centric e-marketplaces are markets where one or a few big sellers work together to build a marketplace for many, small fragmented buyers. Generally cash flows stream from advertisements, commissions on sales, or fees for delivering qualified leads to suppliers. Seller managed hubs add value by lowering costs and offering seamless procurement and shipping.

Neutral e-marketplaces (Third Party) appear where both the sellers and buyers are fragmented. In this environment, a third party creates a neutral exchange and performs multiple transactions through a bid-and-ask system. Third party owners offer a neutral playing field for which they receive a “cut” or transaction fee for each deal. The most important success factor for these e-marketplaces is to reach “liquidity” or a critical mass of both number and size of the transactions running through the e-market.

Figure 1. Example of a catalogue of Allied Electronics (http:// www.alliedelec.com)



Trading Functions

Auction, *reverse auction*, *catalogue*, *exhange* and *commodity exchange* are the main business functions offered by e-markets. An e-market offers at least one of these functions. Most e-marketplace software platform providers can provide solutions that can be modeled into the above models. For example, Commerce One[12], a leading B2B software provider company, provides different *software* solutions that can be modeled into any of the above three models. Commerce One's BuySite or *MarketSite* software is used by many companies to create a *Catalogue* model. Similarly, *Covisint*, a joint venture by General Motors, Ford and Chrysler also uses Commerce One software to create an *Exchange* model.

The functionality of a catalogue model differs from the functionality of an exchange or an auction model. These models are built for different a purpose and functionality, by configuring the software, based on the requirements of the models.

Catalogue

Catalogue e-marketplaces are one of the most widely used models in the B2B market that provides a list of commodities in a form of a catalogue with thousands of parts and products. A consumer can log onto these hubs and buy a commodity simply by choosing any item in the catalogue.

The catalogue model is a fixed price model and creates value by aggregating suppliers and buyers. It is popular in industries that are characterized by fragmented buyers and sellers, who transact frequently for relatively low cost items. An example is AlliedElectronics [13] (see Figure 1).

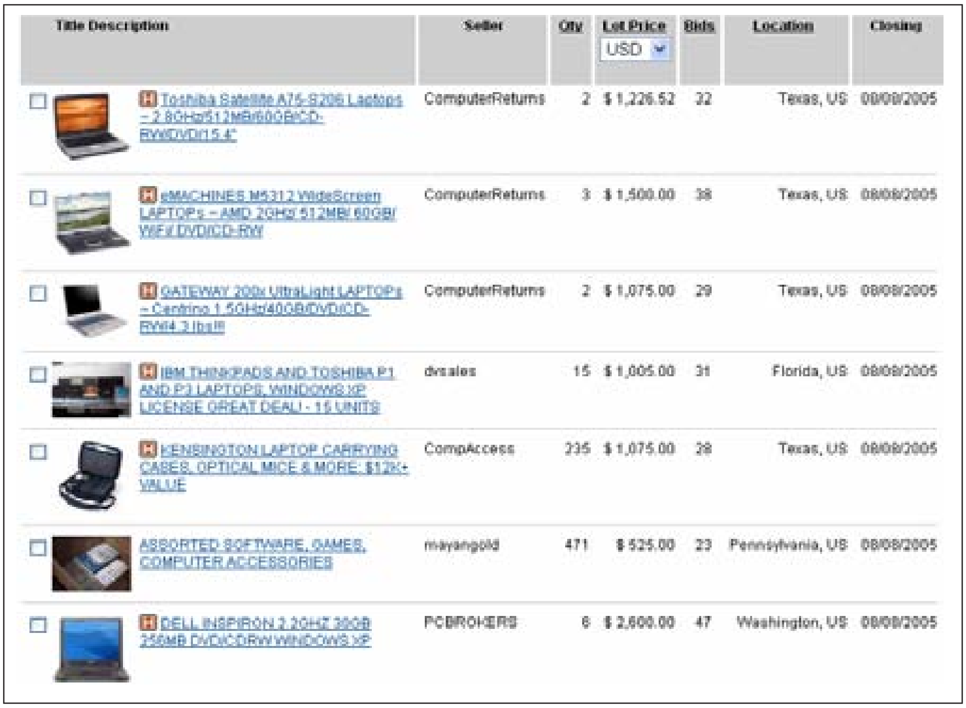
Auction

Auction e-marketplaces are a revolutionary pricing model, in which multiple buyers or sellers bid competitively on a contract. Auctions are dynamic pricing models that enable buyers or suppliers that have very specific or unique items to buy or sell at the latest market price. This is the ideal mechanism for selling or liquidating surplus or perishable products with variable prices at best possible prices as it enables a wide range of potential buyers to bid competitively for products at below-market prices.

There are variations on the final competitive transaction pricing mechanism, but most fall under the following general description:

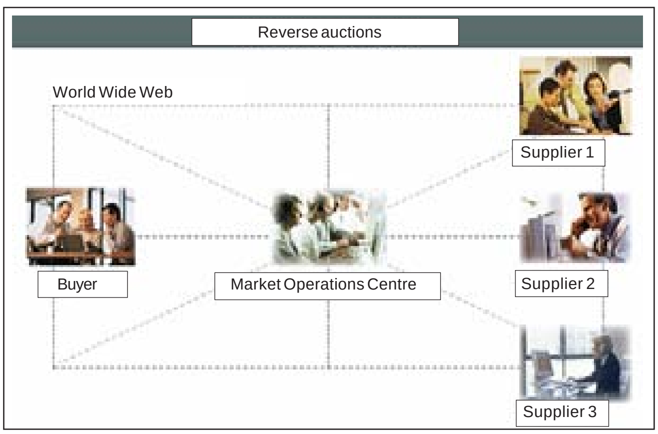
- **Straight auction:** This is the traditional type of auction. Supplier puts products/services up for bid, and prices climb through competitive bidding process of offers by interested parties. The auction takes place during a pre-established period when interested buyers can send bids (an example is given in Figure 2).
- **Reverse auction:** Buyer puts product/services up for quote. The supplier that provides the product/service wins the bid. As opposed to straight auctions, prices here fall through competitive bidding process (an example is given in Figure 3).
- **Blind versus transparent:** Sometimes all competitive respondents know who is bidding and what prices they are offering. Other times, bids are blind.

Figure 2. Example of an auction in Liquidation.com (http://www.liquidation.com)



Title Description	Seller	Qty	Lot Price USD	Bids	Location	Closing
Toshiba Satellite A75-S206 Laptops – 2.8GHz/512MB/60GB/CD-RW/DVD/15.4"	ComputerReturns	2	$ 1,226.52	32	Texas, US	08/08/2005
eMACHINES M5312 WideScreen LAPTOPs – AMD 2GHz/ 512MB/ 60GB/ WiFi/ DVD/CD-RW	ComputerReturns	3	$ 1,500.00	38	Texas, US	08/08/2005
GATEWAY 200x UltraLight LAPTOPs – Centrino 1.5GHz/40GB/DVD/CD-RW/4.3 lbs!!!	ComputerReturns	2	$ 1,075.00	29	Texas, US	08/08/2005
IBM THINKPADS AND TOSHIBA P1 AND P3 LAPTOPS, WINDOWS XP LICENSE GREAT DEAL! - 15 UNITS	dvsales	15	$ 1,005.00	31	Florida, US	08/08/2005
KENSINGTON LAPTOP CARRYING CASES, OPTICAL MICE & MORE: $12K+ VALUE	CompAccess	235	$ 1,075.00	28	Texas, US	08/08/2005
ASSORTED SOFTWARE, GAMES, COMPUTER ACCESSORIES	mayangold	471	$ 525.00	23	Pennsylvania, US	08/08/2005
DELL INSPIRON 2.2GHZ 30GB 256MB DVD/CDRW WINDOWS XP	PCBROKERS	6	$ 2,600.00	47	Washington, US	08/08/2005

Figure 3. Example of a reverse auction at BravoBuild (http://www.bravobuild.com)



Thus, auction trading functions add the functionality of straight auctions and reverse auctions. Interactions are discrete events. The buyer receives better prices and suppliers can dispose of excess inventory. This trading function is effective for after-market sales, perishable goods, commodity items and highly fragmented trading communities.

Exchange

Exchanges are a very common trading function. For manufacturers and other customers on the buying side, exchanges can remove much of the burden for finding the parts they need at a fair price. If a buyer has underestimated its production forecast or has had an increase in demand for production for which it does not have the requisite component parts, an exchange can help find those components much more quickly than calling several service centres around the country or around the world. Exchange e-markets also can be of help to find hard-to-find parts, or parts that are difficult to get through the current supply chain.

In an exchange, the buyer or the seller submit a request to buy or to sell something, usually by filling an online form. This request is then posted in the site or sent by e-mail to the market participants whose profile traduces their eligibility to participate in the transaction.

These requests are of three types:

- **Request for Quotation (RFQ):** consists of an invitation to sellers to present a proposal to supply products, usually of easy description (standardized products), or services (an example is given in Figure 4).
- **Request for Proposals (RFP):** consists of an invitation to seller or suppliers to submit a proposal to supply products or services of difficult description or with many specificities (see and example of a RFP at Manufacturing Quote in Figure 5).
- **Request for Bid (RFB):** consists of an invitation to buyers to submit an offer to a given product or service (see Figure 6).

Commodity Exchange

Commodity exchanges are one of the most dynamic pricing mechanisms. It works like a stock exchange, with prices oscillating permanently. These e-markets trade undifferentiated, commodity-type products, with easy description, that have high transaction flow, such as energy, wood for civil construction, financial instruments, natural gas, etc.

Figure 4. Details of a request for quotation in Exporters.SG (http://www.exporters.sg)

Step 1: View RFQ Details

RFQ ID:	33347
Product Required:	Sony Vaio Notebook - VGNB77GP (49 pageviews)
Date Reviewed:	8/7/2005
Date Expired:	8/28/2005
Buyer:	*Information available to Exporters' Plus subscribers only as this RFQ is more than 3 days old.*
Product Category:	Computer Notebooks
Purchase Type:	one-time
Order Quantity:	130 Units
Target Price per unit:	US$700
Payment Method:	Telegraphic Transfer (T/T)
Deliver Location:	AUSTRALIA
Deliver Time upon confirmation:	21 days
Shipping Terms:	CFR (See definitions)
Additional Information:	Sony Specs: Microprocessor: Intel® Centrino™ Mobile Technology, Intel® Pentium® M Processor 735 (1.70GHz) Processor System Bus: 400MHz Cache: 64 KB/2 MB (on CPU) Main Memory: 512MB DDR-SDRAM (1 SO-DIMM slot unoccupied) Hard Drive: 40GB (C:15GB, D:25GB) Ultra ATA/100 Wireless LAN: IEEE802.11b/g Optical Drive - Read: Reading Speed - DVD-R, DVD+R, DVD+RW, DVD-RW, DVD+R DL: 4x / DVD-ROM: 8x / CD-RW: 15x / CD-ROM: 25x Optical Drive - Write: Writing Speed - CD-R: 24x / CD-RW: 16x Graphic Accelerator: Integrated in Intel® 855GME chipset Video Memory: Maximum 64MB (shared with main memory) Display: 14.1

Step 2: Compare Quotations (Exclusive to Exporters' Plus members only)

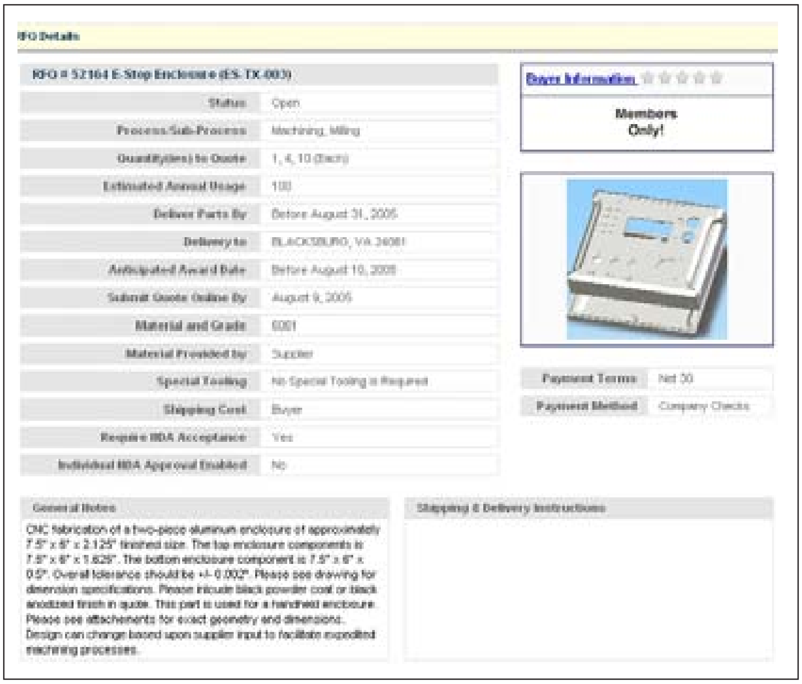
Check if there are any quotations submitted. Use these information to adjust your quotation to increase your competitiveness and your chance of being selected by buyer.

Number of Quotations submitted: 7

Unlike the auction, this is not a negotiation process for a specific product or set of products; it is a continuous process where the price for a product is continuously changing (dynamic attribution of price), based on changes in offer and demand.

They are the true marketplaces for B2B interactions for a many-to-many environment that provides market clearing pricing with continuous and dynamic interactions. Buyers' benefit by hedging risks in volatile markets and suppliers can manage volatility while liquidating inventory. These e-markets work well with commodities, but liquidity is essential.

Figure 5. Details of a request for proposal at Manufacturing Quote (http://www.mfg.com)



IntercontinentalExchange is an example of a commodity exchange, which trades oil contracts and products, power, natural gas, coal and precious metals (see Figure 7).

Examples of Electronic Marketplaces

E-marketplaces can be distinguished by several features, such as its main focus or scope, the implemented revenue strategies, restriction to entry or openness (limitation on number of participants), contents in databases or references (degree of distributiveness of catalogues), degree of automation in transaction (which steps are automated: negotiation, payments, ordering, etc.).

In this section we analyse some important B2B electronic marketplaces[14] that, as well as highlight their distinguishing factors.

Figure 6. Details of a request for bid in Exporters.SG (http://www.exporters.sg)

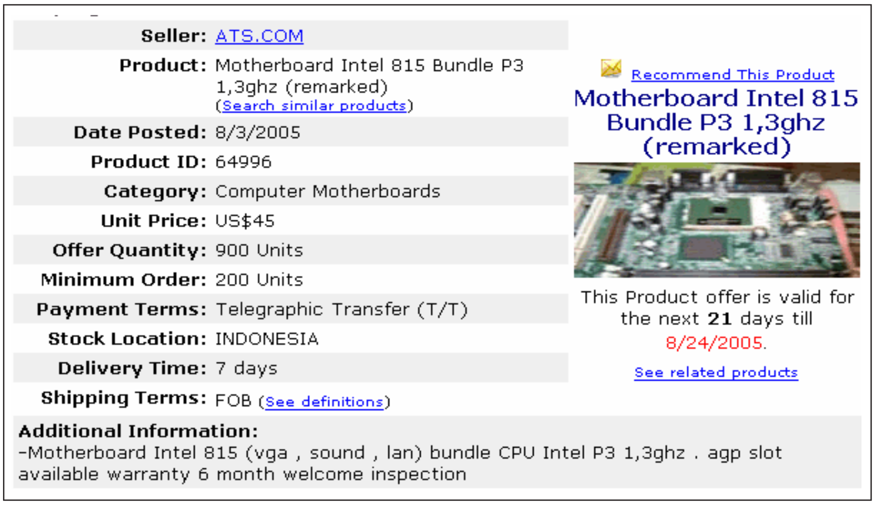
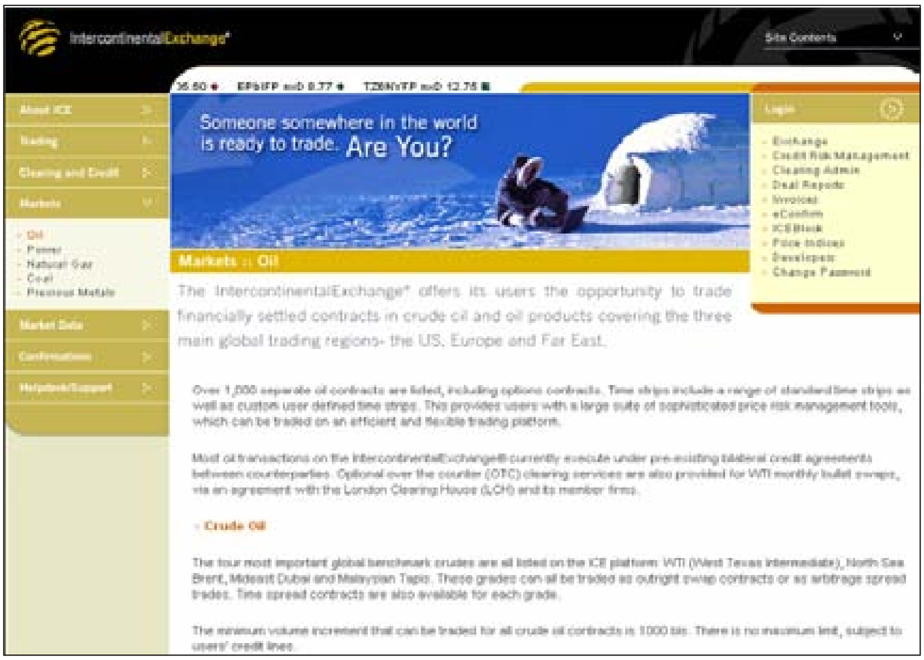


Figure 7. An example of a commodity exchange — The IntercontinentalExchange (http://www.intcx.com)



Several reports by IT analists and scientific papers (for example, Christiaanse & Markus, 2003; Lauren, 2003; Pahladsingh, 2005; Singh, 2004) distinguish several significant e-marketplaces. From that range of significant e-marketplaces referred in the literature we have selected some representative examples that could contribute to A/VE integration. The selected e-marketplaces are: Covisint, Exostar, Elemica, GlobalSources and Manufacturing Quote.

Grouped by industry sectors, our analysis includes the following e-marketplaces:

- **Automotive:** Covisint (http:///.covisint.com)
- **Aerospace and defense industry:** Exostar (http://www.exostar.com)
- **Chemicals:** Elemica (http://www.elemica.com)
- **Multiple industry:** GlobalSources (http://www.globalsources.com)
- **Metalomechanics**: Manufacturing Quote (http://www.mfgquote.com)

Covisint

For many years automotive OEMs have pressured their supply base continually to reduce costs. Cost reduction initiatives and old business models have reached a point of exhaustion, claiming for new value generating business models to help differentiate suppliers from their competitors (Baker et al., 2000). This electronic marketplace performs electronic brokerage between customers and suppliers along the automotive industry supply chain.

Covisint (http://www.covisint.com) consists of a Virtual Supplier Network specifically created for the automotive industry. Its extension to other industries by strategic partnerships was planned since their creation; at present Covisint is applying its *Industry Operating System* to the healthcare sector.

Covisint was officially announced in December 2000 as an independent company, created by Ford, Chrysler, General Motors, Renault and Nissan and a number of development partners. The meaning of the designation is “Co”, symbolising cooperation, collaboration and communication and “vis” for vision and visibility; the “int” means integration and international (Baker et al., 2000).

Covisint project scope includes three major areas:

- **Procurement:** it hosts a global market place where industry participants can purchase and sell a wide range of items and services via the Internet.
- **Product development:** it provides customers the ability to develop products via real-time collaboration and strengthen global integration among partners creating a secure environment.

- **Supply chain:** it allows individual organisations to see the current and future status of their supply chain inventory levels, material flows and capacity constraints via the Internet.

The service encompasses the complete interaction between suppliers or suppliers and their customers, and includes procurement transactions, pre-production collaborative engineering and exchange of information during production or for supply chain management. Covisint was projected to be a one-stop-shop for the automotive supply chain, supporting buying, selling and collaboration on a global platform: buyers can access all their suppliers in one site, and the same way, suppliers can have all their clients in one site, all sharing common procedures and processes (see Figure 8, Figure 9 and Figure 10). In April 2005, Covisint accounted for around 185,000 active users in 22,000 member companies, in 96 countries.

Figure 8. Covisint connection overview 1 (http://www.covisint.com)

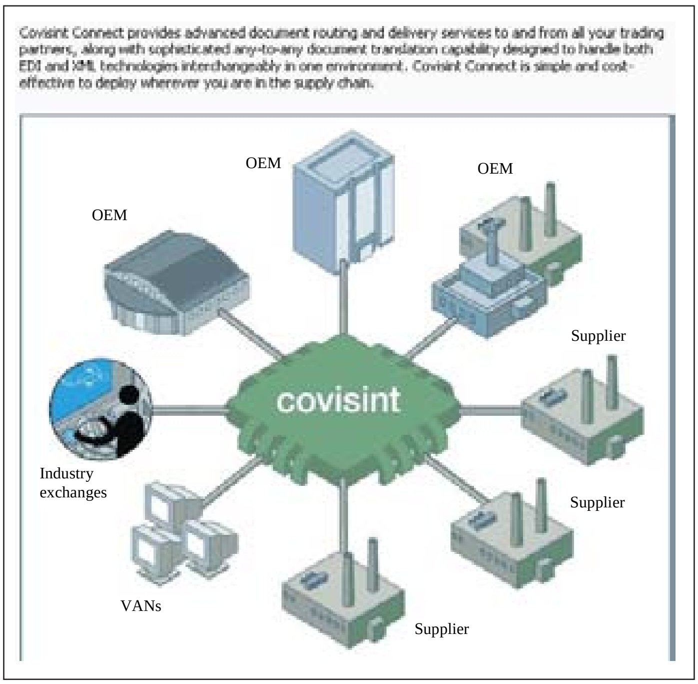


Figure 9. Covisint communication overview 2 (http://www.covisint.com)

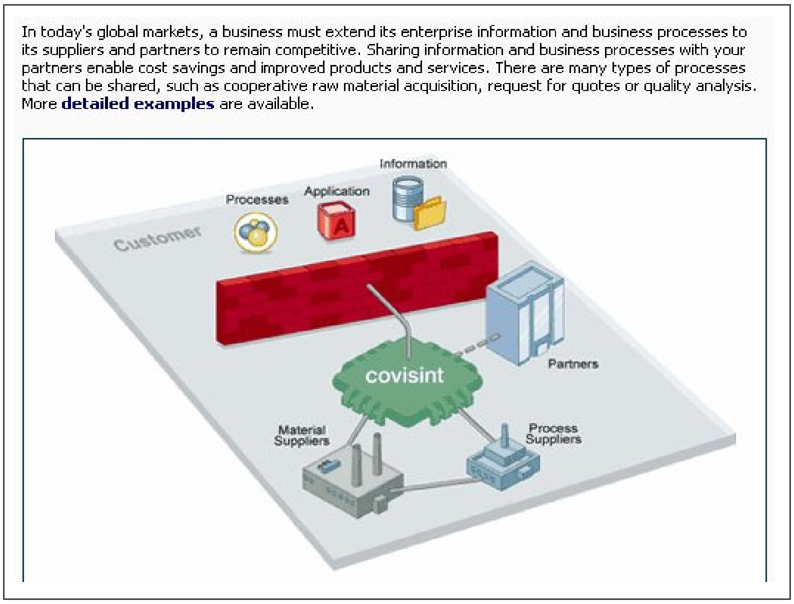


Figure 10. Covisint connection overview 3 (http://www.covisint.com)

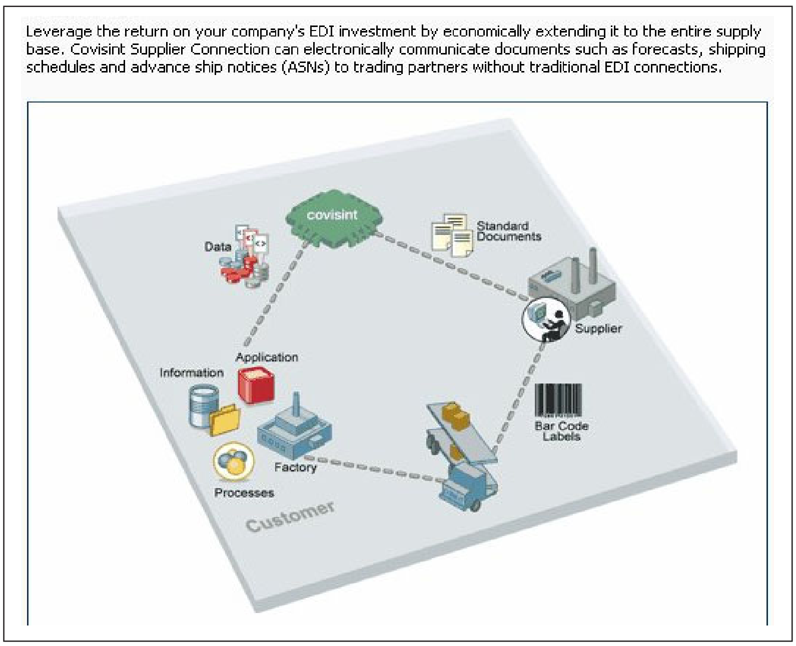


Figure 11. Exostar homepage (http://www.exostar.com)

Exostar

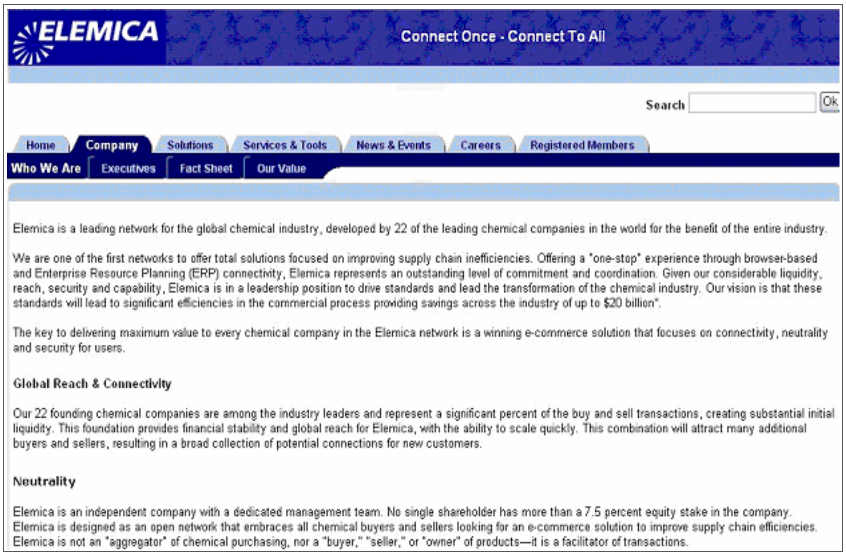
Exostar (http://www.exostar.com) is the leading provider of integrated supply chain solutions to the aerospace and defense industry, connecting manufacturers, suppliers and customers (Figure11). It was founded by Bae Systems, Boeing, Lockheed Martin Group, Raytheon and Rolls Royce.

Exostar offers several levels of membership to suppliers according to the volume of transactions the company receives. The transaction volume is function of purchase orders, change orders or planning schedules submitted by exostar buyers. This e-marketplace works essentially with auctions. For each required product or service, it is launched an auction, specifying conditions, the calendar, to which the interested parts apply.

Elemica

Elemica was founded in August 2000 by 22 of the world's largest chemical firms. It was the premier global neutral information network built to facilitate the order processing and supply chain management, offering an integrated suite of product solutions that enable buyers and sellers of chemicals to streamline their business processes and to collaborate to achieve savings (Elemica, 2005).

Figure 12. Elemica homepage (http://www.elemica.com)



Its core business is an interoperable data exchange service capable of routing messages (such as purchase orders and shipping notices) between participants. In 2003 Elemica was able to connect up the chemical industry by offering integration of participants' ERP systems into a hub-and-spoke network (Metcalfe, 2004). Elemica is an example of collaboration e-marketplace (i.e., emphasizes interaction services) (Christiaanse & Markus, 2003). Collaboration e-marketplaces are expected to benefit participants by reducing the costs and increasing the quality of multiparty information exchange (Christiaanse & Markus, 2003).

Elemica has interconnectivity with other e-marketplaces, including Quadrem (in the mining sector), The RubberNetwork and Omnexus (in the plastics sector).

GlobalSources

GlobalSources (http://www.globalsources.com) is an e-marketplace providing industrial product information and business opportunities worldwide through 23 vertical marketplaces (textile and garment industry, electronics, computers, telecommunications, auto parts, etc.).

The company started in 1971 as a trade magazine publishing and is established as e-marketplace since 1997. In July 2005, this e-marketplace was serving more than 430,000 active and independently certified buyers in over 230 countries,

Figure 13. GlobalSources homepage (http://www.globalsources.com)

who generate more 4.2 million inquiries annually, for over 130,000 suppliers (GlobalSources, 2005).

It is one of the highest traffic sites for general trading in a Request for Information format (Lauren, 2003). In November 2003, and for the second time, this e-marketplace was selected by the U.S. business magazine Forbes as one of the "Best of the Web" (Lauren, 2003).

Figure 14. GlobalSources — Some services offered to suppliers

They offer free listing of suppliers and sell product catalogue hosting (see Figure 14). For buyers, access is free, as well as disseminates information freely, according to buyers' profile. Advertising is another source of income. From the range of services offered, the *Market Intelligence Reports* are useful tools for suppliers, consisting of customized online information about competitors, buyer demands and market trends.

Manufacturing Quote (MfgQuote)

The neutral e-marketplace Manufacturing Quote was founded in 1999 and facilitated its first online sourcing transactions in February 2000. It is an online *Sourcing Management System* with automated supplier discovery and a global network of independent participating suppliers (Figure 15).

MfgQuote uses its proprietary technology to intelligently connect buyers with suppliers of manufacturing services while facilitating the collaboration, quoting, due diligence and analysis processes. This technology supports the request for quotations or proposals process, supplier discovery, engineering data exchange, revision control, collaboration, due diligence, analytics and supplier management.

Buyers using MfgQuote are typically Original Equipment Manufacturers (OEM's) requiring the services of contract manufacturers and job-shops. As a general rule, if an item needs to be manufactured in accordance with a drawing,

Figure 15. Services offered by Manufacturing Quote (http://www.mfgquote.com)

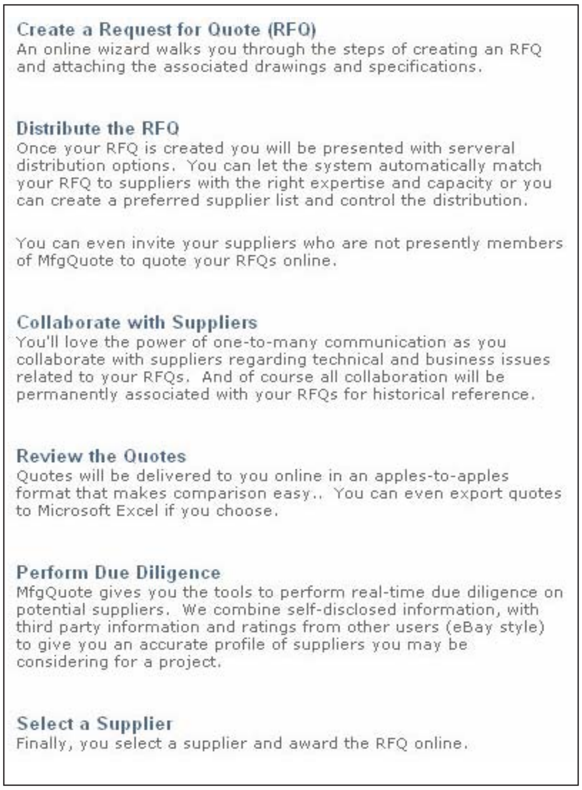
computer-aided design (CAD) model or technical specification, it is appropriate to be sourced via MfgQuote.

Suppliers using MfgQuote are typically contract manufacturers or job-shops. The exception is that some OEM's join MfgQuote as suppliers to fill excess manufacturing capacity. Supplier members are companies that normally produce components, parts or assemblies on an order-by-order basis in accordance with a buyer's exact specifications; they typically do not have catalogues or maintain inventory.

MfgQuote matches buyer requirements with potential suppliers possessing the right expertise, credentials, and capacity for the job being sourced. The service is based on the creation and management of Request for Quotations (Figure 16), offering access to a network that in July 2005 accounted for 1,650 qualified suppliers performing 200 manufacturing processes (e.g., machining, fabrication, molding, die mold making, casting, extrusions, metal stamping and contract manufacturing of electronic components). A total of 41,000 buyers have joined MfgQuote since February 2000 (MfgQuote, 2005).

MfgQuote is announcing the release of MfgQuoteCS, a suite of collaborative sourcing tools that allows buyers to collaborate with other buyers and suppliers across organizations and geography. MfgQuoteCS is designed for environments where multiple buyers and members of management need to collaborate in the sourcing process

Figure 16. Manufacturing quote — Creating a RFQ



On April 13, 2005, the Webby Awards, the leading international honor for Web sites, nominated MfgQuote.com for the Best IT Hardware/Software Web Site of 2005.

Brokerage and Intermediation Strategies

The role of third party intermediaries, linking different parts of a value chain, has been covered extensively by researchers in economics and business, and the question seems to be whether the future will hold a place for intermediaries, given that new technologies facilitate direct links between market players, such as manufacturers and end-consumers of products, or businesses and their suppliers (Bichler & Segev, 1999; Sakar, Butler, & Steinfield, 1995; Segev et al., 1999).

In spite of a quite number of successful examples, e-marketplaces are not yet mature. An open interoperable platform exploiting the emerging standards and technologies is not there yet; the agent technology has not been fully exploited and developed.

Electronic commerce depends on the emergence of capabilities that empower buyers to obtain all the product data they need to make informed purchase decisions, quickly and easily.

Traditional physical markets are often brokered by intermediaries, or parties, that facilitate market transactions by providing brokerage services. The concept of broker, capable of acting on behalf of a customer in guiding the selection of the most suitable product, has long been well known and the extension of this concept to the electronic marketplace is a natural progression.

Brokers allow users to be more focused in dealing with information about commercial services in the global electronic market. Brokers are important in markets, because search costs, lack of privacy, incomplete information, contracting risk, and pricing are better managed through a human. Moreover, brokers provide a central marketplace and are in a key position to provide many essential third party services in electronic commerce (Chircu & Kauffman, 2000).

Brokerage services allow the reduction of costs of coordination across space and time and added value by centralising the search (product/service) match and transaction functions. This makes a firm's outsourcing a transparent process, eliminating the possibility of opportunistic behaviour, as the prices are published in the electronic catalogues, and during the transaction stages, the issues of trust are correctly implemented (safe payment, etc.).

As defended by several authors, Market Brokerage is regarded as the core concept to overcome the current limitations of electronic marketplaces, namely the problems of semantic matching (limiting the access to the global universe of resources) and the coordination of the selection of resources to integrate in an A/VE. Appropriate brokerage services[15] should support new market-led relationships between producers and consumers, where the large number of suppliers and customers are geographically separated, where there are many comparable products, or when prices and product features or models change rapidly.

Basic information and communication infrastructure is indispensable for the establishment of an Electronic Market however the added value comes from the higher-level functions, in our case, to support partner selection and integration processes. From a literature review, it was possible to conclude that it is largely proposed by the model of Electronic Markets offering market functionalities like searching goods or participants, filtering information or helping negotiation, using either Brokerage services, with different degrees of automation (from manual to computer aided) or intelligent agents.

Several authors defend an electronic marketplace mediated by the broker function (Beam, Bichler, & Segev, 1998; Bichler, 1998; Cunha, Putnik, & Ávila, 2000; Eversheim et al., 1998; Hands, Bessonov, Blinov, Patel, & Smith, 2000; Kanet, Faisst, & Mertens, 1999; Manfred & de Moor, 2001; Putnik, 2000; Segev et al., 1999; Sihn, Palm, & Wiednmann, 2000). Other defend the implementation of Intelligent Agents technology (Camarinha-Matos & Afsarmanesh, 1998; Rabelo & M., 1997; Rocha & Oliveira, 1999; Tsvetovatyy, Gini, Mobaster, & Wieckowski, 1997; Viamonte & Ramos, 2000) to support functions of procurement, search of partners in virtual organisations, negotiation, etc., without expressly refer the brokerage function.

In most of the review, part of the electronic brokerage process is performed by intelligent agents (i.e., client brokering and server brokering can be implemented with multi-agent technology), as well as the negotiation process, but under the supervision of a human broker.

The electronic brokerage can be understood as a more broaden activity than the agents technology based solution, as it can offer more than automated search and negotiation processes, combining this artificial intelligence with non automatic technology and knowledge.

Besides the distinction we are making — brokerage and agents technologies — sometimes Multi-Agent technology is used in the implementation of brokerage services. This is the reason why we refer “degrees of automation” when referring brokerage services. The main distinction we make is between the integration of this technology in the marketplace environment and the degree of automation associated.

Electronic Negotiation

Beam and Segev (1997) define negotiation in electronic commerce as the process by which two or more parties multilaterally bargain resources for mutual intended gain, using tools and techniques of electronic commerce. Automated negotiation or electronic negotiation (e-negotiation) takes place when the negotiation function is performed by networked computers. Under this definition, a process in which two executives use e-mail to exchange negotiation offers would not be considered automated negotiation, but a process in which two intelligent agents negotiate a solution electronically and then present it to the executives would be.

However, and according to several authors (Beam & Segev, 1996, 1997; Beam, Segev, & Shanthikumar, 1996; Benyoucef & Keller, 2000), if negotiation is difficult, automated negotiation is even more so. The main reasons respect (1) the need for an ontology for categorizing objects, such that they are semantically meaningful to a software agent, and (2) the need for a negotiation strategy.

The most basic form of e-negotiation is no negotiation at all (i.e., fixed-price sale), where the seller offers the goods or services through a catalogue at take-it-or-leave-it prices (Benyoucef & Keller, 2000). Other styles of negotiation are auctions, bilateral bargaining, combinatory auctions and direct negotiation within a small set of eligible resource providers (bilateral bargaining within a smaller domain, manually performed).

Auctions are popular, distributed and autonomy preserving ways of allocating items among agents (Sandholm, 1999). In a sequential auction, the opportunities are auctioned one at a time. Determining the winner is easy, because that corresponds to selecting the most favorable bid for each item separately. But most of the times this method is not applicable, because of the possibility of combining business offers (for primitive and complex resources providers), and bidders can also present different bids when applying for complex resources provision. The alternative can be a parallel auction design, where the opportunities are open for auction simultaneously, and bidders can place their bids during a certain period.

Combinatorial auction methods allow the bidders to express complementarities between offers (i.e., bidders can bid on combinations of resources) and tend to lead to more efficient allocations in multi-items actions (Sandholm, 1999). This is, however, a complex problem, requiring exhaustive approximation algorithms and dynamic programming.

In bilateral bargaining, the Resource Providers are invited to bargain an opportunity/set of combined opportunities. They are previously qualified based on quantitative data included in their catalogue (prices, delivery time, production capacity) and historical information.

Electronic Contracts

Since the very beginning of human history, the problem exists of mutual trust when people exchange values, and contracts between the exchanging sides have been adopted as a solution that guarantees the rights of the participants and increases mutual trust (Angelov & Grefen, 2002). In business-to-business relationships, contracts form the foundation of a market, "All economic production and exchange processes are organized through contracts. Contracts are the instruments and the means for the organization of exchange relations" (Wingand et al., 1997; quoted by Angelov & Grefen, 2002).

In a multi-agent supported virtual marketplace, where agents can meet to exchange services or trade with a variety of merchandise, the agents can represent various organisations and companies. A negotiation on price and quantity and a contract between two agents can be set up and the transaction carried out within minutes or even seconds. A system of this kind, can be supplied by a third party, being neither buyer nor seller and thereby having a neutral position in the service chain.

The above example also implies the existence of chains of agents negotiating to exchange services. It is important to ensure that the agreement between two agents is valid outside the virtual marketplace (i.e., there must be some sort of legal support in the real world to ensure that the agents can be trusted with the ability to represent an organization).

When chains of agents trade with each other, there is a need to make sure who is responsible in the case that a contract is broken. If there is no legal support, the agents will not be trusted with the ability to represent an actual company, especially if the agent shall be able to set up contracts for exchange involving large sums (Eriksson, 2001).

The relationship between the requestor and the delegates are formalised through bilateral contracts, that is one contract linking the requestor with the delegator, and one contract linking the delegator with each delegatee.

Virtual organisations carry one important disadvantage: the conflict between the secure, but slow preparation mode of traditional cooperation agreements and the fast, but sometimes risky and trust-based, negotiation and contractualisation procedures (Lenz, Oberweis, & Schneider, 2001). As Jarvenpaa et al. demonstrate in their studies on the role of trust in global virtual teams (Jarvenpaa, Shaw, & Staples, 2004), trust affects deeply people's attitudes and behaviors.

In a large, complex project, the amount of written contracts is surely high, and the contracts are usually large as well. Still, different terms and standards cause misunderstandings and delays in project schedule, making risk management difficult. In a networked environment, the complexity still increases, as defended by (Laurikkala & Tanskanen, 2002), bringing additional difficulties for virtual supply chains, the most important of which is the insufficient information flow between the networked participants.

Legal regulations, namely the European directive for electronic signatures (European_Union, 1999) have set up a framework for using electronic contracts (e-contracts) in business. E-contracts are contractual agreements, represented as digital information and signed with the digital signatures of the parties. According to the new regulations, a text that is signed with a digital signature, has the same conclusiveness as a hand-written signature.

Electronic contracting systems may also contain decision support functions. The potential of e-contracting has been discussed since the research in e-marketplaces began. A considerable research effort is taking place, concerning conceptual framework for e-contracting and standardisation processes. An overview of current research initiatives can be found in Angelov & Grefen (2001). Besides the introduction of digital signatures and contract management applications, the development of XML-technologies and industry specific XML vocabularies is important for further progress in e-contracting. XML can be used for representing contracts in a semi-structured format. We highlight ebXML (ebXML, 2001) that supports all phases of the contracting cycle. EbXML (to be addressed later in this chapter) provides a standard for business process specification, aiming at achieving interoperability between parties.

Tele-Operation

Advanced information and communication technologies via TCP/IP and remote sensory systems are the basic structures to the implementation of Advanced Production Systems (Virtual and Distributed manufacturing systems). The "classical" examples of the tele-operation utilisation at the beginning of the sixties, as the spatial experiences, the sub aquatic petrol exploration are well known, culminating with the recent developments of telemedicine.

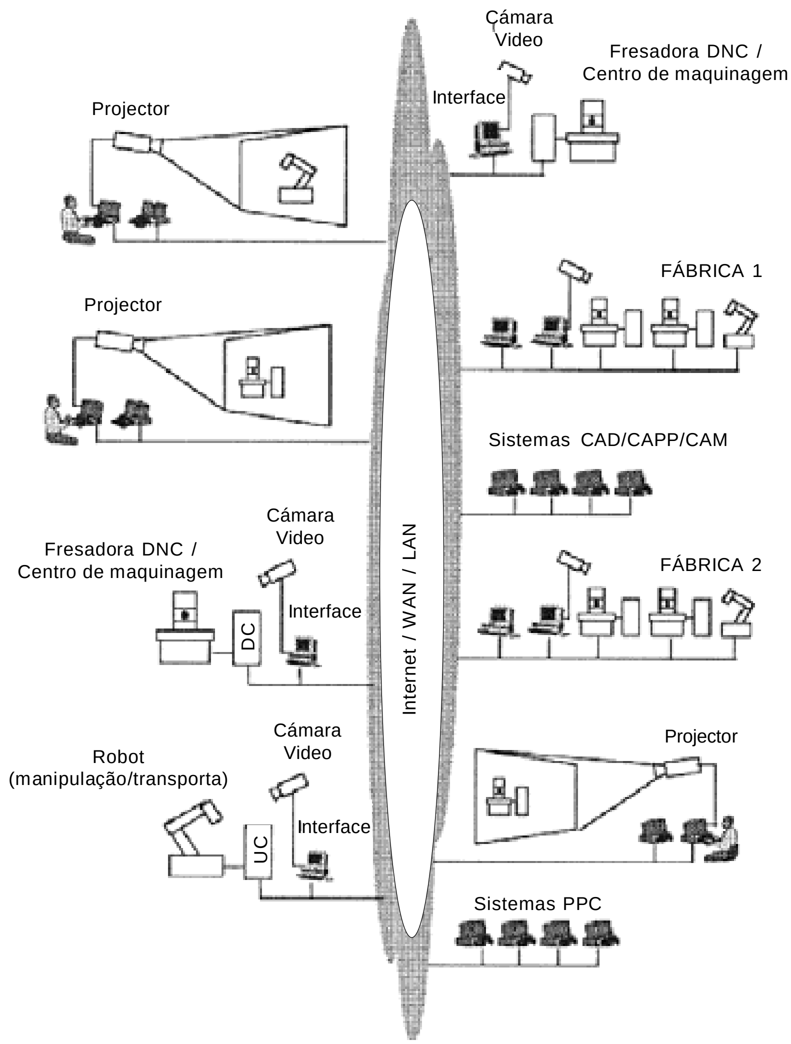
The devices, subject of tele-operation, are essentially robots and ROV's (Remotely Operated Vehicles). Under the manufacturing perspective, there are not many devices conceived to be operated from other location than its physical location, as the actual production systems do not require that functionality. However, the concepts of production systems of the last two decades suggest that need, although the application of teleoperation to industrial devices has been slower than the verified in the domains of the robotics and ROVs.

In 1992, Mitsuishi, Nagao, Hatamura, Kramer, & Warisawa (1992) already described a prototype implementation for operation and control of a machining centre, consisting on a machine at Tokyo University and an operation centre located at United States, University George Washington. This system was described by its authors as the basic technology to the creation of an "*inter-world intelligent manufacturing system*," which would allow the efficient and effective collaboration of globally distributed project and production engineers, in the conception, development and production of product prototypes.

Computer-Aided Manufacturing systems, in globally distributed environments, meet the requirements of the most recent organisational paradigms to the establishment of advanced manufacturing systems. In such organisational models, the control functions to be established are at the level of elementary resources (e.g., machine-tool, robots, conveyors, etc.), responsible by the execution of each operation of production, transport and storing. However, the control functions of the productive devices (elementary resources) raise several implementation problems, as the selection, interfacing and real-time control must overcome the space and time barrier, and thus requiring special interfaces.

Figure 17 represents a model of a prototype for the teleoperation of industrial devices, proposed by (Moreira, 1998; Putnik et al., 1998). This prototype was

Figure 17. Representation of teleoperation and teleservice systems for computer aided manufacturing (Putnik et al., 1998)



developed for the demonstration of distance operation of industrial devices, implemented over Internet, interconnecting Laboratório de Sistemas Automáticos de Produção (LASAP) of the Department of Production and Systems of Minho University, where the control system is located, and the Department of Mechanical Engineering of Minho University, where the machine tools and virtual sensoring elements are physically located.

E-Business Integration

Protocols, or standards for operation have emerged over the last two decades in one of two ways (O'Sullivan, 1998). Firstly, there are the *de facto* (from the fact) standards that simply happen mainly as a result of a technological breakthrough by an individual company, like the classical example of IBM PC. Secondly, there are the *de jure* (by law), that are established by standards organisations, such as the International Standards Organisation (ISO).

E-Business Standards

The representation of information to perform search operations on the WWW has been a problem since the beginning of its utilisation, and represented a limitation for the fully exploitation of the Internet potential. Integration of e-business applications and processes across multiple trading partners requires industry-wide standards. It is needed a common, universal means to describe products, processes, trading partners, and other data types.

Early inter-organisational systems such as EDI have allowed manufacturers to significantly streamline their inbound logistics operations. More recently, new Internet technologies such as *eXtensible Markup Language* (*XML*) that promote server-to-server communications, promise to further improve the new organisational models based on ICT (W3C, 2001).

The Extensible Markup Language (XML) used various "tags" to define the types of data in an electronic document, such as price, invoice number, trading partner, etc., and hence was rapidly becoming the communications standard for data interchange in B2B e-commerce.

However, XML only provided a method for defining the data types, not the actual data types or application responses. This was left to two players: standards bodies, who created *de jure* norms, and e-market software vendors, who created *de facto* standards through the proliferation of their applications (Thomas, 2001).

While the vendors, specifically Ariba and Commerce One, moved first in this field with XML variants based on their own e-marketplace applications, influential standards bodies and industry consortia soon moved in, with OASIS, OpenApplications Group, RosettaNet, and ebXML being representatives of the over 400 e-business standards consortia, most representing a specific interest or industry (Line56, 2000). By mid-2000, there were over one hundred different dialects of XML, each one had the backing of different constituencies with different motives (Gartner_Research, 2001).

Several e-business frameworks are being proposed, containing elements like modelling methods, supporting tools, standards, software and system architectures, etc. The major initiatives include:

- **RosettaNet:** A consortium of major information technology, electronic components and semiconductor manufacturing companies, formed in 1998. It is one of the first standards consortia with XML-based business transaction standards in production use (RosettaNet, 2002). The consortium is working to create and implement industry-wide, open eBusiness process standards, to form a common e-business language, aligning processes between supply chain partners, in the high-technology supply chain and the various business models used within it (RosettaNet, 2003).
- **ebXML (Electronic Business XML):** The United Nations body for Trade Facilitation and Electronic Business (UN/CEFACT[16]) and the Organization for the Advancement of Structured Information Standards (OASIS[17]), have joined forces to initiate a worldwide project to standardize XML business specifications. UN/CEFACT and OASIS have established the ebXML initiative to develop a technical framework that will enable XML to be utilized in a consistent manner for the exchange of all electronic business data. A primary objective of ebXML is to lower the barrier of entry to electronic business in order to facilitate trade, particularly with respect to small and medium-sized enterprises (SMEs) and developing nations (ebXML, 2001). It consists on a modular suite of specifications that enables enterprises to conduct business over the Internet, envisaging the creation of a single global electronic marketplace.
- **BizTalk:** A development environment for business processes, an industry initiative started by Microsoft and supported by a wide range of organizations, from technology vendors like SAP, CommerceOne, and Ariba to technology users. It includes a design framework for implementing an XML schema and a set of XML tags used in messages sent between applications (BizTalk, 2002). BizTalk features include the ability to define business document specifications and how these documents have to be transformed when passed between applications. It provides a standard gateway for

sending and receiving documents across the Internet, as well as providing a range of services that ensures data integrity, delivery, and security. BizTalk Server uses XML internally to "describe" business documents, and it uses standard Internet protocols as HTTP and SMTP to deliver these documents to their destinations, thus allowing to interoperate with various applications running in any environment as long as those applications support Internet standards (BizTalk, 2002).

- **UDDI (Universal Description, Discovery and Integration):** This initiative aims at enabling businesses to discover each other, and define how they interact over the Internet and share information in a global registry architecture. UDDI aims as well to enable businesses to invoke services over the Internet, expanding offerings, extending market reach, and increasing access to current customers. The UDDI project takes advantage of WWW Consortium (W3C) and Internet Engineering Task Force (IETF) standards and the early versions of SOAP. Ariba, IBM, and Microsoft work together on this initiative. It is planned in time, the UDDI project to turn into a standards organization (UDDI, 2004).

Web Services

Web Services consist on an integration architecture that allows the dynamic interconnection of applications on Internet, using open Web technologies. Web Services is a collection of business functions or capabilities taken from a single or multiple software applications that, when bundled together, can be published to a network using standard XML-based protocols for use by other applications. Each Web service is a building block that enables the sharing of software functionality with other applications residing outside of the Web service's native IT environment.

The overall theory behind Web Services is rather simple. What's difficult, however, is actualising the theory (Data_Junction, 2002). The goal of Web Services is to take every program and component object and transform their APIs (Application Program Interface) into XML. Once this occurs, every program or component will publish its logic by XML. Web services consist on software components described by WSDL interfaces, which could be accessed by Internet with SOAP (Standard Object Access Protocol) messages. SOAP messages are XML documents that can be transmitted via standard network protocols, like HTTP, HTTPS, FTP, SMTP, etc. (UDDI, 2001). Web services provide a starting point to enable communication among all programs and applications. A big part of the long-term solution of Web services involves Standard Object Access Protocol (SOAP), Web Services Description Language

(WSDL) and Universal Discovery, Description and Integration (UDDI) (Data_Junction, 2002).

WSDL (Web Services Description Language) is an extension of XML to describe Web Services, its functions, parameters and return values. It describes what the Web service is able to do, where does it “lives” and how to invoke it.

Summary

Information and communication technologies are the support for the emerging agile, distributed and virtual enterprise organizational models. The chapter introduced the most relevant technologies and applications that can be used in the implementation of enablers of the A/VE model, with a special focus on electronic marketplaces.

Globalisation, outsourcing, and Internet connectivity have fundamentally altered the business environment in which enterprises now operate. To become leaner and more competitive, companies have adopted a deeper focus on their core competencies, and increasingly outsource both critical and non-critical operations, from finance to logistics to manufacturing.

Within this outsourced competency approach, process efficiency demands a coordinated flow of information, goods, and actions among various trading partners in the value chain. As a result, trading partners are highly motivated to review, reengineer, and rebuild their shared processes (Aberdeen_Group, 2002). However, as enterprises move their focus from internal enterprise to inter-enterprise process alignment, they will need to overcome a number of business management and technology challenges. The A/VE model requires a new approach for applying technology not only to data exchange, to partner search, to negotiate, to order or to pay, but simultaneously to address the integration of processes of search, negotiation, selection and integration and further coordination of the partnership. E-marketplaces can be seen as a potential support to some activities required by virtual enterprise model, however, they are portals with some negotiation, ordering and payments facilities, but they were not even conceived to implement the VE model.

A fundamental factor to the full exploitation of the potential presented by the Internet-based technologies and applications, able to contribute to the A/VE model, concerns the existence of commonly accepted standards to categorise products and services and to standardise inter-business communication schemes.

References

Aberdeen_Group. (2002). The next B-to-B gestalt: Business process networks. *Market Viewpoint, 15*(2).

ACTS. (1998). *Information brokerage*. Berlin: Advanced Communications Technologies and Services Programme, European Commission DG XIII.

Ahn, H. J., Lee, H., & Park, S. J. (2003). A flexible agent system for change adaptation in supply chains. *Expert systems with applications, 25*, 603-618.

Angelov, S., & Grefen, P. (2001). *B2B eContracting handling — A survey of projects, papers and standards*. Twente University: CTIT Technical Report Series. Retrieved from the World Wide Web at: http://www.ctit.utwente.nl/publications/Tr01/

Angelov, S., & Grefen, P. (2002). A conceptual framework for B2B contracting. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises*. Boston, MA: Kluwer Academic Publishers.

Archer, N., & Gebauer, J. (2000). Managing in the context of new electronic marketplace, *Proceedings 1st World Congress on the Management of Electronic Commerce*. Ontario, Canada.

Ávila, P., Putnik, G. D., & Cunha, M. M. (2002). Brokerage function in agile/virtual enterprise integration — A literature review. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 65-72). Boston, MA: Kluwer Academic Publishers.

Baker, G., Grech, A., Hensley, R., Meckstroth, W., Reisman, L., & Riback, B. (2000). *An exchanging advantage — Supply chain innovation in the new economy* (The White Paper Series Number 2, Autumn 2000). Arthur Andersen.

Bakos, Y. (1998). The emerging role of electronic marketplaces on the internet. *Communications ACM, 41*(8), 35-42.

Baldi, S., & Borgman, H. (2001). Consortium-based B2B e-marketplaces — A case study in the automotive industry, *Proceedings of 14th Bled Electronic Commerce Conference*. Bled, Slovenia.

Bangemann, M. (1994). *Europe and the global information society — Recommendations to the european council (Bangemann Report)*. Brussels: High Level Group of Experts, European Commission — DG V.

Barbuceanu, M., & Fox, M. S. (1995a). *The architecture of an agent based infrastructure for agile manufacturing*. Paper presented at the IJCAI'95, Montreal, Canada.

Barbuceanu, M., & Fox, M. S. (1995b). Issues in building an agent oriented architecture for managing the supply chain. In M. Sadeh (Ed.), *Proceedings of IJCAI — 95 Workshop on Intelligent Manufacturing*. Montreal.

Barbuceanu, M., & Fox, M. S. (1996). Coordinating multiple agents in the supply chain. *Proceedings of Fifth Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises* (pp. 134-142). Stanford, CA: IEEE Computer Society.

Baron, J. P., Shaw, M. J., & Bailey, A. D. (2000). Web-based e-catalog systems in B2B procurement. *Communications of the ACM, 43*(5), 93-100.

Beam, C., Bichler, M., & Segev, A. (1998). A services of a broker in electronic commerce transactions. *EM — International Journal of Electronic Markets, 8*(1), 27-33.

Beam, C., & Segev, A. (1996). *Electronic catalogues and negotiations* (CITM Working Paper 96 - WP - 1016). Berkeley, CA: University of California at Berkeley.

Beam, C., & Segev, A. (1997). *Automated negotiations: A survey of the state of the art* (Technical Report 97-W0-1022). Berkeley, CA: Haas School of Business, U C Berkeley.

Beam, C., Segev, A., & Shanthikumar, G. (1996). *Electronic negotiation through internet-based auctions* (CITM Working Paper 96-WP-1019). Berkeley, CA: University of California at Berkeley.

Benyoucef, M., & Keller, R. K. (2000, September 6-8). *A conceptual architecture for a combined negotiation support system*. Paper presented at the 11th International Workshop on Database and Expert Systems (DEXA'00), Greenwich, London.

Bichler, M. (1998). An electronic broker to business-to-business electronic commerce on the internet. *International Journal of Cooperative Information Systems, 7*(4), 315-331.

Bichler, M., & Segev, A. (1999). A brokerage framework for electronic commerce. *Journal of Distributed and Paralel Databases, Special Issue on E-Commerce, 7*(2), 133-148.

BizTalk. (2002). *BizTalk Product Overview*. Microsoft. Retrieved from http://www.microsoft.com/biztalk/evaluation/overview/biztalkserver.asp

Camarinha-Matos, L. M., & Afsarmanesh, H. (1998). Flexible coordination in virtual enterprises. *Proceedings of the 5th International Workshop on Intelligent Manufacturing Systems, IMS'98* (pp. 43-48). Gramado, Brazil.

Chircu, A. M., & Kauffman, R. (2000). Reintermediation strategies in business-to-business electronic commerce. *International Journal of Electronic Commerce, 4*(4), 7-42.

Christiaanse, E., & Markus, M. L. (2003). Participation in collaboration electronic marketplaces, *Proceedings of the 36th Hawaii International Conference of Systems Sciences (HICSS).*

Cunha, M. M., Putnik, G. D., & Ávila, P. (2000). Towards focused markets of resources for agile / virtual enterprise integration. In L. M. Camarinha-Matos, H. Afsarmanesh, & H. Erbe (Eds.), *Advances in networked enterprises: Virtual organisations, balanced automation, and systems integration* (pp. 15-24). Berlin: Kluwer Academic Publishers.

Dai, Q., & Kauffman, R. (2001). *Business models for internet-based e-procurement systems and B2B electronic markets: An exploratory assessment.* Paper presented at the 34th Hawaii International Conference on Systems Science, Maui, HI.

Data_Junction. (2002). *Web services: The new generation of application integration* [Report]. Data Junction Corporation. Retrieved from http://www.datajunction.com

Dignum, F. (2000). Agents, markets, institutions and protocols, *European perspectives on agent mediated electronic commerce* (pp. 98-114). Springer Verlag.

ebXML. (2001). *Technical architecture specification v1.0.4.* United Nations body for Trade Facilitation and Electronic Business (UN/CEFACT) and Organization for the Advancement of Structured Information Standards (OASIS). Retrieved from http://www.ebxml.org/specdrafts/ebXML_TA_v1.0.4.pdf

Elemica. (2005). *Elemica Overview*. Elemica. Retrieved April, 2005 from the World Wide Web at: http://www.elemica.com

Eriksson, D. (2001). *Contracts and responsibilities in open multiagent systems* (Report in Course on Advanced Software Engineering Topic). Department of Software Engineering and Computer Science, Blekinge Institute of Technology.

ESPRIT. (1997). *ESPRIT and ACTS Projects related to Electronic Commerce*. Esprit Programme & ISPO — Information Society Project Office. Retrieved from http://www.cordis.lu/esprit/src/ecomproj.htm

European_Commission. (1996). *Regulatory transparency in the internal market for information society services* (Proposal for a European and Council Directive amending for the third time Directive 83/189/EEC COM(96) 392). Brussels: European Commission.

European_Commission. (1997). *Uma iniciativa europeia para o comércio electrónico* (Comunicação ao Parlamento Europeu, ao Conselho, ao Comité Económico e Social e ao Comité das Regiões COM(97) 157). Brussels: European Commission.

European_Union. (1999). *EU Directive 1999/93/EC of 13 December 1999 on a Community Framework for Electronic Signatures*. Brussels: European Union.

Eversheim, W., Bauernhansl, T., Bremer, T., Molina, A., Achuth, S., & Walz, M. (1998). Configuration of virtual enterprises based on a framework for global virtual business. In P. Sieber & J. Griese (Eds.), *Proceedings of the 1st VoNet Workshop*. Simowa Verlag Bern.

Fox, M. S., Barbuceanu, M., & Teigen, M. (2000). Agent-oriented supply chain management. *International Journal of Flexible Manufacturing Systems, 12*(2), 165-188.

Freeman, C., & Soete, L. (1997). *The economics of industrial innovation* (3rd ed.). London: Pinter.

Gartner_Research. (2001, July 2001). Top issues in Gartner Research. *The Monthly Research Review*, 11-27.

GlobalSources. (2005, July 25). *Welcome to global sources investor relations*. Trade Media Holdings Ltd. Retrieved July 24, 2005 from http://www.corporate.globalsources.com/IRS/IROVW.htm

Guttman, R., Moukas, A., & Maes, P. (1998). *Agent-mediated electronic commerce: A survey*. Knowledge Engineering Review. Retrieved from http://ecommerce.media.mit.edu/

Hands, J., Bessonov, M., Blinov, M., Patel, A., & Smith, R. (2000). An inclusive and extensible architecture for electronic brokerage. *Decision Support Systems, 29*, 305-321.

Jarvenpaa, S. L., Shaw, T. R., & Staples, D. S. (2004). Toward contextualizes theories of trust: The role of trust in global virtual teams. *Information Systems Research, 15*(3), 250-267.

Jennings, N. R., Farantin, P., Johnson, M., O'Brien, P., & Wiegand, M. (1996a). Agent-based business process management. *International Journal of Cooperative Information Systems, 5*(2-3), 105-130.

Jennings, N. R., Farantin, P., Johnson, M., O'Brien, P., & Wiegand, M. (1996b). Using intelligent agents to manage business processes, *Proceedings of the First International Conference on the Practical Application of Intelligent Agents and Multi Agent Technology*. London.

Jennings, N. R., Sycara, K., & Wooldridge, M. (1998). A roadmap of agent research and development, *Autonomous agents and multi-agent systems* (Vol. 1, pp. 275-306). The Netherlands: Kluwer Academics.

Jennings, N. R., & Wooldridge, M. (1998). Applications of intelligent agents. In N. Jennings & M. Wooldrodge (Eds.), *Agent technology: Foundations, applications and markets* (pp. 3-28): Springer-Verlag.

Kanet, J., Faisst, W., & Mertens, P. (1999). Application of information technology to a virtual enterprise broker: The case of Bill Epstein. *International Journal of Production Economics, 62*, 23-32.

Lauren, J. (2003). *Significant e-Marketplaces* (Electronic source): eMarket Services. Retrieved from http://www.emarketservices.com

Laurikkala, H., & Tanskanen. (2002). Managing contracts in virtual project supply chains. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 93-100). Boston: Kluwer Academic Publishers.

Lenz, K., Oberweis, A., & Schneider, S. (2001). Trust based contracting in virtual organizations: A concept based on contract workflow management systems. In B. Schmid & K. Stanoevska-Slabeva & V. Tschammer (Eds.), *Towards the E-Society — E-Commerce, E-Business and E-Government* (pp. 3-16). Boston: Kluwer Academic.

Line56. (2000). *The paradox of RosettaNet*. Line 56, September 2000. Retrieved from http://www.line56.com

Manfred, A. J., & de Moor, A. (2001). Concept integration precedes enterprise integration, *Proceedings of the 34th Hawaii International Conference of Systems Sciences (HICSS-34)*. Island of Maui, Hawaii.

Metcalfe, D. (2004). *Surging elemica signals the rise of the networks* (Brief): Forrester Research. Retrieved from http://www.forester.com

MfgQuote. (2005). *eSourcing Update* (MfgQuote.com — eSourcing News. Volume I, Issue 3): MfgQuote.com. Retrieved from http://www.mfgquote.com

MIT_Media_Lab. (2001, May). *Projects*. Software Agents Group, Massachusetts Institute of Technology, http://www.ecommerce.media.mit.edu/, (December 2001). Retrieved December 2001, from http://www.ecommerce.media.mit.edu/

Mitsuishi, M., Nagao, T., Hatamura, Y., Kramer, B., & Warisawa, S. (1992). A manufacturing system for the global age. In G. J. Olling & F. Kimura (Eds.), *Human aspects in computer integrated manufacturing* (pp. 841-852): North-Holland.

Moreira, F. (1998). *Operação e Controlo de Equipamento Industrial à Distância: Desenvolvimento de Teleserviços para Sistemas CAM*. Unpublished Tese de Mestrado em Produção Integrada por Computador, Universidade do Minho, Guimarães, Portugal.

MSI. (1997). *Livro Verde para a Sociedade da Informação em Portugal*. Lisboa: Missão para a Sociedade da Informação, Ministério da Ciência e da Tecnologia.

Nwana, H. S., Lee, L. C., & Jennings, N. R. (1996). Coordination in software agent systems. *BT Technology Journal, 14*(4), 79-88.

OECD. (1996). *Information infrastructure convergence and pricing — The internet* (Report GD(96)73): OECD. Retrieved from http://www.oecd.org/dsti/gd_docs/

OECD. (2000). *Competition issues in electronic commerce*. Paris: Organisation for Economic Co-operation and Development. Retrieved from http://www.oecd.org/daf/clp/roundtables/e-com.pdf

OECD. (2001). *The new economy beyond the hype: The OECD Growth Project*. Paris: Organisation for Economic Co-operation and Development.

OECD. (2004). *ICT, e-Business and SMEs*. Paris: Working Party on the Information Economy. OECD, Organisation for Economic Co-operation and Development. Retrieved from http://www.oecd.org/dsti/gd_docs/

Oliveira, E. (1999). *Applications of intelligent agent-based systems.* Paper presented at the 4º Simpósio Brasileiro de Automação Inteligente, SBAI, São Paulo, SP.

O'Sullivan, D. (1998). Communications technologies for the extended enterprise. *Int. Journal of Production Planning and Control*, *9*(8), 742-753.

Pahladsingh, S. (2005). *e-Marketplaces in the retail & consumer goods industry* (Electronic source): eMarket Services. Retrieved from http://www.emarketservices.com

Putnik, G. D. (2000). BM_Virtual Enterprise Architecture Reference Model. In A. Gunasekaran (Ed.), *Agile manufacturing: 21st century manufacturing strategy* (pp. 73-93). UK: Elsevier Science.

Putnik, G. D., Sousa, R. M., Moreira, J. F., Carvalho, J. D., Spasic, Z., & Babic, B. (1998). Distributed / virtual manufacturing system cell: An experimental installation, *Proceedings of 4th International Seminar on Intelligent Manufacturing Systems*. Belgrade, Yugoslavia.

Rabelo, J., & M., S. L. (1997). Mobile-agent-based supervision in supply chain management in the food industry, *Proceedings of Agrosoft'97 — Workshop on Supply-Chain Management* (pp. 451-459). Belo Horizonte, Brasil.

Rocha, A., & Oliveira, E. (1999). An electronic market architecture for the formation of virtual enterprises. In L. M. Camarinha-Matos & H. Afsarmanesh (Eds.), *Infrastructures for virtual enterprises: Networking industrial enterprises* (pp. 421-432). Porto: Kluwer Academic.

RosettaNet. (2002). *Implementing RosettaNet E-Business standards for greater supply chain collaboration and efficiency* (White Paper): RosettaNet. Retrieved from http://www.rosettanet.org/rosettanet/doc/

RosettaNet. (2003). *RosettaNet and Web Services: An executive-level view of RosettaNet and an emerging model for application-based B2B commerce* (White Paper): RosettaNet. Retrieved from http://www.rosettanet.org/rosettanet/doc/

Sakar, M., Butler, B., & Steinfield, C. (1995). Intermediaries and cybermediaries: A continuing role for mediating players in the electronic commerce marketplace. *Journal of Computer Mediated Communication, 1*(3).

Sandholm, T. W. (1999). An algorithm for optimal winner determination in combinatorial auctions. *Workshop on Intelligent Information Integration (IJCAI'99),* 542-547.

Schumpeter, J. A. (1939). *Business cycles*. New York: McGraw-Hill.

Segev, A., Gebauer, J., & Frank, F. (1999). Internet-based electronic markets. *EM — International Journal of Electronic Markets*, *9*(3).

Shen, W., Ulieru, M., Norrie, D. H., & Kremer, R. (1999, May 1999). *Implementing the internet-enabled supply chain through a collaborative agent system.* Paper presented at the Agent's 99 Workshop on Agent-Based Decision Support for Managing the Internet-Enabled Supply Chain, Seattle.

Sihn, W., Palm, D., & Wiednmann, H. (2000). Virtual marketplace for SME co-operation. In Parsei & et al. (Eds.), *Integrated Technology Systems: Academic and Industry Collaboration in Engineering Design and Automation for the New Millenium: Proceedings, 4th International Conference on Engineering Design and Automation*. Orlando, Florida.

Singh, V. (2004). *e-Marketplace Development* (Electronic source): eMarket Services. Retrieved from http://www.emarketservices.com

Thomas, C. (2001). *E-Markets 2000* (Case Number: EC-23). Stanford, CA: Graduate School of Business, Stanford University.

Tsvetovatyy, M., Gini, M., Mobaster, B., & Wieckowski, Z. (1997). MAGMA: An agent-based virtual market for electronic commerce. *Journal of Applied Artificial Intelligence, 11* (Special Issue on Intelligent Agents).

UDDI. (2001). *UDDI version 2 Programmers API Specification* [Report]. UDDI. Retrieved from http://www.uddi.org/pubs/ProgrammersAPI-V2.00-Open-20010608.pdf

UDDI. (2004). *The universal description, discovery and integration (UDDI) specification*. UDDI. Retrieved from http://www.uddi.org/

Viamonte, M. J., & Ramos, C. (2000). A model for an electronic marketplace. *European perspectives on agent mediated electronic commerce* (pp. 115-125). Springer-Verlag.

W3C. (2001). *Extensible markup language (XML), 1.0, second edition* (W3C Recommendation): WWW Consortium XML Working Group. Retrieved fromhttp://www.w3c.org/TR/2000/REC-xml-20001006

Waldo, J. (2002). Virtual organizations, pervasive computing, and an infrastructure for networking at the edge. *Information Systems Frontiers, 4*(1).

Wang, H. J., Cheng, H. K., & Zhao, J. L. (2004). Web services enabled e-market access control model. *International Journal of Web Services Research, 1*(1), 21-40.

Wassenaar, A., Govindaraju, R., Bragado, E. M., Meijer, A., Ribbers, P., & Swagerman, D. (1998). Lessons from managerial theories for improving virtualness in electronic business. In P. Sieber & J. Griese (Eds.), *Proceedings of the VoNet Workshop* (pp. 107-122). Bern: Simowa Verlag Bern.

Whatis.*Online glossary*. Whatis.com, Inc. Retrieved from http://www.whatis.com/workflow.htm

Wingand, R., Picot, A., & Reichwald, R. (1997). *Information, organisation and management: Expanding markets and corporate boundaries*. Chichester, UK: John Wiley.

Wooldridge, M. (1997). Agent-based software engineering. *IEE Proc. Software Engineering, 144*, 26-37.

Wooldridge, M. (1999). Intelligent agents. In G. Weiss (Ed.), *Multiagent systems: A modern approach to distributed artificial intelligence* (pp. 27-78). Cambridge, MA: The MIT Press.

Wooldridge, M., & Jennings, N. R. (1995a). Agent theories, architectures and lLanguages: A survey. In M. Wooldridge & N. R. Jennings (Eds.), *Intelligent agents: Theories, architectures and languages* (Vol. LNAI Vol 890, pp. 1-39). Heidelberg, Germany: Springer-Verlag.

Wooldridge, M., & Jennings, N. R. (1995b). Intelligent sgents: Theory and practice. *The Knowledge Engineering Review, 10*(2), 115-152.

Endnotes

1 An explanation of those properties can be found in Dignum (2000).

2 *eHub* or simply *Hub* and *eMarket* will be used in the text as synonymous for eMarketplace.

[3] http://www.biosupplies.com.au

[4] http://www.alliedelec.com

[5] http://www.telezoo.com

[6] http://www.simplexity.com

[7] http://www.covisint.com

[8] http://www.chemconnect.com

[9] http://www.newview.com

[10] http://www.plasticsnet.com

[11] http://www.globalsources.com

[12] http://www.commerceone.com

[13] http://www.alliedelec.com

[14] We are not concerned with commodity markets for large-volume trades of agricultural goods, precious metals, or financial products. Our approach also excludes consumer-oriented markets and shopping malls.

[15] A detailed broker functions taxonomy can be found in Ávila, Putnik, and Cunha (2002).

[16] http://www.uncefact.org

[17] http://www.oasis-open.org

Chapter VII

Traditional Technologies to Support Agile/Virtual Enterprise Integration

Introduction

Since the mid-nineties, a considerable number of research and development projects and industrial initiatives have been undertaken to define infrastructures and supporting functionalities for Virtual Enterprise integration (i.e., computer supported tools and environments to support any or all of the following functions of the VE life cycle: VE design, search, negotiation, selection and integration of resources into a VE, and coordination functions).

Examples of such developments towards VE integration include:

- Agent technology, a promising approach to support electronic market brokerage and electronic negotiation; and
- Environments for virtual enterprise integration, as the electronic market-places, most of them supporting transaction facilities, negotiation and electronic contracting.

This chapter explains how "traditional" Internet-based tools (WWW search engines, WWW directories, electronic mail and e-marketplaces) can be used to support some of the functionalities required by the A/VE model, analyses costs of subcontracting, and introduces a cost-and-effort model that traduces the activities of A/VE integration that can be undertaken with the support of these traditional tools.

How Traditional Tools Support Agile/Virtual Enterprise Integration

In this section we explain how some traditional technologies are used in the search of resources to integrate an A/VE.

There is some tradition in the use of information technology systems to support or even automate purchasing activities. Usually, however, these systems do not cover the full purchasing process. Internet and World Wide Web technologies are raising hopes of supporting procurement processes, including the search of partners for a partnership, negotiation, contractualisation, in terms of quality, flexibility, speed, and cost efficiency (Cunha, Putnik, & Carvalho, 2002).

Our concept of the *traditional way* (using traditional tools) of searching partners, negotiating, etc., in order to create or reconfigure an A/VE, does not refer to paper-based methods, but to Internet-based methods. The traditional way can be supported by:

- *Internet search engines* and *Internet directories* that help users to find items by using keywords, supporting the information phase, in particular to find new sources. This method supports the search for basic and complex resources. After identifying the search domain (the set of resources providers corresponding to the results of the search using keywords), the process is performed by visiting the resources providers' Web pages, to evaluate their potential, resulting in the negotiation domain identification, followed by contacts by e-mail, exchange of information concerning the resources requirements, negotiation, and contractualisation. None of these are supported by computer-aided tools for selection, negotiation and contractualisation.
- *Internet-based catalogues* that allow buying organizations to browse, search, and/or place orders online. They combine and extend many features of existing channels, such as the content of printed catalogues, the

convenience of online shopping, and the searching capability. Additionally, they allow all parties to immediately track orders electronically.

- A growing number of *Internet-based online auctions* and *bidding systems* supports the negotiation phase by providing a simple negotiation mechanism although yet confined to price.
- The *electronic marketplaces*, namely those for indirect procurement, such as office supplies or computer equipment (i.e., non-production-related procurement), that let buyers combine catalogues from several suppliers, check the availability of items, place and track orders, and initiate payment over the Internet. Some e-marketplaces offer negotiation tools, support payments and contractualisation, but not in an integrated way.

A/VE integration requires specific functionalities of resources requirements specification, search of candidate resources providers, negotiation, payments, contractualisation, contract enforcement, etc., some of them already described in a macro way, which could be detailed in specific tasks.

Considering only the tasks that could be undertaken by the traditional tools (or *e-traditional*), Table 1 presents the main differences between these traditional tools in the way they perform the tasks. However, they do not support the most critical functionalities of the A/VE model, such as knowledge support (to avoid bad specifications of resources requirements or of negotiation parameters),

Table 1. Functionalities supported by the e-traditional ways of resources providers search and selection (Cunha et al., 2002)

Search and Selection Activities	**www search engines/ directories**	**Internet-based catalogues**	**Electronic negotiation (auctions)**	**E-Market places**
- Support for resources requirements specification	NO	YES / NO	YES / NO	YES / NO
- Gather information on candidate partners	YES	YES	YES	YES
- Exchange information	NO	YES	NO	YES
- Support negotiation of resources provision	NO	YES / NO	YES	YES
- Negotiate, validate and sign contract	NO	YES / NO	YES	YES
- Contract enforcement	NO	NO	NO	YES / NO
- Payments	NO	YES	YES	YES

trust, historical information on performance of providers in previous partnerships, monitor and control of the resources providers performance after integration, etc.). An e-marketplace is valuable in terms of electronic procurement, but unable to solve the problem of selecting a partner able to provide an operation/service (resource) to integrate a VE, or to identify reconfiguration opportunities.

Costs of Subcontracting

A critical aspect of subcontracting is to define the terms of the relationship, a process that involves the governance structure of ownership and the contract. In an ideal world, a firm makes an informed assessment of the relevant costs, benefits and risks of outsourcing versus internal procurement (Clemons, Hitt, & Snir, 2000); if there exists a profitable outsourcing opportunity, the client and the suppliers enter into a contract with a full knowledge of the nature of the resource to be provided and the capabilities of the suppliers. This contract covers all aspects of the resources to be delivered and payments to be made, including contingency plans for unforeseen events. Both parties are fully aware of the terms of the contract and if they are not met, appropriate actions can be enforced by a third party, such as a court or arbitrator.

But most contractual relationships cannot meet these ideal conditions, and when thinking about integrating an A/VE rather than outsourcing a service or a set of simple products or operations, the difficulties arise. Selection, negotiation, contractualisation and enforcement can be too complex and too delicate. There is a vast spectrum of available resources providers, each with different characteristics, leading to unique trade-offs in the selection and integration decision. In some cases the contracted services are well-defined and commonplace, involving minimal risk, but frequently the contracted services are ill-defined, or even the service redefinition is subcontracted (Clemons et al., 2000).

While market-based transactions offer the potential for lowering cost or improving profitability, there are also costs associated with procuring services. The costs of outsourcing are composed of both the explicit cost of carrying out the transaction as well as hidden costs due to coordination difficulties and contractual risks. To Besanko et al. (1996), the major costs associated with subcontracting include: (1) the costs of coordination between steps in the vertical chain, (2) the leakage of private information, and (3) transaction costs.

From this set of costs, the first two are of difficult quantification, but the Market of Resources intends to contribute to its reduction, as we discuss in this section, while the third is quantifiable.

Leakage of Private Information

A firm's private information is information that no one else knows, and gives a firm an advantage in the market (Besanko et al., 1996). It may concern to production know-how, product design or consumer information, but when firms use the market to subcontract, they risk losing control of such type of information (Besanko et al., 1996). The A/VE integration using traditional tools has no means to avoid or to reduce this risk.

The Market of Resources can enforce participants to respect that information and, when it is proven a leakage of information, the contracts prevent an indemnity and/or the expulsion from the Market of Resources of the entity that failed to accomplish the duty of seal.

Transaction Costs

The concept of *transaction costs* was described by Coase (1937) as the costs incurred by using market transactions, and which are eliminated by using the firm (centralised direction).

Transaction Cost Theory (Coase, 1937; Williamson, 1975) is an often employed framework in a firm's choice between internalised, vertically integrated structures, and the use of external market agents for carrying out activities that constitute its value system. It can be used to articulate the decision process whereby firms either "make or buy" an intermediary function, that is, whether the firm decides to internalise the function within its organisational boundaries or it chooses to rely on the market. According to *Transaction Cost Economics* (TCE), a firm has two options for organising its economic activities: an internal hierarchical structure, where the function is integrated into its management structure, or a market-like relationship with external firms (Williamson, 1975). When the market mechanism is at work, the flow of materials and services takes the form of external transactions and is coordinated by market forces (Sarkar, Butler, & Steinfield, 1995).

Transaction costs include the time and expense of negotiating, writing and enforcing contracts. They include the adverse consequences of opportunistic behaviour, as well as the costs of trying to prevent it.

Transaction costs can be decomposed into four separate costs, related to transacting *search costs*, *contracting costs*, *monitoring costs* and *enforcement costs* (Williamson, 1985). The meaning of these costs is (Dyer & Wujin, 1997):

- **Search costs:** Costs of gathering information to identify and evaluate potential trading partners;
- **Contracting costs:** Costs associated with negotiating and establishment of contract;
- **Monitoring costs:** Associated with monitoring the accomplishment of the contract and ensure that each party fulfils the predetermined set of obligations;
- **Enforcement costs:** Costs associated with *ex post* haggling and sanctioning a trading partner that does not respect the contract.

Given that the component of cost — coordination flow — is independent of the method for integration (traditional tools or Market of Resources), as well as the attribution of a cost to the risk of leakage of private information, we will consider specially the search cost, the only that can be formulated and traduced by a mathematical expression allowing comparison between traditional method and Market of Resources. We will also assume that contracting, monitoring and enforcement costs via the Market of Resources will not be higher, due to the specialisation of the Market in performing contracts and advanced monitoring procedures.

We feel that an A/VE integration comparative cost model (Market of Resources versus the Internet-based traditional method) is a relatively straightforward application of TCE, keeping in mind that there remain costs associated with the development and coordination of external relationships as well as the costs required to establish the trust needed for truly A/VE, but correspond to functions independent of the method of resources search and selection.

Cost-and-Effort Model for Traditional Internet-Based A/VE Integration

In this section it is developed a cost model for A/VE integration using the above-described traditional method that will be used in the comparison with the Market of Resources performance.

Traditional E-Based A/VE Integration: Main Activities

In our cost-and-effort model, we are mostly concerned with search costs and contracting costs. Monitoring and enforcement costs can be done independently of the method, even if the A/VE integration has taken place in the Market of Resources environment.

The activities to perform in order to create a new A/VE (or to reconfigure an existing A/VE) that are of possible support by traditional Internet-based tools are the following:

- **A/VE Request[1]:** Undertaken by the "owner" of the A/VE, this activity corresponds to the preparation and the start of the search process, using one of the following methods: (1) the identification of the most appropriate directories/yellow pages Web categories to combine in order to address the potential resource providers for the required resource(s); (2) the execution of a search on the WWW using a search engine and a specific group of keywords that may allow the discovery of the potential resource providers or even (3) the submission of a request to a suitable electronic marketplace. It involves the preparation of the search and the start of the search process (for instance the request to be made to the e-procurement service, or the WWW search). Although in the traditional method, the activity of A/VE Request integrates only this subactivity, designated A/VE Design, we are using this classifications to allow the integration of this model with the Market of Resources cost-and-effort model. The result of the A/VE Request corresponds to the designated *search domain*, the domain where the eligible resources will be searched.
- **Resources Search and Selection:** Involves the analysis within the search domain (the results of the WWW search), by contacting the resources providers of the search domain or visiting its Web pages, in order to identify the eligible resources providers; negotiation will take place within the set of eligible resources providers, to select the candidate providers for integration and finally the selection of the best available solution to the A/VE. If using an e-marketplace, this step of eligible resources identification can be automated. Possible negotiation methods are: (1) manual direct negotiation (through *request for bids*, or individually with each eligible resource provider), if directly searching the WWW; (2) auction/reverse auction if using an online auction service; and (3) possibly automated (reverse auction), if using an e-marketplace.
- **A/VE Integration (contractualisation and establishment of the network):** Some traditional mechanisms can support automated contractualisation (e-contracts), otherwise it must be done manually, as well as contract management. None of the methods support enforcement, as far as our research has confirmed, neither offer monitoring and coordination mechanisms.

Table 2. Description of A/V E creation activities (traditional e-based way)

Activity	Activity Description
A/V E Request	
- *A/V E Design*	- Selection of the directory category/subcategories that best traduce the required resources, or search using a WWW search engine (search domain identification).
Resources Search and Selection	
- *Eligible Resources Identification*	- Analysis and sorting of the results of searching the Web (search domain) and identification of which of them can contain the solution (visit domain); - Visit to this set (visit domain) and identification of its eligibility, to reduce the domain for negotiation (negotiation domain or eligible resources domain); - Eligible resources will be a subset of the visited resources.
- *Negotiation*	- Negotiation with the eligible resources, to identify the candidate resources for integration; the traditional method forces to a manual request for bids (RFB) or direct negotiation.
- *Selection*	- Sorting of the negotiation results and identification of the best combination of resources providers, and confirmation with the selected providers.
A/V E Integration	
- *Contractualisation*	- By e-mail, using the digital signature facilities; - Elaboration of specific contracts for every situation; - Negotiation of contracts terms with suppliers.

These activities are listed in Table 2, based on the utilisation of a World Wide Web search engine or directory and electronic mail.

Influence of Selection Models

There is a major difference between searching K resources under dependent and independent selection models. As the effort is greatly dependent of the solution space dimension, our model will consider two views — independent and dependent selection model.

Independent Selection Model

In the situation of performing a search on a WWW directory or using a search engine, we could consider that, for each required resource, a new search is to be undertaken. If K is the number of required resources, then the total effort to perform the search ($t_{K\ Resources\ search}$) is, in the limit, the sum of the effort to search each one of the K required resources ($t_{Resource\ i\ Search}$).

$$t_{K\ Resources\ search} = \sum_{i=1}^{K} t_{Resource\ i\ Search}$$

However, if we accept that some of the required resources are related and that the set of potential providers is in some cases coincident, some scale economies can be achieved, although considering independent selection. For example, if in a group of K resources, two of them can be provided by the same resources providers, then, when performing the A/VE Design operation (searching on the WWW using a search engine), only K-1 operations of A/VE Design would be required. Thus, the total effort to to perform the search ($t_{K\ Resources\ search}$) is situated in the interval:

$$t_{1\ Resource\ Search} \leq t_{K\ Resources\ search} \leq \sum_{i=1}^{K} t_{Resource\ i\ Search}$$

This could be a basic model, for small K. If dealing with a larger K, a factor of complexity, (traducing the complexity of managing a larger volume of data or dealing with a more complex project) growing exponentially with K, could be considered.

Dependent Selection Model

Selection time is a function of the Solution Space dimension, which depends on the selection model.

The traditional model, even considering the e-marketplaces, can hardly support dependent search. For each resource required, it is necessary to repeat the selection of eligible resources, negotiation, and so on, for all the possible combinations. The traditional model does not offer automated support, and dependent selection would correspond to an exponential effort for the user in managing all the candidate resources providers offers for each combination of primitive resources, run negotiations and, at the end, make the selection.

When searching for K resources (basic/complex) in dependent search model, using WWW search or a WWW directory or index, the combinations of the K

resources to be provided by a given resources provider must be negotiated one-by-one, within the N providers of the Search domain and decision making after having information of the up to N^K possible combinations (Solution Space).

Eligible resources providers' identification is performed only once within the Search domain, but for each eligible provider, the number of request for bids (RFB) or queries to perform in order to identify the candidate resources providers for integration is, on the limit:

$$\sum_{i=1}^{k} C_k^i$$

As the number of resources that a given resources provider is prequalified to provide can vary between 1 and all the K required resources, the number of request for bids (RFB) to perform with each of the N eligible resources providers is situated in the interval:

$$\boldsymbol{1 \leq \textit{number of RFB per Eligible Resource Provider}} \leq \sum_{i=1}^{k} C_k^i$$

Considering either an auction-based negotiation with the N eligible resources providers, or a direct negotiation, the total number of request for bids or of contacts is:

$$\boldsymbol{N \leq \textit{Total number of RFB}} \leq N * \sum_{i=1}^{k} C_k^i$$

Considering the analysis of the bids and final selection of the candidate resources for integration, the number of combinations to analyse (Solution Space) is:

$$\boldsymbol{N \leq \textit{Solution Space} \leq N^K}$$

It could also be considered a complexity factor, as the effort to specify, negotiate, and select is not a linear function of the number of required resources (K), but we will not suppose large K neither large N.

The Cost-and-Effort Model

Several parameters and variables, such as search domain dimension, A/VE project complexity, available time for integration, available knowledge to perform the search and negotiation, the availability of the solution, are critical to the performance of the resources selection and integration processes. Some of the parameters to consider could not be objectively quantified, as for example A/VE project complexity, or the required knowledge. Others are based on a different scale, such as available time for integration.

The A/VE project could involve highly integrated complex resources that could not be supplied by an e-marketplace, or it could not be possible to identify them using a WWW directory.

The model will not consider all the measures of performance. Our cost-and-effort model can only integrate the quantifiable variables common to both methods (the traditional tools and the Market of Resources).

Search effort (and cost) is mainly a function of:

- The complexity of the A/VE project, resultant of:
  - The number of resources to integrate, their interrelation or dependency, their specificity, their level in the product process plan.
  - The difficulty to express the A/VE project in a search on a WWW directory or their availability in an e-marketplace, due to the consequences of a deficient specification.

  The A/VE project complexity also impacts the time required for identification of eligible resources, for negotiation with each candidate resource, and for contractualisation, due to the lack of computer-aided facilities.
- The complexity inherent to the search process, itself function of the search domain, selection method (and consequently the solution space dimension), and the negotiation method. In the Market of Resources, the solution space dimension is not expected to be of major impact (because of automation of selection process), as it is when using the traditional way.
- The required knowledge to undertake the activities conducing to the A/VE design, search and negotiation. As a result of the project specificity and complexity, in a high complexity project, the user can require expert advisory, (which can be given by the broker in the Market of Resources). This advisory support will increase the cost.

Effort = f(A/VE project complexity, search complexity, required knowledge)

Search Complexity = f(Search Domain dimension, Selection method, Negotiation method, Solution Space dimension)

The main entity responsible of cost that we are going to consider is human resources time (i.e., the user time required for searching the WWW, visiting and negotiating with the eligible providers and decision-making time for selection).

From now on, we will designate as Cost the sum of Search Costs with Contracting Costs.

The model we have developed is based on several variables, represented by the abbreviations listed in Table 3, with the corresponding meaning.

Table 3. List of variables of the cost-and-effort model (traditional tools)

Abbreviations	Meaning
K	- The project complexity, that was simplified to consider only the number of required resources for integration.
SD	- Search Domain in the traditional method: the dimension of the result of the first step of the search in the WWW (using a search engine or a directory).
VD	- Visit Domain in traditional method: the number of resources to be visited in order to evaluate its eligibility (we will assume that VD = 20% * SD). As the results of the WWW search are not focused only 20% of SD will be visited.
ND	- Negotiation Domain, or eligible resources: the number of resources providers with whom to undertake a negotiation process. ND = VD * R1 = 20% * SD * R1.
CD	- Candidate resources providers, resultant from negotiation process. CD = ND * R2 = VD * R1 * R2.
SS	- Solution Space: possible combinations of resources providers in order to perform the final selection process.
C_x	- Fixed time constant (set-up time) to perform operation x (x = auction, direct negotiation or candidate resource evaluation regarding its selection).
t_x	- Time to perform operation x (x = design, analysis of results, visit to resource provider, request for bid, direct negotiation, candidate resource evaluation regarding its selection, contract negotiation).
R1	- Ratio between the identified eligible resources and the number of visited resources (VD): this ratio will be used in the simulations using this model. R1 = ND / VD.
R2	- Ratio between the identified candidate resources and the eligible resources (the proportion of the eligible resources classified as candidate resources: this ratio will be used in the simulations using this model. R2 = CD / ND.

Search and Selection of 1 Resource Using Independent Selection Model

The generic model for calculating the required time for searching 1 resource (basic or complex), *obviously* with an independent selection model is presented in Table 4.

The user of the traditional way can decide the dimension of the set of resources for visiting (VD). We only considered this set to be 20% of SD, but according to SD dimension, he can reduce or increase this percentage.

Table 4. Generic model of traditional e-based search and selection of one basic/complex resource using independent selection

Activity	Time	Assumptions /explanations
A/V E Request		
- *A/V E Design* *(T_D)*	$T_D = t_D$	t_D –time to perform the 1st step of the search for 1 resource (definition of the search domain, SD).
Resources Search and Selection - Identification of the required resource within SD		
- *Eligible Resources Identification* *(T_{ERI})*	$T_{ERI} = t_A * SD + t_E * VD$	t_A – time per analysis of each of the results contained in SD, to identify the resources to be visited. t_E – time per resource provider visit, to determine its eligibility considering that 20% of SD will be visited (VD).
- *Negotiation*	ND = R1 * VD corresponds to the eligible resources, with whom to undertake the negotiation.	
. Request for bids *(T_{RFB})*	$T_{RFB} = C_{RfB} + t_{RfB} * ND$	C_{RfB} – negotiation setup time or auction set-up time. T_{RfB} – time per contact and request for bid.
. Direct Negotiation *(T_{DN})*	$T_{DN} = C_{Dn} + t_{Dn} * ND$	C_{Dn} – direct negotiation set-up time t_{Dn} – time per direct negotiation process.
- *Selection* *(T_S)*	$T_S = C_S + t_S * CD$	C_S – selection set-up time. t_{ST} – selection time per candidate resource (evaluation of negotiation results).
A/V E Integration		
- *Contractualisation* *(T_C)*	$T_C = t_C$	t_C – contract negotiation with the selected resource.

Search and Selection of K Resources Using Independent Selection Model

Searching *K* resources (basic or complex) using independent selection can be considered, on the limit, the undertaking on *K* independent processes of search and selection. However, and as previously mentioned, this is the upper limit. As

Table 5. Generic model of traditional e-based search and selection of K resources using independent selection

Activity	Time	Assumptions /explanations
A/V E Request		
- *A/V E Design (T_D)*	$T_D \leq K * t_{Di}$	On the limit, K independent processes of identification of the Search Domains (SD_i). t_{Di} – time to perform the 1st step of the search for resource *i* (definition of the search domain SD_i), $\forall i \in [1:K]$.
Resources Selection		
- *Eligible Resources Identification (T_{ERI})*	$T_{ERI} \leq [\sum_{i=1}^{K} (t_{Ai} * SD_i) + \sum_{i=1}^{K} (t_{Ei} * VD_i)]$	t_{Ai} – time per analysis of each of the results contained in SD_i, to identify the resources to be visited. t_{Ei} – time per resource provider visit, to determine its eligibility, for each required resource *i*.
- *Negotiation*	$ND_i = R1 * VD_i$ corresponds to the eligible resources for each required resource *i*, with whom to undertake the negotiation. $R2_i * ND_i$ ($=CD_i$) corresponds to the candidate resources for the selection of the required resource *i*.	
. Request for bids (reverse negotiation) (T_{RFB})	$T_{RFB} = K * C_{RfBi} + \sum_{i=1}^{K} (t_{RfBi} * ND_i)$	C_{RfBi} – negotiation set-up time for each required resource *i*. t_{RfBi} – time per contact and request for bid within the eligible resources for the provision of each required resource *i*.
. Direct Negotiation (T_{DN})	$T_{DN} = K * C_{Dni} + \sum_{i=1}^{K} (t_{Dni} * ND_i)$	C_{Dni} – negotiation set-up time for each required resource *i*. t_{Dni} – time per direct negotiation within the eligible resources for the provision of each required resource *i*.
- *Selection (T_S)*	$T_S = K * C_{Si} + \sum_{i=1}^{K} (t_{Si} * CD_i)$	C_{Si} – selection setup time for each required resource *i*. t_{Si} – time per candidate resource.
A/V E Integration		
- *Contractualisation (T_C)*	$T_C = K * t_C$	t_C – contract negotiation per selected resource.

the *K* resources belong to the same A/VE Project, some effort saving could be archived in the activities of A/VE Request and Eligible Resources Identification.

The generic model for calculating the required time for searching *K* resources (basic or complex), with an independent selection model is presented in Table 5.

The model could be designed associating also a selection complexity parcel or a selection complexity factor to the time of some activities, for example, instead of a linear relation between selection time and *K*, due to the constant value of t_{Si} (time per candidate resource selection), the variable t_S could be affected by factor traducing the complexity associated with a larger number of candidate resources.

This way, the selection time for a given resource selection (K=1), could be given by the expression:

$C_{Si} + t_{Si} * CD_i + (P_S * CD_i)$ - considering an linear complexity parcel ($P_S > 0$)

$C_{Si} + t_{Si} * CD_i^{FS}$ - considering a complexity factor ($F_S > 1$)

Search and Selection of K Resources Using Dependent Selection Model

It is not possible to consider the search of 1 resource under dependent selection model. In the dependent selection, *K* >= 2 resources.

Using a WWW search for each of the *K* required resources or by combination of similar resources (to benefit from some effort savings), a search domain (SD) should be found. The identification of the *K* sets of eligible resources providers is obtained, as in independent selection, by analysing potential providers and visiting the selected ones.

The result is *K* sets of Negotiation Domains (ND_i, $1 \leq i \leq K$). Merging these *K* Negotiation Domains and eliminating repetitions, it is obtained a global negotiation domain (*ND*) containing all the eligible providers of between one and *K* resources.

It is within this set of all the possible combinations of the *ND* resources providers to provide the required *K* resources that negotiation is to take place. Each of the *ND* resources providers is required to present its bid for all the combinations of resources he was considered eligible to provide.

This negotiation results in the identification of the candidate resources and the set of all possible combinations of these to provide the *K* resources corresponds to the Solution Space. The evaluation of the possible solutions (solution space) in order to select the providers is very complex and hard.

Table 6. Generic model of traditional e-based search and selection of K resources using dependent selection

Activity	Time	Assumptions /explanations
A/V E Request		
- *A/V E Design (T_D)*	$T_D \leq K * t_{Di}$	On the limit, K independent processes of identification of the Search Domains (SD_i). t_{Di} –time to perform the 1st step of the search for resource *i* (definition of the search domain SD_{Ti}), $\forall i \in [1:K]$.
Resources Selection		
- *Eligible Resources Identification (T_{ERI})*	$T_{ERI} \leq [\sum_{i=1}^{K} (t_{Ai} * SD_i) + \sum_{i=1}^{K} (t_{Ei} * VD_i)]$	t_{Ai} – time per analysis of each of the results contained in SD_i, to identify the resources to be visited. t_{Ei} – time per resource provider visit, to determine its eligibility, for each required resource *i*.
- *Negotiation*	$ND \leq \sum_{i=1}^{K} (R1 * VD_i)$ → requires elimination of repetitions. R2 * ND corresponds to the candidate resources for the selection of the required *K* resources providers.	
. Request for bids (reverse negotiation) (T_{RFB})	$T_{RFB} \leq [K * C_{RfB} + ND * \sum_{i=1}^{k} C_k^i * t_{RfB}]$	C_{RfB} – negotiation set-up time for each required resource. t_{RfB} – time per contact and request for bid within a given auction, for each resource.
. Direct Negotiation (T_{DN})	$T_{DN} \leq [K * C_{Dn} + ND * \sum_{i=1}^{k} C_k^i * t_{Dn}]$	C_{Dn} – negotiation set-up time for each resource. t_{Dn} – time per direct negotiation within the eligible resources *i*.
- *Selection (T_S)*	$T_S \leq [K * C_S + CD^K * t_S]$ *or* $T_S = K * C_S + SS * t_S$	C_S – selection set-up time for each required resource. t_S – time per candidate resource.
A/V E Integration		
- *Contractualisation (T_C)*	$T_C = K * t_C$	t_C – contract negotiation per selected resource.

$$\textit{Solution Space Dimension (SS)} \leq (R2 * ND)^K$$

Table 6 presents the generic model for calculating the required time for searching *K* resources (basic or complex), using dependent selection model.

Summary

We have discussed, in this chapter, how Internet-based technologies and tools can help some activities of A/VE integration. Internet search engines, electronic mail, online catalogues, auction and biding systems and electronic marketplaces can support some activities of partners search, gathering information about potential participants, negotiation, contract negotiation, etc. But networked organizational models have implicit cots when compared with vertically integrated models owning all the resources in its four walls: the cost associated to leakage of private information and transaction costs are the two classes of cost to consider and control. The chapter introduced a cost-and-effort model to traduce A/VE integration using the traditional tools and considering two of the four classes of transaction costs: search and contracting costs. This model was developed in harmony with the cost-and-effort model to be introduced in Chapter VIII for the Market of Resources, to allow a comparative analysis of performances of both ways in the support of A/VE integration.

References

Besanko, D., Dranove, D., & Shanley, M. (1996). *Economics of strategy*. New York: John Wiley.

Clemons, E. K., Hitt, L. M., & Snir, E. (2000). *A risk analysis framework for information technology outsourcing* (Working Paper). Pensylvania: University of Pensylvania.

Coase, R. (1937). The nature of the firm. *Economica, 4,* 386-405.

Cunha, M. M., Putnik, G. D., & Carvalho, J. D. (2002, November 1-2). Infrastructures to support virtual enterprise integration. In R. Hackney (Ed.), *Proceedings of 12th Annual BIT Conference — Business Information Technology Management: Semantic Futures*. Manchester, UK, The Manchester Metropolitan University (CD-ROM).

Dyer, J. H., & Wujin, C. (1997). *The determinants and economic outcomes of trust in supplier-buyer relations* (Working Paper). International Motor Vehicle Program.

Sarkar, M., Butler, B., & Steinfield, C. (1995). Intermediaries and cybermediaries: A continuing role for mediating players in the electronic commerce marketplace. *Journal of Computer Mediated Communication, 1*(3).

Williamson, O. (1975). *Markets and hierarchies: Analysis and antitrust implications*. New York: Free Press.

Williamson, O. (Ed.). (1985). *The economic institutions of capitalism*. New York: Free Press.

Endnote

1 Let us call it VE Request, for consistency with the designations to be used in the Market of Resources.

Chapter VIII

The Organizational Model for a Market of Resources

Introduction

This chapter presents a complete specification of the Market of Resources, to allow a complete understanding of how is this environment able to support the implementation and management of Agile/Virtual Enterprises.

The model of the Market of Resources includes three views:

1. The functional specification of the service provided, its processes structure and data structure using IDEF0 and IDEF1x modelling techniques;
2. The definition of a regulation regarding the operation and management procedures of the Market of Resources; and
3. A cost and effort model to allow a further analysis of the model performance.

The chapter starts with the selection of an adequate methodology to adopt in the functional specification of the Market, justifying the option by the IDEF[1] suit, and also presents the main topics of this technique to prepare the not familiarized reader to better understand the diagrams.

The Global Structure of the Market of Resources section presents the overall structure of the Market of Resources, the entities present and the relationships between them, defines the main concepts (such as resource, resource provider, negotiation, etc.) and details how A/V E design, integration and reconfiguration takes place and is supported by the Market.

The Market of Resources Project section describes the creation of the Market of Resources, its organization, maintenance and optimization. This section also introduces a regulation guiding the Market of Resources project (creation and management), a "design rules system" describing and regulating the processes of subscription and unsubscription of the service by the participating entities, their corresponding duties and responsibilities.

The Operation of the Market of Resources section, details the main operations performed by the Market of Resources, concerning requests for A/V E creation or reconfiguration, negotiation and contractualization. The section also introduces an "operation rules system" regulating A/V E design and integration and A/V E operation, including contractualization procedures, negotiation between resources providers and selection, taxation and operation management.

To complete the specification, this chapter presents the overall data architecture to support the Market of Resources, based on IDEF1x diagrams, and the final section introduces the cost and effort model developed to traduce the operation of the Market of Resources, with the purpose to allow the comparison of performance between the Market of Resources and the traditional, Internet-based technologies (introduced in Chapter VII), in the support of activities of A/V E integration.

A Methodology for the Functional Specification

A model is an abstract representation of reality that excludes details of the world, which are not of interest to the modeler, or the ultimate users of the model (Presley, 1997). Ross and Schoman (1977) lists the four main requirements of any modelling technique. These include:

- A distinct purpose for the model,
- The range of the model, which is commonly referred to as the boundaries of the model,
- The viewpoint of the model, and
- The detailing level of the model.

Major research and development activities in the area of software engineering during the last decades have resulted in the development of relevant methods for system description and specification in the following fields:

- **Information or Data Modelling:** Entity-Relationship (E/R) (Chen, 1976);
- **Functional and Process Modelling:** Structured Analysis and Design Technique (SADT) (Ross, 1977), Structured Analysis (SA) (Yourdon, 1989), Petri-Net-based Methods, etc.;
- **Object Oriented Modelling:** Objected Oriented Modelling Technique (Rumbaugh & Blaha, 1991), *Unified Modelling Language (UML)*.

Extensive work has been undertaken in the development of enterprise architectures and frameworks, some of them as result of major research and development projects in the field of CIM (*Computer Integrated Manufacturing*). Examples of methods for enterprise modeling include:

- **ARIS (Architecture of Integrated Information Systems)** (Scheer, 1994).
- **IDEF (ICAM Definition Method):** includes a series of modelling methods for functional modelling, information modelling, business process modeling, object modelling and for ontology modelling (SofTech, 1981).
- **GRAI-GIM: GIM (Grai Integrated Methodology):** a methodology for design and analysis of production systems (Doumeingts, Vallespir, Zanettin, & Chen, 1992).
- **CIMOSA (CIM Open System Architecture):** provides guidelines, architecture and an advanced modelling language for enterprise modelling (ESPRIT-Consortium-AMICE, 1989).
- **PERA (Purdue Enterprise Reference Architecture):** a methodology for enterprise engineering of industrial plants (Williams, 1996).
- **ISA (Information Systems Architecture):** frequently called the Zachman Framework (Sowa & Zachman, 1992; Zachman, 1987).

- **GERAM (Generalized Enterprise Reference Architecture and Methodology):** a generalization of CIMOSA, GIM and PERA (IFIP-IFAC_Task_Force, 1999).

For the purpose of specifying the structure of the Market of Resources we need a methodology able to represent the structural aspect of the proposed environment, the entities of data manipulated and the processes they are involved in.

There are several ways to model a system, from process-centred to data-centred models. Different types of methodologies could be used for our purposes, from the typical process-centred methodologies of the information systems development, as Structured Analysis (consisting on Data Flow Diagrams complemented with the Entity-Relationship data model), Systems Analysis and Design Technique (on the origin of IDEF modelling) to the data centred models, as the Object Oriented approach.

We have opted by a process-centred methodology because we want to model a service from the perspective of the processes, the sequencing of actions, and data flows. This does not mean we are not concerned with the description of data. Data-centred methodologies support a formal description of data but are poor in the description of the system activities or processes.

Process models offer a systematic, well-defined way of representing the structure of a firm's operations (Busby & Williams, 1993). They record the activities that are performed in order to achieve a well-defined purpose of some kind, together with the activities' inter-dependencies. There are many types of process models, the most common are probably flow charts, which represent a process as a series of steps with arrows connecting the order in which they are performed (Malone, Crowston, Lee, & Pentland, 1993). Data flow diagrams are similar, but show ordering relationships by focusing on the data interdependencies of the steps. Other approaches to representing processes include state transition diagrams, Petri nets, simulation models, etc., but these are not able to support simultaneously the structural aspects of the system, the data architecture and the dynamic aspect.

A model is a representation of a set of components of a system or subject area, and is developed for understanding, analysis, improvement or replacement of the system. Systems are composed of interfacing or interdependent parts that work together to perform a useful function. System parts can be any combination of things, including people, information, software, processes, equipment, products or raw materials. The model must describe what a system does, what controls it, what things it works on, what means it uses to perform its functions, and what it produces.

The IDEF Method

To the specification of the Market of Resources, and given the above description of what is expected from a model, we opted by using a modelling methodology composed by a modeling language (semantics and syntax) and associated rules, known as ICAM DEFinition Method (IDEF).

IDEF is presently a suite of modeling methods, which developed out of the Air Force's Integrated Computer Aided Manufacturing (ICAM) project in the 1980's. Each of the IDEF methods provides a set of modelling syntax and steps for describing a particular perspective or view of an enterprise. The IDEF suite provides for functional or activity modeling (IDEF0), information modeling (IDEF1), data modeling (IDEF1x), systems dynamics modeling (IDEF2), process description capture (IDEF3), object-oriented design (IDEF4) and ontology capture (IDEF5), among others.

A strong factor on the behalf of IDEF was its versatility. This methodology has a strong past in the specification of important projects of advanced manufacturing systems definition and design, project management and integration.

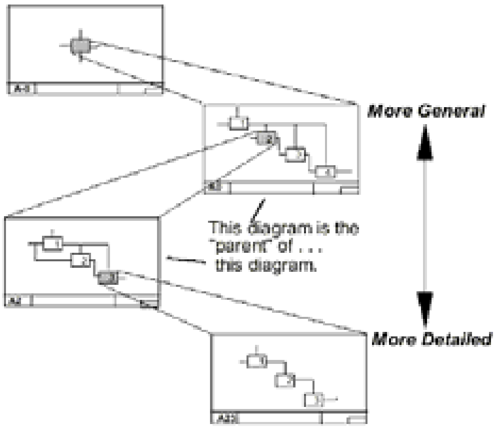
IDEF0 is a widely used technique for the structured analysis and design of systems. Its use in improving the productivity and communications in computer-integrated manufacturing systems and, more recently, as a tool for business process reengineering efforts, is widely documented (Presley & Liles, 1995).

During the late 1970s, the Air Force Program for Integrated Computer-Aided Manufacturing (ICAM[2]) — a multiyear, heavily funded program to enhance manufacturing technology sought to increase manufacturing productivity through systematic application of computer technology (Ross, 1985). As a result, there was developed a series of techniques known as the IDEF (ICAM Definition) techniques (FIPSP, 1993a), which included the following: (1) IDEF0, used to produce a "function model", which is a structured representation of the functions, activities or processes within the modeled system or subject area; (2) IDEF1, used to produce an "information model", which represents the structure and semantics of information within the modeled system or subject area; (3) IDEF2, used to produce a "dynamics" model, which represents the time-varying behavioural characteristics of the modeled system or subject area.

In 1983, the U.S. Air Force Integrated Information Support System program enhanced the IDEF1 information modeling technique to form IDEF1x (IDEF1 Extended), a semantic data modeling technique.

IDEF0 and IDEF1x techniques, as well as other subsequent developments, are widely used in the government, industrial and commercial sectors, supporting modeling efforts for a wide range of enterprises and application domains, and are

Figure 1. Decomposition overview (Mayer, 1990, 1992)



supported by software tools, as for instance those developed by MetaSoftware Corporation and by Knowledge Based Systems Inc.

Although IDEF2 was intended to be used as a dynamic modelling method for simulation, the numerous simulation methods commercially available have supplanted this method.

Other major IDEF methods include: Process Description Capture Method (IDEF3) (Mayer & Cullinane, 1992), Object Oriented Design (IDEF4) and Ontology Capture (IDEF5) (Mayer, Painter, & de Witte, 1992).

IDEF3 consists of process flow diagrams and object-transition networks, and intends to model the behaviour of the model components. IDEF5, the ontology capture method, is used for modeling concepts and the relations between these concepts; ontologies are powerful tools to capture a knowledge base of the information in a given domain.

Most of the IDEF methods utilise a subordinate principle of abstraction called decomposition (Rumbaugh & Blaha, 1991), which corresponds to the breaking down of each (activity) into more detail in a continuous manner until the greatest level of details is achieved (Marca & McGowan, 1988), as represented in Figure 1.

IDEF is based on graphical models, which assures the uniqueness of interpretation, objectivity and easy interpretation.

Since its conception, IDEF technique has also been adopted in CIM projects, requiring analysis and design structured techniques, as for example the definition of generic CIM systems, or of flexible manufacturing systems in a CIM context.

The technique is both a descriptive and analytical tool. As a descriptive tool, it is used to identify the components of a system that behave as agents of change in a system. As analytical tool, it can be used as basis for simulation or to test the performance of flexible manufacturing systems configurations.

The IDEF0 Approach

IDEF0 (Integration DEFinition language 0) had its beginning with Structured Analysis and Design Technique™ (SADT™) developed by Douglas T. Ross (Ross, 1977, 1985; Ross & Schoman, 1977) and SoftTech, Inc.

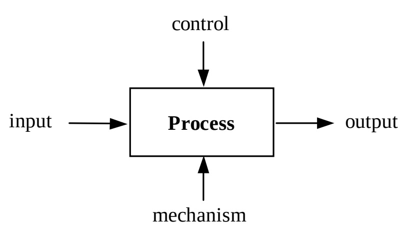
IDEF0 may be used to model a wide variety of automated and non-automated systems. IDEF0 is used to represent the *functional* (i.e., activity) framework of a system. It is designed to model the decisions, actions and activities of an organisation or a system. Its strength is in representing the "what-is-done" aspect of a system (Presley, 1997).

IDEF0 is based on combined graphics and text that are presented in an organised and systematic way to gain understanding, support analysis, provide logic for potential changes, specify requirements, or support systems level design and integration activities.

An IDEF0 model is composed of a hierarchical series of diagrams that gradually display increasing levels of detail (tree) describing functions and their interfaces within the context of a system; at the top of the tree there is a high-level description of the global system.

There are three types of diagrams: graphic, text and glossary; the graphic diagrams define functions and functional relationships via box and arrow syntax and semantics; the text and glossary diagrams provide additional information in support of graphic diagrams. The two primary modeling components are functions (represented in a diagram by boxes) and the data and objects that interrelate those functions (represented by arrows).

Figure 2. IDEF0 representation



There are five elements in the IDEF0 functional model: each process (or activity) of the system is represented by a box, where *inputs* are represented by the arrows flowing into the left hand side of an activity box and *outputs* are represented by arrows flowing out the right hand side. *Inputs* and *outputs* connect the process to other boxes (processes), see Figure 2 . The top of the box is reserved for *control* information or constraints on the activities and arrows in the base represent *mechanisms* that carry out the activity. The *input*, *output*, *control* and *mechanism* arrows are also defined as ICOMs.

The IDEF notation represents some of the systems' principles: inputs are transformed into outputs, control flows constraints or restricts the conditions in which the transformation occurs and mechanisms describe how the functions are executed. All inputs are converted, by influence of mechanism and control, into output.

The IDEF1x Approach

Within the IDEF techniques, data modeling is accomplished by the IDEF1x method. IDEF1x is most useful for the logical design of database systems where the implementation of a relational database is the desired end (Mayer, 1992). IDEF1x is oriented toward the identification of data elements, keys and tables for a relational system, which basic concepts include entity, attribute and relationships.

The theoretical roots for IDEF information modeling approach stemmed from the early work of Codd (1970; 1979) on relational theory and Chen (1976) on the entity-relationship model (FIPSP, 1993b).

A principal objective of the technique is to support integration. The "conceptual schema" provides a single integrated definition of the data within an enterprise, which is unbiased toward any single application of data and is independent of how the data is stored or accessed. The objective of this conceptual schema is to provide a consistent definition of the meanings and interrelationship of data, which can be used to integrate, share, and manage the integrity of data.

This technique is used to produce a graphical information model, which represents the structure and semantics of information within an environment or system, to support the management of data as a resource, the integration of information systems and the construction of computer databases.

The components of an IDEF1x model are:

1. Entities
   - Identifier-independent Entities
   - Identifier-dependent Entities
2. Relationships
   - Identifying Connection Relationships
   - Non-identifying Connection Relationships
   - Categorization Relationships
   - Non-specific Relationships
3. Attributes/Keys
   - Attributes
   - Primary Keys
   - Alternate Keys
   - Foreign Keys
4. Notes

Entity (or more formally Entity Class) refers to a collection of similar data instances, which can be distinguished from one another; it represents the things of interest in an IDEF1x view. They are displayed in diagrams and are defined in a glossary. An IDEF1x "view" is a collection of entities and assigned attributes domains, assembled for some purpose. A view may cover the entire area being modeled or a part of that area, so an IDEF1x model is comprised of one or more views.

The Design: IDEF Tool

IDEF0 and IDEF1x diagrams can be generated by a variety of graphics packages commercially available, such as Visio Professional (by Visio Corporation), respecting the corresponding representation standards. Several automated tools are also available to support the development of IDEF models. These tools include those which run on popular platforms including both Macintosh and DOS-based personal computers. These tools support the development and conversion of the methodologies presented, offering data consistency verification, integration of methodologies and report generation, the maintenance of a data dictionary, database creation, etc.

For IDEF0 and IDEF1x modeling we have used the Design/IDEF™ tool, release 3.7. for Microsoft Windows™, developed by MetaSoftware Corporation (MetaSoftware, 1996).

Global Structure of the Market of Resources

The service provided by the Market of Resources is supported by:

1. A knowledge base of resources and results of the integration of resources in previous A/VEs,
2. A normalized representation of information,
3. Computer aided tools and algorithms,
4. A brokerage service, and
5. A regulation (i.e., management of negotiation and integration processes), as well as contract enforcement mechanisms (Cunha & Putnik, 2005; Cunha, Putnik, & Gunasekaran, 2003; Cunha, Putnik, Gunasekaran, & Ávila, 2005).

The service is able to offer:

a) Knowledge for A/V E design, resources providers search, negotiation, selection and its integration in a A/V E, performance evaluation in the accomplishment of contracted tasks, identification of reconfiguration needs or opportunities;
b) Specific functions of A/VE integration and operation management; and
c) Contracts and formalizing procedures to assure the accomplishment of commitments, responsibility, trust, and deontological aspects, envisaging that the integrated A/V E accomplishes its objectives of answering to a market opportunity (Cunha & Putnik, 2005; Cunha et al., 2003).

The environment supports not only the *integration* process, but, what is most important when the fast and proficient reaction to change is a key element, is also able to effectively support *dynamic integration*, which is the main reason for the concept of the Market of Resources as an institution (Cunha et al., 2003).

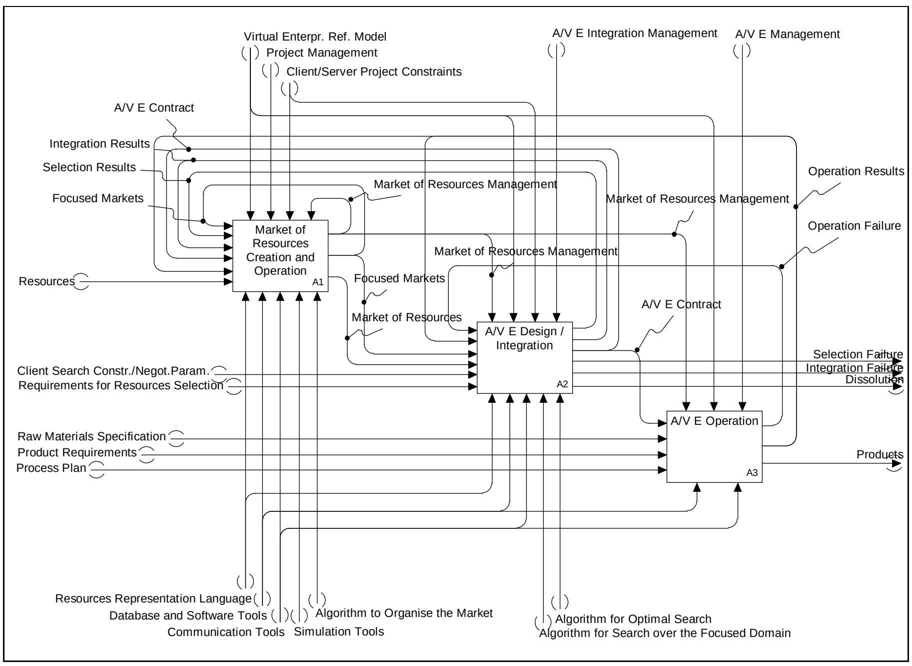
This section introduces the main characteristics of the Market of Resources.

Global Process Structure of the Market of Resources

The overall functioning of the Market of Resources is represented by an IDEF0 diagram (Figure 3). It consists of the creation and management of the Market of Resources itself (Process A.1.), as the environment to support the design and integration of the A/V E (Process A.2.) that under the coordination of the environment, operates to produce a product to answer to a market opportunity (Process A.3.). The Market of Resources offers technical and procedural support for the activities of identifying potential partners, qualifying partners, and integrating the A/VE, as well as coordination and performance evaluation mechanisms. The model herein proposed respects the *BM_Virtual Enterprise Architecture Reference Model — BM_VEARM* (Putnik, 2000).

- *Process A.1. — Market of Resources creation and operation:* This process corresponds to the creation and operation (management and

Figure 3. IDEF0 representation of the global process for the creation of a Market of Resources and for A/V E design, integration and operation (Source: Cunha et al., 2003, 2005)



maintenance) of the environment, from the technological aspects, such as the creation of databases and development of software tools, implementation of communication systems, etc., up to the definition and permanent adaptation and updating of the managerial aspects, such as regulation and rules, criteria for selection, management and brokerage procedures, organization of the Market, commitments definition, evaluation, etc., including the performance of the Market itself in order to improve the Market of Resources organization. It also includes the organization of the resources providers into meaningful combinations of resources, to increase efficiency of the selection process and to reduce search time; this process takes place

Table 1. Description of flows in the global representation of the Market of Resources

Processes	Market of Resources requires – Input Flows –	Market of Resources provides – Output Flows –
Process A.1 Market of Resources Creation and Operation	- Resources: information concerning the enterprises that subscribe the Market of Resources to provide resources (products, operations, services). This includes: (1) enterprise generic information and (2) characterization of the resources, conditions for delivery, specification, availability, restrictions and constraints. - Selection Results: to allow the adaptation of criteria for resources selection and of Service/Process Patterns and Client Search Patterns, as well as to adjust the organization of the Focused Markets. - Integration Results: to allow the adaptation of criteria for resources selection and to adjust procedures for integration. - Operation Results: to update historical information concerning the participation of an enterprise in an A/V E and to allow the actualization of Market of Resources Management; this flow is also used to determine A/V E reconfiguration or dissolution, a task to be dealt by Process A.2. - Focused Markets: to allow the organization of the resources knowledge base as well as to allow the organization of the Focused Markets themselves. - A/V E Contract: the evaluation of a substitution of a resources provider, or the unsubscription from the Market, requires information about the ongoing projects in which it is involved in, to identify the disentailing implications.	- Market of Resources Management: rules and procedures to regulate the functioning of the environment, methodologies to evaluate performance, brokerage and all the support documents; this flow will be a control in processes A.2. and A.3. and also a control in subprocesses of A.1. These management procedures are permanently adjusted to allow a better response, based on the Selection Results and Operation Results. - Market of Resources: database of resources, clients, brokers, products, operation results, performance and historical information. - Focused Markets: organization of the Market of Resources in meaningful combinations, according to (1) Service/Process Patterns (patterns of the concrete services / processes that can be asked to the Market - this information is permanently adjusted from the Selection Results) and (2) Client Search Patterns (patterns of the possible constraints of the services that can be asked, like quality level, negotiation constraints, available time for search, cost - this information is permanently adjusted from the Selection Results).

Table 1. continued

Processes	Market of Resources requires – Input Flows –	Market of Resources provides – Output Flows –
Process A.2 A/V E Design / Integration	- Market of Resources (output flow of A.1.) - Focused Markets (output flow of A.1.) - Client Search Constraints /Negotiation Parameters - Requirements for Resources Selection - Operation Failure: in case of failure of the A/V E, it is necessary to substitute the responsible resources, which implies a new A/V E project and selection/ integration (reconfiguration). - Operation Results: to evaluate the opportunity or need of reconfiguration.	- Selection Results - Integration Results - Selection Failure: when it is not possible to find resources matching the requirements or agreement in negotiation is not achieved. - Integration Failure: when the selected resources are unable to interoperate. - A/V E Contract: the contract between the selected participants, is the result of the integration of the selected resources in an A/V E. - Dissolution: dissolution of the A/V E
Process A.3 A/V E Operation	- A/V E Contract (output flow of A.2.) - Raw Materials Specification - Product Requirements - Process Plan	- Operation Results: the results of the coordination activity of the Market and performance evaluation in order to keep actualized the historic and to allow evaluate the opportunity of reconfiguring the A/V E - Operation Failure: information of the inability of the integrated resources providers to accomplish the contract. - Products: information on the A/V E results.

off-line and its results are designated as focused markets (Cunha, Putnik, & Ávila, 2000).

- *Process A.2. — A/V E design and integration*: This process consists of two activities: (1) resources selection and (2) A/V E integration. Resources selection involves the design of the A/V E that matches the requirements to produce the desired product and the search for the "best" combination of resources that will be integrated in the A/V E. Selection is performed on a specific domain consisting of combinations of focused markets. The redesign or reconfiguration of an A/V E, implying the substitution or integration of new resources is also considered in this process, as well as the dissolution of the A/V E. Integration consists of formalizing the A/V E (contractualisation) and of establishing procedures regarding the integration of the participants and the implementation of management and evaluation techniques.

- *Process A.3. — A/V E operation:* The service provided by the Market of Resources controls the operation of the integrated A/V E, tracking the performance of each resource, and restructuring the A/V E design whenever necessary (dynamical adjustment) to make possible the achievement of the results. The operation results are of interest to keep actualized historical information concerning the performance of the resources, to be taken into consideration in future selection processes, and to adjust the management procedures.

Table 2. Mechanisms and controls in the global representation of the Market of Resources

Mechanisms	- Resources Representation Language: normalized form of describing the entities in interaction (Clients, Resources, Resources Providers) - Database and Software Tools - Communication Tools - Simulation Tools: to simulate alternative combinations of search patterns, to improve the performance of the Market of Resources - Algorithm to Organize the Market: organization of the Market into Focused Markets - Algorithm for Search over the Focused Domain: search of resources on a Focused Domain, to identify eligible resources for negotiation - Algorithm for Optimal Search: final selection between the resources providers able to integrate the A/V E, to obtain the best combination of candidate resources.
Controls	- Virtual Enterprise Reference Model - Project Management: management procedures for creating the Market of Resources (Process A.1.) - Client/Server Project Constraints: constraints concerning the possible combination of resources in the design or reconfiguration of an A/V E; it is dictated by the Broker. - A/V E Integration Management: management of the integration of the selected resources in the A/V E and corresponds to the Broker activity - Market of Resources Management: (already defined, as output of process A.1.).

The meaning of the input and output flows of the processes represented in Figure 3 is systematized in Table 1. As we will see later, on the detailed representation of each process of Figure 3, (A.1., A.2. and A.3.), there are some more flows, that are omitted from this global high-level representation.

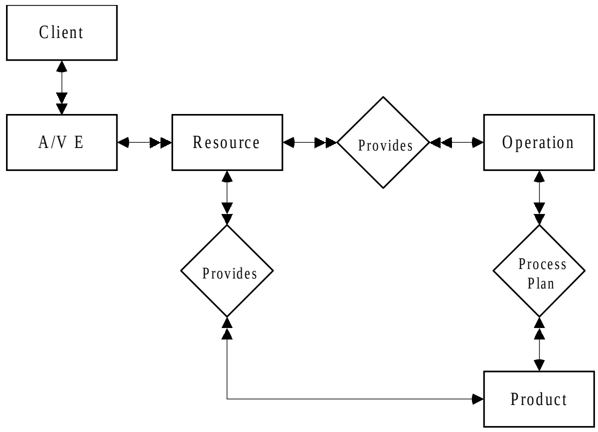
Table 2 includes a list of mechanisms and control information related with Figure 3.

The Market of Resources Entities and Relationships

The entities present at the Market of Resources are:

- *Clients* (the Client of the Market of Resources, or A/V E Owner): those looking for a product, components or operations, to integrate an A/V E, according to an A/V E project to be designed together by the Client and the Broker. Information considered relevant concerns the enterprise itself and, for each request from the Market, information about the product to be produced and its process plan, the negotiation parameters, project constraints and so forth.
- *Agile/Virtual Enterprise:* the set of integrated resources providers respecting the A/V E project, able to answer to a market opportunity. The A/V E created/reconfigured is itself a complex entity, constituted by the Client (owner of the A/V E) and the resources providers integrated to provide the operations to manufacture the product or its parts. The resulting A/V E is expected to produce the specified product, according to the process plan defined by the Client, respecting all the project constraints. Information considered relevant concerns the network structure, dependencies between the resources providers, the contract and commitments between the integrated resources and the Client and all the details in order to manage the process.
- *Resources Providers:* enterprises registered in the Market to specifically provide resources (operations or products) or to add value to products or processes; resources providers are mapped into resources. Information considered relevant consists concerns the enterprise, its structure, products/operations provided, conditions, and negotiation details. The same enterprise can be present in the market offering several resources (an enterprise can offer several resources, according to its intra-flexibility).
- *Products*[3] (components or assemblies): Resources[4] providers are mapped into components or parts of Products. Information considered relevant concerns conditions in which resources providers provide each product or part, negotiation details, and availability.

Figure 4. The entity-relationship diagram for the entities of the Market of Resources



- *Operations* (associated to each component of a product): elementary operations performed by resources providers while executing an operation on a specific product or part. Resources providers are mapped into Operations and Operations are mapped into Products. Information considered relevant concerns conditions under which resources providers provide each operation, negotiation details, information to allow further production control, and evaluation.

Figure 4 represents a simplified version of an *Entity-Relationship Diagram*[5] (Chen, 1976) inter-relating the five above described entities, which will detailed later in the chapter.

The information associated with those entities can be represented at several different plans or dimensions: At the first plan, we can have the product and its structure (bill of materials) of components or parts. At a parallel plan, we propose the process plan, which is the set of operations necessary to produce the product (components and assemblies). A mapping is made between the two plans (lattice). This way, we say Operations are mapped into Products.

Resource providers are linked either to Products or to Operations, representing all possible instances of adding value to a product or producing a product or component. Resource Providers are mapped into Products and into Operations.

Products and Operations that Resources Providers can perform are presented in meaningful groups or sets, called patterns for client search ("Client search constraints," in Figure 3).

Agile/Virtual Enterprise Design and Integration in the Market of Resources

The process of A/VE design and integration consists on the alignment between the *client* of the Market of Resources (the one capturing and traducing the customer or the market requirements for a certain business opportunity into product requirements), and the *entities involved in A/VE integration* (i.e., candidate enterprises) (mapped into resources) and products/operations (into which, resources providers are mapped), and corresponds to Process A.2.

The implementation of this process should follow the reference model BM_VEARM.

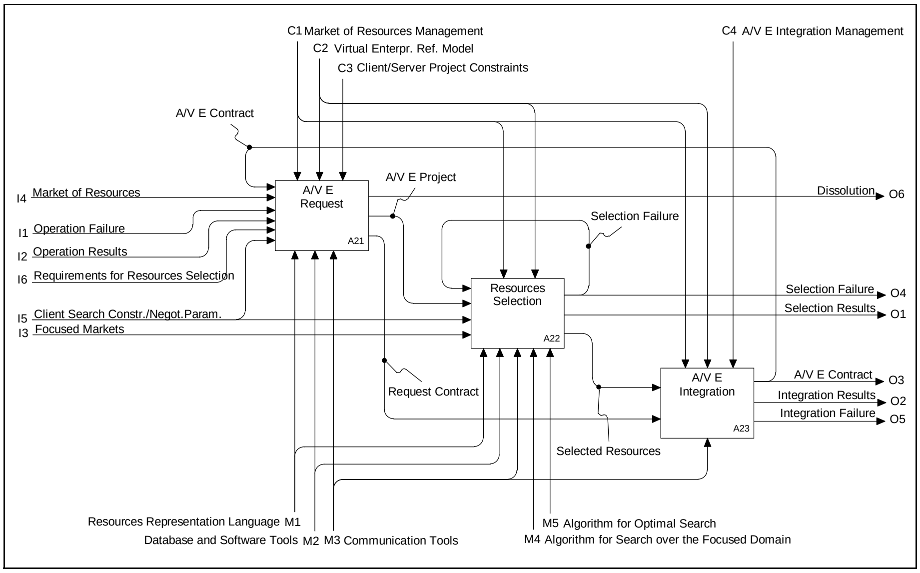
Agile/Virtual Enterprise Design and Integration

When the Client entity requires the services of the Market of Resources, it must specify the conditions and characteristics for the A/V E that will answer the market opportunity (i.e., the objective of the A/V E). This specification consists of the technical and operational requirements to produce the desired product and the managerial requirements, and correspond to the input flows of Process A.2.: "Requirements for Resources Selection" and "Client Search Constraints / Negotiation Parameters" (Figure 3). Process A.2., graphically represented in Figure 5, is explained in this subsection.

Process A.2. is started with a request for an A/V E creation (Process A.2.1.) presented by a Client, a request for reconfiguration or dissolution, or a reconfiguration proposal following the monitoring activities performed by the Market of Resources. The evaluation of the operation results can suggest the need of reconfigure the A/V E. The result of this process is the design of an A/V E project traducing the Client requirements and a Request Contract, between the Market of Resources and the Client, which will be detailed later.

To keep the dynamics of the Virtual Enterprise model, the search for the "best" combination of resources to integrate should be obtained almost in real time. As the search problem is complex, which search effort grows exponentially in function of the domain size, we have proposed the decomposition of the Market of Resources (the global set /domain of resources) into subsets, of meaningful combinations, designated *Focused Markets of Resources* (Cunha et al., 2000),

Figure 5. IDEF0 representation of Process A.2. — A/V E Design and integration



a process that takes place inside Process A.1. After designing the A/VE traducing the requirements of the Client, the Resources Selection process (Process A.2.2.) will define a Focused Domain for search (a composition of Focused Markets), reasonably dimensioned to allow a good match at a limited time, where negotiation will take place.

This way, the search in the Market of Resources will take place at two phases: the first, occurs off-line (in Process A.1.), and consists on separating the Market of Resources into Focused Markets, according to previously identified and determined Patterns of Client Search Constraints and Service/Project Patterns. The second phase takes place online (Process A.2.2.) and consists of defining a Focused Domain for Search and on selecting the resources verifying the search constraints required by the Client inside this domain, the negotiation between them, and selection of the best combination, in order to propose the set of resources to be integrated in the A/VE.

The correct capture of the search constraint patterns (Client Search Constraints, Service/Project Patterns and Negotiation Parameters) performed in Process A.1. is essential to the efficiency of the Resources Selection (specifically the Focused Market identification). The set of patterns must be permanently calibrated in function of the results of the Selection and Integration processes, to assure an optimal Focused Domain identification, to be used by the Resources Selection process. The control of the patterns is done in Process A.1. and is represented in Figure 8.

The process of Resources Selection (Process A.2.2.) corresponds to the accomplishment/ fulfillment of the three already mentioned components of the strategic business alignment for A/VE selection and integration: (1) market alignment, (2) resources alignment, and (3) resources providers alignment. The strategic alignment is performed by the algorithms "Algorithm for Search over Focused Domain" and "Algorithm for Optimal Search" (see Table 2).

The alignment is a continuous activity, as even A/VE operation is controlled by the "A/VE Management" function. The dynamics requirement is a permanent characteristic of the A/VE model, and is a consequence of continuous alignment; resources can need to be replaced, the A/VE project can be subject of adaptations or corrections or deliberated change, so quick response is a permanent challenge.

As we have considered the reconfiguration or re-design of an A/VE (the substitution of resources or rearrangement of integrated resources) an operation to be undertaken by this process A.2., we also consider the dissolution of the A/VE a special case of re-design.

The A/VE Integration (Process A.2.3.) consists of establishing procedures, normalizing processes, assuring interoperability, and defining responsibilities and assuring commitments through legalizing contracts between the participants.

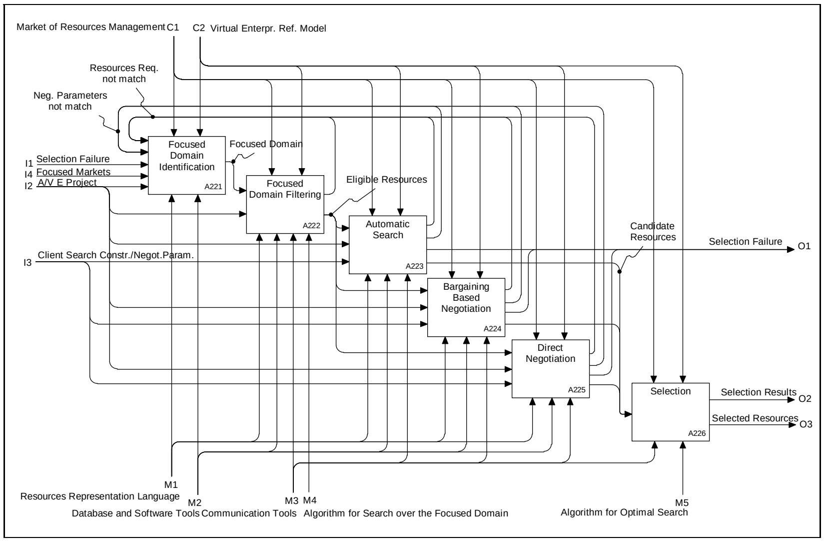
While selection means to check availability and to find the best resources that meet the requirements, integration means effective allocation and formalization of the partnership.

Resources Providers Selection

The Resources Providers Selection Process takes place in three phases: (1) eligible resources providers identification, (2) negotiation (identification of candidate resources providers), and (3) final selection (identification of selected resources providers).

The dimension and the quality of the focused domain that is proposed to this process are critical. The dynamics of the A/VE model demands the selection to take place almost at real time. To increase efficiency, Process A.2.2. (Figure 6) starts with the proposal of the domain where selection takes place, the Focused Domain Identification (Process A.2.2.1.), to be filtered into the set of eligible resources, according to the A/VE Project, which already resulted of the translation of the A/VE requirements, in Process A.2.1.

Figure 6. IDEF0 representation of Process A.2.2. — Resources selection



The process of Focused Domain Filtering (Process A.2.2.2.) corresponds to a search performed on the subset of the Market of Resources database designated as the Focused Domain, in order to identify the resources characteristics and perform a first match considering the resources requirements The result is the set of resources providers able to provide the required resources, with which the second phase will take place. If the resulting set of eligible resources does not present a satisfying dimension face to the Client Search Constraints and Negotiation Parameters defined by the Client, the Focused Domain must be redefined.

The set of eligible resources is then submitted to a second phase, corresponding to the negotiation with the resources providers. Different resources can be reached according to different negotiation methods or as combination of them: Automatic Search (Process A.2.2.3.), Auction-Based Negotiation (Process A.2.2.4.) and Direct Negotiation (Process A.2.2.5.). Negotiation results in the set of candidate resources, consisting of the resource providers in condition of providing the required resources (i.e., in condition to integrate the A/VE). However, as different selection models can be used and some processes can be combinatorial, all the combinations of resources must be analyzed to find the best.

The selection of resources is function of: (1) cost, (2) resources availability and timing, and (3) schedule; the process of resources selection must consider essentially the techniques of Activity Based Costing, artificial intelligence and simulation based scheduling techniques. In the case of configuration of an A/VE, the algorithm for the selection of resources shall include strategic and qualitative factors besides the three mentioned.

The third phase is the final selection (Process A.2.2.6.), which is supported by an algorithm and controlled by the broker, and produces a combination of resources providers considered to be the best possible within the solution space.

Why to Create Focused Domains and Focused Markets

The complexity of the resources selection in general means that a compromised domain dimension (as a basis for the solution space construction) should be used for each resource search. *Focused domains* will designate this concept.

We define the concept of *focused domain* as a combination of subsets of the Market of Resources (combination of *focused markets of resources*) where a given search for an independent resource is to take place. The proposal of a *focused-domain* approach, complemented by automatic search over the knowledge base, makes possible to solve the problem, if possible, almost in real time except when more sophisticated negotiation methods are required.

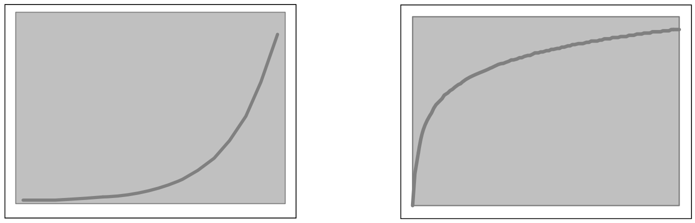
The Market of Resources is a universe (not the universe) of resources able to furnish a reasonable solution space.

The *focused domain* is the output of the execution of an algorithm, having as input, besides the description of the pretended resource, some functional search parameters (time, money, etc., available for the search), introduced by the client of the service. These parameters will determine the dimension of the *focused domain* (subdomain space), as a subset of the Market of Resources. The search algorithms (Figure 6) will work within the focused domain and provide the best, or the best "with high probability," resource therein included.

As a consequence of the complexity associated with the optimal search, the constitution of the market for the integration of resources in Agile/Virtual Enterprises has for two requisites:

1. The identification of a *focused domain*;
2. The separation "in time and space" of:
   - The process of the focused markets identification, to enable the further *focused domain* proposal, and
   - The search and selection processes.

Figure 7. Complexity of a) the resources search effort in function of the domain dimension and the search algorithm and b) the quality in function of the search effort



Search_effort = f (Domain size, Search_algorithm) *a)*   *Quality = f (Search_effort)* *b)*

The first requisite derives from the fact that the search and selection effort (and hence search time) grows exponentially with the domain size (as well as it depends of the concrete search algorithm applied, Figure 7a). Another fact that implies the need for the *focused domain* is that the quality of the search result (match of the requirement and the resource identified) grows with the solution space (i.e., to the total quality corresponds an infinite search time). So, a compromised dimension is to be found, as search time is a critical resource, and it is directly connected with either the search cost and with the dynamics of business opportunities. From the other side, the shape of the "quality function" is "convex" (i.e., the growth rate of the function decreases — the second derivation of the function is negative) and probably it is not practical to extend the search time too much, Figure 7b).

A *focused domain* should be proposed for each search, reasonably dimensioned, to allow a good match, at a limited time.

The second requisite derives from the facts that there are two completely distinct processes; distinct either because of the kind of information processed and because of the dynamics associated with the entities involved in the A/VE integration.

For the *focused-markets* definition, the main input is the information concerning the resources (primitive or complex resources) included in, or subscribed to, the Market of Resources database or knowledge base. The process consists on the off-line filtering the database (Market of Resources) into *focused markets* (i.e., before the requirement for the resources search for the concrete service), from the following reason. As we do not know in advance which one of resources present on the Market of Resources is appropriate and which one is inappropriate, it is necessary to visit all (or as much as possible) resources on the Market of Resources. If this process is performed after receiving the requirement for the resource search, due to the limited search time it could happen that we cannot find any appropriate (or candidate) resource although it exists on the Market of Resources (during the allowed search time we could visit by chance only inappropriate resources).

On the other side, as we have to identify the focused market before receiving the concrete requirement for the resource search (i.e., for a future, hypothetical requirement), the *focused market* identification process must be based on some requirement patterns (i.e., service or process patterns of the concrete services or processes that will appear in the future for which the resource is required). The service/process patterns will determine the qualitative contents of the *focused market*. But the *focused market* contents does not depend on the service/process patterns only but also on the client's search constraints as, for example, the required quality, the negotiation constraints, the available time to identify the required resource and the cost the client is willing to pay for the service. These constraints will determine the *focused markets* dimension. As the *focused markets* identification process should be performed off-line, as we said above, it must be based on the client's search constraint patterns. In other words, as the process is supposed to be performed off-line (i.e., before the concrete requirement for the resource search), we should have some ideas about hypothetical types and constraints of client's requirements.

So, the second part of the input in the *focused markets* identification process consists of the service/process patterns and client search constraints patterns.

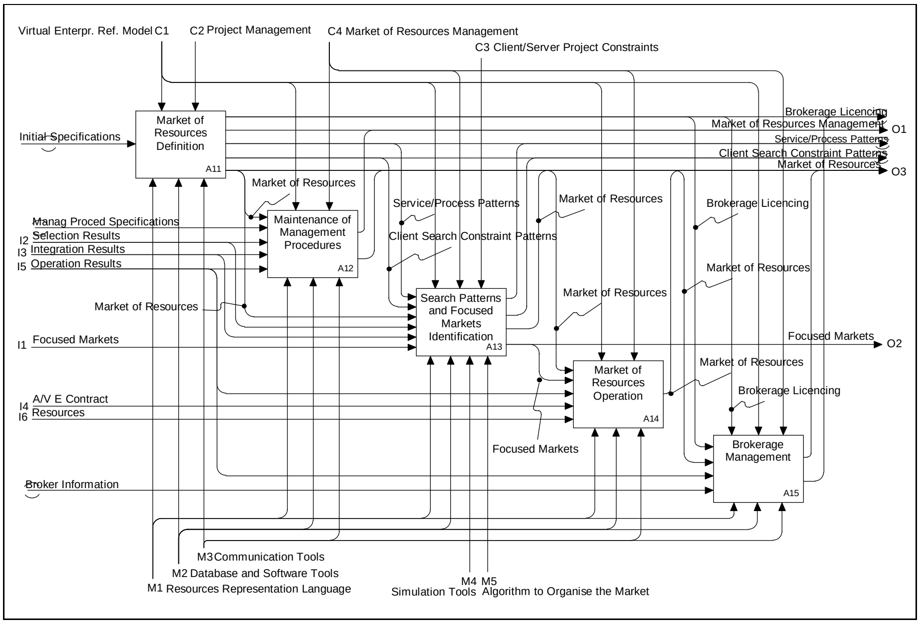
The *focused markets* definition is performed in Process A.1.3. (Figure 8). Process A.1., will be detailed later in the chapter.

The practical consequence of this approach is that we will have identified a knowledge base on the set of *focused markets* that correspond to different service/process patterns and search constraints patterns (i.e., to different hypothetical types of requirements for resources). This set of *focused markets* is prepared in advance in order to allow a fast identification of a *focused domain* when a request arrives, providing efficient, online optimal (or optimized) concrete resource identification when the time comes.

Market of Resources Regulation

The task of managing the creation and the operation of the Market of Resources corresponds to the control flow "Market of Resources Management" in the several IDEF0s diagrams presented. It is a "Computer-Aided" task, conducted by the Market manager, bounded by a system of rules.

Figure 8. IDEF0 representation of Process A.1. — Market of Resources creation and operation



Besides the introduction of the underlying definitions presented in this section, the regulation is composed by two distinct parts, distributed between the "Design Rules System" and "Operation Rules System" sections of this chapter, corresponding to: (1) the specification of the main principles guiding the Market of Resources creation and maintenance (that corresponds to process A.1.), and (2) the regulation of the Market operation management — negotiation, selection, contractualisation (that corresponds to processes A.2.and A.3.).

Scope of the Regulation

The first part of this Regulation (developed in the "Design Rules System" section) covers the procedures of subscription and unsubscription of the entities in the Market of Resources: Brokers, Clients and Enterprises, while the second (developed in the "Operation Rules Systems" section) covers the management of the service that the Market of Resources provides in supporting the life cycle of the A/VE, from the demands from the clients, the creation of an A/VE including the search of resources, negotiation, integration, reconfigurations, evaluation and registration of the historic, reconfiguration, until the dissolution (which is also a form of reconfiguration). Taxation and indemnity aspects are also mentioned, although not exhaustively explained.

This Regulation is itself a dynamic tool (namely the quantifiable aspects, which are out of the scope of this text), because it is subject of actualization or adaptation as a consequence of the evaluation of the performance of the service, which takes place periodically or after each intervention, as requested by the "manager" with the objective of increasing the performance of the service. The regulation regulates all the activity of the Market of Resources and regulates also its actualizations.

When subscribing the service, the entities accept the conditions and rules established by the regulation; the introduction of alterations must be preceded by a transitory period of information and explanation. The alterations must give attention to ongoing projects that can, under certain circumstances, be managed according to the previous version(s).

The alterations to the Regulation are bounded by delimitations accepted by the entities when of its subscription in the Market. The participating entities can also make proposals of revisions that can be evaluated by the Manager of the Market of Resources.

Definitions

Before presenting the Regulation, some entities and operations must be clarified. In this section we introduce the concepts of: Market of Resources; Broker; Resource; Resource Provider; Agile/Virtual Enterprise; A/VE Owner; A/VE Request; Integration; Reconfiguration; Dissolution; Evaluation; Negotiation; Contract; Illegalities (unauthorized or unlicensed activities) and Unaccomplishments (of contracted tasks).

- **Market of Resources (or simply Market):** It is the environment where offer and demand for resources is matched (i.e., where electronic negotiation of resources takes place) in a narrow sense. In a broad sense, it is a service offering an electronically delivered intermediation or brokerage service between (1) the set of registered resources providers, (2) organizations looking for A/VE dynamic integration and its business alignment (A/VE Owners). It is able to offer: (1) knowledge for A/VE design (selection of resources, negotiation and its integration in and A/VE), (2) specific functions of A/VE operation management, and (3) contracts and formalizing procedures to accomplishment of responsibility, enforcement, trust and deontological aspects, within the consortium or integrated A/VE. Membership is required, both for Resource Providers, A/VE owners and Brokers. The identity on both sides of a transaction or service is protected.

- **Resource:** Resource is the object of transaction in the Market. A resource can be a product, part or assembly, a service or an operation, and is supplied by an entity enterprise. A resource can be primitive or complex (a complex resource is a meaningful combination of primitive resources, e.g., an assembly or a complex operation). Resources are mapped into components or parts of Products. Resources are mapped into Operations, and Operations are mapped into Products.
- **Resource Provider:** A resource provider is a private or public enterprise/institution from any sector of economical activity, or an individual, willing to offer its competencies or products — resources (primitive or complex). It must be registered in the Market to specifically provide operations or products/add value to products or processes. The processes of subscription and unsubscription of resources providers will be detailed later in this chapter.
- **Agile/Virtual Enterprise:** An A/VE is the set of integrated resources respecting the A/VE project, able to answer to a market opportunity. The A/VE is itself a complex and dynamic entity, constituted by the Client (owner of the Virtual Enterprise) and the resources integrated to provide the operations to manufacture the product or its parts or to deliver the service. A/VE competitiveness and business alignment requirements introduce dynamics in the partnership, which is permanently subject of reconfigurability (instantiations).
- **A/VE Owner or Client:** The Client of the Market of Resources is the one (enterprise or individual) looking for resources providers to integrate an A/VE, according to an A/VE project. The A/VE Owner can be an enterprise of any dimension from any sector of activity (manufacturing, commerce or services), a Public institution or even an individual that owns an idea or has captured a market opportunity.
- **Membership:** Membership is required to allow participation. Participants can use the Market only when their application is approved (i.e., when accepted as members). The Market offers three types of membership: Resource Provider membership (or seller membership), Client membership (buyer membership) and Broker membership. Depending on their needs and qualifications the same enterprise/individual can be simultaneously buyer and seller.
- **A/VE Request:** An A/VE request corresponds to a demand originated by a Client or A/VE Owner. The request includes product and/or process information, negotiation data and other requirements, and will trigger the

process of A/VE Design. A request can also correspond to a reconfiguration of an A/VE or its dissolution, as the last phase of the A/VE life cycle.

According to the information for negotiation provided and of the type of product/service required, the Market can offer a service with different degrees of automation.

- **Broker:** The Broker is the A/VE configuration manager, according to the reference model we are following. It is the individual or entity /enterprise that holds itself out as having knowledge or skills for A/VE design, negotiation and integration in certain fields of business (or to which such knowledge should be attributed), and that using the Market of Resources helps matching between offer and demand. Brokers are essential elements for a credible service, reinforcing trust and confidence between the participants in the market.

  Its intervention is a function of the degree of automation associated to the request (i.e., of the constraints for negotiation introduced by the A/VE request and of the patterns for negotiation selected by each resources provider). He can have a significant participation on selection and negotiation, or simply allocate agents/algorithms to perform these functions.

  The functions of the broker (brokerage) are detailed and regulated in the "Design Rules System" section.

- **Negotiation:** In the Market of Resources, negotiation between the Client and the candidate Resources Providers can be manual, semi-automated or highly automated, depending, in general, on the nature of the negotiable parameters.
  - If the number of parameters to be considered is fixed with objectively quantifiable values, a high degree of automation can be introduced.
  - On the contrary, if the introduction of new parameters during the negotiation process is allowed, or if the domain of values that the parameters can assume is not determined prior to the negotiation start, the negotiation must be closely conducted by the broker.

  The negotiation is never fully automated, but is always computer-aided (even when it is manual), under the control of a Broker.

- **Search and Selection:** The resources providers to be integrated in the A/VE, according to the A/VE Design, are the result of a set of processes labeled by Resources Search and Selection that assure the desired business alignment. When subscribed to the Market, the resources provided by each enterprise are classified into Focused Markets, an off-line process, to facilitate search and selection. After an A/VE Request and the elaboration of the corresponding A/VE Design, the Market identifies the Focused Markets susceptible to contain the solution, filters them, and triggers the selection within this resulting set. Three types of selection are offered: automatic search, bargain-based negotiation (including request for bids and auctions) and direct negotiation. Finally, it is performed by the compilation of the possible solutions and identification of the most suitable one.

- **Integration:** Integration envisages the establishment of effective and efficient interactions between the elements selected to participate in one instance of an Agile/Virtual Enterprise, assuring interoperability, portability and other dimensions of integrability, as well as permanent alignment with business. The Market of Resources offers translation tools, verifies compatibilities, etc. The Market must assure that both: (1) technological support verifies all the necessary requirements for integrability, and that (2) procedural, organizational and contractualisation dimensions are correctly agreed, so that the project is not compromised by predictable sources of disagreement, especially if generated inside the cooperating resources providers. These aspects are discussed within the negotiation process. In the stage of integration, all the management, coordination, communication and exchange protocols and procedures are set up.
- **Reconfiguration:** Reconfiguration consists on the substitution of resources in one A/VE instantiation, provoking a transition to another instantiation, and can happen mainly from three reasons: (1) reconfiguration during an A/VE life cycle as a consequence of the product redesign in the product life cycle; (2) reconfiguration as a consequence of the nature of the particular product life cycle phase (evolutionary phases); and (3) reconfiguration as a consequence of the evaluation of the performance of the resources during one instantiation of the A/VE, or voluntarily by the participating resources disentail. Reconfiguration involves the evaluation of the state of the actual instantiation and the cost/benefits of transition to another instantiation, by substitution of resource providers or simply the integration of new resource providers. If the need of reconfiguration is imputable to the deviation of any resource provider faced with the contracted tasks, quality, timings, etc., damages must be quantified and corresponding indemnities are due.
- **Dissolution:** Whenever the A/VE Owner decides to extinguish the partnership, either because the market opportunity that originated the enterprise is fulfilled, or because it is not competitive to stay in the market, or because any other motivation, he requires the dissolution. Dissolution is a particular case of reconfiguration, as it is also required the evaluation of the ongoing tasks and contracts between the parts to be disentailed; it can involve indemnities to the partners, etc., until an agreement is found. It is a special form of negotiation and is mediated by the Market, driven by a Broker. If dissolution imputable to the A/VE Owner generates

unaccomplishment of contracted tasks, indemnities to participating resources providers are to be evaluated, according to the contracting terms.

- **Evaluation:** All the results of the Market intervention (selection, negotiation, etc.) are subject of evaluation in order to maximize the service efficiency and effectiveness. The Market supervises the operation of the A/VE, to assure that the best performance is being achieved, and that all the participants are respecting the responsibilities that were committed through the contracts formalizing the consortium. The behavior of resources providers during negotiation, their performance within its participation in a given A/VE and the way that the contract clauses are respected, is registered as historical information and will be taken into consideration in further processes of negotiation and selection.
- **Contract:** The relationships involved in a partnership can be either trust-based or contract-based. In the Market all the relations are subject of a contract, which can be automated. We can say that an A/VE is a complex, multi-lateral contract among resources providers and the A/VE Owner. If the selection and integration is mediated by the Market of Resources, then participants are object of a contract with the Market, which empower the Market for negotiation, to boost the process. The Market should be certified to represent a resource provider in the formalization of the contract with the A/VE owner. Five different classes of contracts can exist in the Market of Resources, corresponding to the contracts between: (1) a resources provider and the Market, (2) a client and the Market, (3) a broker and the Market (license), (4) a resources provider and an A/VE (formalizing the integration), and (5) the client with the broker for advisory and validation activities.
- **Illegalities and Unaccomplishments:** An illegality corresponds to an activity performed by any participant in the Market that was not allowed or who was not licensed to perform it, or an abuse of competencies, and is punishable. Punishable is also the violation of a contract or the unaccomplishment of contracted tasks, when imputable to a participant, as well as violation of duties, such as seal duty. These are explicitly defined in the contracts. Punishment varies from the suspension of the participation in the Market until the expulsion, and may include, when applicable, the payment of a fine and/or the compensation of originated losses or damages to the damaged parties.
- **Access to the Market of Resources' Facilities:** Members are responsible for all of their *Internet* charges and for providing all personal computer and communications equipment to gain access to the Market's facilities via the Internet. The service is operational 24 hours a day, except when subject of any unexpected interruption or for maintenance, but this situation is

informed to all the participants. Each member has a pair of usernames and passwords, for which he assumes entire responsibility. However, in requests or negotiation, additional security measures are considered.

Market of Resources Project

This section describes the creation of the Market of Resources, its organization, maintenance and optimization.

Creation and Management of the Market of Resources

Market of Resources creation and operation corresponds to Process A.1., represented in the IDEF0 diagram of Figure 8. The Market of Resources has two components: (a) the organizational or managerial one, integrating the criteria for resources selection, procedures to manage, control and evaluate the environment, and (b) the infrastructural or informational one (databases).

In this section we describe how:

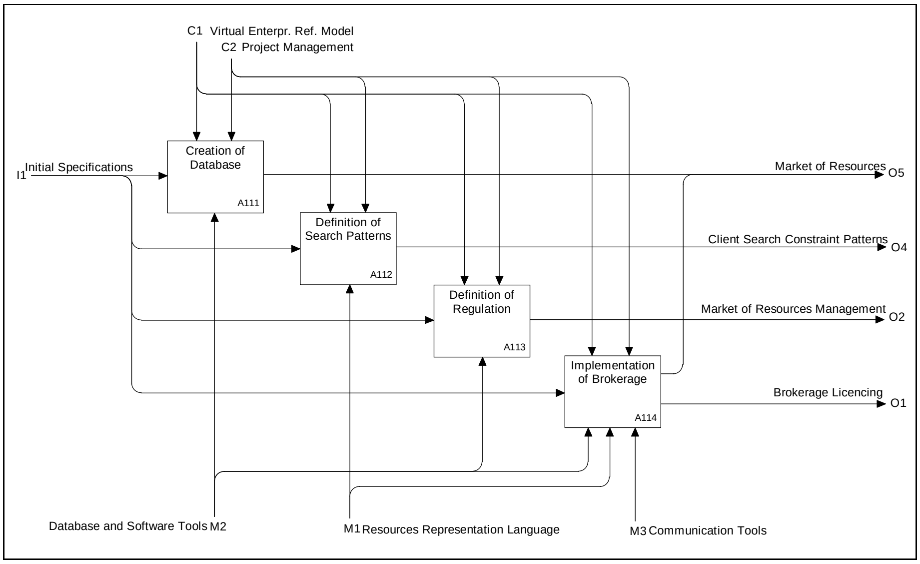
1. The two components (organizational and informational) of the Market of Resources are created (for the first time): Process A.1.1. — Market of Resources Definition;
2. The organizational component is operated and kept actualized: Processes A.1.2. — Maintenance of Management Procedures and A.1.3. — Search Patterns and Focused Markets Identification; and
3. The Market of Resources information (database) is managed: Processes A.1.4. — Market of Resources Operation and A.1.5. — Brokerage Maintenance.

The five proposed processes (A.1.1., to A.1.5.) are described next.

Process A.1.1. — Market of Resources Definition

This process (Figure 9) corresponds to the creation of the Market of Resources environment — the organizational component and the support infrastructures — for the first time. Subsequently, the components of the Market can be updated and operated, through processes A.1.2. to A.1.5.

Figure 9. IDEF0 representation of Process A.1.1. — Market of Resources definition



As we have already mentioned, the scope of the service comprises, besides the selection and integration of resources, the management of the A/VE design, selection and integration of resources and the evaluation of A/VE operation.

From the set of initial specifications, the environment (Market of Resources) is created. This corresponds briefly to the creation of the Market of Resources information structure (Process A.1.1.1. — Creation of Database), the definition of the search patterns to be used in the selection process (Process A.1.1.2. — Definition of Search Patterns), the definition of the management procedures to control all the operation of the Market and of the processes of selection and integration of A/VE and A/VE Operation (Process A.1.1.3. — Definition of Regulation) and the implementation of the brokerage function (Process A.1.1.4. — Implementation of Brokerage).

After the creation, the Market of Resources is ready to be operated and to perform its projected activities of selection, integration and management.

Process A.1.2. — Maintenance of Management Procedures

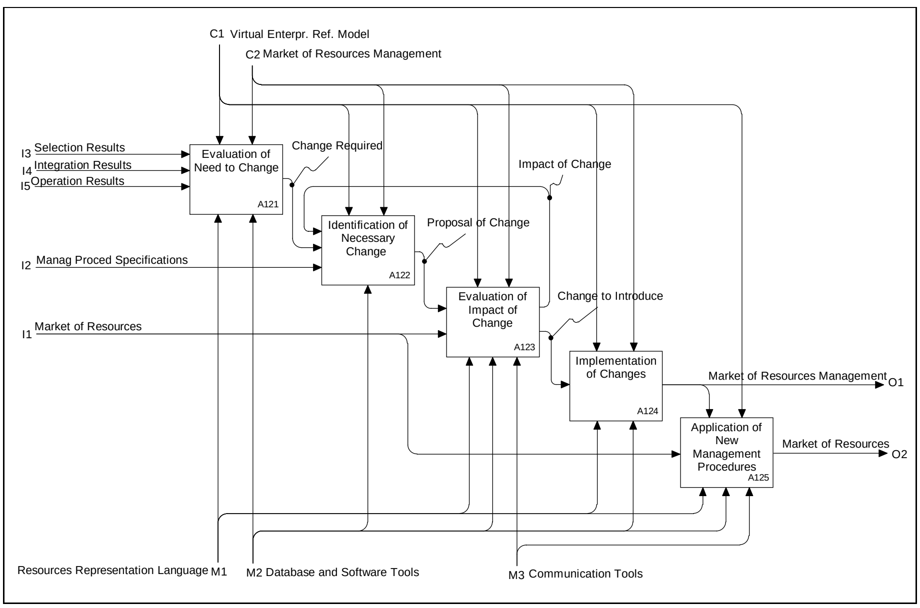
All the operation of the Market of Resources is constrained by a control, designated Market of Resources Management, defined for the first time in process A.1.1 and used as a control in every process thereafter.

The Market of Resources Management represents all the procedures and rules that govern the Market, and is maintained actualized in order to provide maximum efficiency in the processes of selection of resources, integration of A/VE, control of A/VE operation and management of the operation of the Market, and this maintenance is accomplished by this process A.1.2., represented in Figure 10.

The output flow Market of Resources Management is a control flow in all the processes, except in process A.1.1. Even the application of changes in the Market of Resources Management to the ongoing A/VE operation and to the resources registered in the Market (Process A.1.2.5.) is constrained by this control.

Periodically, or after each activity of the Market, the results of the operations of resources selection, integration or of A/VE operation control are evaluated (Process A.1.2.1.) in order to determine the need of introducing any change in any of the management procedures. The adjustment of the management procedures is an iterative process, where the impact of the necessary adjustments on the present environment (resources subscribed, ongoing activities, etc.) is evaluated and measured, until an equilibrium is found, between the management rules adjustment and the effect on the environment (Processes A.1.2.2. and A.1.2.3.). When the elements of the management procedures that will assure an improvement of the Market operation performance, with a minor

Figure 10. IDEF0 representation of Process A.1.2. — Maintenance of management procedures



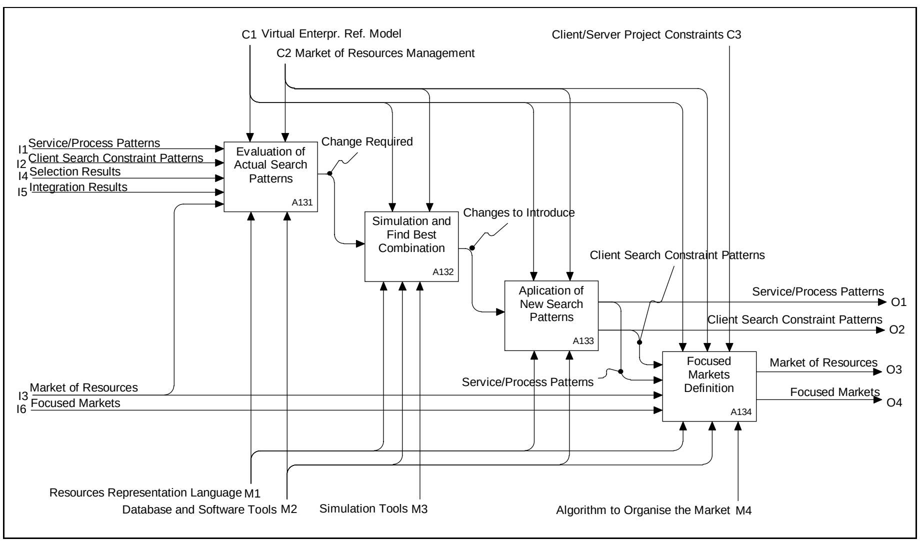
disturbance of the ongoing activities are found, the changes are effectively implemented (Process A.1.2.4.), originating a new control “Market of Resources Management,” output flow from this process. Finally, the new management procedures are set to the ongoing activities and entities registered and operating in the Market (Process A.1.2.5.).

Process A.1.3. — Search Patterns and Focused-Market Identification

As mentioned earlier, the selection of resources is improved by the identification of a set of patterns and the organization in Focused Markets. These must be permanently calibrated in function of the results of the Selection and Integration processes, to increase the efficiency of the Selection process.

As we can see in Figure 11, when it is detected (by process A.1.3.1.) the necessity of updating the search patterns, which can happen as a consequence of the evaluation of the performance of the selection and integration processes, an iterative process (A.1.3.2.) is triggered; this process simulates the best combination of patterns to maximize the efficiency of the selection, namely, the identification of the Focused Domains where the Resources Selection process will find the optimal combination of resources to be integrated. After the conclusion of this process (A.1.3.2.), the new combination will be made

Figure 11. IDEF0 representation of Process A.1.3. — Search patterns and focused markets identification



applicable to the future (Process A.1.3.3.) and traduced in a new organization of the Focused Markets (Process A.1.3.4.).

The Focused Markets Definition is performed by an algorithm ("Algorithm to Organize the Market of Resources") and is constrained (besides by the *BM_VEARM* Reference Model) by two main kinds of control information: (1) the Market of Resources management rules and (2) the constraints of the focused-market identification process itself (seen on the diagram "Client/Server Project Constraints").

Process A.1.4. — Market of Resources Operation

This process corresponds to the maintenance of the database of resources, consisting of three processes, as represented in Figure 12:

1. Subscription of the service by resources providers willing to make their resources available for integration — Process A.1.4.1.
2. Actualization of information related to the resources subscribed, either required by the resources providers themselves or the registration of the

Figure 12. IDEF0 representation of Process A.1.4. — Market of Resources operation

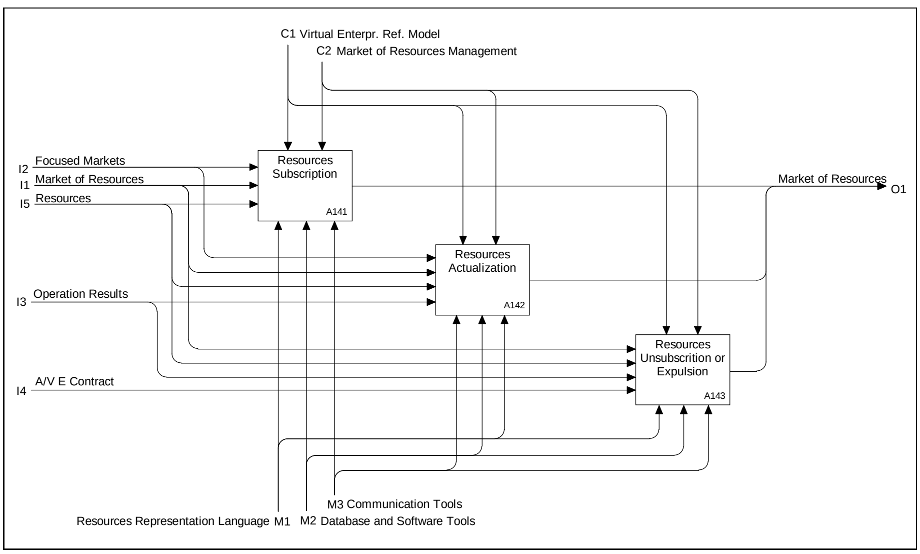
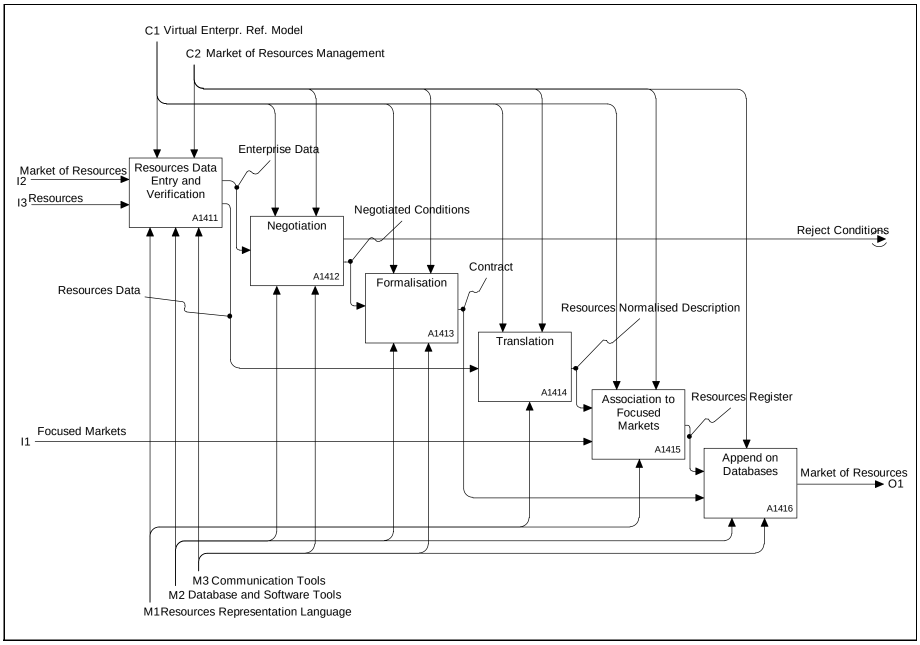


Figure 13. IDEF0 representation of Process A.1.4.1. — Resources subscription



results of an A/VE operation, updating the historical information of resources providers' performance — Process A.1.4.2.

3. Removal of resources providers from the Market of Resources' database, if required by the enterprises themselves or expulsion as a consequence of failure in the accomplishment of obligations, or inobservance of commitments — Process A.1.4.3.

In Figure 13, Figure 14 and Figure 15, we detail the processes A.1.4.1., A.1.4.2. and A.1.4.3., respectively.

- *Process A.1.4.1. — Subscription*: The first step of the subscription consists of the data entry and verification, in order to analyze the interest of both parties and negotiate the conditions of integrating the Market of Resources (Process A.1.4.1.1.). If it is found agreement between the parties (Process A.1.4.1.2.), the negotiated conditions are formalized under a contract (Process A.1.4.1.3.) and the specification of the resources to be provided and conditions are translated (Process A.1.4.1.4.)

Figure 14. IDEF0 representation of Process A.1.4.2. — Resources actualization

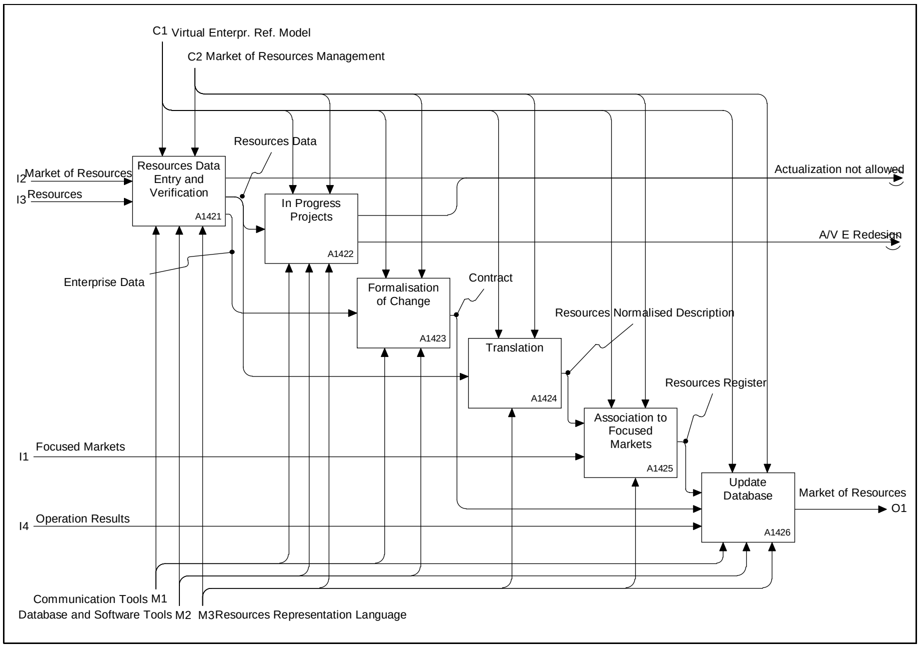
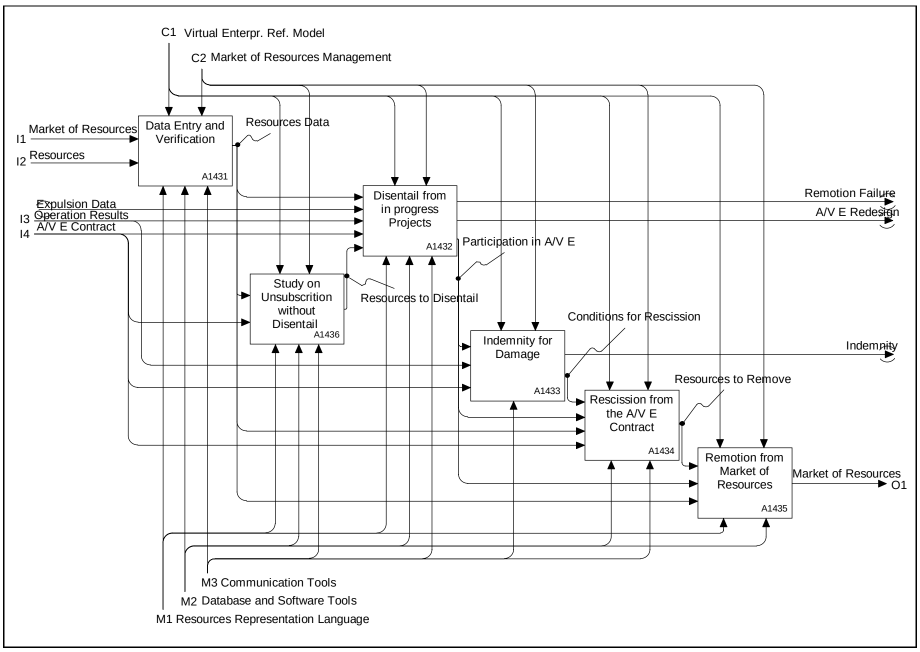


Figure 15. IDEF0 representation of Process A.1.4.3. — Resources unsubscription or expulsion



using a specific Resources Representation Language (mechanism M1) for normalizing resources description in order to allow the use of automatic search algorithms in process A.2. The resources normalized description is associated to the established Focused Markets of Resources (Process A.1.4.1.5.) and all the information is appended to the Market of Resources database (Process A.1.4.1.6.).

- *Process A.1.4.2. — Actualization*: Two types of information actualization are identified: the first is required by the resources provider and respects the actualization of information concerning the characteristics of the resources, conditions to provide them, details for negotiation; and the second is automatically triggered by the service and respects to the update of the historic with the results of the participation of a resource in an A/VE.

  In the first case, it starts with the data entry (identification of the resources and the characteristics and conditions to be altered) and verification of the involvement of the resources in ongoing A/VE, or the existence of any commitment or compromise (Process A.1.4.2.1.). If so, it is necessary to see if the pretended changes will affect those compromises (Process A.1.4.2.2.) and if this is true, the possibility of A/VE redesign without disruption will have to be analyzed. If it is not possible to introduce the changes without prejudice of assumed compromises, they will not be accepted, until their accomplishment. When it is possible to accept the required actualization, an amendment to the contract is agreed to (Process A.1.4.2.3.), the new information is translated (Process A.1.4.2.4.), associated with Focused Markets (Process A.1.4.2.5.) and the database is updated (Process A.1.4.2.6.).

  In the second case, the update of the database with the operation results will trigger only the process A.1.4.2.6.

- *Process A.1.4.3. — Unsubscription or Expulsion*: This process aims at removing a resources provider from the Market of Resources database, and is a consequence of two situations: as a request of the resources provider, corresponding to the unsubscription operation, or as a consequence of a bad performance or failure in the accomplishment of obligations, corresponding to expulsion.

  In the first case (the voluntary unsubscription) two situations are possible: (1) the resources provider suspends its participation in the Market but keeps its compromises until the end of ongoing A/VE projects, a situation that requires the approval of the A/VE owner, as after unsubscription from the Market, he loses the right to enforce this resources provider or (2) associated with the unsubscription is also the wish to cancel the contracts, which requires disentangling from ongoing projects.

Unsubscription starts with the data entry (identification of the resources to be unsubscribed) and the verification of the involvement of the resources in ongoing A/VE, or the existence of any commitment or compromise (Process A.1.4.3.1.). If the resources provider wishes to cancel contracts, it is necessary to study the possibility of disentangling the resources from the operations in which they are involved, even if it is necessary to redesign the A/VE under operation (Process A.1.4.3.2.) and the indemnities to pay for the damage caused by the substitution and the redesign of the A/VE are calculated (Process A.1.4.3.3.), the contract with the operating A/VE is rescinded (Process A.1.4.3.4.) and finally, the contract with the Market of Resources is rescinded and the records of the database are actualized (Process A.1.4.3.5.). If after the disentangling study it results in high indemnities, the resources provider should reconsider waiting until the accomplishment of the contracts.

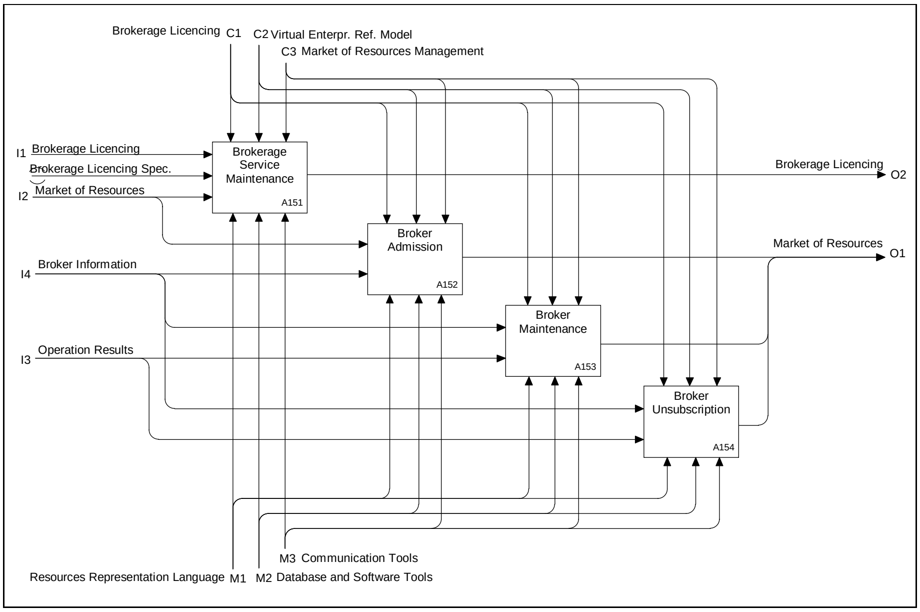
If, otherwise, the resources provider wishes to unsubscribe from the Market, but wants to respect the contracts until the end, after the verification of the involvement of the resources in ongoing A/VE (Process A.1.4.3.1.), this possibility is explored, if possible giving time to prepare the new A/VE instantiation (Process A.1.4.3.6.), and, the resources provider is removed (Process A.1.4.3.5.) or its disentangling follows the same above description (Processes A.1.4.3.3. and A.1.4.3.4.).

In the second case, the expulsion is a consequence of the input flow Operation Results, and starts with the study of the possibilities of disentangling the resources from operating A/VE and the respective redesign (Process A.1.4.3.2.), and continues as with processes A.1.4.3.3., A.1.4.3.4. and A.1.4.3.5.

Process A.1.5. — Brokerage Maintenance

This process, represented in Figure 16 is responsible by two kinds of activities: (1) the maintenance of brokerage rules and procedures (called “Brokerage Licensing”), whenever it is necessary to review and to change them (Process A.1.5.1.); and (2) the maintenance of the contracts between the Market of Resources and Brokers, integrating the Admission of Brokers (Process A.1.5.2.), actualization/updating of information concerning a broker, either externally by its request, or internally by the Market in function of A/VE Operation Results, if any mistake or fault has been attributed to the Broker (Process A.1.5.3.) and finally the Broker unsubscription (Process A.1.5.4.) again by its request or as an expulsion from the Market.

Figure 16. IDEF0 representation of Process A.1.5. — Brokerage maintenance



Design Rules System

In this section, we describe the processes of subscription and unsubscription of the service by the entities Broker, Resource Provider and Client, as well as their duties and responsibilities. It is divided in Brokerage, Resources Providers and A/VE Owner.

Brokerage Regulation

The service provided by the Market of Resources is supported by intermediation activities, provided by individual (or collective) entities designated by "Brokers," as previously defined. As the information manipulated within the Market is confidential and sensitive, the brokerage activity must be subject, itself, of a specific regulation, to define and limit the intervention of the Brokers, defining their responsibilities and duties, and conditions to supply the brokerage services. Brokers must be accepted by the Market and, under a contract with the Market (license), they must respect the regulation and respond in the case of failure/ unaccomplishment.

Brokers Admission

The concession of the permission for the exercise of the brokerage function depends of the verification of a set of requirements/requisites, such as idoneousness, knowledge, professional competencies and trust, to assure a high level of competency, safety and efficiency, as well as the possession of technical and material means.

The concession of the Broker's statute is given by domains (e.g., business, health, construction, etc.), corresponding to aggregations of Focused Markets, in function of the recognized competencies of the applicant Broker. As the Broker gets expertise/knowledge in other domains or it contracts experts (as a Broker is not exclusively a single person) he can apply for an enlarged domain of intervention.

The Market of Resources Manager is committed to define the criteria for brokerage application and for broker operation (which services is he allowed to offer), as well as to recognize competencies by domains of activity.

When an application of a Broker is accepted, it is established a contract between him and the Market of Resources, specifying the operation conditions, functions, domains of activity, obligations, duties, including the unsubscription process and the law court where irregular situations are to be judged.

The requirements of acceptability of the Broker consist on the verification of the existence of human and material means to assure a high performance, idoneousness, safety and efficiency and the ability to accomplish the processes of assisting the A/VE design and resources search, negotiation and selection. This includes the characteristics of the information systems and technology, the organizational aspects (time to dedicate to the function, management and control, etc.), prevention of conflicts of interest between enterprises /resources.

Idoneousness and professional competency is permanently assessed during and after each intervention of the broker. Seal, time, mediation of conflicts, results, and efficiency are parameters to be analyzed and can determine the renovation of the permission to participate in the Market or not, as well as the authorization to perform other services and more autonomy in the utilization of the Market technical resources or the enlargement /restriction of the domain of intervention.

If it is not possible to conclude about the competencies of the broker, his application is not accepted.

It is possible, after an evaluation process, to compel the rescission of the contract with the broker, when it is found to be an element capable of threatening the interests either of the Market or of the participating entities (Clients and Resource Providers), or in detected situations of illegal actuation or violation of agreements.

Relation Between the Broker and the Market of Resources

Brokers are independent in relation with the Market of Resources and are not subject of any exclusiveness with this service[7], insofar as he scrupulously follows its duties and accomplishes its responsibilities.

The Broker pays a fee to belong to the Market and receives a part of the amount charged by the Market for each intervention, which is a function of the dimension of the business and of the associated effort. The attribution of a Broker to a Request is done by the Market or by selection by the Client from a set of Brokers proposed by the Market, taking into consideration, besides other parameters, its efficiency. The Client can also propose a Broker, as a result of a trust base created along previous contacts.

It is also possible that the Broker brings into the Market of Resources an A/VE Request (which means a new Client) and wants to satisfy it using the Market. In this situation, the Broker has a participation in the tax paid by the Client. An equivalent situation occurs when the Broker brings to the Market new Resource Providers.

Functions of the Broker

Ávila et al. (2002) propose a taxonomy for the broker functions, as the different broker models proposed by several researchers attribute different functions to this entity. In the framework of the *BM_VEARM* (Putnik, 2000), and respecting the authors' taxonomy, the activities to be undertaken by the brokers are the following:

- Reception of demands for the integration of A/VE, forwarded by the Market of Resources;
- Guidance on the design of an A/VE instantiation (translation of the product and/or process requirements into an A/VE project), making sure that the requirements for triggering the selection and negotiation processes are complete;
- Guidance on the definition of the most suitable negotiation processes to achieve the optimal results, and launch of the same, or utilization of the software tools to perform automated search for the resources on the Market of Resources;
- Negotiation with the eligible resources and reception / management of bids, if it is the negotiation process selected;
- Selection of the optimal resources;
- Evaluation of A/VE reconfiguration requests;

- Engagement of new participants (Resource Providers and Clients) to the Market;
- Consultancy on evaluation of products and services;
- Consultancy/guidance on the A/VE operation evaluation and reconfiguration management, with identification and evaluation of alternative configurations ("post-integration" support service).

Obligations of the Broker

Brokers must orient its activity towards the protection of the legitimate interests of its clients and of the efficiency of the Market of Resources. In the relations with all the participants, they are expected to observe all the principles of trust and confidence, loyalty and transparency.

Some of the main obligations and duties of the Broker consist on:

- Make available to the Client information about the situation of his request;
- Make available to the Market information about the request and undergoing negotiation and selection processes;
- To respect the duty of seal and not to use confidential information (about Requests, Clients and Resources Providers) outside the Market;
- Before accepting the mediation, be sure that he has knowledge and capacity to undertake the requested project;
- Report to the Market Manager any detected illegal situation or the unaccomplishment of contracts;
- Accomplish the timings to answer to the requests;
- Management of the negotiation conditions with the resources providers, in observance of the established with the Client;
- Requests submitted to the Market of Resources and allocated to a Broker cannot be satisfied by the same outside this environment, unless is authorized both by the Market and the Client;
- Get organized and act in order to avoid or to reduce to a minimum extent the risk of conflict of interests;
- Whenever a Broker is not able to complete a Request he must transmit it to the alternative Broker, nominated by the Market Manager, the actual situation of the running processes of negotiation and selection;
- In a situation of conflict of interests he must assure transparent and equitative treatment to all the entities involved and let the Market of Resources to undertake the mediation of the situation and the decision-making.

The unaccomplishment of its duties and obligations can be punished by the Market and lead to compensations, either to the Market or to the damaged parties, and to the Brokers' suspension or expulsion.

Rights of the Broker

When respecting all its obligations and duties, the Broker can claim for certain rights from the Market of Resources. And its main rights are:

- A Request (or part of a Request, if it is complex and involving more than one domain of expertise) is allocated just to one Broker and, unless it fails to give a good solution in reasonable time, or violates any principle, it will not be discharged of the same.
- To the Broker is given the right of giving up the resolution of a Request if the A/VE Owner fails to accomplish its side of the contract, namely the provision of the necessary information, payments, etc.
- A Broker has the right of equal treatment as the others, unless he violated any principle or failed to accomplish its responsibilities and duties.

Broker Suspension or Expulsion

Due to the unaccomplishment of its duties and obligations, the Market of Resources can determine the suspension or expulsion of the Broker, as well as to start a lawsuit requiring indemnifications to the damaged parties.

Broker Unsubscription

A Broker is free to unsubscribe the Market whenever he wants, unless he is involved in ongoing negotiation or selection processes. In this case, the Market of Resources studies each process individually and determines the conditions to the unsubscription, which can vary from time to prepare the broker substitution until indemnities if he is not able to give the necessary time.

The Broker is committed by deontological principles to the duty of seal, so it is supposed that he will not use information gathered about products or resources. This is assured by the contract celebrated between the Market of Resources and the Broker, when of its subscription.

Resources Providers Regulation

Resources providers can be private enterprises from all sectors of activity, public institutions and individuals, willing to make their resources available for integration in an A/VE. Resources providers register in the Market and provide a catalogue developed according to a specification language defined by the Market, and furnishes information concerning the provision of the resources, negotiation parameters accepted, timings, and other requirements.

Subscription

Before initiating its activity, the members of the Market of Resources celebrate a contract with the Market. At the subscription it is formalized as a contract whereby the enterprise accepts the rules of the Market and corresponding responsibilities/obligations, defines the accepted terms for negotiation (fixed price, auction, bids, case-by-case), and empowers the Market for contractualisation with the A/VE Owner when the Resource Provider is selected for integration, etc.

When subscribing, the provider must specify its production capacity for each resource he is able to provide, negotiation conditions, prices, time to deliver the resource, etc.

To prevent eventual unaccomplishments, the Market can require bank guarantees or other, in function of the expected volume of transactions the provider is expected to participate in. According to the volume of transactions and according to the behavior in respecting the A/VE contracts and performance, guarantees can be increased or decreased. The contract determines also penalizations and the court of law where irregular situations are to be judged.

It is possible, after an evaluation process, the rescission or the suspension of the contract with the resources provider, when it has failed in accomplishing a responsibility and the fault is directly imputable, or when are detected situations of illegal actuation or violation of agreements.

The subscription of the Market corresponds to the payment of a fee by each resource the resources provider wants to make negotiable in the Market.

Admission Requirements

The acceptance depends on the idoneousness and competency of the candidate provider and on the certification of the resources it intends to provide, according to the adequate standard. If it has been expelled from the Market of Resources in the past, this aspect must be taken into consideration and requires investigation on its performance since the expulsion. The Market of Resources can refuse subscriptions if the resources to be provided are not of interest to the Market clients or that do not assure confidence.

The Market can also require references about the candidate resources provider.

Relation Between the Resources Provider and the Market of Resources

The resources provider is not tied to maintain any sort of exclusiveness with the Market. The enterprise can offer its resources in other concurrent market, as far as it accomplishes all its obligations corresponding to the resources to be offered in the Market of Resources.

Obligations/Duties of the Resources Providers

The resources provider must also:

- Accept the decisions of the Market that have been taken under the legal regulation of the Market valid and appropriate to the situation.
- Provide true information and prove it when requested either by the Market (at any time, since the subscription) or by the Broker, namely certification of processes or products, references, etc.
- Provide all the information necessary to the management of the Market, even if this information is subject to secrecy (between the enterprise and its competitors), otherwise the Market of Resources cannot assure efficiency.
- Accomplish the contractualised tasks (provide the contractualised resources) observing all the requirements of the same in the negotiated terms.
- It is expected the duty of seal concerning secret information about projects, when this is expressed in the contracts with the A/VE Owner. Although it is not possible to follow this subject, it can lead to suspension of expulsion from the Market of Resources if it is proved to be verified.
- The payment of the contractualised fee, otherwise the enterprise can be temporarily suspended from the Market until it regularizes the payments in debt. If the delay exceeds a limit, the Market can determine the expulsion.

Rights of the Resources Providers

The Resources Providers have some rights, being the most relevant:

- The right of equal treatment as the others, unless there is any historic information of failure to accomplish its responsibilities and duties, which lead to a penalization.
- The right of a transparent treatment.
- The right of confident treatment of the information provided, either from the side of the Broker, and from the Market.

Resources Provider Unsubscription

The resources provider is free to unsubscribe from the Market any or all the resources, whenever he wants, unless they are involved in any A/VE. In this case, the Market of Resources studies each participation individually and determines the conditions to disentail, which can vary from time to prepare the resource substitution until indemnities if he is not able to give the necessary time for substitution, or if the substitution is not possible.

A/VE Owner Regulation

When a Client (looking for Resources) requests a service from the Market of Resources and registers with a Broker, it is formalized a contract, defining the forms of negotiation and allowing the Market/Broker to negotiate with Resource Providers and to represent them in the A/VE contract that corresponds to the integration of the selected resources. The acceptance of a Request is conditioned by some requirements and only when these are verified, it is allowed the registration with a Broker, and the start-up of the A/VE project.

Requirements for Request Acceptance

First of all, the acceptance is bounded by the domains of activity where the Market of Resources has expertise for intervention. The Market can also accept a Request conditionally in certain domains where it is not possible to assure an efficient support, due to a small domain of resources providers, safeguarding the quality of the results.

In general, the acceptance is conditioned by:

- The idoneousness of the A/VE Owner.
- Historic information concerning previous Requests and its behavior ("trust-ability") in previous negotiations with the Market of Resources.
- The Market of Resources can require guarantees, references, etc.

Relation Between the A/VE Owner and the Market of Resources

The A/VE Owner is not forced to any sort of exclusiveness with the Market. He can present the same request to other concurrent services, but by signing the contract with the Market, it is due a payment corresponding to the Request.

A request may be satisfied in cooperation with other similar services, when it is decided that the Market does not have knowledge or resources to assure an answer to the request with quality.

Obligations/Duties of the A/VE Owner

The main duties of the A/VE Owner consist of:

- Providing the Market and the Broker with the necessary information to carry out the design of the A/VE project and search for the optimal solution to its Request.
- Providing true information and references when requested by the Market of Resources.
- Reporting to the Market any illegal situation or unaccomplishment of contracts.
- Accomplishing the negotiated conditions with the Resources Providers, the Broker and the Market.

The unaccomplishment of its duties during the satisfaction of the Request by the Market and the Broker can determine the suspension or conclusion of the negotiation process. The unaccomplishment within an A/VE of the contracts can be subject of a lawsuit requiring indemnifications to the damaged parties.

Rights

The most relevant rights of the A/VE Owner are:

- Require the substitution of the Broker allocated by the Market, or require the evaluation of its performance, if it fails in accomplishing the contracted parameters (especially time to perform the search and quality of the solution).
- Require an evaluation of a Resource if it fails in accomplishing the contracted parameters, and its substitution (the Market can, after evaluation of the situation, consider its consequent suspension or expulsion).
- Require the observance of the contractualised indemnities when it is proved to have been damaged by a third party (Resource Provider or Broker).
- If the A/VE Owner feels the service provided by the Market is not satisfactory, or the Market failed to accomplish its part of the contract, he can apply legally; however, the contract safeguards the effectiveness of the solutions in what is imputable to the Resources Providers performance.
- The right of a transparent treatment.
- The right of confident treatment of the information provided, both from the side of the Broker, from the Market and from the Resource Providers.

Patterns for Search and Identification of Focused Markets

For each *Request* (for A/VE creation or reconfiguration), the broker selects the domain for selection (*focused domain*), composed by the *focused markets* where each component of the A/VE project is supposed to exist. This domain for selection, defined by the Broker in process A.2.2.1., consists of a compromised solution between the required quality of the search (negotiated within the Request) and the available time to perform the resources search and selection.

Focused markets (FM) can be horizontal or vertical. Horizontal FM (HFM) consist on multifunctional resources combinations and Vertical FM (VFM) integrate combinations of resources providers within a field /domain of activity, as we will see later in this section, and are the result of an analysis on patterns of resources requests ("Service/Process Patterns," in the IDEF0 diagrams).

Patterns are the result of the requests and the evaluation of selection results and traduce the behavior of the demand side. Horizontal Focused Markets are the organization of the offer according to the demand patterns. HFM consists of meaningful combinations of resources in order to facilitate selection of complex requests and patterns are used to validate its identification. The identification of these patterns is the result of datamining algorithms applied to the knowledge base, considering A/VE instances, A/VE projects and resources providers performances.

The permanent adjustment in the focused markets (based on the identified patterns) represents one of the main functionalities of the Market of Resources to enable quick response, that is, to enable dynamics, and at the same time, reliability.

HFM structure results from the permanent calibration of A/VE requests and aims at optimizing more complex searches than the search of a sole resource. An example of a request requiring a HFM could be the installation of a CAD program, a printing/plotting device and some more hardware (monitor, computer) in an engineering/design office; besides involving different groups of resources (hardware and software), they are related horizontally.

The organization of Resources and Resources Providers in the FM structure is automatic. Resources providers should be described using a Resources Representation Language, which corresponds to the mapping of the Resources Providers in the tree of the Focused Markets.

Vertical Focused Markets integrate complex resources, aggregated in Resources Classes (RC). HFM are combinations of Resources Classes components, and Resources Classes can be shared by VFMs. Resources Classes can be decomposed in primitive resources. VFM is a tree, with primitive resources on the basis (leaves) and complex resources on the top. Resources are automatically mapped into this tree structure.

Figure 17 represents an attempt to illustrate the above classification. Vertical and Horizontal Focused Markets are represented by the abbreviations VFMx (VFM1, VFM2…) and HFMx (HFM1, HFM2…) respectively. Resources Classes are represented as RCx (RC A, RC B…) and the resources integrating each Resources Class are represented as Xi (RC A includes resources A1, A2 and A3). Resources Providers (RPy) are able to provide resources Xi, (for instance, RP1 is able to provide resources A1, A2, A3 and C1).

We have selected the domain of Information Systems and Technology to illustrate a possible tree of organization of resources, which contributes to facilitate the Focused Market identification. The example is not exhaustive, it is merely illustrative.

A Request could address the top domain — the planning and implementation of an information system from the beginning (e.g., an ERP system), including hardware, software development, installation, maintenance, etc., — or merely the development of an application to be integrated in an existing information infrastructure (e.g., an order management application, the enterprise Web pages, etc.).

Some examples of Vertical Focused Markets (VFM):

- Hardware commercialization
- Software commercialization
- Software analysis and development
- IT/IS consultancy

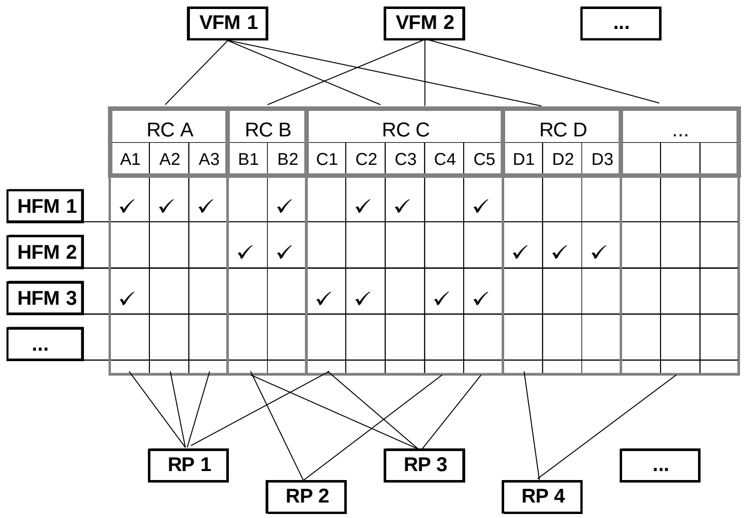
Some examples of Horizontal Focused Markets (HFM):

- ERP solutions
- E-commerce solutions
- Office Automation solutions

Some examples of Resources Classes (RC):

- Products Resources Classes
  - Development tools and platforms
  - Standard applications

Figure 17. Vertical and horizontal focused markets



- ° Computer communication
- ° Components libraries
- ° Utilities
- ° Operating systems
- ° Parameterized software
- ° Databases and libraries
- ° Hardware

- Operations or Services Resources Classes
    - ° Software analysis
    - ° Software development
    - ° Post sales services
    - ° Electronic publishing
    - ° Hardware installation and maintenance
    - ° E-business planning and design
    - ° Web design
    - ° Web development
    - ° Acquisition Guidance/consultancy

Decomposition of some of the above Resources Classes:

- Development tools and platforms
  - Compilers, interpreters
  - Web design
- Database
  - Computer-Aided Software Engineering
  - Application generators
  - Prototyping tools
  - Workflow tools
  - Modeling tools
  - E-business development platforms
- Computer communication
  - Videoconference
  - Networks-Communication devices
- Software analysis
  - Requirements analysis
  - Functional analysis
  - Software design
  - Prototyping
  - Planning and project management
- Software development
  - Programming/codification
  - Screen /interface design
  - Prototyping
  - Installation
  - Maintenance
  - Testing
  - Software development planning and project management

A Request involving the simple acquisition of equipment corresponds immediately to a Vertical Focused Market, as well as a Request for the Web design of an enterprise Web site corresponds immediately to a Resources Class of the Software Analysis and Development Vertical Focused Market.

A Request for the development of an e-commerce solution requires a search on a horizontal focused market, as there are involved resources classes of several VFMs (hardware products, installation and management, Web design, requirements analysis, software development, etc.).

Operation of the Market of Resources

In this section we detail some operations performed by the Market of Resources that were not included in the previous section, like negotiation and contractualisation, and the regulation corresponding to the Market operation.

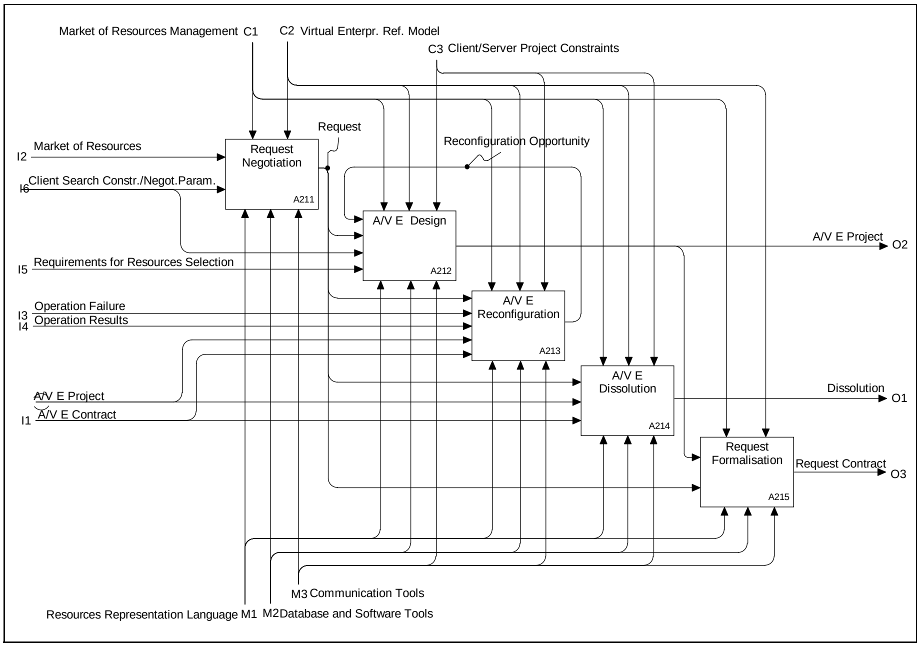
Request for A/VE Creation / Reconfiguration / Dissolution

Process A.2. (A/VE Design and Integration) starts with a request for A/VE creation, required by a Client, or reconfiguration or dissolution (as a special case of reconfiguration), either required by the Client or suggested by the Market, corresponding to Process A.2.1. This process, detailed in Figure 18, involves a request negotiation with the Market and the allocation of a Broker, suggested by the Market or selected by the Client (Process A.2.1.1.). When the request corresponds to an A/VE creation, the requirements for resources selection as well as the search constraints and negotiation parameters are discussed with the Broker and the A/VE is designed, as well as all the selection and negotiation procedures are accorded (Process A.2.1.2. – A/VE Design). When the request corresponds to a reconfiguration, the conditions for reconfiguration are evaluated and the new A/VE instantiation is planned (Process A.2.1.3. – A/VE Reconfiguration), and the results of the identification of the reconfiguration opportunity ("Reconfiguration Opportunity" flow) are used again to design the new instantiation of the A/VE (Process A.2.1.2.). The request can also correspond to a dissolution request, and the process is also prepared with the Broker (Process A.2.1.4. – A/VE Dissolution).

Process A.2.1.2. is responsible by the design of the first instantiation (or physical structure) of an A/VE project as well as subsequent instantiations, when a reconfiguration is to take place.

Before proceeding with the resources selection, it is formalized the contract between the Client and the Market, traducing the service framework, corresponding to the A/VE Project (Process A.2.1.5.).

Figure 18. IDEF0 representation of Process A.2.1. — A/V E request



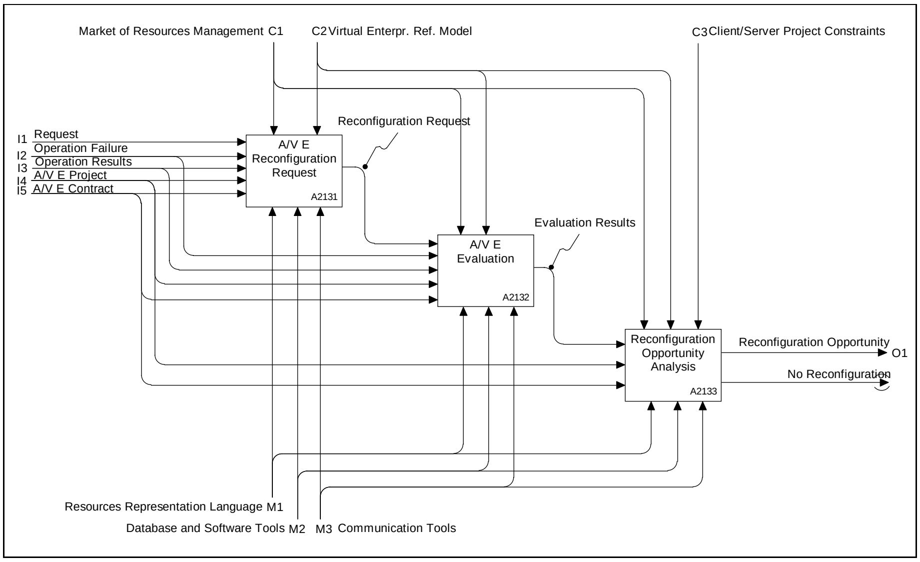
When the reconfiguration is the result of the A/V E performance evaluation, the opportunity of reconfiguration is analyzed (Process A.2.1.3.) followed by A/VE Design if it is found a reconfiguration opportunity.

Process A.2.1.3. (A/VE Reconfiguration) is detailed in Figure 19 and can be started by a client request, with Process A.2.1.3.1., followed by the A/VE Evaluation (Process A.2.1.3.2.), or periodically triggered by the broker, with the A/VE Evaluation (Process A.2.1.3.2.). In both situations, the results of the A/VE evaluation are used in the Reconfiguration Opportunity Analysis (Process A.2.1.3.3.)

Negotiation and Selection in the Market of Resources

The process of selection takes place in two phases, the first off-line, automatically through the organization of the Market into Focused Markets (vertical and horizontal), and the second takes place online. This second phase starts after a Request, with the definition of a domain for search (Process A.2.2.1.), and a computer aided filtering (performed by the Broker allocated to the A/VE), resulting in the set of eligible resources (Process A.2.2.2.), as in Figure 6.

Figure 19. IDEF0 representation of Process A.2.1.3. – A/V E reconfiguration



The selection of the candidate resources within the set of eligible resources can be done through three methods, one passive and two active, defined by the Request:

- **Passive selection:** where an algorithm searches for resources satisfying the product requirements at a satisfactory price, in a take-it-or leave-it basis, without bargaining; this method corresponds to an automatic visit to resources providers.
- **Active Selection — Auction-based:** the implementation of a reverse-auction or Request for Bids, to which the eligible resources can apply and present the conditions for provision; this format of auction/bid is also mediated by the broker and corresponds to an automatic negotiation, under conditions defined by the Broker.
- **Active Selection — Direct Negotiation:** performed by the broker (manually or automated under its supervision), by visiting the resources providers and inquiring the availability and inviting for bilateral bargaining the conditions of the provision.

These negotiation methods are implemented by Processes A.2.2.3., A.2.2.4. and A.2.2.5., respectively (see Figure 6).

- **Process A.2.2.3. — Automatic Search:** For the resources of the A/VE Project to be selected under this method, the eligible resources providers are visited in order to identify the availability and the negotiation parameters of the resources, according to the requirements for resources selection, traduced in the A/VE Project, and the "Client Search Constraints/Negotiation Parameters". This is a faster method, indicated when it is not required a high quality solution or the financial amounts are not considerable, or the complexity of the product is not high. The search is constrained by two kinds of control information: (1) the Market of Resources management rules and (2) the Virtual Enterprise Reference Model. From this process will result a list of the best resources to satisfy the client requirements for resources to integrate the concrete A/VE, the candidate resources.
- **Process A.2.2.4. — Offer/Bid-Based Negotiation (Reverse Auction):** The Broker decides the most suitable type of auction to be implemented for each resource required and prepares the offers to be performed, set-up the conditions and parameters for negotiation, according to the "Client Search Constraints/Negotiation Parameters" defined with the A/VE Owner. The Broker coordinates the integration of the bids results, especially when in presence of combinatorial processes. This is a fast method, however it is of limited utilization when the A/VE Project is complex and the selection model is dependable and combinatorial, because of its automation.
- **Process A.2.2.5. — Direct Negotiation:** When this method is selected, the eligible resources are selected and invited the negotiation and to bargain for the best resources provision conditions of the A/VE Project, starting from a negotiation base defined on the "Client Search Constraints/Negotiation Parameters", under the Broker control.

  As it is less automated, this method requires more time. It is suitable for parts of complex A/VE Projects or when it is desired to undertake a dependent selection model and it is desired an accurate and less automated negotiation (more knowledge-based negotiation) or when the A/VE Project or part of it is ill-defined and as such cannot be more automated. It is a more participative negotiation, a bilateral bargaining process, where complexity grows with the solution space dimension.

The results of each resource negotiation can determine the redefinition of the Focused Domain for that resource search, if the negotiation fails to find resources matching the resources requirements and accepting the negotiation parameters. It is possible also to undertake the passive selection method and simultaneously an active method.

The final selection involves the integration of the partial negotiation activities results. The final selection (Process A.2.2.6.) consists on the application of a search algorithm to the candidate resources in order to select the best combination of resources to integrate, which corresponds to the output flow "Selected Resources" (Figure 6). This output corresponds to one of the various possible instantiations of the A/VE project.

Some parameters determine the most suitable negotiation method for a given resource, for instance:

- The transaction value (V), the amount involved in the transaction (money),
- The complexity or specificity of the required resource (C),
- The price (P) that the A/VE Owner is willing to pay to the Market (and the Broker) for the search and selection service (traducing the effort to be applied in the negotiation process) and
- The available time (T) for the negotiation process,
- The expected negotiation domain dimension (D) is relevant, as direct negotiation is unbearable when the number of eligible resources for negotiation is high (unless the available time is not a restriction).

Table 3 presents the suitability of each negotiation method, when the value of the parameter increases.

Operation Rules System

This set of principles intends to explain the processes of A/VE Design and Integration (Process A.2) and A/VE Operation (Process A.3), namely contractualization procedures, selection of resources, negotiation between resource providers and satisfaction of a Client Request, Taxation, and A/VE Operation management.

Contractualisation in the Market of Resources

In an ideal world, a firm makes an informed assessment of the relevant costs, benefits and risks of outsourcing *versus* internal procurement (Coase, 1937). If

Table 3. Suitability of negotiation methods in function of negotiation parameters; suitability of each negotiation method when the value of the parameter increases

Negotiation methods	Parameters				
	↗ V	↗ C	↗ P	↗ T	↗ D
Automatic search	L/M	L	L	L	H/M
Bilateral bargaining – offer/bid	L/M	L/M	L/M	M/H	M
Direct negotiation	H	H	M/H	H	L

Legend: L (low), M (medium), H (high) suitability

there exists a profitable outsourcing opportunity, the client and the supplier enter into a contract with a full knowledge of the nature of the work/product/service to be delivered and the capabilities of the suppliers. This contract covers all aspects of the services to be delivered and payments to be made, including contingency plans for unforeseen events. Both parties are fully aware of the terms of the contract and if they are not met, appropriate actions can be enforced by a third party, such as a court or arbitrator.

In this ideal world, without contractual problems, clients can benefit of using outside vendors, including economies of scale, scope or specialization in the form of improved quality, lower cost or faster time to market. But, in reality, most contractual relationships cannot meet these conditions. Most of the situations differ from the simple procurement of commodities, and include complex combinations of resources.

The degree of interaction between any entity and the contractor depends on the nature of the development effort and the type of contract used. When requirements are well defined and the risk of development is low, a fixed-price type contract is probably the right choice. Where requirements are ill defined and accomplishment risk is high, a more flexible contract may be more appropriate.

The contract instrument, namely the one respecting the integration of an A/VE, must be designed to clearly express a vision of final product goals and development effort requirements.

The Broker must have a serious interaction with the Client to establish all the requirements, schedules and support needs, being sure that well-defined specifications yield an easier and faster negotiation, easier contractualisation and a better response from Resources Providers.

In order to avoid building contracts from the beginning, the Market uses patterns to generate contracts. Contracts can be generated from a given set of parameter values, which capture the variable part of a class of contracts. These parameters, fixed or negotiable, are included with the information concerning both the resources providers and the clients of the Market of Resources.

In the Market, there are established five classes of contracts, formalized under the format of electronic contracts, by means of digital signatures (supported by certified world-wide entities), according to the legislation that is under development:

- **Brokerage license:** Broker – Market of Resources contract;
- **Resource provider contract:** Resource provider – Market of Resources contract, traducing membership and establishing negotiation and provision of resources conditions and giving the Market power to represent the enterprise in the A/VE contract;
- **Client contract:** Client – Market of Resources contract, traducing the membership;
- **Request contract:** A/VE Owner – Broker – Market of Resources contract, establishing the request conditions and negotiation parameters.
- **A/VE contract:** involving the Owner, the Resources Providers and the Market of Resources, is the contract established as support to an A/VE instantiation, and is used by the Market as the main management tool. This contractual agreement documents:
    - The terms and conditions for the provision of the resources and its integration in the product;
    - The requirements for the products to be developed;
    - The delivery conditions;
    - The dependencies between the resources;
    - The conditions under which revisions to products must be done;
    - Acceptance criteria to be used in evaluating the provided resources;
    - Procedures and evaluation criteria to be used by the Market in the monitoring and performance evaluation;
    - Payment conditions;
    - Penalties to be applied in case of failure (either from the Owner or of the Resources Provider);
    - Court to be used;
    - Etc.

Contracts implemented in this environment give the Market representation to jointly move a lawsuit to a party developing illegal activities or violating a contract, joining the injured parties.

Request for A/VE Creation / Reconfiguration / Dissolution

Suppliers or resources providers register in the Market of Resources and provide a catalogue developed according to specific rules, and formalize a contract empowering the Market for contractualising with the clients. When a Client asks the Market for a Request and registers with a broker, he also formalizes a contract, allowing the broker to negotiate with suppliers and to represent them in an A/VE contract.

The Request must be thorough; resources selection and evaluation factors should be rigorously defined; the proposal risk, performance confidence assessment, and cost/price evaluation factors for negotiation should also be well defined.

Evaluation factors should only, however, measure those items that are valid discriminators and directly traceable to requirements. The Broker must require that each proposal submitted contain sufficient information for a thorough assessment of each resource provider experience, tool availability, product assurance, team skills and experience, support, etc. In more complex situations, the resources provider bid/application should describe how their product/process/service will satisfy the desired requirements.

To formalize the Request for a new A/VE, a contract is established among the A/VE Owner, the Broker allocated to the Request and the Market of Resources and covers two stages: (1) the A/VE Design and selection of resources and (2) the integration. The first empowers the Broker to negotiation in the Market environment, to offer the best solution to the Request. When the A/VE Owner accepts the solution presented, the second stage allows the representation of the A/VE Owner in the contractualisation with the selected resource providers.

The Request for Reconfiguration implies an amendment to the contract corresponding to the changes facing the new instantiation. Even if the reconfiguration is suggested by the Market (Broker) as a consequence of the performance evaluation, it implies the amendment to the contract. Dissolution corresponds to the rescission of the contracts.

Selection and Negotiation

This section defines the main principles guiding the selection and negotiation for the provision of the resources. The Market forces the respect by the Negotiation rules and can suggest negotiation modalities most suitable for each situation[8] and also suspend or exclude resources providers from negotiation processes.

Negotiation Rules

The general negotiation rules applicable to the Market are formalized under the format of an electronic contract to be signed by all the participants. Specific clauses can be amended in particular circumstances.

The domain for search and selection must include only Resources Providers in full legality (i.e., in complete accomplishment of all the duties towards all the members with whom it keeps relationships, including the payment of the fees to the Market).

The service (Broker) must implement, in every A/VE Project creation or reconfiguration, the negotiation methods and the reference prices (if applicable) faced with the negotiation requirements/parameters established in the Request contract, between the Client and the Market.

Negotiation Methods

There exist two classes of negotiation: the negotiation between the Client and the Market (Process A.2.1.1. — Request Negotiation) and the negotiation undertaken between the Market and the eligible resources providers, on behalf of the Client (Processes A.2.2.3., A.2.2.4. and A.2.2.5.). Both have already been described previously.

The request contract must be very clear as well as the negotiation parameters associated with an A/VE project, which are to be traduced in the contract with the Market.

The broker is responsible by advising the Client in the selection of the most suitable negotiation method, as well as in the specification (and validation) of negotiation parameters, which are to be used in the negotiation with eligible resources providers. The Broker can also suggest alternatives, such as to trigger a negotiation process broader than within the Focused Domain, if the Client wishes it, by launching a wide auction or invitation to negotiate or a proposal, instead of negotiating just with the eligible resources. If it is a raw material or a not too specialized product or services, or when the quantities involved justify, it is possible the existence of several providers for the same resource.

Suspension of Negotiation

The Market of Resources can suspend, during the negotiation phase, resources providers that: (1) are subject of temporary suspension of its subscription (registration) in the Market (2) happened circumstances of unaccomplishment of any duty during the negotiation, which will determine the evaluation of the suspension of its registration or even expulsion from the Market of Resources.

Exclusion from Negotiation

In a given ongoing negotiation process, can be excluded the Resources Providers that had been subject of suspension or of expulsion from the Market, or in sequence of any fail in the process, which will determine the evaluation of the suspension of its subscription or even expulsion from the Market of Resources.

A/VE Operation Management

This corresponds to the operation of the integrated A/VE (i.e., to the provision of the resources by the integrated resources providers), where the Market has no interference, except in managing agreements and in performance monitoring/ evaluation.

In the sequence of the monitoring and performance evaluation task committed to the Market, several procedures should be defined, to deal with situations of illegality, which require consequent substitution in the project, suspension of participation, expulsion from the Market and/or the payment of indemnities.

Suspension of Participation

The Market of Resources can suspend the subscription of resources providers that verify at least one of the situations: (1) the requisites that conducted to its admission in the Market are not verifiable anymore, since that the situation is temporary and curable (otherwise will lead to expulsion from the Market), and (2) occurrence of circumstances of unaccomplishment or of bad performance that may damage its integration in other projects. Suspension of participation can determine suspension or exclusion of negotiation during a given period, until it is proved that the causes that lead to suspension are solved.

Exclusion from the Market

The Market can exclude Resources Providers, Clients and Brokers if the requisites that conducted to its admission are not verifiable anymore, if the failures or problems are not solved, or if the unaccomplishment of their duties justifies the exclusion.

The excluded member can apply later to subscription in the Market, if it is able to prove that the motives that lead to the expulsion are of improbable repetition.

Indemnities

In general, the existence of the indemnity intends to put the injured party exactly in the same position as it should be if nothing wrong has occurred. In business, it may be that this is not exactly possible. However, the intention is to keep participants aware of the possibility of contracts enforcement, and the conduction of situations of unaccomplishment to the court where the indemnities should be applied.

Indemnities are applicable to all the participants that failed to accomplish a contract or did not respect their duties, and as a consequence has been identified as damaging to any involved party. These include, for example, the Broker that does not give all the elements of information considered as necessary to the processes he is involved in, the Broker that breaks the duty of seal, the Resources Providers whose performance failed to correspond to what defined in the contract, the A/VE Owner that failed to act according to any contract.

If the service provided by the Market is not transparent and impartial, or if it is proved to happen due to deviation of information or undue utilization of the same, the damaged entity has the right to an indemnity by the responsible entity (The Market or the Broker), recurring to the legal bodies.

Taxation

Taxes and Fees

The operations of: (1) registration in the Market as Resources Provider, and (2) request by a Client of a service of A/VE creation and possible coordination and reconfiguration management, are taxed operations.

The Resources Provider pays an annual fee, calculated by a function of the number of resources provided and the number of horizontal-focused markets where each resource is to be registered in. He also pays a percentage in every business he is selected to participate in and accepts.

The Client pays the service provided by the Market, according to the amount of contractualised business, the product complexity, the search and selection time and the Broker utilization time.

Guarantees

When accepting a contract, both for an A/VE creation and to the provision of Resources, the Market should require a deposit of a bank guarantee, proportional to the amount of the contract, to face eventual unaccomplishments and the need to indemnify third parties, including the Market (or the Broker). This aspect should be a strong driver of trust, but of very difficult implementation.

Market of Resources Management

If the concept of Virtual Enterprises is a revolutionary one, the new concept of Market of Resources has the potential to radically alter most of the economical activities and the surrounding social environment, claiming for new frameworks for conducting business. As an intermediation service, it will provide mechanisms for efficiently put in contact and agreement buyers and providers of resources, conciliating opportunities, negotiation parameters, limitations, managing, controlling and evaluating the process. The function of management provided by the Market of Resources is crucial. In the manufacturing sector, for instance, the VE is mostly integrated from resources provided by SME, having no definite relations among them. This situation leads to a very complex management of the value-chain, as well as a very complex coordination of the logistics.

Market of Resources Management is an output flow of Process A.1. and is a control flow in Processes A.2. and A.3. The implementation of all the aspects of the regulation previously presented is the responsibility of Market of Resources Management function. This section introduces the main functions, duties, rights, and protections of the Market, intended to provide safety and trust for all the involved.

Functions of the Market of Resources

The main functions of the Market of Resources consist of assuring efficient brokerage service, integrability of the selected resources, business alignment, negotiation mediation, reconfigurability management, performance evaluation and contractualisation management. The Market is also committed in the exercise of authority in maintenance of the rights and duties of the involved parties and in monitoring (which often requires tracking of parties' duties and performance, and contract fulfillment). These functions are regulated by what we call Market of Resources Management.

Duties / Obligations of the Market of Resources

Given the Market of Resources functions, some of the main obligations can be derived:

Duties of the Market of Resources to the Brokers

The Market also has a commitment to define the system so that the Brokers can get work done efficiently, which implies:

- Assure equity of treatment between Brokers of identical profile.
- Make available to each Broker the operational means to accede the databases and resources of information in the domain for which he was admitted, in equity of conditions to all the brokers.
- Implement safety mechanisms of information transfer and payment.

Duties of the Market of Resources to the Resources Providers

The Market duties towards Resources Providers include:

- Assure equity of treatment between Resources Providers of identical profile.
- Integrity and impartiality in the evaluation of performance.
- To watch over a confidential treatment of information.
- Provide truth information.
- Resolution of conflicts.
- Implement safety mechanisms of information transfer and payment.

Duties of the Market of Resources to the A/VE Owners

The Market duties towards A/VE Owners or Clients include:

- To watch over a confidential treatment of information.
- Integrity and impartiality in the evaluation of possible unaccomplishment of contracts.
- Provide truthful information.
- Inform the A/VE Owner about the possibility of offering or not offering good results to its Request — quality of the solution (which is a function of the dimension of the existing search domain for the Request).
- Assure coherence of prices and the transparency of operations.
- Resolution of conflicts.
- Implement safety mechanisms of information transfer and payment.

Rights of the Market of Resources

The acceptance, by the participants, of the Market of Resources conditions, grants the Market with some rights, essential to assure the service quality. The Market has the following set of rights:

- To supervise all of the processes of selection, negotiation, performance monitoring and to use the results as historical information.
- To require references when faced with registration demands by unknown or dubious entities.
- To suspend or expel participants from negotiation or from the Market if it is proved the undertaking of illegal acts or unaccomplishment of duties.

Protections of the Market of Resources

Regarding the safeguard of its interests, the Market of Resources can:

- Refuse a Request when the Market Manager or the Broker finds that there are no conditions to satisfy it with the available resources or knowledge.
- Refuse a Request when the Owner does not supply the necessary information for the design of the required A/VE.
- Require financial guarantees.
- To condition the quality of the expect results to the solution space dimension.
- Answer to a Client's request in partnership with other Markets of Resources.
- The Market is not responsible by the performance of the participants (Brokers, Resources Providers or A/VE Owners), it is only committed to enforce contracts and to direct the damaged parties to the competent services.
- The Market is not responsible for the payments between parties (A/VE Owners and Resources Providers). The payment of the Broker is conditioned to the payment due by the A/VE Owner to the Market, respecting the satisfaction of the Request.

Market Dissolution

Every business has a life cycle: it is created, operates, modifies or readjusts itself as necessary to keep competitiveness and when it is no longer of interest (or because of external causes), it is dissolved. If the participants have duties to the Market, the Market has the responsibility of not causing damage to its participants.

Dissolution of the Market should occur with little disruption of the ongoing processes of A/VE creation and coordination. If we admit the existence of other markets of resources, adequate partnerships should be made in order to allow the transfer of the activities to these.

A special fund or reserve should be created by the Market of Resources to allow, in case of dissolution, the indemnity of injured parties according to the evaluation of the damage provoked to ongoing activities, and also to support the transfer of activities to the partnership formed.

Data Architecture to Support the Market of Resources

Figure 20 represents a global IDEF1x diagram, with the main entities and relationships to support the IDEF0 specification for the Market of Resources previously presented. The main entities are: Client, Market of Resources (in the diagram corresponding to the Focused_Market), Resource_Provider, Product and Operation, represented by rectangles; the other entities included in the diagram are the result of the information normalization and from the decomposition of n:n arity relationships. Only the key attributes are represented to reduce the overall complexity.

Only parts of the global IDEF1x diagram representing the entities and relationships involved in some of the main processes are presented with some more detail. Many of the attributes were omitted to simplify the representation.

Figure 21 represents the entities and relationships involved in the resources provider contractualisation with the Market for the provision of a given resource, and the relationships between the entities Resource Provider, Product, Operation and Focused Market. The relationships between the entities Resource_Provider and Product and between Resource_Provider and Operation are of n:n arity, so are decomposed through the relationships Provides_Oper and Provides_Prod. The Focused_Market entity is composed by Products and by Operations, which are classified in Focused Markets.

The IDEF1x diagram of Figure 22 represents the registration of the historical information about a resources provider participation in an A/VE instantiation.

For each A/VE instantiation and within each Resources Provider contract, can exist several performance registration, resulting from evaluation operations, registered in the Historical file.

In Figure 23 it is presented some detail of the resources requirements representation and negotiation parameters, and respective relationships.

Cost-and-Effort Model for the Market of Resources

While firms in the late 1960s formed conglomerates to economize on transaction costs with external companies, today we see the reverse. At a first glance, it would seem that ICT-based environment to support search and negotiation

Figure 20. Global IDEF1x diagram representing the main entities and relationships

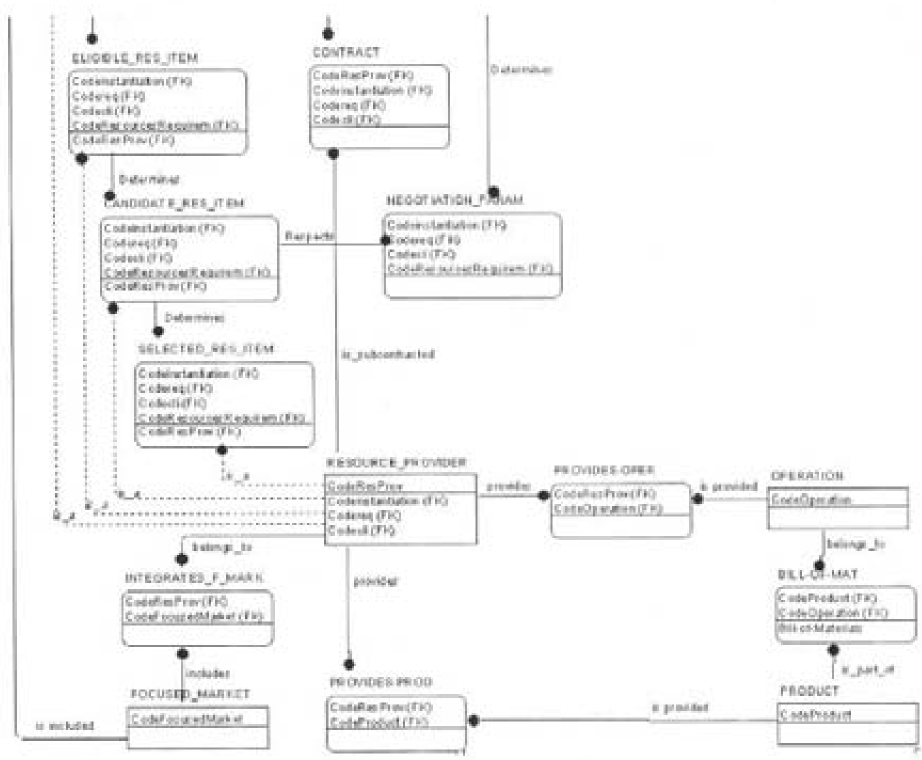
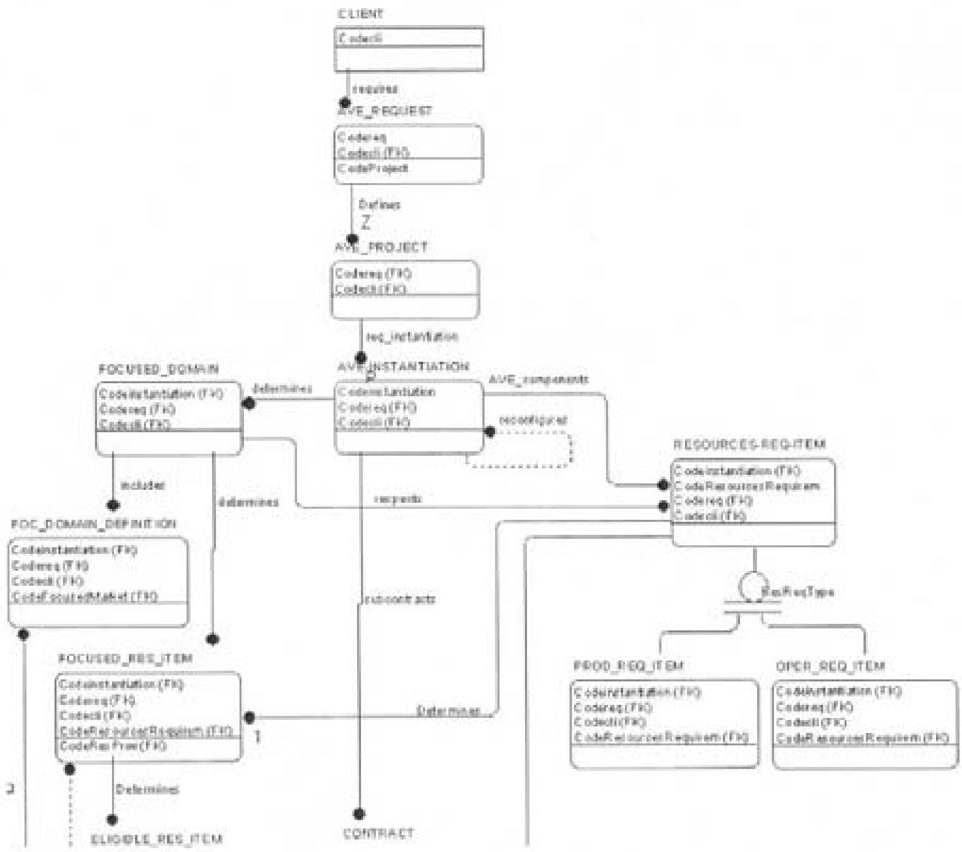
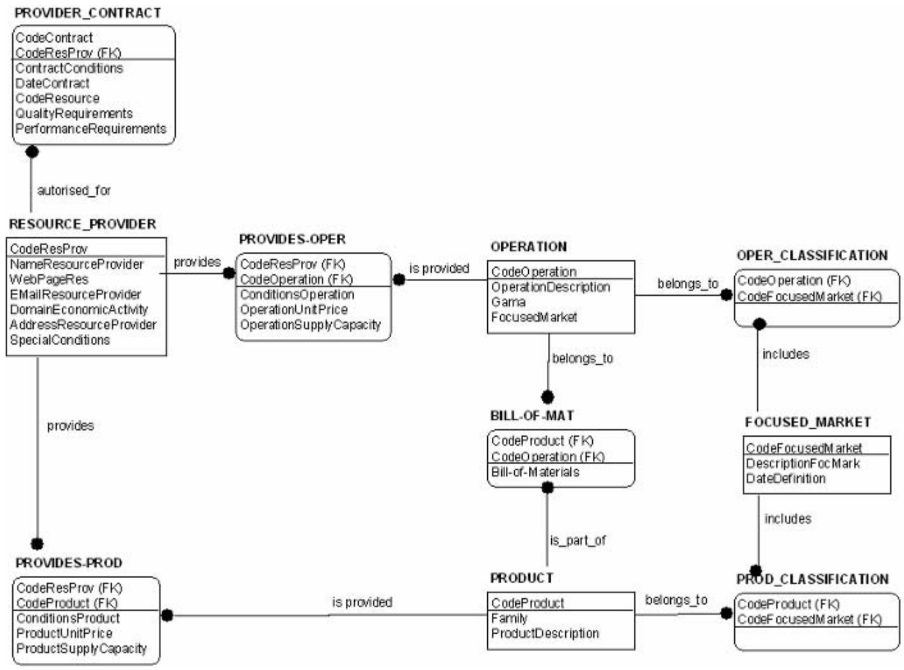


Figure 20. continued



viewing A/VE integration would lead to reduced transaction costs. However, it is still of considering coordination and trust establishment costs. Maybe the increasing performance of ICT and the emerging applications will make efficient what today seems inefficient. Maybe the Market of Resources increases opportunities of subcontracting, increasing supply chain dimension. Reduced search costs achieved by the Market together with reduced times can result in a better response to the dynamics requirements of the A/VE organizational model.

Figure 21. IDEF1x representation of the entities Resource_Provider, Product and Operation



In this section it is developed a cost model for A/VE integration using the Market of Resources, to be used in the validation of this environment, for comparison with the performance achieved via the traditional Internet-based tools, using the corresponding cost-and-effort model discussed in the previous chapter.

A/VE Integration: Main Activities

The main activities undertaken either using the traditional tools or the Market of Resources regarding the selection and integration of partners originate search and contracting costs. Monitoring and enforcement costs are not considered in the cost model, given that the traditional tools do not support them (and our objective will be the comparison of both methods), by one side, and by the other, there is no information to help its identification.

Figure 22. IDEF1x representation of the main entities involved in historical registration

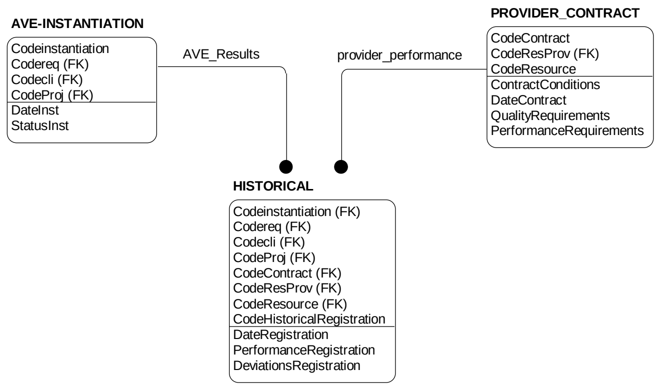
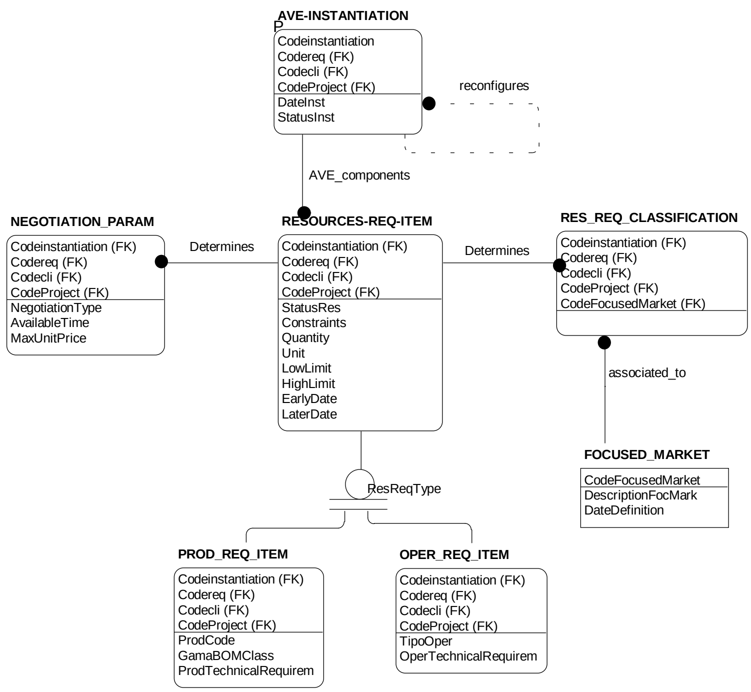


Figure 23. IDEF1x representation of the resources requirements associated with one instantiation of an A/V E project



The activities to perform in order to create and integrate (or to reconfigure) an A/VE are:

- **A/VE Request (Process A.2.1.):** Request involves the negotiation with the Market of Resources, broker allocation and A/VE Design. The A/VE Design complexity is function of product complexity and requires time to answer (by the Market of Resources).

There is an amount of resources needed to completely define the A/VE (creation or reconfiguration) Project (these resources are Broker time, knowledge and effort). This A/VE project consists on a number of instructions and specifications that will drive the search, negotiation and integration, and is associated with a degree of complexity.

A/VE Design is an activity to be undertaken by the Client after being validated by the Market (Broker), or in alternative, undertaken interactively by the Client and the Broker, depending on the request complexity, or on the Client ability/ knowledge to define the Project.

This model will not consider A/VE Reconfiguration, specifically, as it is a particular case of A/VE creation.

- **Resources Search and Selection (Process A.2.2.):** Search, negotiation and selection consist of several steps: the identification of potential resources, separation of eligible resources, negotiation within these to the identification of candidate resources, and finally the selection among these and find the best combination for integration. In the Market, the negotiation can be done using different approaches (automated, reverse auction and direct negotiation).
- **A/VE Integration (Process A.2.3.):** In this activity will consider only the contractualisation aspect. The Market of Resources assures an automated contractualisation.

In the performance analysis chapter we will use a real example to illustrate and compare the effort associated to these three main activities, using analytical simulation.

In Table 4 we describe these three main activities and sub-activities for A/VE creation/reconfiguration.

Table 4. Description of A/V E creation activities (using the Market of Resources)

Activity	Activity Description
A/V E Request	
- *Request negotiation*	- Registration, specification of the request, broker allocation and contractualisation with the Market of Resources
- *A/V E Design*	- Computer-aided A/V E design, with specification of the resource requirements and of negotiation parameters - The selected broker will validate the Design, or will support the Design, in complex products or when complex negotiation methods are required.
Resources Search and Selection	
- *Eligible Resources Identification*	- Selection of the Focused Market(s), vertical and/or horizontal, where it is intended to perform the search (Search domain) - Focused Domain filtering – automatically, from the requirements of the A/V E Design (eligibility is automatically driven from the resources database)
- *Negotiation*	- Computer aided (more or less automated) negotiation with the eligible resources, to identify the candidate resources for integration; in the cost and effort model, and later in the analytical simulations, we will distinguish between automatic search and inverse auction (request for bids).
- *Selection*	- Computer-aided and broker mediated decision-making for final selection of resources to integrate; sorting of the negotiation results and identification of the best combination of resources providers, followed by confirmation with the selected providers. Depending on the complexity, it involves more or less Broker dedication.
A/V E Integration	
- *Contractualisation*	- Automatically, when a selected resources provider confirms its participation. - Selection of the adequate contract from a standardized collection (for request formalization, integration, etc.) - The Market also offers integration procedures, which are not considered here.

Influence of the Selection Models

The Selection Model (dependent vs. independent search) influences the solution space dimension and hence the complexity and selection time (and cost). Four situations could be identified, considering the selection model and the search of basic and complex resources (Table 5). Given that there is a major difference between searching K resources under the two selection models, while the difference between selecting basic and complex resources relies more on the time required to perform the involved activities, than in the processes or in complexity, our model will consider only two views, based on the selection models (using independent and using dependent selection model).

Table 5. Characterization of possible situations

Selection Model	Resources	Comments
Independent Selection Model	- Basic Resources	Requires little time to specify requirements for resources selection and negotiation, as resources are primitive or basic
	- Complex Resources	Requires more time to specify requirements for resources selection and for negotiation
Dependent Selection Model	- Basic Resources	Complexity of the process is high, brokerage cost is higher, requires a precise definition of requirements
	- Complex Resources	Complexity of the process is very high, brokerage cost is very high, requires a precise definition of requirements

It would also be possible to distinguish, for each selection model, between searching a small number of resources and a larger number, because of the complexity associated with the description of the required resources, the negotiation overlapping possibility, etc.

However, three situations are going to be considered (as with the e-traditional cost model): (1) search and selection of one resource using independent selection, (2) search and selection of *K* resources using independent selection, and (3) search and selection of *K* resources using dependent selection.

Independent Selection Model

When estimating the time to perform the search for *K* resources using the Market, some operations need to be performed only once (Request negotiation and broker allocation), corresponding to a constant *C*, while the time to perform some other activities is directly proportional to the number of required resources.

$$t_{1\ Resource\ Search} = C + t'_{1\ Resource\ Search}$$
$$t_{K\ Resources\ search} = C + K * t'_{1\ Resource\ Search}$$

This model could be valid for a small *K* (*K*=1, 2, 3), but considering a larger *K*, the time required for some activities, for instance, Design or Validation can be considered to grow exponentially with the number of required resources (*K*). This complexity could be traduced by a complexity factor *F*.

This complexity factor, *F* (F > 1), should traduce the combination of the influence of the several F_i associated with the *N* activities contributing to the transaction costs.

$$t_{1\ Resource\ Search} = C + t'_{1\ Resource\ Search}$$
$$t_{K\ Resources\ search} = C + (K * F^K) * t'_{1\ Resource\ Search}$$

Considering computer-aided negotiation and selection, the dimension of the solution space only introduces complexity to the algorithm that performs the selection or the automated negotiation, and will not be considered, as the main effort contributing to the search cost is human effort, not computational effort (except for intractable situations).

One must not forget that if the solution is not considered of quality, a new search must take place. According to the traditional method, the search of the missing resources is to be re-started, while in the Market, the Design should be redone, with the help of the Broker, and validation. But we will not consider this situation.

Dependent Selection Model

Selection time is a function of the Solution Space dimension, which, as we mentioned before, depends on the selection model (dependent or independent).

In the Market of Resources, after the definition of the A/VE project and after the definition of the feasible combinations of the required resources with the corresponding validation by the broker, the process is automated and there is no difference (from the point of view of human effort) between dependent and independent selection method, except if considering a complexity factor.

The main required effort is attributable to operations of specification, validation or direct negotiation, the others are automated. For tractable dimensions, the fact that, for instance, the number of request for bids in auction-based negotiation is high, or that the solution space for selection[9] is bounded by N^K (N is the number of candidate resources), should not affect the results as drastically as using the traditional tools.

The Cost-and-Effort Model

Several parameters and variables, such as search domain dimension, A/VE project complexity, available time for integration, available knowledge to perform the search and negotiation, the availability of the solution, are determinant to the performance of the resources selection and integration processes.

Some of the parameters to consider could not be objectively quantified, as for example A/VE project complexity, or the required knowledge. Others are based on a very different scale, such as available time for integration, as we will conclude that the Market largely reduces the required time for integration, mainly when the search domain is large. The A/VE project could involve highly integrated complex resources that could not be supplied by an e-marketplace, or it could not be possible to identify it using a WWW directory, while in the Market, the availability could be more dependent of the providers subscribed to the Market, as the broker can overtake the difficulties of the traditional tools.

Our cost model can only integrate the quantifiable variables common to both methods (e-traditional and Market), susceptible of comparison.

Either using the traditional tools or using Market, search effort (or search cost) is mainly function of:

- The complexity of the A/VE project, resultant of:
  - The number of resources to integrate, their inter-relation or dependency, their specificity, their level in the product process plan.
  - The difficulty to define the project (i.e., to express the resources requirements and negotiation parameters) in order to develop the A/VE project with the broker.

  The A/VE project complexity also impacts the required time for identification of eligible resources, for negotiation with each candidate resource, and for contractualisation, especially in the traditional way, due to the lack of computer-aided facilities.
- The complexity inherent to the search process, which is itself a function of the search domain, selection method (and consequently the solution space dimension), and the negotiation method. In the Market, the solution space dimension is not expected to be of major impact, as via the traditional way.
- The required knowledge to undertake the activities conducing to the A/VE design, search and negotiation. As a result of the project specificity and complexity, in a high complexity project, the user can require expert advisory, given by the broker in the Market. This advisory/broker support will increase the cost.

Effort = f(A/VE project complexity, search complexity, required knowledge)

Search Complexity =

f(Solution Space dimension, Selection method, Negotiation method)

As the processes are automated in the Market, the impact of the search domain will justify increased computational effort and hence will be charged to the provided service price, but the amount is not as significant as the Brokerage time.

The main responsible of cost we are going to consider is human resources time (effort), that is, the sum of the user time with the broker time in the Market. The cost model will evaluate the cost of using the Market of Resources to satisfy a request based on broker's time, considering a cost three times higher than the user's time.

The cost model only considers human effort; for example, time to prepare an auction-based negotiation process and time per resource of the negotiation domain, etc. Time of automated contacts to distribute the requests for bids, their reception, etc., is computing time. Selection time is not considered either, as the Broker only selects the most adequate selection algorithm, triggers the process and validates the solution proposed by the algorithm.

From now on, we will designate as Cost the sum of Search Costs with Contracting Costs. In the Market, the Cost corresponding to the time to perform the search can be automatically derived.

The Cost and Effort model we have developed is based on several variables, represented by abbreviations, as listed in Table 6.

Table 6. List of variables (Market of Resources cost-and-effort model)

Abbreviations	Meaning
K	- The project complexity, that was simplified to consider only the number of required resources for integration.
FD	- Focused Domain of potential resources (later we will assume that $FD_M = 20\% * SD_T$[1], as besides the much more reduced dimension of the Market, the results are more focused).
ND	- Negotiation domain (or eligible resources): the number of resources providers with whom the negotiation process will take place. ND = FD * R1
CD	- Candidate resources providers, resultant from negotiation process. CD = ND * R2 = FD * R1 * R2
SS	- Solution Space: possible combinations of resources providers in order to perform the final selection process.
C_x	- Fixed time constant to perform operation x.
t_x	- Time to perform operation x.
R1	- Ratio between the number of eligible resources or negotiation domain dimension (ND) and the focused domain dimension (FD): this ratio will be considered of 20% in the simulations using this model. R1 = ND / FD
R2	- Ratio between the number of identified candidate resources and the number of eligible resources (the proportion of the eligible resources classified as candidate resources): this ratio will be considered of 20% in the simulations using this model. R2 = CD / ND

Table 7. Generic model of search and selection of one basic/complex resource in the Market of Resources, using independent selection

Activity	Time	Assumptions /explanations
A/V E Request		
- *Request negotiation (T_{RN})*	$T_{RN} = C_R$	C_R – Request negotiation set-up time (for small K we will consider it constant)
- *A/V E Design (T_D)*	$T_D = C_D + t_D + C_V + t_V$	Divided in specification/design and validation by the broker. C_D – design set-up time t_D – time to specify the resource requirements for 1 resource C_V – validation set-up time t_V – time to validate the resources requirements for 1 resource
Resources Selection		
- *Eligible Resources Identification (T_{ERI})*	$T_{ERI} = C_{FD} + t_{FD} * FD$	C_{FD} – focused domain identification and filtering set-up time t_{FD} – time per record analysis (of the focused domain)
- *Negotiation*	ND = R1 * FD correspond to the eligible resources, with whom to negotiate	
. Automatic *(T_{AN})*	$T_{AN} = C_{Aut} + t_{Aut} * ND$	C_{Aut} – automatic search set-up time t_{Aut} – time per automatic search operation within ND
. Auction *(T_{RFB})*	$T_{RFB} = C'_{RfB} + C_{RfB} + t_{RfB} * ND$	C'_{RfB} – global set-up time for auction-based negotiation C_{RfB} –setup time per auction (for each required resource) t_{RfB} – time per contact and request for bid, in a given auction
. Direct Negotiation *(T_{DN})*	$T_{DN} = C_{DnM} + t_{Dn} * ND$	C_{Dn} – direct negotiation process set-up time (performed by the Broker) t_{Dn} – time per contact and direct negotiation process (performed by the Broker)
- *Selection (T_S)*	$T_S = C_S + t_S * CD$	C_S – selection set-up time t_S – analysis time per candidate resource (evaluation of negotiation results)
A/V E Integration		
- *Contractualisation (TC)*	$T_C = C_C + t_C$	C_C – automatic contractualisation set-up time t_C – contract negotiation with the selected resource

Search and Selection of 1 Resource Using Independent Selection Model

For the particular case of search and selection of one resource (basic or complex), the generic model for calculating the required time and effort with an independent selection model, is presented in Table 7.

Table 8. Generic model of search and selection of K basic/complex resources in the Market of Resources, using independent selection

Activity	Time	Assumptions /explanations
A/V E Request		
- *Request negotiation (T_{RN})*	$T_{RN} = C_R$	C_R – Request negotiation set-up time (for small K we will consider it constant)
- *A/V E Design (T_D)*	$T_{RN} = C_D + K * t_D +$ $+ C_V + K * t_V$	Divided in specification /design and validation by the broker. C_D – design set-up time t_D – time to specify the resource requirements per required resource C_V – validation set-up time t_V – time to validate the resources req. per required resource
Resources Selection	we will have a partial Focused Domain per required resource (FD_i)	
- *Eligible Resources Identification (T_{ERI})*	$T_{ERI} = K * C_{FD} + \sum_{i=1}^{K} (t_{FD} * FD_i)$	C_{FD} – focused domain identification and filtering set-up time, per required resource t_{FD} – time per record analysis (of each focused domain, FD_i)
- *Negotiation*	$ND_i = R1 * FD_i$ correspond to the eligible resources, with whom to negotiate for required resource i	
. Automatic (T_{AN})	$T_{AN} = K * C_{Aut} + \sum_{i=1}^{K} (t_{Aut} * ND_i)$	C_{Aut} – automatic search set-up time per required resource t_{Aut} – time per automatic search operation within ND
. Auction (T_{RFB})	$T_{RFB} = C'_{RfB} + K * C_{RfB} + \sum_{i=1}^{K} (t_{RfB} * ND_i)$	C'_{RfB} – global fixed time for auction-based negotiation C_{RfB} –set-up time per auction (for each required resource) t_{RfB} – time per contact and request for bid, in a given auction
. Direct Negotiation (T_{DN})	$T_{DN} = K * C_{Dn} + \sum_{i=1}^{K} (t_{Dn} * ND_i)$	C_{Dn} – direct negotiation process set-up time (performed by the Broker) per required resource t_{Dn} – time per contact and direct negotiation process (performed by the Broker)
- *Selection (T_S)*	$T_S = K * C_S + \sum_{i=1}^{K} (t_S * CD_i)$	C_S – selection fixed time per required resource t_S – analysis time per candidate resource (evaluation of negotiation results)
A/V E Integration		
- *Contractualisation (T_C)*	$T_C = C_C + K * t_C$	C_C – automatic contractualisation set-up time t_C – contract negotiation with each selected resource

Search and Selection of K Resources Using Independent Selection Model

Table 8 presents the generic cost and effort model for the search and selection of *K* resources (basic or complex) using independent selection model.

As some activities are performed by the user, other than by the Broker, in Table 9 we distinguish between these two sources of effort. Computing effort was not considered.

Table 9. Distribution of effort between the user (client) and the broker

Activity	Total Time	User Time	Broker Time
A/V E Request			
- *Request negotiation* (T_{RN})	$T_{RN} = C_R$	C_R	
- *A/V E Design* (T_D)	$T_D = C_D + K * t_D + C_V + K * t_V$	$C_D + K * t_D$	$C_V + K * t_V$
Resources Selection			
- *Eligible Resources Identification* (T_{ERI})	$T_{ERI} = K * C_{FD} + \sum_{i=1}^{K} (t_{FD} * FD_i)$		$K * C_{FD} + \sum_{i=1}^{K} (t_{FD} * FD_i)$
- *Negotiation*			
. Automatic (T_{AN})	$T_{AN} = K * C_{Aut} + + \sum_{i=1}^{K} (t_{Aut} * * ND_i)$		$K * C_{Aut} + \sum_{i=1}^{K} (t_{Aut} * ND_i)$
. Auction (T_{RFB})	$T_{RFB} = C_{RfB} + K * C'_{RfB} + + \sum_{i=1}^{K} (t_{RfB} * ND_i)$		$C_{RfB} + K * C'_{RfB} + + \sum_{i=1}^{K} (t_{RfB} * ND_i)$
. Direct Negotia tion (T_{DN})	$T_{DN} = K * C_{Dn} + \sum_{i=1}^{K} (t_{Dn} * * ND_i)$		$K * C_{Dn} + \sum_{i=1}^{K} (t_{Dn} * ND_i)$
- *Selection* (T_S)	$T_S = K * C_S + \sum_{i=1}^{K} (t_S * CD_i)$		$K * C_S + \sum_{i=1}^{K} (t_S * R2 * ND_i)$
A/V E Integration			
- *Contractualisation* (T_C)	$T_C = C_C + K * t_C$		$C_C + K * t_C$

Search and Selection of K *Resources Using Dependent Selection Model*

The search of *K* resources using dependent selection model starts also with a request and an A/VE Design, validated by the Broker, and the definition of the partial Focused Domains *i*, potentially including the i^{th} resource. Before proceeding with the negotiation, all the combinations of eligible resources obtained within the partial focused domains (FD_i) are merged into a global Negotiation Domain. After the negotiation and identification of candidate resources providers, Solution Space is the set of all possible combinations of providing the required resources. The generic cost and effort model is presented in Table 10.

Table 10. Generic model of search and selection of K resources in the Market of Resources, using dependent selection

Activity	Time	Assumptions /explanations
A/V E Request		
- *Request negotiation (T_{RN})*	$T_{RN} = C_R$	C_R – Request negotiation set-up time (for small K we will consider it constant)
- *A/V E Design (T_D)*	$T_D = C_D + K * t_D + C_V + K * t_V$	Divided in specification and validation by the broker. C_D – design set-up time t_D – time to specify the resource requirements per required resource C_V – validation set-up time t_V – time to validate the resources required per required resource
Resources Selection	we have a global negotiation domain composed by all the resources providers eligible to provide between 1 and all the required resources.	
- *Eligible Resources Identification (T_{ERI})*	$T_{ERI} = K * C_{FD} + \sum_{i=1}^{K} (t_{FD} * FD_i)$	C_{FD} – focused domain identification and filtering set-up time, per required resource t_{FD} – time per record analysis (of each focused domain, FD_i)
- *Negotiation*	$ND \leq \sum_{i=1}^{K} (R1 * ND_i)$ → requires elimination of repetitions R2 * ND corresponds to the candidate resources for the selection of the required *K* resources providers	
. Automatic (T_{AN})	$T_{AN} \leq \left[K * C_{Aut} + ND * \sum_{i=1}^{k} C_k^i * t_{Aut} \right]$	C_{Aut} – automatic search set-up time per required resource t_{Aut} – time per automatic search operation within ND
. Auction (T_{RFB})	$T_{RFB} \leq \left[C'_{RfB} + K * C_{RfB} + ND * \sum_{i=1}^{k} C_k^i * t_{RfB} \right]$	C'_{RfB} – global fixed time for auction-based negotiation C_{RfB} –set-up time per auction (for each required resource) t_{RfB} – time per contact and request for bid, in a given auction, for a given resource.
. Direct Neg. (T_{DN})	$T_{DN} \leq \left[K * C_{Dn} + ND * \sum_{i=1}^{k} C_k^i * t_{Dn} \right]$	C_{Dn} – direct negotiation process setup time (performed by the Broker) per required resource t_{Dn} – time per contact and direct negotiation with each eligible resource provider (performed by the Broker)
- *Selection (T_S)*	$T_S \leq \left[K * C_S + CD^K * t_S \right]$ *or* $T_S = K * C_S + SS * t_S$	C_S – selection fixed time per required resource t_S – analysis time per candidate resource (evaluation of negotiation results)
A/V E Integration		
- *Contractualisation (T_C)*	$T_C = C_C + K * t_C$	C_C – automatic contractualisation set-up time t_C – contract negotiation with each resource

For the A/VE Request activity, it is considered to take the same effort as using independent selection.

Summary

A complete specification of the Market of Resources as an enaber of Agile/ Virtual Enterprise implementation and management support was presented in this chapter, composed by a process specification, complemented by regulation to guide the operation and management of the Market, a data architecture specification and a cost and effort model traducing the support to A/VE integration. This specification provides a deep understanding of the global structure of the Market of Resources and its operation, and the creation and maintenance of the Market itself.

The Market of Resources is supported by: (1) a knowledge base of resources, resources providers, A/VE owners and historical information of resources providers' performance; (2) a normalized representation of information; (3) computer-aided tools and algorithms; (4) a brokerage service (providing knowledge for A/VE design, integration and reconfiguration); (5) a regulation guiding the management of negotiation and integration processes, A/VE integration management, A/VE operation management, contract enforcement, and so forth. The Market is able to offer: (1) knowledge for resources search, negotiation, selection, integration in an A/VE and identification of reconfiguration needs or opportunities; (2) contracts and formalizing procedures to assure the accomplishment of commitments, responsibility, trust and deontological aspects, envisaging that the integrated A/VE competitively accomplishes the objectives of answering to a market opportunity.

References

Ávila, P., Putnik, G. D., & Cunha, M. M. (2002). Brokerage function in agile/ virtual enterprise integration — A literature review. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 65-72). Boston: Kluwer Academic Publishers.

Busby, J. S., & Williams, G. M. (1993). The value and limitations of using process models to describe the manufacturing organization. *International Journal of Production Research, 31*(9), 2179-2194.

Chen, P. (1976). The entity-relationship model: Towards a unified view of data. *ACM Transactions on Database Systems, 1*(1), 9-36.

Coase, R. (1937). The nature of the firm. *Economica, 4*, 386-405.

Codd, E. F. (1970). A relational model of data for large shared data banks. *Communications ACM, 13*(6), 377-387.

Codd, E. F. (1979). Extending the database relational model to capture more meaning. *ACM Transactions on Database Systems, 4*(4), 397-434.

Cunha, M. M., & Putnik, G. D. (2005). Market of resources for agile/virtual enterprise integration. In M. Khosrow-Pour (Ed.), *Encyclopedia of information science and technology* (pp. 1891-1898). Hershey, PA: Idea Group Publishing.

Cunha, M. M., Putnik, G. D., & Ávila, P. (2000). Towards focused markets of resources for agile / virtual enterprise integration. In L. M. Camarinha-Matos, H. Afsarmanesh, & H. Erbe (Eds.), *Advances in networked enterprises: Virtual organisations, balanced automation, and systems integration* (pp. 15-24). Berlin: Kluwer Academic Publishers.

Cunha, M. M., Putnik, G. D., & Gunasekaran, A. (2003). Market of resources as an environment for agile/virtual enterprise dynamic integration and for business alignment. In A. Gunasekaran & O. Khalil (Eds.), *Knowledge and information technology management in the 21st century organisations: Human and social perspectives* (pp. 169-190). London: Idea Group Publishing.

Cunha, M. M., Putnik, G. D., Gunasekaran, A., & Ávila, P. (2005). Market of resources as a virtual enterprise integration enabler. In G. D. Putnik & M. M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 145-165). London: Idea Group Publishing.

Doumeingts, G., Vallespir, B., Zanettin, M., & Chen, D. (1992). *GIM - GRAI integrated methodology: A methodology for designing CIM systems* (Version 1.0.). Bordeaux, France: University of Bordeaux 1.

ESPRIT-Consortium-AMICE. (1989). *CIM-OSA: Open systems architecture for CIM*. Berlin: Springer-Verlag.

FIPSP. (1993a). *Integration definition for function modelling (IDEF0)* (Federal Information Processing Standards Publication 183): Federal Information Processing Standards Publications.

FIPSP. (1993b). *Integration definition for information modelling (IDEF1x)* (Federal Information Processing Standards Publication 184): Federal Information Processing Standards Publications.

IFIP-IFAC_Task_Force. (1999). *Generalised enterprise reference architecture and methodology (GERAM)*. IFIP-IFAC Task Force on Architectures for Enterprise Integration. Retrieved from http://www.cit.gu.au/~bernus/taskforce/geram/versions

Malone, T. W., Crowston, K., Lee, J., & Pentland, B. (1993). *Tools for inventing organizations: Toward a handbook of organizational processes*. Cambridge, MA: MIT Sloan School of Management.

Marca, D. A., & McGowan, C. L. (1988). *SADT: Structured analysis and design technique*. New York: McGraw-Hill.

Mayer, R. J. (1990). *IDEF0 functional modeling*. College Station, TX: Knowledge Based Systems.

Mayer, R. J. (1992). *IDEF0 function modelling — A reconstruction of the original Air Force Wright Aeronautical Laboratory Technical Report - AFWAL - TR-81-4023 (the IDEF0 Yellow Book)*. College Station, TX: Knowledge Based Systems.

Mayer, R. J., & Cullinane. (1992). *Information integration for concurrent engineering (IICE) — IDEF3 process description capture method report*. College Station, TX: Knowledge Based Systems.

Mayer, R. J., Painter, M., & de Witte, P. (1992). *IDEF family of methods for concurrent engineering and business reengineering applications*. College Station, TX: Knowledge Based Systems.

MetaSoftware. (1996). *Design/IDEF user's manual for MSWindows* (release 3.7.). Cambridge, MA: MetaSoftware Corporation.

Presley, A. (1997). *A representation method to support enterprise engineering*. Unpublished doctoral dissertation, The University of Texas at Arlington, TX.

Presley, A., & Liles, D. (1995, May). *The use of IDEF0 for the design and specification of methodologies*. Paper presented at the Industrial Engineering Research Conference, Nashville.

Putnik, G. D. (2000). BM_Virtual Enterprise Architecture Reference Model. In A. Gunasekaran (Ed.), *Agile manufacturing: 21st century manufacturing strategy* (pp. 73-93). UK: Elsevier Science Publishers.

Ross, D. T. (1977). Structured analysis (SA): A language to communicating ideas. *IEEE Trans. Software Engineering, SE-3*(1), 16-34.

Ross, D. T. (1985). Applications and extensions of SADT. *Computer*, 25-34.

Ross, D. T., & Schoman, K. E. (1977). Structured analysis for requirements definition. *IEEE Trans. Software Engineering, SE-3*(1), 6-15.

Rumbaugh, J., & Blaha, M. (1991). *Object oriented modelling and design*. Englewood Cliffs, NJ: Prentice-Hall.

Scheer, A. W. (1994). *Business process engineering: Reference models for industrial enterprises*. Berlin: Springer-Verlag.

SofTech. (1981). *ICAM architecture Part III* (AFWAL-TR-81-4023). Ohio 45433: Materials Laboratory, Air Force Wright Aeronautical Laboratories, Air Force Command, Wright-Patterson Air Force Base.

Sowa, J. F., & Zachman, J. A. (1992). Extending and formalizing the framework for information systems architecture. *IBM Systems Journal, 31*(3), 590-616.

Williams, T. J. (1996). An overview of Pera and the Purdue methodology. In P. Bernus, L. Nemes, & T. Williams (Eds.), *Architectures for enterprise integration*. London: Chapman & Hall.

Yourdon, E. (1989). *Modern structured analysis*. Englewood Cliffs, NJ: Yourdon.

Zachman, J. A. (1987). A framework for information systems architecture. *IBM Systems Journal, 26*(3), 276-292.

Endnotes

1 IDEF stands for ICAM DEFinition methodology (ICAM — Integrated Computer-Aided Manufacturing). IDEF diagrams illustrate the structural relations between two processes and the entities present in the system. The processes (represented as boxes) transform the *inputs* into *outputs* (respectively the left and the right arrows of a process), using the *mechanisms* for the transformation (the bottom arrows of a process) and constrained by *control_information or conditions* under which the transformation occurs (the top arrows).

2 A significant showpiece of the ICAM effort was the conceptual framework of "The Factory of the Future" in 1984. The objective of this project was to create a baseline model for the total system of the aerospace enterprise and its operations, including design, finance, manufacturing, inventory control, etc. (Ross, 1985).

3 We are considering products and services, but we are including services in products entity. So when referring products, we are referring products and services.

4 Although both products and operations are resources, we are representing them separately because the information characterising them differs.

5 In the representation, squares represent the entities, the arrows the relationships, and the respective line ends, the arity of the relation. The

lozenges supports the decomposition of n:n arity relationships into 1:n arity relationships.

6 It is important to remark that the Market of Resources Management, besides being an output flow, is a control, and as such, should be described using the same specification methodology as processes are described; but due to limitations of the specification methodology, only processes can be described, not control (neither mechanisms) flows. The methodology also does not allow the transformation of an output flow into an activity box, as we needed to define the control Market of Resources Management.

7 Depending on the evolution of the environments supporting A/V E design and integration, it is possible for a Broker to work concurrently with different services, except in using the Market of Resources to satisfy an external request. Requests to the Market of Resources must be satisfied in it, except when cooperation with other services is accepted by the Market Manager.

8 The Market by means of the Broker allocated to the A/V E Project.

9 The expressions proposed in Chapter II for the e-traditional method are applicable here.

10 Indexes T and M in the variables will allow to distinguish between the variables of the cost and effort model developed for the traditional tools (T) and variables of the cost-and-effort model of the Market of Resources (M).

Chapter IX

Development of the Market of Resources

Introduction

In earlier chapters we have presented the main information and communication technologies and applications that can be used to implement functionalities of the Market of Resources, namely Internet technology, Agent technology, Internet-based marketplaces, etc., and standards for integrability. Electronic Marketplaces aggregate a set of technologies able to respond to some of the requirements of the Market of Resources, which can be complemented with other technologies.

This chapter introduces some technology that can support the development of the Market of Resources and discusses its utilisation, as well as presents a prototype developed to demonstrate the operation of some functions of the Market of Resources. This prototype is used later, in Chapter X, in the analytical simulation of the Market of Resources performance.

Technological Support for the Market of Resources: E-Marketplace Software Platform Providers

This section introduces some of the e-marketplace software platform providers commercially available.[1] From several tens of platforms, we have selected four leading forerunner vendors (*Ariba*, *Broadvision*, *Commerce One* and *i2 Technologies*) and two emerging e-marketplace software platform from software giants (*Microsoft* and *Oracle*), to be analysed from their ability to support some of the Market of Resources' functionalities.

Currently, maybe due to recently B2B e-marketplaces closing, *Ariba* and *i2 Technologies* discontinued their e-marketplace standard solutions, *Ariba Marketplace* and *i2 TradeMatrix* platforms, to focus on specialized e-commerce solutions, *Ariba Spend Management* and *i2 Value Chain Management*, which can be used for building private e-marketplaces. However, both companies played a very important role on run the development of existing e-marketplace platforms and continue to manage successfully public e-marketplaces (*Ariba Commerce Service Network* and *FreightMatrix*).

Commerce One is leading e-marketplace industry, since the e-marketplace boom, and *Broadvision* is turning one of the most dynamic and prolific e-commerce companies.

Microsoft is the major software company and *Oracle* is the most important enterprise software company. *Microsoft* and *Oracle* are involved with the development of e-commerce solutions, so their importance in the e-commerce arena is expected to increase.

Among the foremost e-marketplace software platform developers not considered in this analysis, we should mention *Free Markets* and *VerticalNet*. Both companies' e-marketplaces are *Microsoft* supported by *Net* technology and *BizTalk Server 2000*. In addition to these more established vendors, several start-ups have emerged with innovative software and services targeted at online marketplaces. Of all the technologies, the most critical areas are multi-vendor catalogues, negotiation systems and online payment transaction solutions.

Ariba

Ariba (http://www.ariba.com) has set the standard for Internet-based user interface and workflow solutions for buy-side e-commerce.

Ariba offers a suite of solutions to help companies manage spending, so that expenses fall faster than revenues in down times, and grow more slowly than revenues in up times. *Ariba Spend Management Solutions* significantly improves the bottom line results of a business.

Since its founding in 1996, *Ariba* has remained at the forefront of the Internet evolution, providing easy-to-implement, robust online commerce solutions for proven cost savings and return on investment. *Ariba* now leads the *Enterprise Spend Management* (ESM) market. *Enterprise Spend Management* is a new class of solutions that focus on delivering a closed loop of control and leverage over a company's spend, including assessing spending activities, conducting effective sourcing and capturing and reconciling spend enterprise-wide. The *Ariba Spend Management Suite* provides a single point of visibility and control allowing companies to engage, manage, and leverage the entire spend lifecycle from analysis, through sourcing, to procurement across the enterprise, while providing systematic measurement, tracking and reporting of best practices. Ariba also runs a public e-marketplace, the *Ariba Supplier Network*.

Broadvision

Broadvision (http://www.broadvision.com) provides an array of business solutions from content management to enterprise business portal applications. *BroadVision* is the leading provider of portal software to Fortune 500 companies; they use *BroadVision* to power their enterprise business portal initiatives — leveraging the Web and wireless devices to unify and extend their enterprise applications, information and business processes, to collaborate with over 50 million users. *BroadVision's* customer base represents a broad spectrum of organizations, including *British Telecom*, *The Boeing Company*, *E*Trade*, *Ericsson*, *FleetBoston Financial*, *General Electric Supply*, *Home Depot*, *Rockwell Automation*, *Sears*, *State of California*, *Renault*, *Toyota* and *Vodafone*.

Commerce One

Commerce One (http://www.commerceone.com) is one of the world's leading providers of solutions that connect and optimise the interactions between buyers and suppliers. They streamline sourcing and procurement to reduce both costs and time-to-market. And they offer enterprises heightened control over, and visibility into, their entire purchasing process from source to pay. Since 1996, *Commerce One* has been helping the world's leading companies — *Boeing*, *Deutsche Telekom*, *General Motors*, *Daimler Chrysler*, and others — drive costs out of their sourcing and procurement processes. Initially focusing on the supply chain, where customer demand is greatest, *Commerce One* solutions utilize *Web services* technology to streamline the sourcing and procurement process, and make the supply chain more flexible. *Commerce One* solutions have been implemented in more than 550 customers worldwide, supporting complex requirements for industries such as automotive, utilities/energy, healthcare, metals and mining, aerospace, and consumer packaged goods. *Commerce One* runs *CommerceOne.Net* (http://www.commerceone.net), a focused marketplace serving the North American MRO market.

i2 Technologies

i2 Technologies (http://www.i2.com) offers several package applications for e-business and supply/demand chain management, which they call *Value Chain Management*. *i2 Technologies* is a leading provider of supply chain management solutions. *i2's* supply chain management solutions help companies plan and execute the activities involved in managing supply and demand. These solutions span the entire scope of supply chain interactions, including supplier relationship management, supply chain management and demand chain management. They have prominent customers in all main industries, such as *Continental*, Daimler *Chrysler*, *Dell*, *Ford*, *Philips*, *Samsung*, and *Volkswagen*.

Microsoft

Microsoft (http://www.microsoft.com), far the major software company, is also providing solutions for the e-business market. Nowadays, *Microsoft* is a leading enabler of business-to-business e-commerce (e.g., over 50% of the Forbes B2B 200 run *Microsoft*) with offerings ranging from e-procurement and supplier enablement to e-marketplace and supply chain solutions with various platform partners (*Commerce One*, *SAP*, *Clarus*, *Ariba*, *Manugistics*, etc.). The *MS Commerce Server 2002* is the Microsoft's weapon for conquer a place in the e-marketplaces platform battlefield.

Oracle Corporation

Oracle Corporation (http://www.oracle.com) is the world's largest enterprise software company. *Oracle* offers its database, tools and application products, along with related consulting, education, and support services. *Oracle* has developed and deployed 100 percent Internet-enabled enterprise software across its entire product line: database, server, enterprise business applications, application development, and decision support tools. *Oracle* is capable of implementing complete global e-business solutions that extend from front office customer relationship management to back office operational applications to platform infrastructure. At present, over 35 active e-marketplaces were built on *Oracle Exchange Technology*. Examples are *Sears* and *Carrefour*, and *Auto-Xchange* supported by *Ford Motor Company*. *Oracle*, like *Ariba* or *Commerce One*, developed its own e-marketplaces, *Oracle Exchange Services*, on its technology.

Table 1. Features supported by each e-marketplace platform (Cunha, Putnik, & Silva, 2005)

Features \ E-Marketplace Platform	Ariba	Broadvision	Commerce One	i2 Technologies	MS Commerce Server	Oracle Exchange
Localization Requirements (language, currency, decimals and date format)	Yes	Yes	Yes	Yes	Yes	Yes
Private Exchanges	Yes	Yes	Yes	Yes	Yes	Yes
B2BMarketplaces	Yes	Yes	Yes	Yes		Yes
Catalogue	Yes	Yes	Yes	Yes	Yes	Yes
Content Management	Yes	Yes	Yes	Yes	Yes	Yes
Complex product configuration	No	No	Yes	Yes	Yes	Yes
Survey & Campaign Management	No	Yes		Yes	Yes	Yes
Forward Auction	Yes	Yes	Yes	Yes	Yes	Yes
Reverse Auction	Yes		Yes	Yes	Yes	Yes
RFP – Request For Proposals	Yes	Yes	Yes	Yes	Yes	Yes
RFQ – Request For Quotation	Yes	Yes	Yes	Yes	Yes	Yes
Order Status Tracking	Yes	Yes	Yes	Yes	Yes	Yes
Order Fulfillment	Yes	Yes	Yes	Yes	Yes	No
Order Brokering	No	No	No	Yes	No	No
Multi-protocol Order Routing	Yes	Yes	Yes	Yes	Yes	Yes
Project Management	No	No	Yes	Yes		Yes
Negotiation Mechanisms	Yes	Yes	Yes	Yes		Yes
Interactive Forum Support		Yes				Yes
Collaborative planning forecasting and replenishment (CPFR)	Yes	Yes	Yes	Yes	Yes	No
Contract Management	Yes	Yes	Yes	Yes	No	Yes
User and Role Management	Yes	Yes	Yes	Yes	Yes	Yes
Logistics and Delivery Support	Yes	Yes	Yes	Yes	Yes	Yes
Messaging	Yes	Yes	Yes	Yes	Yes	Yes
Workflow	Yes	Yes	Yes	Yes	Yes	Yes
Consolidated Invoicing	Yes		Yes	Yes		Yes
Payment Options	Yes	Yes	Yes	Yes	Yes	Yes
Security (SSL / HTTPS)	Yes	Yes	Yes	Yes	Yes	Yes
Digital Authoring (PKI, X.509)	Yes	Yes	Yes	Yes	Yes	Yes
High Availability (24 x 7)	Yes	Yes	Yes	Yes	Yes	Yes
E-Business Analytics (OLAP, KPIs)	Yes	Yes	Yes	Yes	Yes	Yes
Marketplace to Marketplace Integration	Yes		Yes	Yes		Yes

How Does the Available Technology Support the Functionalities of the Market of Resources?

This section analyses the features supported by the e-marketplaces software platform makers that are relevant to the implementation of the Market of Resources project. This analysis considers also features that are not part of the solution but can be integrated by the same vendor application packages or close technology/platform partners solutions. Table 1 indicates whether each platform supports or not each feature. We were not able to find information to fill the entire table; there are some missing situations. The information was obtained mostly from information made available by the vendors at their Web site (catalogues, product specifications, reports).

Table 2. Technologies and standards supported by each e-marketplace platform (Cunha et al., 2005)

Technologies and Standards / E-Marketplace Platform	Ariba	Broadvision	Commerce One	i2 Technologies	MS Commerce Server	Oracle Exchange
Java, JSP, Java Beans, J2EE	Yes	Yes	Yes	Yes	No	Yes
Microsoft .NET	No	Yes		No	Yes	No
XML (eXtensible Markup Language)	Yes	Yes	Yes	Yes	Yes	Yes
cXML (commerce XML)	Yes	Yes	Yes	Yes	Yes	Yes
xCBL (XML Commerce Business Library)	No	Yes	Yes	Yes	Yes	No
EDI	Yes	Yes	Yes	Yes	Yes	Yes
CIF (Catalog Interchange Format)	Yes	No	Yes	No	No	No
STEP standard format	No	No	No	No	No	Yes
Web Services (SOAP, WSDL)		Yes	Yes	Yes	Yes	Yes
ebXML	No	No	No	No	No	Yes
RosettaNet	No	No	Yes	Yes	Yes	Yes
BPEL4WS (Business Process Execution Language for Web Services)			No		Yes	No
128 bit SSL (Secure Sockets Layer)	Yes	Yes	Yes	Yes	Yes	Yes
Real-time ERP integration	Yes	Yes	Yes	Yes	Yes	Yes

The technologies and standards play an important role on the facilities provided by each platform, as well as on the interoperability between different e-marketplaces. We followed the same approach of the previous analysis on considering also technologies and standards that are not part of the solution but can be integrated by the same vendor application packages or partners solutions. The result is systematised in Table 2.

Developing a Prototype for the Market of Resources

The prototype of the Market of Resources, based on the data architecture developed for the Market (IDEF1x Diagrams), intends:

- To show how some of the operations of A/VE creation/reconfiguration take place in the Market of Resources, and
- To enable the estimation of the amount of time required to perform some operations, to be used as constants in the cost and effort models.

In this section we present the demonstrator for the operations of Client Registration, Client Request (registration and definition of the A/VE Project) and Resources Provider Subscription.

Client Registration

The first page of Client Registration process is presented in Figure 1 . It consists of the acquisition of the main information concerning a candidate Client of the Market of Resources. Further information, namely banking information, financial information, etc., could also be considered.

Resources Provider Registration

Figure 2 intends to present the main aspects of the first step of Resources Provider Subscription. The possible list of capabilities is very large and our example only includes a few, however, not even all of these are shown.

Figure 1. Client registration in the Market of Resources

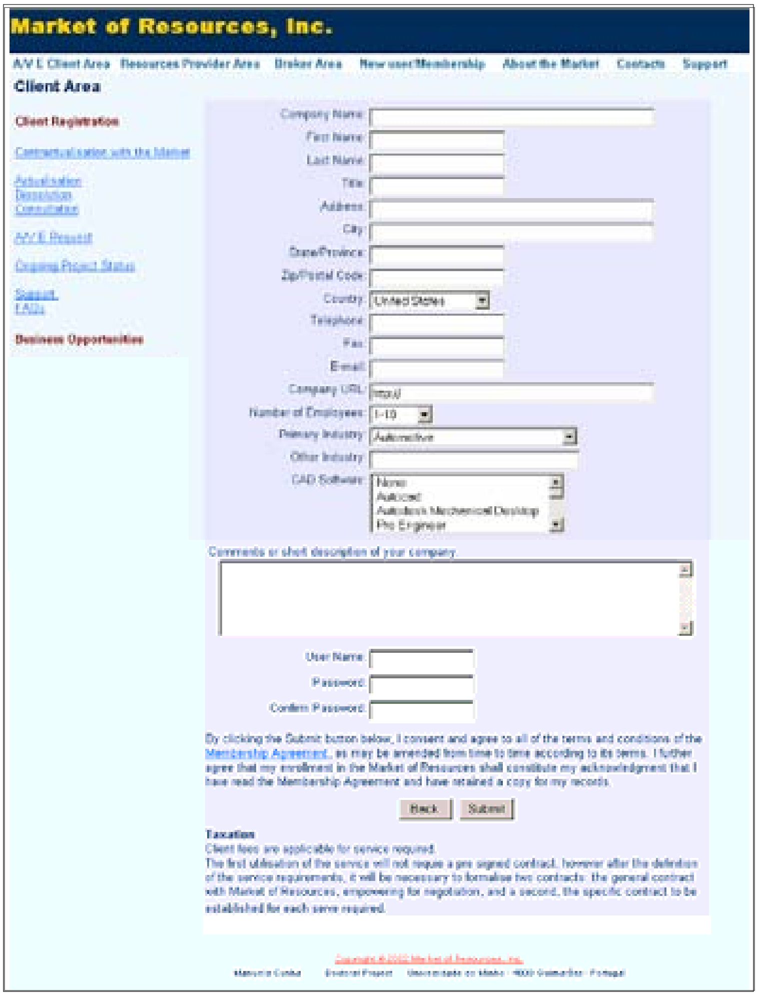
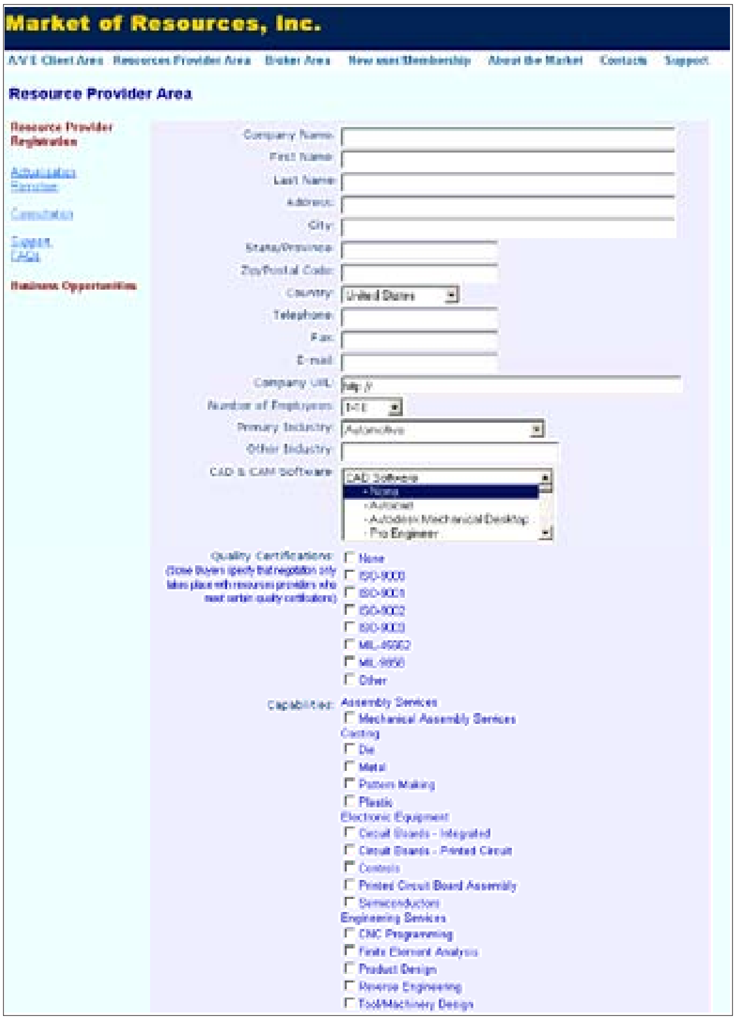


Figure 2. Resources provider registration in the Market of Resources



Client Request for A/VE Creation

This operation is one of the most effort-intensive for the user in its interface with the Market. As we have proposed in the functional specification, the Request for an A/VE Creation (which can include reconfiguration and dissolution, besides creation), represented in Process A.2.1. is composed by Request Negotiation (Process A.2.1.1.), A/VE Design (Process A.2.1.2.) and Request Formalization (Process A.2.1.5.).

Figure 2. continued

We are partially representing the Negotiation of an A/VE Creation Request, where in the first step (Figure 3) the overall aspects of the required project are defined, client search constraints, overall negotiation parameters and a first attempt to fit the project in one or more focused markets (to facilitate the identification of a Broker) and in the second step (Figure 4), the Broker is allocated. At this stage, the Client could require an estimation of the cost of the service he is requiring, but the exact cost can only be calculated after the conclusion of the A/VE Design.

The Request for A/VE Creation continues with the A/VE Design, where, for each of the required resources, in two steps, the Client specifies the Requirements for Resources Selection and Negotiation Parameters (Figure 5) followed by a corresponding validation face to the grammar associated to the Resources Representation Language (Figure 6). It is intended that the Broker can *chat* with the Client to provide guidance in the design process. After the request for validation, the Client receives a list of errors detected on the overall project evaluation, until de A/VE Project is fully designed and valid.

Finally, after the validation of the project, the request for the service of creating an A/VE according to the project can be formalized (Figure 7).

Figure 3. Request Negotiation for A/V E Creation — Step 1

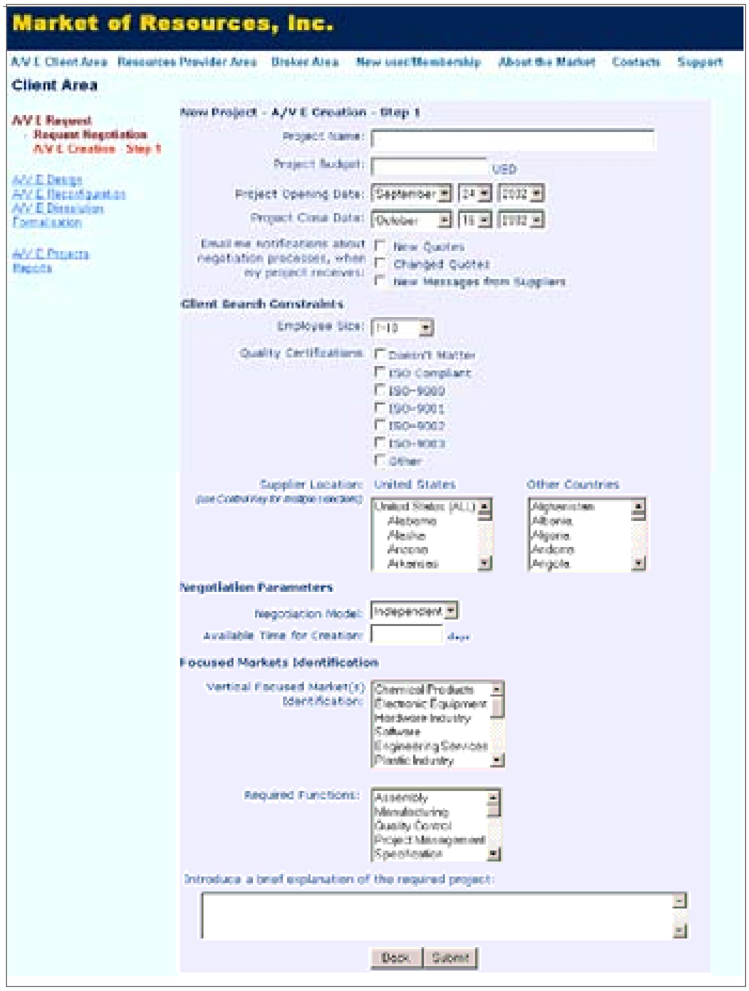


Figure 4. Request Negotiation for A/V E Creation — Step 2

Figure 5. A/V E Design — Step 1

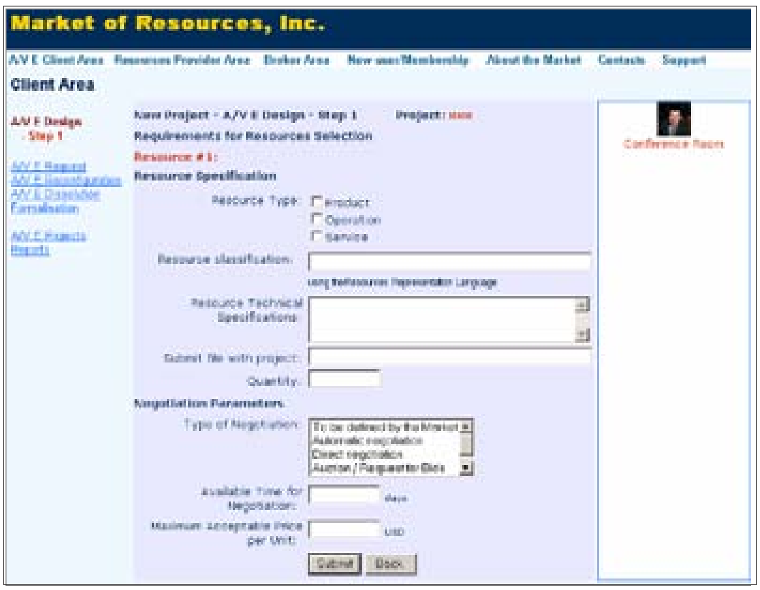


Figure 6. A/V E Design — Step 2

Figure 7. A/V E Request formalization

Summary

This chapter intended to demonstrate that the existing technologies are able to implement physically the Market of Resources. We have summarized the main developers or solution providers of the e-marketplace industry, the main features supported and standards supported by each platform. We have also presented some pages of the prototype the authors developed for the Market of Resources.

Reference

Cunha, M. M., Putnik, G. D., & Silva, J. P. (2005). Information technology infrastructure and solutions. In G. D. Putnik & M. M. Cunha (Eds.), *Virtual enterprise integration: Technological and organizational perspectives* (pp. 351-165). Hershey, PA: Idea Group Publishing.

Section III

Market of Resources and Agile/Virtual Enterprises Implementation and Management Support: Validation and Potential

Chapter X

Performance Analysis

Introduction

Chapter VII discussed how traditional Internet-based technologies could support Agile/Virtual Enterprise integration. Chapter VIII presented the specification of the Market of Resources as an enabler of this organizational model and Chapter IX introduced its development. This chapter discusses the ability of the Market of Resources to cope with the requirements of Agile/Virtual Enterprises and compares its performance with the performance of traditional Internet-based technologies.

It starts with the explanation of the cost-and-effort analysis undertaken, based on the cost-and-effort models introduced in Chapters VII and VIII, followed by the parameterization of this models, by identifying its time constants. This chapter presents a comparative study of performance between the traditional Internet-based tools and the Market of Resources, based on the results of an analytical simulation of the cost and effort of the Market of Resources compared with the utilization of traditional tools in the support of A/VE integration. Finally it identifies the solution space where the Market of Resources presents more efficiency in A/VE integration.

The Cost-and-Effort Analysis

This section explains the cost-and-effort analysis, based on the two cost-and-effort models previously developed and presents a situation (a case) of a project to create an A/VE, which is used to apply the cost-and-effort models. This situation or case is used: (1) to identify some of the time constants to use in the cost-and-effort model of the Market of Resources, based on the prototype already presented, and (2) to identify some of the time constants to use in the cost-and-effort model of the Internet-based traditional tools.

We are concerned essentially with search costs and contracting costs, which correspond to the activities where objectively the Market of Resources can introduce great improvement, and where it is possible to compare performances of both ways of A/VE integration (Market *versus* e-traditional). Monitoring and enforcement costs can be done independently of the Market of Resources, even if the A/VE integration has taken place in the Market of Resources environment, although we believe that the Market can also introduce efficiency in the monitoring the A/VE performance. The traditional Internet-based way does not support monitoring and enforcement activities, so it would not be possible to include such costs in the cost-and-effort model.

Main Activities in Agile/Virtual Enterprise Integration

In Table 1 we compare the main activities and sub-activities associated with search and selection of basic/complex resources, conducing to search and contracting costs, under both methods. Search costs correspond to the first two activities (A/VE Request and Resources Search and Selection) and contracting costs to the third (A/VE Integration).

In the performance analysis we illustrate and compare the effort estimation associated to these three main activities, in a hypothetical situation or case, using both cost-and-effort models.

Cost Drivers

The Cost Driver designation corresponds to units of measurement and control, defined by Brimson (1991) as a basis or a key to divide indirect costs. According to Brimson, the cost driver represents the first cause of the activity, the motive motivating the cost. A cost driver is a transaction that determines the amount of work and consequently the cost of an activity. When calculating the cost of an activity, several cost drivers can be used.

Table 1. Search of basic/complex resources — Comparison of activities

Activity	Traditional Internet-based Method	Market of Resources
	Activity Description	***Activity Description***
A/V E Request	Systematization of the A/V E Project and preparation for search and selection	
- *Request negotiation*		- Registration, specification of the request, broker allocation and contractualisation with the Market of Resources.
- *A/V E Design*	- Selection of the directory category/subcategories of a search engine that best traduce the required resource, or the definition of keywords and perform a WWW search using a search engine (Search domain identification).	- Computer-aided A/V E design, with specification of the resource requirements and of negotiation parameters; - The selected broker will validate the Design, or will support the Design, in complex products or when complex negotiation methods are required.
Resources Search and Selection	Identification of eligible resources for each required resource of the A/V E project, negotiation within this set and selection of the best combination of resources providers.	
- *Eligible Resources Identification*	- Analysis and sorting of the results of searching on the selected subcategories Search domain and identification of a set possibly containing the solution (Visit domain); - Visit to this set and identification of its eligibility, to reduce the domain for negotiation; - Eligible resources or Negotiation domain will be a subset of the visited resources.	- Selection of the Focused Market(s), vertical or horizontal, where it is intended to perform the search (Focused domain); - Focused Market filtering – automatically, from the requirements of the A/V E Design to identify Eligible Resources or Negotiation domain (eligibility is automatically driven from the catalogues / resources database).
- *Negotiation*	- Negotiation with the eligible resources, to identify the candidate resources for integration (Candidate domain); the traditional method forces to a manual request for bids (RFB) or direct negotiation.	- Computer-aided (more or less automated) negotiation with the eligible resources, to identify the candidate resources for integration; we distinguish between automatic search, inverse auction and direct negotiation.

Search and Contracting Costs are function of several variables, some of them represented in Table 2, both for the *Traditional Internet-based Tools* (e-traditional Method) and for the Market of Resources. These variables correspond to the models' cost drivers.

To simplify, it is considered that the A/VE complexity (which is a not a quantifiable cost driver) corresponds to the number of required resources for

Table 1. continued

Activity	Traditional Internet-based Method	Market of Resources
	Activity Description	*Activity Description*
Resources Search and Selection	Identification of eligible resources for each required resource of the A/V E project, negotiation within this set and selection of the best combination of resources providers.	
- *Selection*	- Sorting of the negotiation results and identification of the best combination of resources providers, and confirmation with the selected providers.	- Computer-aided and broker-mediated decision-making for final selection of resources to integrate; sorting of the negotiation results and identification of the best combination of resources providers, followed by confirmation with the selected providers. Depending on the complexity, it involves more or less Broker dedication.
A/V E Integration	Contractualisation with the selected resources for integration.	
- *Contractualisation*	- By e-mail, using the digital signature facilities; - Elaboration of specific contracts for every situation; - Negotiation of contracts terms with suppliers.	- Automatically, when a selected resources provider confirms its participation; - Selection of the adequate contract from a standardized collection (for request formalization, integration, etc.); - The Market of Resources also offers integration procedures, which are not considered here.

Table 2. Main cost drivers for search and contracting costs

Costs Classification	eTraditional Method	Market of Resources
Search costs	- Product complexity (number of required resources); - Search domain dimension; - Visit domain; - Negotiation domain; - Selection model (dependent/independent).	- Product complexity => A/V E Project complexity; Requirements for resources selection and Negotiation requirements; - Selection model (dependent/independent).
Contracting costs	- Complexity of contracts.	- Not relevant.

integration (*K*), and also that this number is small, to avoid the introduction of a complexity factor.

Later we will estimate values to the models' constants, such as the time required to perform each operation. The variables (cost drivers), such as Search Domain dimension and Focused Domain dimension will receive values for simulations. The other variables, such as Negotiation domain, Solution Space size, etc., will result from the application of a ratio to the previous domain dimensions.

Cost drivers impact differently the A/VE integration performance. The main variables to be considered in the model are:

- Product complexity (and consequently project complexity), corresponding to the number of required resources for integration (*K*).
- The Search Domain dimension (SD) (i.e., the number of potential resources providers where the first step of the search is to take place); to simplify, we assume that the Search Domain dimension in the Market of Resources (designated Focused Domain (FD) dimension), for the same situation, is 20% of Search Domain dimension using the eTraditional way.
- The dimension of subsequent domains, Visit Domain (VD), Negotiation Domain (ND), etc., will result from the application of a ratio to the previous.

If we consider as main cost drivers: (1) the *product complexity* (traduced by the number of required resources) — *K* —; (2) *the search domain dimension* — *SD* or *FD* —, (3) the *negotiation domain dimension* — *ND* —, and (4) the *solution space dimension* — *SS* —, and their expected impact on e-traditional or market-based A/VE integration performance, in function of the selection model, is presented in Table 3.

Table 3. Impact of product complexity (K), search domain dimension (SD), negotiation domain dimension (ND) and solution space dimension (SS) on A/V E integration effort in function of the selection model

Selection Model	**e-Traditional tools**				**Market of Resources**			
	K	*SD*	*ND*	*SS*	*K*	*FD*	*ND*	*SS*
- Independent selection model	High	Medium	High	High	Medium	Low	Low	Low
- Dependent selection model	High	Medium	Very High	Not mea surable	Medium	Low	Medium	Medium

The Cost-and-Effort Models

In this section we present both cost-and-effort models already developed for the Traditional e-based tools and for the Market of Resources.

To make easier the application of the cost and effort models, we have tried to use the same designation for the variables common to both cost models, which are distinguished by an index T or M whether belonging to the e-traditional's or to the Market's cost model. These variables and corresponding abbreviations are listed in Table 4.

Table 4. List of variables and abbreviations for the cost-and-effort models

Abbreviations	Meaning
K	- Number of required resources.
SD_T or SD	- Search Domain in the Traditional method (WWW directory): corresponds to the dimension of the result of the first step of the search in the WWW. The results of the WWW search are not focused as the operation of "focused domain identification" using the Market of Resources (Process A.2.2.1.).
FD_M or FD	- Focused Domain in the Market of Resources (we will assume that FD_M = 20% * SD_T), as although the much more reduced dimension of the Market, the results are more focused.
VD_T or VD	- Visit Domain in the Traditional method: corresponds to the number of resources to be visited in order to evaluate its eligibility. We will assume that VD = 20% * SD_T. As the results of the WWW search are not focused only 20% of SD_T will be visited.
ND_T and ND_M	- Negotiation Domain or set of eligible resources: corresponds to the number of resources providers with whom to undertake a negotiation process. $ND_T = VD_T * R1_T = 20\% * SD_T * R1$ $ND_M = FD_M * R1_M$
CD_T and CD_M	- Candidate resources providers, resultant from the negotiation process. $CD_T = ND_T * R2_T$; $CD_M = ND_M * R2_M$
SS_T or SS_M	- Solution Space, possible combinations of candidate resources providers in order to perform the final selection process. Under dependent selection, SS is equivalent to CD.
C_{xT}	- Fixed time constant to perform operation x using the e-traditional way.
C_{xM}	- Fixed time constant to perform operation x using the Market of Resources.
t_{xT}	- Time to perform operation x using the e-traditional way.
t_{xM}	- Time to perform operation x using the Market of Resources.
$R1_T$	- Ratio between the identified eligible resources (ND_T) and the number of visited resources (VD_T). $R1_T = ND_T / VD_T$
$R1_M$	- Ratio between the eligible resources and the focused domain (FD). $R1_M = ND_M / FD_M$
$R2_T$	- Ratio between the identified candidate resources and the eligible resources (the proportion of the eligible resources classified as candidate resources). $R2_T = CD_T / ND_T$
$R2_M$	- Ratio between the identified candidate resources and the eligible resources (the proportion of the eligible resources classified as candidate resources). $R2_M = CD_M / ND_M$

Table 5. Cost models corresponding to search and selection of K resources using the independent selection model

Activity	eTraditional	Market of Resources	Explanations
A/V E Request			
- *Request negotiation (T_{RN})*		$T_{RN} = C_R$	C_R – Request negotiation set-up time (for small K we will consider it constant)
- *A/V E Design (T_D)*	$T_D \leq K * t_{DT}$	$T_D = C_D + K * t_{DM} + C_V + K * t_V$	C_D – design setup time t_{DM} – time to specify the resource requirements, per required resource t_{DT} – time to perform the first step of the search, per required resource (definition of SD) C_V – validation set-up time t_V – time to validate the resources requirements, per required resource
Resources Selection	It will be considered $R1_T = R1_M$ and $R2_T = R2_M$ to allow comparative analysis		
- *Eligible Resources Identification (T_{ERI})*	$T_{ERI} \leq \left[\sum_{i=1}^{K} (t_A * SD_i) + \sum_{i=1}^{K} (t_E * VD_i) \right]$	$T_{ERI} = K * C_{FD} + \sum_{i=1}^{K} (t_{FD} * FD_i)$	t_A – time per analysis of each of the results contained in SD_i t_E – time per resource provider visit, to determine its eligibility C_{FD} – focused domain identification and filtering set-up time, per required resource t_{FD} – time per record analysis (of each focused domain, FD_i)
- *Negotiation*			
. Automatic (T_{AN})		$T_{AN} = K * C_{Aut} + \sum_{i=1}^{K} (t_{Aut} * ND_{Mi})$	C_{Aut} – automatic search set-up time per required resource t_{Aut} – time per automatic search operation within ND
. Auction (request for bids / inverse auction) (T_{RFB})	$T_{RFB} = K * C_{RfBT} + \sum_{i=1}^{K} (t_{RfBT} * ND_{Ti})$	$T_{RFB} = C'_{RfB} + K * C_{RfBM} + \sum_{i=1}^{K} (t_{RfBM} * ND_{Mi})$	C'_{RfB} – global fixed time for auction-based negotiation C_{RfBT} and C_{RfBM} – set-up time per auction (for each required resource) t_{RfBT} and t_{RfBM} – time per contact and request for bid, in a given auction
. Direct Negotiation (T_{DN})	$T_{DN} = K * C_{DnT} + \sum_{i=1}^{K} (t_{DnT} * ND_{Ti})$	$T_{DN} = K * C_{DnM} + \sum_{i=1}^{K} (t_{DnM} * ND_{Mi})$	C_{DnT} and C_{DnM} – direct negotiation process set-up time per required resource t_{DnT} an and t_{DnM} – time per contact and direct negotiation process
- *Selection (T_S)*	$T_S = K * C_{ST} + \sum_{i=1}^{K} (t_{ST} * CD_{Ti})$	$T_S = K * C_{SM} + \sum_{i=1}^{K} (t_{SM} * CD_{Mi})$	C_{ST} and C_{SM} – selection fixed time per required resource t_{ST} and t_{SM} – analysis time per candidate resource (evaluation of negotiation results)
A/V E Integration			
- *Contractualisation (T_C)*	$T_C = K * t_{CT}$	$T_C = C_C + K * t_{CM}$	C_C – automatic contractualisation set-up time t_{CT} and t_{CM} – contract negotiation with each selected resource

Both cost-and-effort models corresponding to search and selection of *K* resources using independent selection model are presented in Table 5 , side by side.

The difference between searching basic or complex resources relies on the value of some constants (time to perform some of the operations), namely A/VE design time and negotiation time, but we feel that most of it relies on the dimension of search domains and on the ratios R1 and R2. The complexity of the required resources affects the dimension of the search domain and focused domain dimension; the tightening of the negotiation requirements (traduced by the defined ratios) determines the negotiation domain dimension and the number of candidate resources.

Both cost and effort models corresponding to search and selection of *K* resources using dependent selection model are presented in Table 6.

Table 6 . Cost-and-effort models corresponding to search and selection of K resources using the dependent selection model

Activity	eTraditional	Market of Resources	Explanations
A/V E Request			
- *Request negotiation (T_{RN})*		$T_{RN} = C_R$	C_R – Request negotiation set-up time (for small K we will consider it constant)
- *A/V E Design (T_D)*	$T_D \leq K * t_{DT}$	$T_D = C_D + K * t_{DM} + C_V + K * t_V$	C_D – design set-up time t_{DM} – time to specify the resource requirements per required resource t_{DT} – time to perform the first step of the search per required resource (definition of SD) C_V – validation set-up time t_V – time to validate the resources required per required resource
Resources Selection	It will be considered $R1_T = R1_M$ and $R2_T = R2_M$ to allow comparative analysis in the validation		
- *Eligible Resources Identification (T_{ERI})*	$T_{ERI} \leq \left[\sum_{i=1}^{K} (t_A * SD_i) + \sum_{i=1}^{K} (t_E * VD_i) \right]$	$T_{ERI} = K * C_{FD} + \sum_{i=1}^{K} (t_{FD} * FD_i)$	t_A – time per analysis of each of the results contained in SD_i t_E – time per resource provider visit, to determine its eligibility C_{FD} – focused domain identification and filtering set-up time, per required resource t_{FD} – time per record analysis (of each focused domain, FD_i)

Table 6. continued

Activity	eTraditional	Market of Resources	Variables
- *Negotiation*	$ND \leq \sum_{i=1}^{K} (R1 * VD_i)$		
. Automatic (T_{AN})		$T_{AN} \leq [\, K * C_{Aut} + ND_M * \sum_{i=1}^{k} C_k^i * t_{Aut}]$	C_{Aut} – automatic search set-up time, per required resource t_{Aut} – time per automatic search operation within ND
. Auction (request for bids / inverse auction) (T_{RFB})	$T_{RFB} \leq [\, K * C_{RfBT} + ND_T * \sum_{i=1}^{k} C_k^i * t_{RfBT}]$	$T_{RFB} \leq [\, C'_{RfB} + K * C_{RfBM} + ND_M * \sum_{i=1}^{k} C_k^i * t_{RfBM}]$	C'_{RfB} – global fixed time for auction-based negotiation C_{RfBT} and C_{RfBM} – set-up time per auction (for each required resource) t_{RfBT} and t_{RfBM} – time per contact and request for bid in a given auction
. Direct Negotiation (T_{DN})	$T_{DN} \leq [\, K * C_{DnT} + ND_T * \sum_{i=1}^{k} C_k^i * t_{DnT})]$	$T_{DN} \leq [\, K * C_{DnM} + ND_M * \sum_{i=1}^{k} C_k^i * t_{DnM}]$	C_{DnT} and C_{DnM} – direct negotiation process set-up time, per required resource t_{DnT} and t_{DnM} – time per contact and direct negotiation process
- *Selection* (T_S)	$T_S \leq [K * C_{ST} + CD_T{}^K * t_{ST}]$ *or* $T_S = K * C_{ST} + SS_T * t_{ST}$	$T_S \leq [K * C_{SM} + CD_M{}^K * t_{SM}]$ *or* $T_S = K * C_{SM} + SS_M * t_{SM}$	C_{ST} and C_{SM} – selection fixed time per required resource t_{ST} and t_{SM} – analysis time per candidate resource (evaluation of negotiation results)
A/V E Integration			
- *Contractualisation* (T_C)	$T_C = K * t_{CT}$	$T_C = C_C + K * t_{CM}$	C_C – automatic contractualisation set-up time t_{CT} and t_{CM} – contract negotiation with each selected resource

Expected Results

We feel that, independently of the Search Domain dimension, the relation between the A/VE complexity (traduced by the number of required resources) and the effort (and hence the cost) of integrating an A/VE, following an independent selection model using the Market and using the traditional Internet-based method, follows a representation similar to the one represented in Figure 1.

Later, in the analytical simulations phase, we will limit the value of K, meaning that we are dealing with simple products (not complex A/VE design). A complex product would require deeper attention by the Broker (or of a group of brokers, depending on the complexity and multidisciplinarity) and a more complex specification, and cannot be compared with the traditional model.

When following a dependent selection model, it is expected that, independently of the Solution Space dimension, the effort using the Market and the traditional method, may have a representation similar to the one of Figure 2. In Figure 3 and Figure 4 it is represented as the effort of searching a given number of resources, in function of the Search Domain dimension, for the independent and dependent selection models respectively.

The objective of the cost-and-effort analysis is to identify the X point (decision point) in terms of A/VE complexity (Figure 1 and Figure 2) and in terms of the Search Domain and Focused Domain dimension (Figure 3 and Figure 4).

Figure 1. Effort in function of the number of required resources using the independent selection model

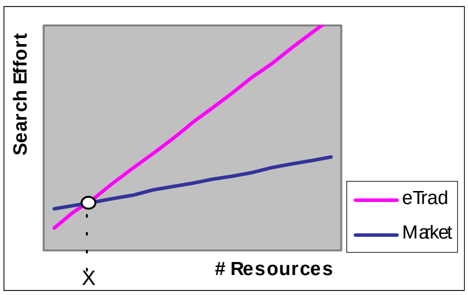


Figure 2. Effort in function of the number of required resources using the dependent selection model

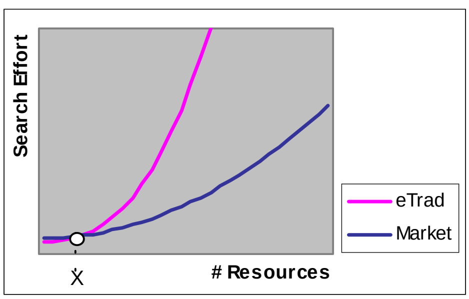


Figure 3. Effort for searching K resources in function of the search domain dimension using the independent selection model

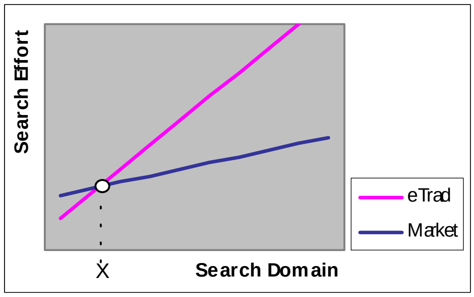


Figure 4. Effort for searching K resources in function of the search domain dimension using the dependent selection model

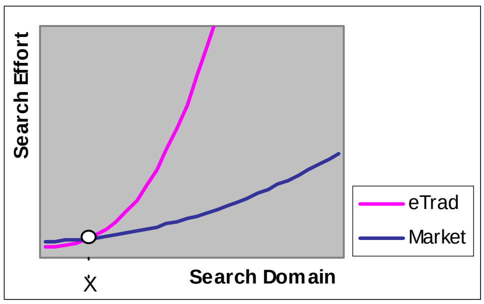
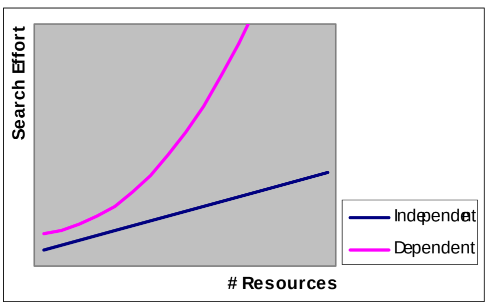


Figure 5. Search effort associated with the dependent and independent selection models



The relation between the effort of using the independent and the dependent model is supposed to follow the curves represented in Figure 5, both for the traditional Internet-based tools and for the Market of Resources.

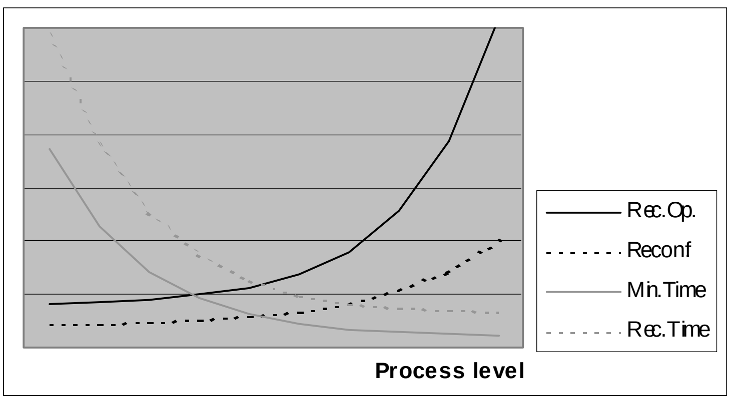
The Market of Resources, as an organized environment, has precisely the objective to "boost" the dynamics as well as to support the high dynamics of the A/VE model reconfiguration and integration.

Objective of Reconfigurability Dynamics Analysis

Given the costs of evaluating the need to reconfigure the A/VE and given the complexity of the process of selection and integration, in many cases the reconfiguration is overtaken, with sacrifice of the A/VE performance, the reason for the fact that dynamics is not as high as it should be expected (ideal reconfigurability dynamics is not achieved) and that partnerships do not achieve as high of performances as should be expected, unless there exists an environment to support dynamic reconfiguration and integration.

Reconfiguration implies technical and behavioral adaptation inside the resources provider, besides the organizational aspect of preparing the integration. Reconfiguration cannot happen instantaneously after the resources selection and formalization of the integration in the A/VE. Besides the time-intensive operations of search, negotiation, selection and contractualisation, integration procedures need to be set, human resources need to be adapted to the new environment, machines need set up, etc., and this would require extra time.

Figure 6. Representation of reconfigurability frequency and reconfiguration time in function of the product process level



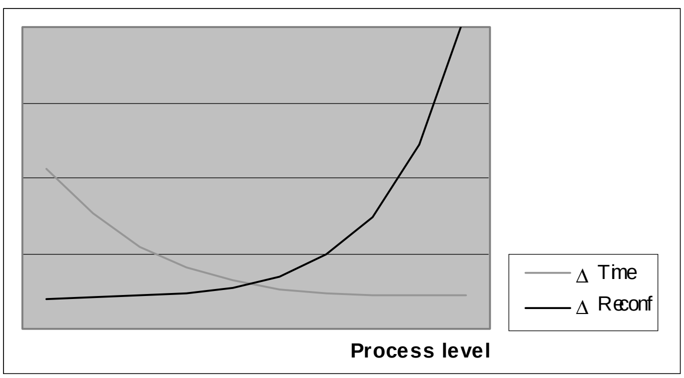
The minimum required reconfiguration time is given by the line “Min.Time” in Figure 6, and is inversely proportional to the product (resource) process level.

One of the objectives of the Market of Resources is to allow the line of the real reconfigurability dynamics (represented by “Reconf” line in Figure 6) to remain as close as possible to the line of reconfigurability opportunities or optimal reconfigurability (represented by “Rec.Op.” line), which means, to assure that the required time to perform the reconfiguration (represented by “Rec.Time” line) can decrease until its minimum (“Min.Time”).

We are imagining that both the differential between: (1) ideal and real reconfigurability dynamics in function of the product process level, and (2) ideal and real reconfiguration time in function of the product process level, to have a behavior similar to the representation of Figure 7.

The underlying reasoning is that for top process-level operations, the gains in reconfigurability dynamics are not significant, but there is a larger margin for reconfiguration time gains than in deep process levels. For deep process levels, the opportunity for increased reconfigurability dynamics is expected to be significant, but with less margins for reconfiguration time reduction (per resources provider); however, given the increasing number of contracts along with the product process level, total time reduction can be significant when multiplying reduction margins per contracted resources providers by the number of contracts.

Figure 7. Differential between ideal and real reconfigurability dynamics and between ideal and real reconfiguration time



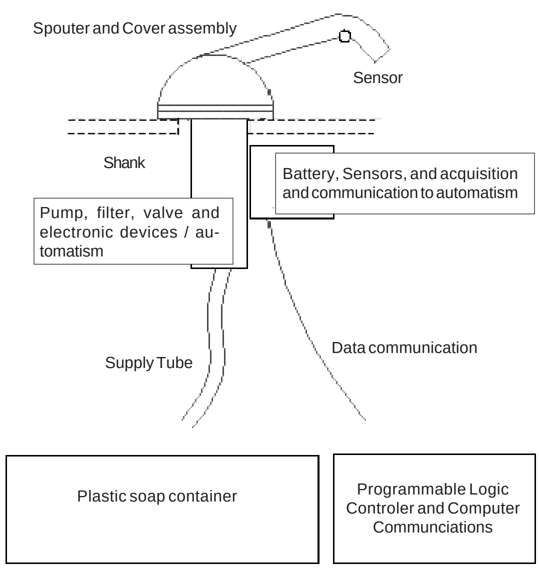
The Case to Support the Validation

In this section we outline a hypothetical situation of creating an A/VE to produce intelligent automatic soap dispensers to install in public lavatories. The situation was used to prepare the analytical simulations as follows:

1. Via the traditional Internet-based tools, WWW searches were performed in order to get information about the number of potential providers of some parts of the project and visit to some of these, followed by simulation of negotiation and selection effort, until integration, using the cost and effort model. We have also tried the search for some resources on an industry directory, Global Sources (http://www.globalsources.com).
2. Via the Market of Resources, the time to present the A/VE Request, to specify some of the required resources, to design the corresponding A/VE and to the validation by the broker was obtained using the prototype interfaces. Subsequent operations were simulated using the cost-and-effort model.

Supposing that we are in the role of the A/VE owner, we have the product project (a CAD drawing file) and the specification of all components and operations required. A simple draft of the project is given in Figure 8. Each eligible resources

Figure 8. Soap dispenser project



provider receives the part of the project and specifications (materials and/or operations) corresponding to the resources under their scope of activity.

Soap dispensers are mounted in all the lavatories and share a common soap container. Each dispenser automatically detects the presence of hands and dispenses a portion of soap.

We present as example, some technical specifications (materials) to be provided to eligible resources providers, when defining the requirements for resources selection (if using the Market of Resources).

Product Technical Specifications - Materials:

- Spout and Cover — stainless steel with bright polished finish.
- Body and Shank — high-impact resistant ABS recipient with the maximum of 50mm diameter or side, and 100 mm long, where filter, pump, valve and other mechanical devices must be installed.
- Pump — Stainless steel inside ABS Cylinder; corrosion-resistant to most soaps and detergents.
- Flexible Hose (supply tube) — 15 mm diameter, black, flexible PVC.
- Soap Container — Multi-lavatory soap reservoir in resistant PVC, with capacity for 4 litres of soap. A visible indicator of capacity should be provided.

Market of Resources Versus Traditional Internet-Based Search and Selection: Determination of Time Constants

In this section we identify values for some of the variables of our cost and effort models. Variables as time to perform operations and set-up times must be transformed in time constants, while the variables of the models should only be the dimension of domains where each operation takes place (Search Domain dimension, Negotiation Domain dimension, Solution Space dimension, etc.).

Concerning the traditional Internet-based way, we have performed exhaustive searches (using WWW search engines or directories), for some of the required resources corresponding to the soap dispenser project, trying to identify the time to select between the list of solutions obtained from a search engine or a WWW directory, time to visit these and evaluating their eligibility for negotiation.

Using the Market of Resources, the objective consists of performing the firsts steps (A/VE Request and A/VE Design), which are the most (human) effort consuming, based on the physical demonstrator. We assume that the user is familiarized with the interfacing with the Market of Resources and that it is already a member of the Market of Resources (to overtake the registration activity) and that he is able at specifying what he wants using a given resources representation language, whatever its interfacing implementation.

We will suppose that the difference between searching basic or complex resources relies essentially on the solution space size, more than on the time to perform elementary operations of search, negotiation, etc.

Using of the Traditional Internet-Based Way[1]

In order to identify the Search Domain size and the time to visit potential providers, for some resources required for the soap dispenser project presented previously, we decided to use:

- A WWW directory (Yahoo[2])
- A search engine (Google[3]) and
- An e-marketplace (Global Sources[4]) for industrial products search.

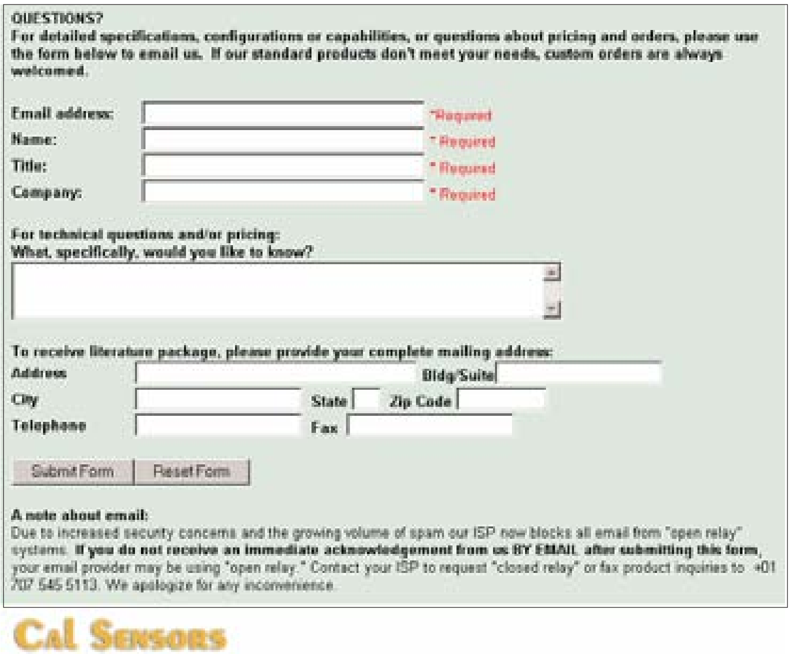
The selection of Yahoo and Google is due, in the case of Yahoo to its recognized richness of contents, and in the case of Google (which is a partner of Yahoo) because after some tests (with AltaVista, HotBot, etc.), it was the search engine offering a larger number of results.

It is important to notice two aspects when using electronic marketplaces: first, we must select an adequate e-marketplace for each resource search (e.g., electronic components) and second, there exist many e-marketplaces for products but very few for operations or functions (e.g., design, plastic injection molding). This is why we consider the traditional method of limited utilization and have decided to use World Wide Web searches instead of e-marketplaces, in the identification of time constants for the cost and effort model.

The resources used in the experience were: infrared sensors for the soap dispenser and production of the mold to be used in the plastic container manufacturing. Some of the achieved search results are presented in this section.

A limitation of the traditional way is the impossibility that sometimes happens when deciding about resource providers' eligibility, after losing time in visiting

Figure 9. A potential resources provider that does not provides online information about the products



them. This situation happens when it is not found information available online concerning the resource we are looking for (see Figure 9 for example).

Search for Infrared Sensors Manufacturers Using Yahoo

In Figure 10 it is presented an example of using the Yahoo Directory to identify the Search Domain to start the search of providers of infrared sensors, from the Web Site Directory (Step 1) until the selection of types of sensors (Step 6).

In Step 5 or 6, we could have performed a search with keywords (Figure 11) instead of selecting a sensor type. The obtained search domain dimension would be 22 (Figure 12).

Figure 10. Sequence of steps to find a search domain to perform a search of providers of infrared sensors using the Yahoo Directory

Figure 11. Search for "infrared sensors" using Yahoo

Figure 12. Search results for "infrared sensors" using Yahoo

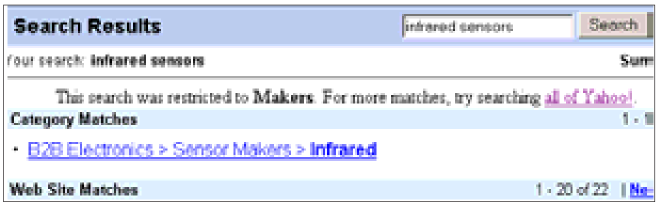


Figure 13. Search results for "infrared sensors" using Google

Search for Infrared Sensors Manufacturers Using GOOGLE

The difficulty in using a search engine concerns the high number of results obtained, requiring deeper and deeper search conditions. The first iteration produced 2,010 results, as shown in Figure 13.

Search for Infrared Sensors Manufacturers Using Global Sources

This e-marketplace has a special category for electronic components and produced as result (Figure 14) six products and a short description and contact of 78 potential suppliers (Search Domain dimension) of the six products.

Figure 14. Search of infrared sensors suppliers using Global Sources

Figure 15. Search of plastic injection molding producers using Yahoo Directory

Search for Plastic Injection Molding Service Providers Using Yahoo

Without major effort, the Yahoo Directory gives a search domain of 243 potential providers of the service of producing injection moulds (Figure 15).

Using the Market of Resources

The estimation of time constants when using the Market of Resources was the result of several experiments in the definition of requirements for resources selection, using the prototype for the A/VE Request activity, considering the specification of all resources requirements and negotiation parameters definition, the attachment of specifications and drawings when applicable.

Table 7. Time constants for search and selection of K resources (in minutes)

		Traditional Internet-based		Market of Resources	
A/VE Request	*Request Negotiation*			Set-up time for request negotiation	20
	A/V E Design	Specification time per required resource	5	Set-up time for A/V E design	10
				Specification of requirements per required resource	10
				Set-up time for A/V E validation	20
				Time for validation of requirements per required resource	5
Resources Selection	*Eligible Resources Identification*	Analysis of each of the results contained in Search Domain	1	Set-up time for focused domain identification	10
		Time per resource provider visit, to determine eligibility	3	Time per record (resources provider) analysis	0,5
	Negotiation (considering Request for Bids)	Set-up time for auction-based negotiation	10	Global set-up time for auction-based negotiation	10
		Time for contact and request for bid	3	Set-up time per auction	10
				Time for contact and request for bid per required resource	0,1
	Selection	Set-up time for selection, per required resource	10	Set-up time for selection	10
		Evaluation of negotiation results per candidate resource	5	Evaluation of negotiation results per candidate resource	0,1
Integration	*Contractualisation*	Contract with selected resource	60	Contractualisation set-up time	10
				Contractualisation with selected resource	2

Time Estimation

From the experiences performed, we are able to estimate values for the time variables of the A/VE Request activity for both models, to be used as constants in the analytical simulations. The time associated with the other activities (Resources Selection and A/VE Integration) was only estimated, as there is no support for its measurement in the Market of Resources (the Physical Parameter does not yet include these activities), nor have we undertaken any negotiation or contractualisation activity within the experiences using the traditional Internet-based tools.

In the case of the Market of Resources, the estimated values can be considered overestimated, especially when considering simple projects (low complexity), with a small number of required resources (2 or 3 resources). The values of these constants are presented in Table 7, expressed in minutes.

Comparative Study on Performance

The objective of this section is to identify the circumstances where the Market of Resources gives more efficient results and to verify if the Market is able to offer the opportunity for increased dynamics.

In the beginning of this book we briefly introduced and discussed the “make or buy” decision (using the market firms, i.e., subcontracting, or producing in-house). We are not concerned with the decision-making whether make or buy, but with the value added that, at least in some circumstances, the Market of Resources can offer when the firm decides to buy from the market, and with the identification of these circumstances. As a consequence, it is also possible to suppose that the number of situations whether the “make-or-buy” decision can be taken can increase, as the number of reconfiguration opportunities increases.

We demonstrate that the Market of Resources can contribute to longer supply chains and to increase dynamics, but we are conscientious that coordination costs would also increase, and hence, a deep cost benefits analysis, for should be required for each situation.

As the benefits of using the Market of Resources instead of subcontracting in the traditional Internet-based way in the market do not disappear, by the contrary, we think they will increase, we intend only to analyze and compare the common costs between the Market of Resources and the traditional Internet-based way.

In this section we present the simulation results for the search and selection time and cost, using independent and dependent selection methods, for different dimensions of Search and Focused Domains and different values of *K*.

Some previous considerations:

1. The user of the traditional way can decide the dimension of the set of resources for visiting (VD); we considered this set to be 20% of the Search Domain (SD), but according to SD quality, he can reduce or increase this percentage.
2. We are assuming that the Focused Domain dimension is 20% of the World Wide Web Directory search results (search domain). This way, Visit Domain dimension (VD) equals the Focused Domain dimension (FD) and comparisons will be possible.
3. The cost of User time is 1 Cost Unit (CU) per minute. Our model does not consider subscription taxes, fees, etc., but considers that the Market of Resources cost is 3 CU per minute (includes the Broker cost, and is calculated on the basis of Broker utilization time).
4. The negotiation method used in both situations (e-traditional way and Market of Resources) is Request for Bids.

The comparative study on performance is made based on time and on cost. Even if in certain situations a Market of Resources solution can present higher cost when compared with the e-traditional way cost, the available time to reconfigure an A/VE could force to the utilization of the Market of Resources.

Search and Selection of K Resources Using Independent Selection Model

Using the estimations of Table 7 and the above considerations, Table 8 presents search, selection and integration time for different values of *K*, considering Search Domain dimensions varying between 10 and 1,000, both for the traditional way and for the Market of Resources, under independent selection method. In the e-traditional way, cost corresponds to 1 Cost Unit (CU) per minute and using the Market of Resources, time is calculated separately for the user and broker and cost corresponds to 1 CU/minute for user time and 3 CU/minute for broker time.

The difficulty consists of identifying the Visit Domain and performing the visits.

Table 8. E-Traditional vs. Market of Resources — Time and cost comparison — Independent selection model

		eTraditional							Market of Resources							
domain size	SD =	10	25	50	100	250	500	1.000								
	VD =	2	5	10	20	50	100	200	FD =	2	5	10	20	50	100	200
K = **1**																
Total time		107	139	193	300	623	1.160	2.235		118	120	123	129	146	175	232
User time		107	139	193	300	623	1.160	2.235		40	40	40	40	40	40	40
Broker time										78	80	83	89	106	135	192
Cost		**107**	**139**	**193**	**300**	**623**	**1.160**	**2.235**		**274**	**280**	**288**	**306**	**357**	**444**	**616**
K = **2**																
Total time		213	278	385	600	1.245	2.320	4.470		166	170	176	187	222	279	394
User time		213	278	385	600	1.245	2.320	4.470		50	50	50	50	50	50	50
Broker time										116	120	126	137	172	229	344
Cost		**213**	**278**	**385**	**600**	**1.245**	**2.320**	**4.470**		**399**	**409**	**427**	**461**	**565**	**737**	**1.082**
K = **3**																
Total time		320	416	578	900	1.868	3.480	6.705		214	220	228	246	297	384	556
User time		320	416	578	900	1.868	3.480	6.705		60	60	60	60	60	60	60
Broker time										154	160	168	186	237	324	496
Cost		**320**	**416**	**578**	**900**	**1.868**	**3.480**	**6.705**		**523**	**539**	**565**	**617**	**772**	**1.031**	**1.548**
K = **4**																
Total time		426	555	770	1.200	2.490	4.640	8.940		263	270	281	304	373	488	718
User time		426	555	770	1.200	2.490	4.640	8.940		70	70	70	70	70	70	70
Broker time										193	200	211	234	303	418	648
Cost		**426**	**555**	**770**	**1.200**	**2.490**	**4.640**	**8.940**		**648**	**669**	**703**	**772**	**979**	**1.324**	**2.014**
K = **5**																
Total time		533	694	963	1.500	3.113	5.800	11.175		311	319	334	363	449	593	880
User time		533	694	963	1.500	3.113	5.800	11.175		80	80	80	80	80	80	80
Broker time										231	239	254	283	369	513	800
Cost		**533**	**694**	**963**	**1.500**	**3.113**	**5.800**	**11.175**		**772**	**798**	**841**	**928**	**1.186**	**1.618**	**2.480**
K = **10**																
Total time		1.065	1.388	1.925	3.000	6.225	11.600	22.350		552	569	598	655	828	1.115	1.690
User time		1.065	1.388	1.925	3.000	6.225	11.600	22.350		130	130	130	130	130	130	130
Broker time										422	439	468	525	698	985	1.560
Cost		**1.065**	**1.388**	**1.925**	**3.000**	**6.225**	**11.600**	**22.350**		**1.395**	**1.446**	**1.533**	**1.705**	**2.223**	**3.085**	**4.810**

A Search Domain of 100 records will produce a Visit Domain of 20 (and corresponds to a Focused Domain of 20 potential resources providers), which applying the ratios R1 and R2 stipulated in Table 7, correspond to a Negotiation Domain of 10 eligible resources providers and 5 candidate resources. A Search Domain of less than 20 records (or a Focused Domain of less than 4) will be assumed to provide 1 candidate resource.

Figure 16 represents the time associated to the search of 1, 2 and 5 resources (K=1, K=2 and K=5), in function of the Search Domain size (SD), both for the

Figure 16. Traditional Internet-based method vs. Market of Resources using independent selection method: Search and selection time for K=1, K=2 and K=5, in function of search domain size

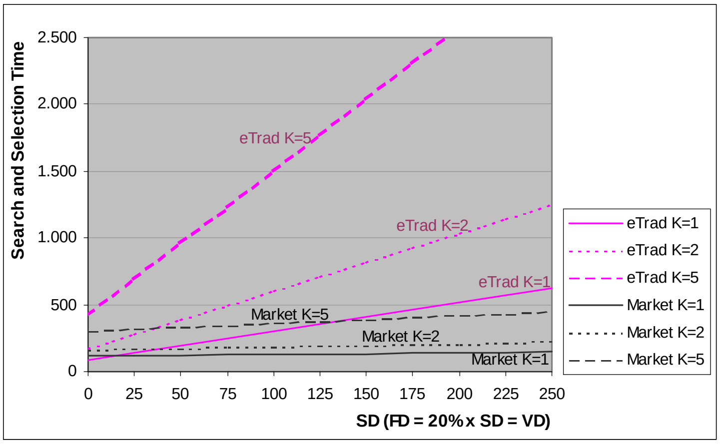
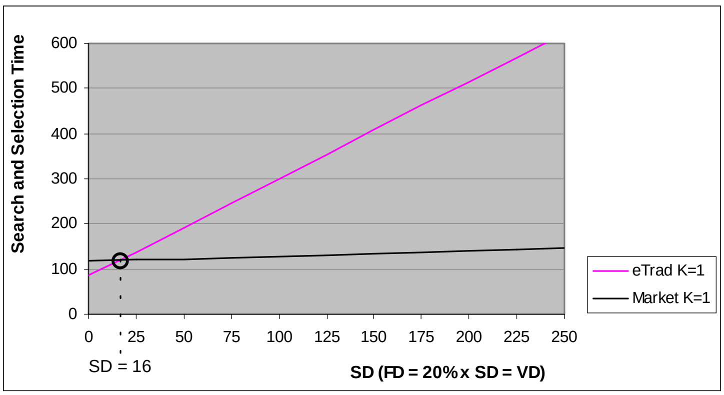


Figure 17. Traditional Internet-based method vs. Market of Resources using independent selection method: Decision point for search and selection time for K = 1 in function of search domain size



traditional method and the Market of Resources. We are considering the Focused Domain (FD) size to be 20% of SD as well as the Visit Domain (VD). For K=1, the line representing time (Figure 16) for the traditional method intersects the corresponding line for the Market of Resources, determining the point at the left of which the traditional Internet-based method is faster and to the right of which the Market of Resources is faster. This only happens for K=1,

Figure 18. Traditional Internet-based method vs. Market of Resources using independent selection method: Search and selection cost for K=1, K=2 and K=5*, in function of search domain size*

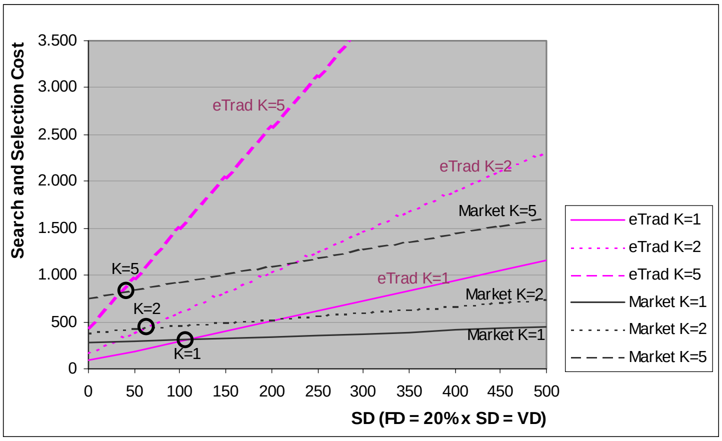
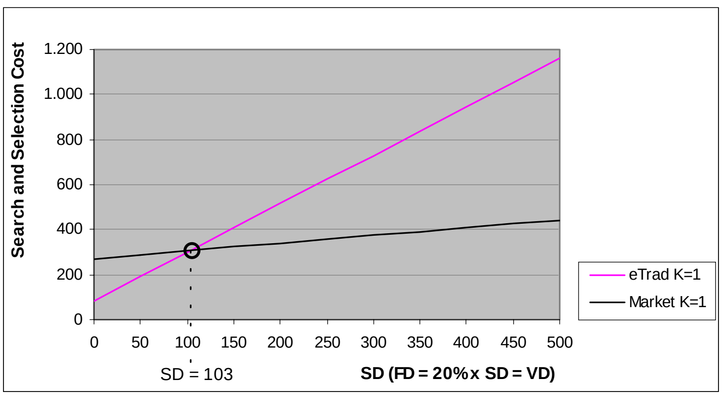


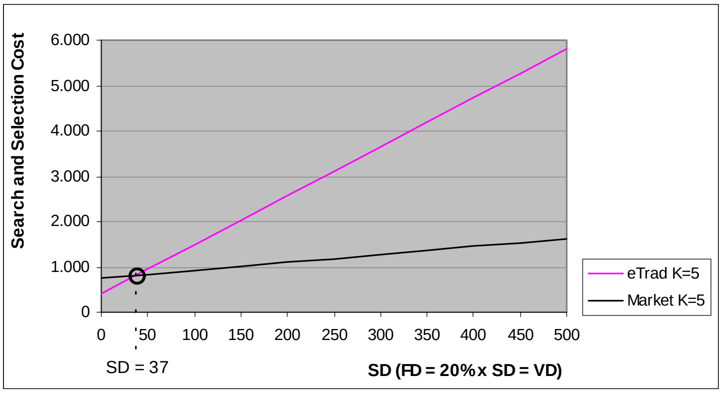
Figure 19. Traditional Internet-based method vs. Market of Resources using independent selection method: Decision point for search and selection cost for K=1 in function of search domain size



in the other situations the Market of Resources presents less time independently of the Search Domain and Focused Domain dimension.

For *K*=1 it is possible to have a more reduced search time using the traditional way, which corresponds to a Search Domain of less of 16 records, meaning a Visit Domain of 3 eligible resources providers (20% x 16) and a Focused Domain with 3 records, as represented in Figure 17. As we can see in Figure 16,

Figure 20. Traditional Internet-based method vs. Market of Resources using independent selection method: Decision point for search and selection cost for K=5 in function of search domain size



the line representing search, selection and integration time using the Market of Resources has a little slope, traducing a weaker dependency of Search Domain size, due to the automation that the Market offers.

Considering search, selection and integration cost instead of time, we can see that the traditional way presents advantages for small Search Domain sizes, both for *K*=1, 2 and 5, as represented in Figure 18, due to the higher cost of the Market per unit of time (Broker time). These decision points, considering cost instead of time, for *K*=1 and *K*=5, are presented in Figure 19 and Figure 20, respectively.

This situation of a Search Domain of 16 corresponds (in the traditional way) to visiting 3 possible suppliers (Visit Domain) and considering 50% of them as eligible for negotiation (let us consider 2). The negotiation (auction based, in our example) within this set of 2 leads to 1 candidate resource, for the selection of the best solution to provide the required resource.

The Search Domain dimension of 103 (Figure 19) corresponds to a Visit Domain and a Focused Domain dimension of 21 (21 potential resources providers) and using the ratios R1 and R2, corresponds to 11 eligible resources providers and 5 candidate resources providers.

A Search Domain dimension of 37 for each of the 5 required resources (K=5), as represented in Figure 20, corresponds to 7 potential resources providers, 4 eligible and 2 candidate resources providers.

It is important to highlight that the risks of the traditional Internet-based way are not being accounted, or by the other side, benefits of the Market of Resources

Figure 21.Search and selection time differential using independent selection method for K=1, K=2 and K=5

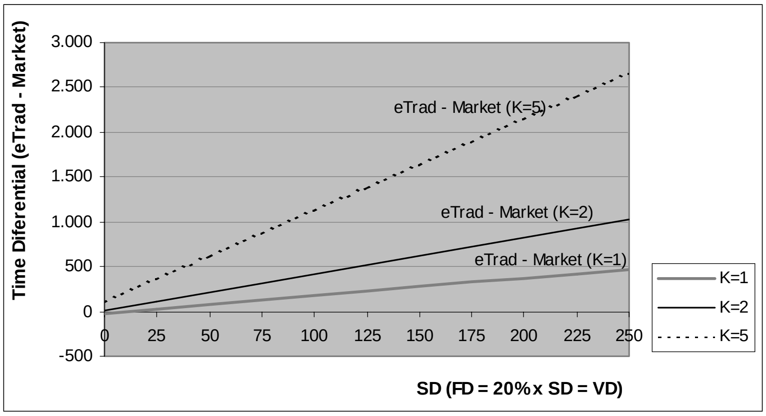
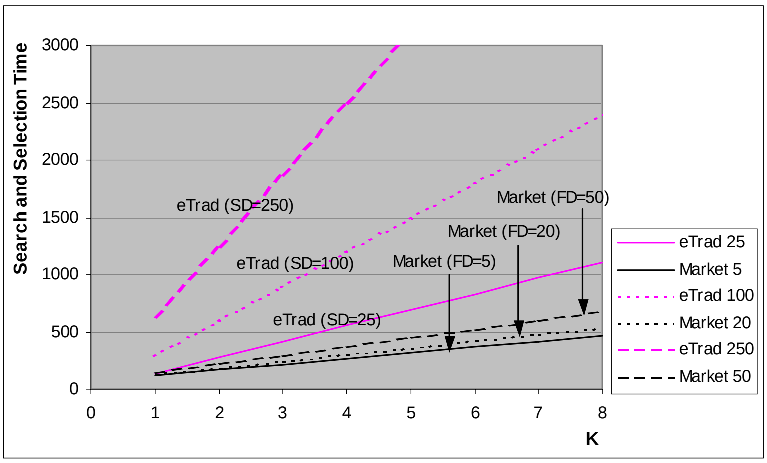


Figure 22. Traditional Internet-based method vs. Market of Resources using independent selection method: Search and selection time in function of K, for SD=25, SD=100 and SD=250 (or FD=5, FD=20 and FD=50)



(increased trust, regulations, protection of private information) are not considered. If they were being taken into consideration, the decision point should be displaced to the left or even disappear (in favor of the Market of Resources).

The differential between the traditional way and the Market of Resources in terms of time (i.e., time savings) when using the Market, is presented in Figure 21.

Figure 23. Traditional Internet-based method vs. Market of Resources using independent selection method: Search and selection cost in function of K, for SD=25, SD=100 and SD=250 (or FD=5, FD=20 and FD=50)

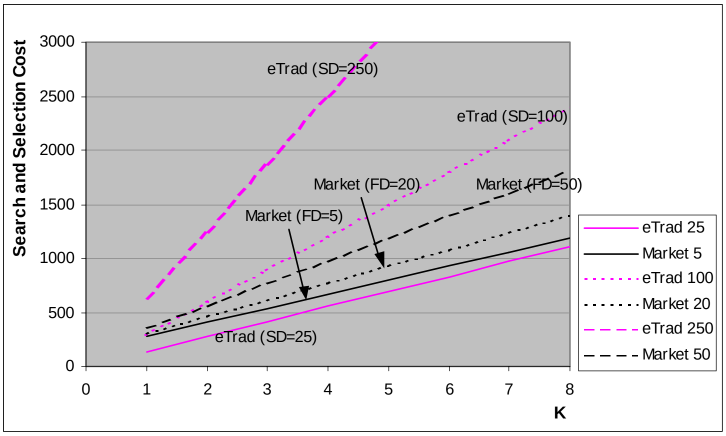
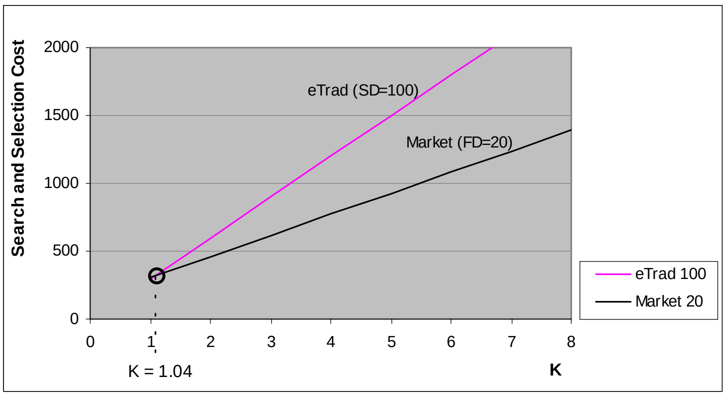


Figure 24. Traditional Internet-based method vs. Market of Resources using independent selection method: Decision point for search and selection cost in function of K, for SD=100 (FD=20)



It is also of interest to analyze time and cost for different average Search Domain sizes in function of *K*. Figure 22 represents search and selection time in function of *K*, for average Selection Domain sizes of 25, 100 and 250 (corresponding to Focused Domain dimensions of 5, 20 and 50, respectively).

Due to the automation offered by the Market of Resources, the Search Domain dimension does not affect search complexity with the same intensity as in the traditional Internet-based way. Also the dependency of search, selection and integration time in function of *K* is more reduced in the Market than in the traditional way.

Figure 23 is equivalent, but considering cost instead of time. It is possible to see that for SD = 25 (FD = 5) the cost of using the Market of Resources is higher than the utilization of the traditional way, for small *K*; intersection should occur for *K* = 16. For SD = 100 (FD = 20), the intersection is close to *K* = 1 (Figure 24).

Search and Selection of K Resources Using Dependent Selection Model

Using the estimations of Table 7, which are common to both selection models, and the considerations introduced at the beginning of this section, Table 9 presents search and selection time for different values of *K*, considering Search Domain sizes varying between 25 and 500, both for the traditional way and the Market of Resources, considering dependent selection method. In the traditional way, cost corresponds to 1 Cost Unit per minute and using the Market, time is

Table 9. E-Traditional vs. market of resources — Time and cost comparison — Dependent selection model

	eTraditional					Market of Resources				
domain size SD =	25	50	100	250	500					
VD = / FD =	5	10	20	50	100	5	10	20	50	100
K = 2										
Total time	280	406	705	1.976	5.345	170	176	190	237	342
User time	280	406	705	1.976	5.345	50	50	50	50	50
Broker time						120	126	140	187	292
Cost	**280**	**406**	**705**	**1.976**	**5.345**	**410**	**428**	**469**	**611**	**925**
K = 3										
Total time	437	678	1.570	11.746	81.830	220	231	261	499	1.959
User time	437	678	1.570	11.746	81.830	60	60	60	60	60
Broker time						160	171	201	439	1.899
Cost	**437**	**678**	**1.570**	**11.746**	**81.830**	**541**	**573**	**662**	**1.376**	**5.756**
K = 4										
Total time	625	1.080	4.555	125.135	1.958.915	272	289	376	2.837	39.596
User time	625	1.080	4.555	125.135	1.958.915	70	70	70	70	70
Broker time						202	219	306	2.767	39.526
Cost	**625**	**1.080**	**4.555**	**125.135**	**1.958.915**	**676**	**728**	**987**	**8.371**	**118.647**
K = 5										
Total time	873	1.778	17.780	1.530.629	48.837.200	326	355	699	31.025	977.273
User time	873	1.778	17.780	1.530.629	48.837.200	80	80	80	80	80
Broker time						246	275	619	30.945	977.193
Cost	**873**	**1.778**	**17.780**	**1.530.629**	**48.837.200**	**817**	**906**	**1.936**	**92.915**	**2.931.658**

Figure 25. Traditional Internet-based method vs. Market of Resources using dependent selection method: Search and selection time for K=2, K=3 and K=5 in function of search domain size

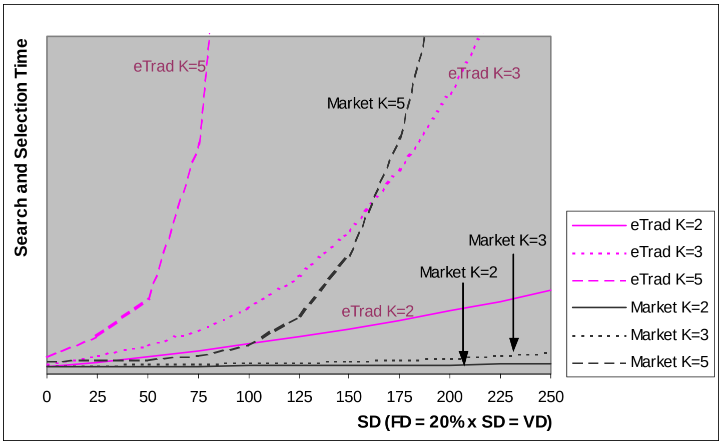
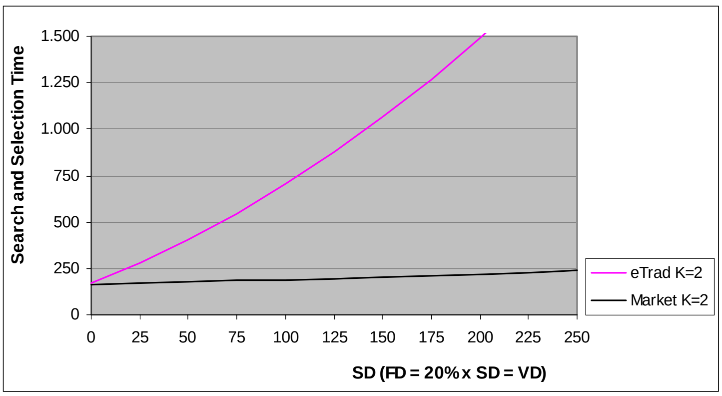


Figure 26. Traditional Internet-based method vs. Market of Resources using dependent selection method: Search and selection time for K=2 in function of search domain size



calculated separately for the user and broker and cost corresponds to 1 CU / minute for user time and 3CU /minute for broker time.

The dependent selection method is complex due to the possibilities of combinations. The simulation presented in Table 9 considers the maximum effort.

Figure 25 represents the time associated to the search of 2, 3 and 5 resources (*K*=2, *K*=3 and *K*=5)[1], in function of the search domain size (SD), both for the

Figure 27. Traditional Internet-based method vs. Market of Resources using dependent selection method: Search and selection cost for K=2, K=3 and K=5 in function of search domain size

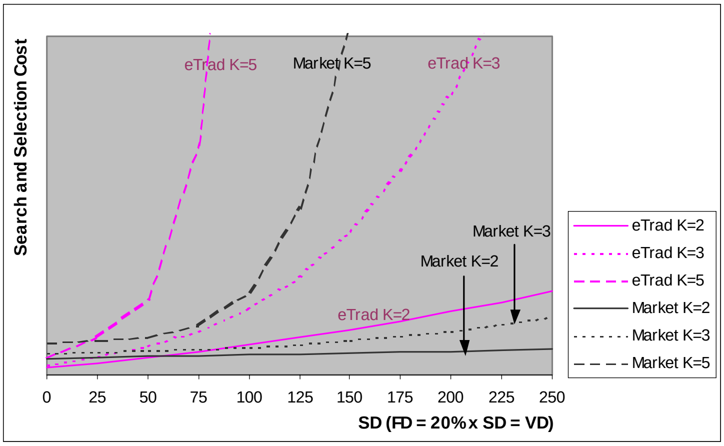
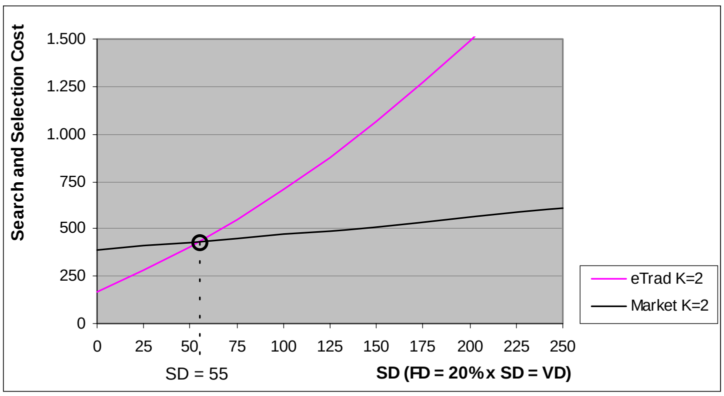


Figure 28. Traditional Internet-based method vs. Market of Resources using dependent selection method: Decision point for Ssearch and selection time for K=2 in function of search domain size



traditional method and the Market of Resources. Again, we are considering the Focused Domain (FD) size to be 20% of SD as well as the Visit Domain (VD).

There are no intersections between Search and Selection time using the Market and the e-traditional way for corresponding values of K, not even for K=2 (Figure 26). The Market of Resources is faster for all the represented situations of K and SD.

Figure 29. Traditional Internet-based method vs. Market of Resources using dependent selection method: Decision point for search and selection time for K=5 in function of search domain size

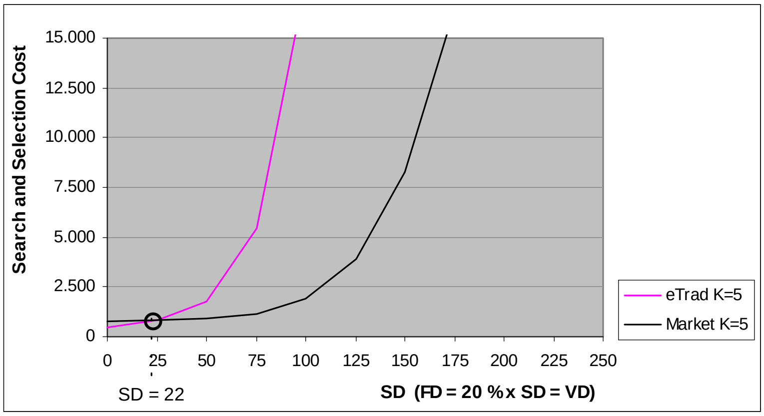
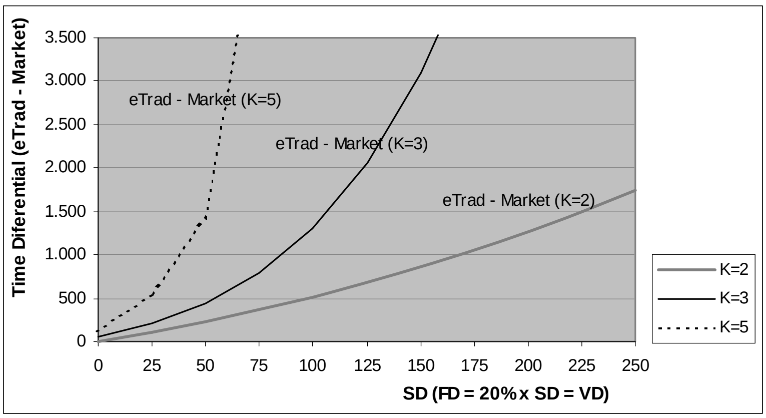


Figure 30. Search, selection and integration time differential using dependent selection method for K=2, K=3 and K=5



Considering search and selection cost instead of time, we can see that the traditional way presents advantages for small Search Domain dimensions, both for *K*=2, 3 and 5, as represented in Figure 27, due to the higher cost per unit of time of broker utilization. These decision points, considering cost instead of time, for *K*=2 and *K*=5 are presented in Figure 28 and Figure 29, respectively.

The Search Domain dimension of 55 (Figure 28) corresponds to a Visit Domain and a Focused Domain dimension of 11 (11 potential resources providers using

Figure 31. Cost differential using dependent selection method for K=2, K=3 and K=5

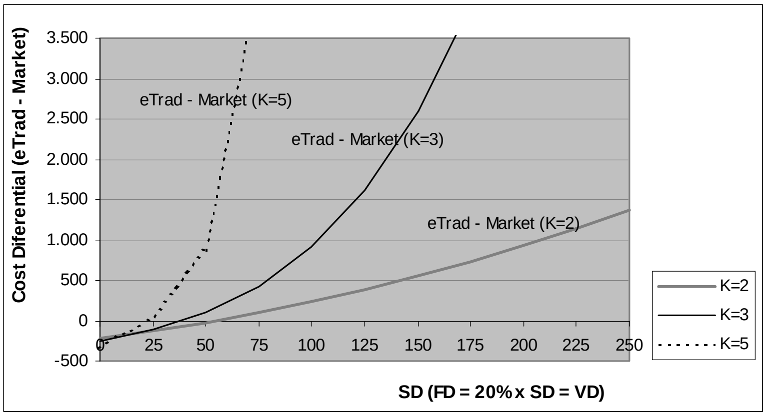
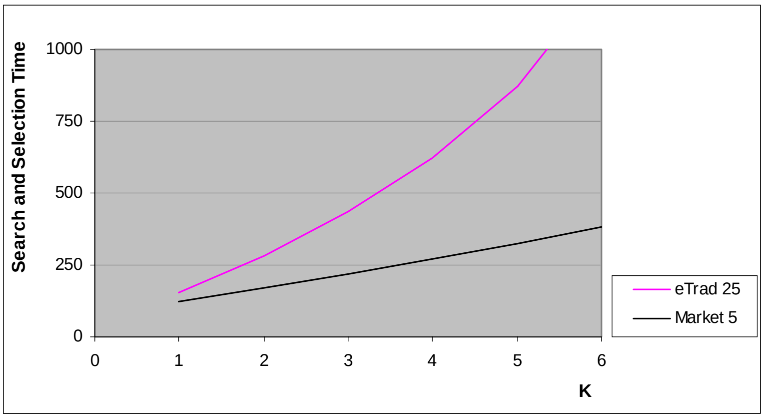


Figure 32. Traditional Internet-based method vs. Market of Resources using dependent selection method: Time in function of K for SD=25



the Market) and using the ratios R1 and R2, corresponds to 6 eligible resources providers and 3 candidate resources providers.

The Search Domain dimension of 22 (Figure 29) corresponds to a Visit Domain and a Focused Domain dimension of 4 and to 2 eligible resources providers and 1 candidate resources provider.

The differential between the traditional way and the Market of Resources both in terms of time (i.e., time savings when using the Market) and in terms of cost (i.e., cost savings when using the Market) are presented in Figure 30 and Figure 31, respectively. In terms of time, the Market of Resources is faster in all the situations, while in terms of cost, for small SD, the traditional Internet-based way is slightly advantageous.

Domain of Opportunities for the Market of Resources

The cost-analysis validation allows us to conclude about the Market of Resources performance, offering reduced search, selection and integration time and cost than the traditional way, for certain conditions, which are function of the number of the required resources and search domains dimension.

We are supposing the Market of Resources as capable of supporting the A/VE model, but if we consider a supply chain where reconfigurability dynamics is an important parameter, the Market is able to cope with it more efficiently than the traditional way, for the conditions identified in the previous sections.

Table 10 summarizes the break-even points between the traditional way and the Market efficiency, considering the two selection models, the number of required resources (*K*), and the Search Domain dimension (Focused Domain dimension is considered 20% of search domain dimension). For each value of *K* it is presented the Search Domain dimension (and Focused Domain dimension)

Table 10. Break-even points between the traditional way and the Market of Resources for different values of K

	K (number of required resources)							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Independent selection model								
- Time								
Search domain dimension (SD)	16	0	0	0	0	0	0	0
Focused domain dimension (FD)	3	0	0	0	0	0	0	0
- Cost								
Search domain dimension (SD)	103	61	48	41	37	34	32	31
Focused domain dimension (FD)	21	12	10	8	7	7	6	6
Dependent selection model								
- Cost								
Search domain dimension (SD)	-	55	39	29	22	15	9	5
Focused domain dimension (FD)	-	11	8	6	4	3	2	1

where the search, selection and integration times, using the traditional way, equals the corresponding times by using the Market.

As done for the independent selection model, it is also of interest to analyze time and cost for different average Search Domain sizes in function of *K*. Figure 32 represents search and selection time in function of K, for a very small Selection Domain, with a dimension of 25, corresponding to a Focused Domain dimension of 5. In Figure 33 we use larger Search Domain dimensions (SD = 100 and SD = 250).

Figure 33. Traditional Internet-based method vs. Market of Resources using dependent selection method: Time in function of K, for SD=25, SD=100 and SD=250 (or FD=5, FD=20 and FD=50)

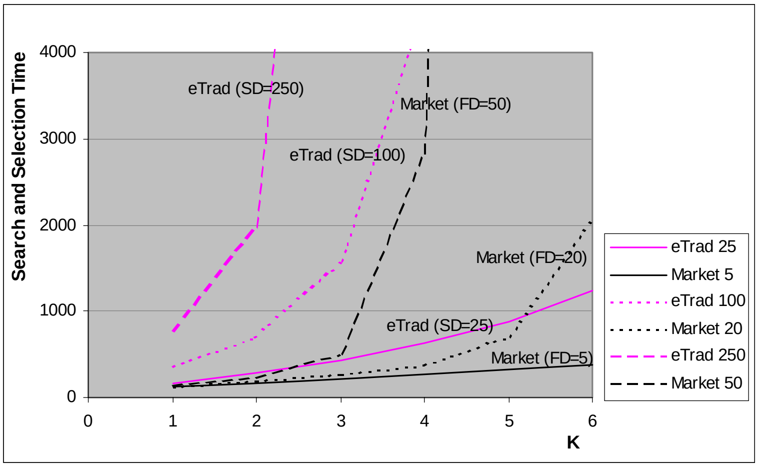


Figure 34. Break even points based on search and selection cost and time using the independent selection model

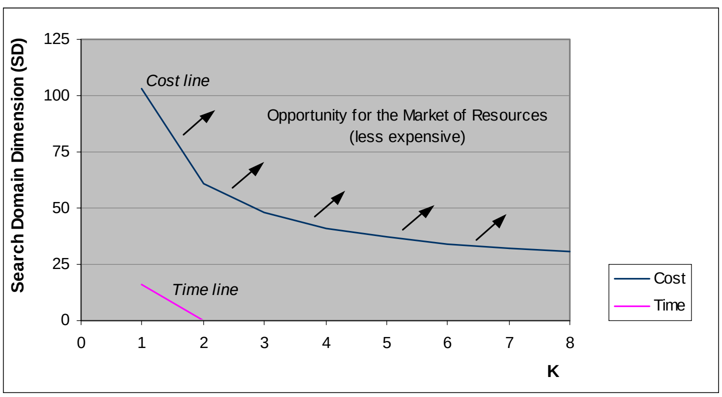
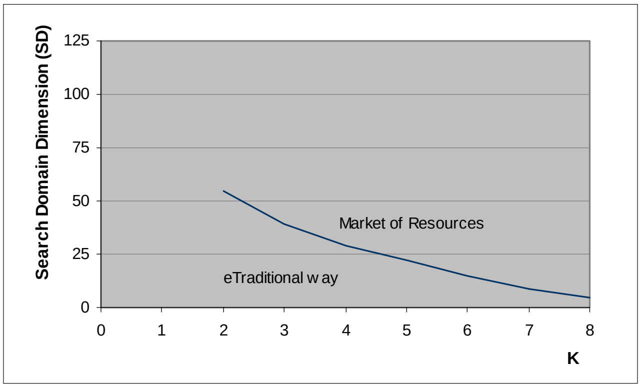


Figure 35. Break even point based on search and selection cost using the dependent selection model



Again, due to the automation offered by the Market of Resources, search time is not affected by the Search Domain dimension with the same intensity than in the traditional way, as well as the relation between search effort and the number of required resources (*K*). The dependency of search and selection time in relation with K is more reduced in the Market than in the traditional way.

In the case of independent selection model, it was also considered the time variable, for *K*=1, where the Market is more efficient only if the Focused Domain dimension exceeds 3. For the dependent selection model considering search and selection time, the Market is always more advantageous.

When considering time, we are able to identify the situations where the Market copes with increased dynamics, which are all except for *K*=1 and FD < 3 using independent selection, and all the situations using dependent selection method.

For the independent selection model, as represented in Figure 34 , the area under the cost line corresponds to the situations where the traditional way is less expensive and the situations under the time line corresponds to the situations where the traditional way is faster. Considering the dependent selection model, as represented in Figure 35, the area under the cost line corresponds to the situations where the traditional way is less expensive and the Market of Resources is always faster, independently of the number of required resources and search domain dimension.

The Market of Resources contributes to the possibility of reconfigure an A/VE within a few hours. If dealing with simpler projects, broker intervention could be reduced and reconfiguration could be faster. However, it is possible to search, negotiate, contactualise an A/VE creation or reconfiguration, for example for

K=3 and an average Focused Domain of size 50, in less than 5 hours (300 minutes) using independent selection, or in 8.3 hours (500 minutes) using dependent selection. For the same situations, the values offered by the traditional way are respectively 31 hours (1,868 minutes) and 196 hours (11,746 minutes), an unbearable value.

This way, it is demonstrated that the Market of Resources allows an efficient integration of resources in an A/VE and that the Market is able to cope with the requirements intrinsic to the A/VE model.

It was also demonstrated that the Market of Resources can be implemented with the existing technologies, and that it is the environment assuring the attainment of the full potential of the A/VE model.

Summary

The analytical simulation based on the cost-and-effort models both for the traditional tools and for the demonstrator of the Market of Resources allowed the identification of the space of opportunities for the utilization of the Market of Resources. The Market of Resources revealed the ability to support higher reconfiguration requirements than the traditional tools (due to the more reduced reconfiguration time it allows) and its suitability increases with product complexity (here traduced by the number of required resources).

As demonstrated, the Market of Resources contributes to an enhanced dynamics of the A/VE model, one of its intrinsic characteristics, and a determinant of its emergency. In this section we validated the opportunity for the Market of Resources concept as an enabler for the A/VE model, as the here designated by traditional tools were not developed with such purpose.

We are supposing the Market of Resources as capable of supporting the A/VE model, but if we consider a supply chain where reconfigurability dynamics is an important parameter, the Market of Resources is also able to cope with it more efficiently than the traditional way.

We believe that a new generation of Internet-based advanced environments, such as the example of the Market of Resources and other similar solutions will provide the opportunity to greatly extend the benefits of electronic business and to implement the new paradigm of the dynamically reconfigurable networks as the virtual enterprise model.

Reference

Brimson, J. (1991). *Activity accounting — An activity-based costing approach*. New York: John Wiley & Sons.

Endnotes

1 Searches performed on 12th January 2005.

2 http://www.yahoo.com

3 http://www.google.com

4 http://www.globalsources.com

5 By definition of dependent selection, the number of required resources (*K*) should be at least 2.

Chapter XI

Market of Resources:
Exploitation and Future Trends

Introduction

Electronic Marketplaces (e marketplaces) appear to be a promising solution to B2B e-commerce, however its role, as well as the role of other solutions we have identified that can be used to help or to partially support A/VE integration, must go beyond helping to identify suppliers, improving the efficiency of purchasing transactions, etc., as also confirmed by several credible analysts and information technology research sources.

Simultaneously, and considering the perspective of the recent virtual enterprise models, we could not see any other environment to cope with its requirements than the integrated environments as the one we are proposing: a Market of Resources or similar solutions.

In this chapter we analyze the context in which the Market of Resources appears, identifying favorable existing conditions and reviewing forecasts by credible analysts and consultancy houses, present a SWOT[1] analysis, present some critical success factors associated with the exploitation of the Market of Resources, identify the targeted users, and finally explore some potential opportunities and expected benefits. This chapter also identifies the opportunities for the Market of Resources, presenting the e-marketplaces' evolution, the failure of the first generation of e-marketplaces and presenting some research forecasts for B2B Internet-based transactions. In addition, it highlights the main strengths and weaknesses of the Market of Resources' ability to support the A/VE model requirements and the main opportunities and threats associated to its exploitation, using a SWOT analysis. This chapter presents the set of critical success factors for the Market of Resources, their definition or explanation and the competitive advantage that each critical success factor confers. It identifies the target users of the Market of Resources and reflects on the opportunities and expected benefits presented by the creation of the Market of Resources to its targeted users and to the implementation of the A/VE organisational model. Finally, it presents some conclusions and future trends.

Opportunities for the Market of Resources

The main opportunities for the Market of Resources deployment are related with the actual e-business situation. To plan the Market of Resources exploitation, it is important to understand the economics of e-business and of e-marketplaces, the types of e-marketplaces that are likely to emerge, how companies are likely to use them, etc. This section presents an analysis on the opportunities for a Market of Resources and it is mainly based on a review of e-business analyses and forecasts by technology analysts and consultancy houses, as GartnerGroup,[2] Forrester Research,[3] Aberdeen Group,[4] Deloitte & Touche /Deloitte Consulting,[5] AMR Research,[6] CommerceNet,[7] Boston Consulting Group, Inc.,[8] WorldCom[9] and Legg Mason Wood Walker, Inc.,[10] most of them available online at the respective Web sites.

E-Marketplaces: Past, Present and Future

The initial wave of e-marketplaces (1998-2000) was characterized by the expectative of strong growth of the USA economy, highly supported by the valorization of the so-called "*Internet economy*", a situation that was traduced on the easy access of capital of risk, in the development of new software platforms for electronic markets and simultaneously on an excessive optimism or excess of confidence on the ability of capturing participants to the markets and generate liquidity. This conducted to the massive creation of e-marketplaces during this period.

This first generation of independent e-marketplaces presented a very positive and confident vision about the future of electronic commerce. The idea of enabling the contact between wide communities of buyers and sellers world wide, to exchange goods and services, of enabling instantaneous transactions and with reduced transaction costs was very attractive. But the announced principles, very easy to enumerate, were of difficult implementation and these first businesses were not able to accomplish their promises. Compounding the serious technological challenges in linking companies' diverse procurement processes, suppliers would come if the demand was there and companies would only participate if there was a critical mass of suppliers (Raczkowski, 2001). The opposite objectives of buyers and sellers, the implementation of inadequate business models, and other motives, turned impossible the operation of many e-markets that, in year 2000, or closed or merged with other, due to the inability of attracting a reasonable number of participants (buyers and sellers) enough to assure enough transactions to justify its existence and the permanence of the participants, the inability of obtaining enough liquidity, inability to offer value added services and adjusted business models.

Participants required integrated and value added services, confidence, security, responsiveness, reliability. To these enumerated factors one must also associate the consequences of the crash of the stock exchange on the information and communication technologies sector (the "*dot-coms crash*"), in March 2000, which disabled the flow of the capital of risk that was financing most e-marketplaces

Between 1998 and 2000, B2B e-commerce grew more than 1000%. At the beginning of year 2000, the analysts of Gartner (Gartner_Research, 2001b) previewed that about 10,000 electronic marketplaces should be created until the end of 2005. Few months later, another house *AMR Research* previewed that, instead of the 10,000 markets, only less that 1,000 should survive. Indeed, and according to the *Wall Street Journal* (Anders, 2000), in October 2000, there existed less than 1.500 *e-marketplaces*.

And this was the first wave or generation of e-marketplaces, which coincided with the flourishing and multiplication of independent e-marketplaces. Although many of those have disappeared, and besides the uncertainty of their future, it is to admit that the future will deserve an important role for them, in the transaction of goods and commodities of low value added or standardized.

Then we have assisted to the emerging of vertical private markets, leaded and financed by sectorial consortia of dominant enterprises (and concurring) of the same sector of economical activity, which corresponded to the second wave.

And in 2001, several market analysis (e.g., *Accenture and CommerceNet working paper;* Davenport, Brooks, & Cantrell, 2001) anticipated that these models should dominate the B2B e-commerce sector.

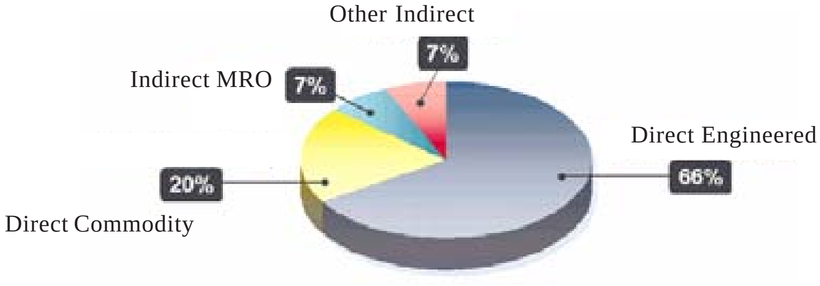
However, later studies (e.g., Holzmuller, 2002) started to indicate that, in future, integration services should have the same importance than transaction services, as in the previous phases. The ability of creating environments of collaboration and of global improvement of the whole supply chain started to be a strong concern (Berryman, 2002). Not all e-marketplaces will provide the same sets of transaction and integration services, each will be faced with the challenge of identifying the *mix* of core services to offer, but tendentiously it will be emphasized the importance of interaction services (collaboration e-marketplaces) (Christiaanse & Markus, 2003).

The third wave of e-marketplaces will not be concerned just on transaction costs reduction, acquisition prices or aggregation, but also on the capability of creating environments for collaboration and improvement in the supply chain (Premkumar, 2003) and for collaborative design chain management (ProjectLink, 2003), for example.

These collaboration e-marketplaces represent the new tendency, the third wave. A relevant example is Covisint, where cooperation between the founding enterprises was one of the main reasons to its success. However, the actual cooperation and the relative dimension of the market can also help the involved enterprises to consolidate their negotiation power.

According to an example provided in ProjectLink (2003), the basic concept of market, facilitating dynamic pricing, in truth, limits its relevance to indirect goods (consumables, etc.) or to direct goods (standardized components, raw materials). Besides the interest of this function, it only covers partially the opportunity. Although in several sector of activity the expenditure in indirect goods can correspond to more than a half of the total, in industry, as for example in the

Figure 1. Costs of procurement in the automotive industry (Source: ProjectLink, 2003)



automotive industry, indirect goods together with direct goods correspond to around 34%. The remaining 66% belong to the class of engineering products that are designed to the client through a collaborative process involving client and a network of providers (see Figure 1).

By outsourcing more of the design, development and production of their products that in the past, the industry assumes the role of systems integrator, manufacturers increasingly take on the role of systems integrators, blending the collaborative contributions of an entire network of "design chain" partners to bring a new product to life (ProjectLink, 2003).

It is previewed that the evolution of the electronic marketplaces and the requisites of the collaborative project and development will converge. The ideal platforms will enable B2B processes that precede and succeed procurement.

Why Did Some Public Marketplaces Fail?

Several technology research analysts (for example, Forrester Research, Gartner Research, and Booz Allen & Hamilton) reported the public e-marketplace failure. As the potential for streamlining supply chains became evident with the advent of the Internet, many start-up companies were created with the promise of bringing buyers and sellers together to shave costs, drive down prices, and facilitate collaboration. This was the first wave or generation of e-marketplaces. These capabilities of public marketplaces simply have not materialized, according to a Gartner Research report on e-marketplaces analysis (Gartner_Research, 2001b).

The mentioned report highlighted several factors that accounted the lack of success of this first generation e-marketplaces:

- **Lack of critical mass and liquidity:** the first public e-marketplace*s* faced the challenge of convincing buyers and sellers that these marketplaces did, in fact, have a unique value proposition. Because of the primary pricing focus of these marketplaces, sellers felt their products would become commoditized. Without the sellers, buyers would not join and marketplaces conducted very few transactions.
- **Lack of value-added service offerings:** buyers have established long-standing relationships with their sellers. It was not evident what additional services, over the already existing supply chain technologies, e-marketplaces were going to bring.
- **Reluctance of participants to share critical information due to security and privacy concerns:** companies hesitated to display their purchasing data to the world and specifically to their rivals.

- **High cost of participation:** the revenue model of many public e-marketplaces includes the charge of a transaction fee (from 0.5% to 8% per transaction). Some public e-marketplaces have charged a flat rate subscription fee for annual participation at their beginning, but later start charging transaction fees. Some public marketplaces lost the majority of their members after switching their pricing strategy from subscription to transaction fees.

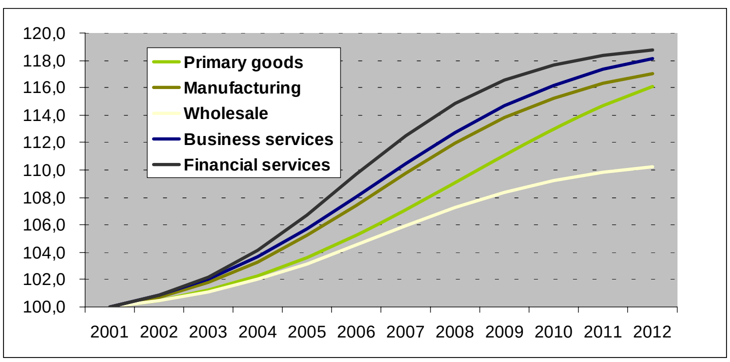
Research Forecasts on Internet B2B Transactions

It is expected the growth of B2B e-commerce to accelerate sharply over the next few years, both in the United States and worldwide. Real US B2B e-commerce in 2003 reached $2.4 trillion, according to a Forerster Research forecast, cited by BusinessWeek online (Mullaney, 2003).

To project the timing, magnitude and source of efficiency gains, Forrester Research created the *e-Business Productivity Model* (Forrester_Research, 2001). The Forrester *e-Business Productivity Model* projects the incremental productivity (revenue/hours worked) industries will achieve, that is specifically attributable to outward-facing e-business activities. According to this model, e-business will provide U.S. economy with an average incremental productivity gain of 1.3% annually over the period 2001 to 2012, in three distinct stages (Figure 2) (Forrester_Research, 2001):

- 2001 to 2003 — *Foundation stage*: as firms lay the foundations of their online collaboration capability, e-business productivity increases by 0.8%

Figure 2. Productivity growth by industry sector (Forrester_Research, 2001)



annually. Productivity improvements require e-business applications to be built on standards that allow low-cost adoption and functionality.

- 2004 to 2007 — *Expansion stage*: as firms begin to use new e-business tools, e-business productivity will grow by 1.7% annually. Main drivers will be the *Web* services technologies, as XML-based applications.
- 2008 to 2012 — *Normalisation stage*: e-business productivity gains will have peaked before 2008 for most industries, but it will continue to drive productivity growth in this period. E-business productivity growth will slow to 1.2% per year as firms fine-tune their usage of online tools.

E-Business Hype Cycle

The *Hype Cycle* is a method to characterise the life cycle of technologies or trends and provides a snapshot of the position of a set of technologies in the inevitable cycle of hype and disillusionment that accompanies a technology's path to maturity (Gartner_Research, 2001a). The *Hype Cycle* consists of the following phases (Gartner_Research, 2001a):

- **Technology Trigger:** A breakthrough, public demonstration, product launch or other event generates significant press and industry interest.
- **Peak of Inflated Expectations:** During this phase of over enthusiasm and unrealistic projections, a well-publicized activity by technology leaders results in some successes, but more failures, as the technology is pushed to its limits.
- **Trough of Disillusionment:** Because the technology does not live up to its inflated expectations, it rapidly becomes unfashionable and the media will abandon the topic.
- **Slope of Enlightenment:** Focused experimentation and solid hard work by a diverse range of enterprises leads to true understanding of the technology's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools become available to ease the development process.
- **Plateau of Productivity:** The real-world benefits of the technology are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. The final height of the plateau varies according to whether the technology is broadly applicable or benefits only a niche market.

Figure 3. E-marketplace hype curve pattern (Gartner_Research, 2001c)

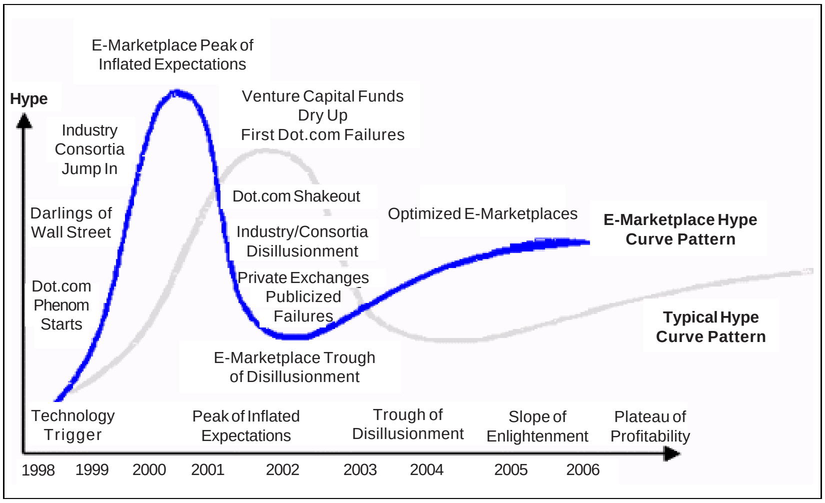
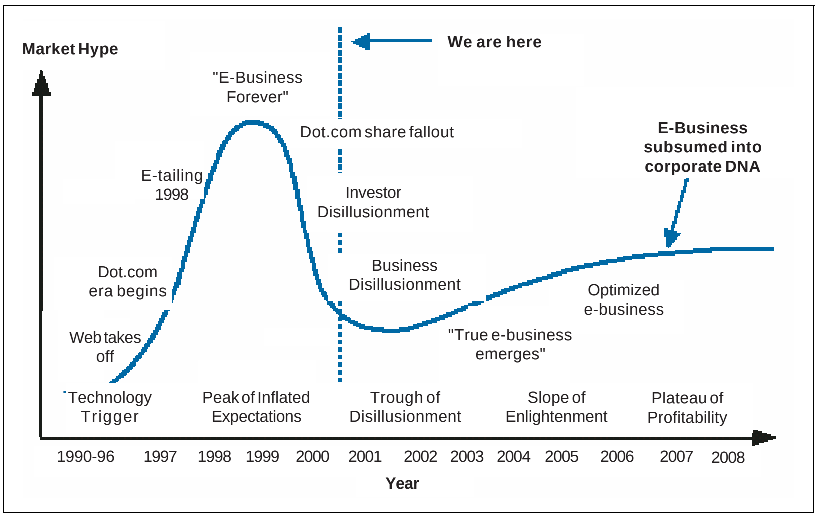


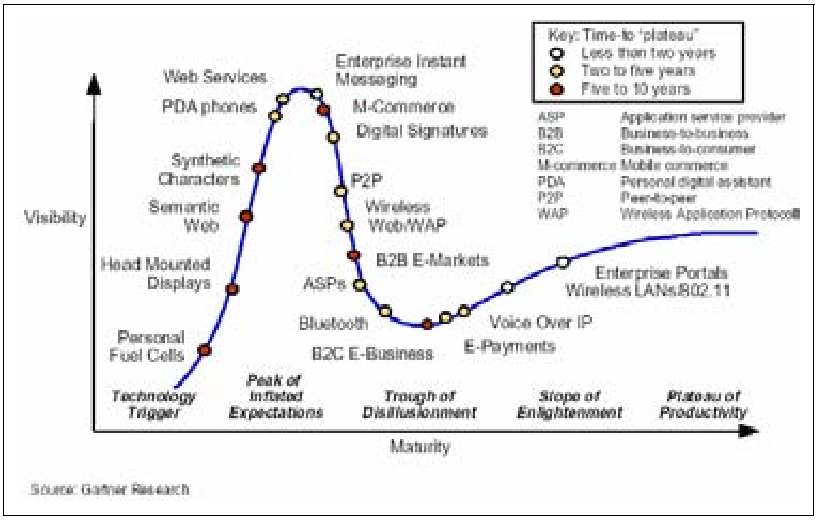
Figure 4. E-business hype cycle (Gartner_Research, 2001c)



Gartner Research (2001c) proposed that *e-Marketplace Hype Curve* pattern should be shorter that the typical *hype curve* pattern (Figure 3), and forecasted the e-marketplace disillusionment by 2002.

As predicted in Gartner's report (Gartner_Research, 2001c), *true e-business* emerges by 2004 and optimised e-business by 2006 or 2007 (Figure 4).

Figure 5. Gartner hype cycle: 2001 emerging technologies and trends (Gartner_Research, 2001a)



Stabilization should happen around 2008. The Market of Resources could be classified as a support to this new generation of e-business (*optimised e-business*).

Gartner (Gartner_Research, 2001a) presented an overall *Hype Cycle for 2001*, as a normalised consolidation of the single e-business technology *hype cycles* (each technology is on a different time scale). In 2001, the projection estimated B2B e-marketplaces to achieve the plateau of productivity within five to ten years (Figure 5).

Market of Resources: A SWOT Analysis

SWOT (Strengths, Weaknesses, Opportunities, and Threats) is a tool of situation analysis, used in the preliminary stage of strategic decision-making (Johnson, Scholes, & Sexty, 1989), where it provides the basic framework for strategic analysis. SWOT generates lists of strengths, weaknesses, opportunities and threats. These lists are used by organizations to generate strategies that fit their particular anticipated situation, their capabilities and objectives (Pearce & Robinson Jr., 1998).

Table 1. Market of Resources exploitation: A SWOT analysis

Strengths	Weaknesses
- Trust and responsiveness - Knowledge based guidance in A/V E design and integration - Electronic automated negotiation and contractualisation - Performance evaluation of the A/V E participants - Contracts management and enforcement	- Difficulty in expressing the resources characteristics (due to the lack of unified information representation) - Dependability on other similar services to increase the coverage of as many as possible domains of activity - Dependency on the existence of a critical mass to keep members interest
Opportunities	**Threats**
- Emerging A/V E organisational model - Technological development - The enterprises' investment in information and communication technology - Competitive pressures - Technology accessibility to small & medium sized enterprises	- The fast pace of technological development is enabling e-procurement and e-negotiation, etc., and enterprises will go for the best deal - Concurrency: competition from other similar services

Strengths and Weaknesses are analysed from the internal perspective and the Opportunities and Threats from the external. The objective is to transform the Threats in Opportunities.

This section highlights the main strengths and weaknesses of the Market of Resources' ability to support the A/VE model requirements and the main opportunities and threats associated to its exploitation, are summarised in Table 1, using a SWOT analysis.

Strengths

Strengths consist on the aspects that the Market of Resources is able to offer, that are not assured by the so-called traditional Internet-based solutions (for example electronic marketplaces and electronic negotiation tools). These aspects are the leading objectives in the Market of Resources project and as such have already been explored in previous chapters.

The main strengths of the Market are: (1) the ability to assure trust (given by the partnership performance monitoring and utilization of historical information in new processes of search and selection) and responsiveness; (2) knowledge-based guidance in A/VE design and integration (assured by the introduction of brokers, as proposed by the BM_Virtual Enterprise Architecture Reference Model); (3) electronic automated negotiation and contractualisation; (4) performance evaluation of the A/VE participants; and (5) contract management and enforcement (based on performance evaluation of the A/VE participants).

Trust and Responsiveness

Trust is a major concern that any environment to support A/VE integration must assure. In the Market of Resources, trust is assured by a detailed regulation, enforcement procedures through contracts and safety mechanisms, duty of seal, etc.

Responsiveness or almost real-time answer is essential. The Market enables the reduction of the integration time and increases integration efficiency as demonstrated in Cunha and Putnik (2003a, 2003b).

The cost associated to the integration of an A/VE surpasses the sum of costs of making contacts, with the cost of overcoming distance, etc., it is also the opportunity cost, the cost of loosing an opportunity because of taking a few more hours or days to locate resources or to reconfigure the A/VE.

Knowledge-Based Guidance in VE Design and Integration

Brokerage implementation (human brokerage), search–and-selection support algorithms[11] and an efficient organisation of the Market of Resources knowledge base are on the origin of this knowledge-based guidance. The Broker, supported by computer-aided tools, validates all the steps in the process of designing the A/VE project that is most suitable to achieve the underlying objectives.

Electronic Automated Negotiation

The Market of Resources service is designed to offer different processes of electronic negotiation (passive and active), and is supported by automated tools of search, selection and negotiation, which can increase the performance of the process when the solution space dimension is high.

Performance Evaluation of the A/VE Participants

The requirement for permanent alignment of the A/VE with the market (business) asks for a dynamic process of A/VE performance evaluation and the analysis of reconfiguration opportunities. To answer to this requirement the Market of Resources offers procedures for performance monitoring and, through the Broker allocated to a given A/VE project and using computer-aided coordination mechanisms, is permanently monitoring the partnership and recording historical information to be used in future. The Market of Resources makes use of historical information of the behaviour of the resources providers in previous integrations, in the search processes, to increase trust and achieve better results.

This activity of monitoring the performance of every integrated resource increases trust and contributes to the highest possible performance of the A/VE.

Contracts Management and Enforcement

The uncertainty concerning the behaviour of the resources to integrate increases the risks associated with the ability to answer to the production of an ordered product (the motive that led to the integration of the A/VE) and therefore must be taken into consideration. The Market of Resources offers mechanisms for contract generation, management and enforcement. To reduce the contractualisation time, the Market of Resources (empowered to represent the parties in the contract formalisation) is able to perform almost real-time contractualisation between the parties to integrate in the A/VE.

Weaknesses

Three of the main weaknesses identified are related to: (1) the difficulty of expressing the resources requirements by the Client, who must be able to use a resources representation language, (2) the strong dependency on the existence of a critical mass of members in the Market of Resources and (3) the necessity to implement partnerships with other services in order to extend the coverage domain.

Difficulty in Expressing the Resources Characteristics

The efficiency of the service is dependent upon: (1) the ability of representation and organisation of the resources information in the Market of Resources database, and (2) on the capture and translation of the requirements for resources selection and negotiation parameters, regarding database-retrieving operations. If the first is dependent solely of a unified representation language, the second requires also the ability of the A/VE Client to translate the requirements for the A/VE project into this language, which is far more complex than describing the individual resources provided by Resources Providers.

The lack of normalisation in information representation is a serious limitation to the implementation of the Market. We have mentioned a Resources Representation Language as a "mechanism" in IDEF0 diagrams of Chapter VIII, but the recent developments towards unified representation languages[12] represent a possible contribution, that the Market of Resources should adopt as a tool for integrability.

Limitations in Coverage — Dependability on Similar Services

A project can touch many different areas, and our Market is both vertical and horizontal (matricial), to allow a better coverage of domains of activity. To overcome the lack of coverage, it is necessary to establish partnerships with other similar markets, so that the Broker does not see its search space limited to the Market of Resources database. Considering again the soap dispenser project introduced in Chapter X, it is possible that our Market is not able to cover all the products and operations required (electronic, plastic moulds, pumping and valves mechanisms).

But this situation of partnering with similar services is constrained by the existence of unified representation languages (e-marketplace to e-marketplace integration). If this does not happen, translating software will be required, to support interoperability between services, or the Broker will have to know different representation languages, in order to transport the request into other services.

Dependency on the Existence of a Critical Mass of Members

The strong dependency of a project on a given factor, by itself, is already a weakness. The Market of Resources can only exist if it has an equilibrated number of members — resources providers, clients and brokers — to allow the satisfaction of their legitimate expectancies, to create a high volume of requests and of business opportunities.

Opportunities

Cost savings does not seem to be a major key driver for enterprises to use the Market of Resources. Rather they should be interested in time and quality benefits, trust, dynamic reconfigurability, etc. Opportunities should come from technological developments, which will enable more efficiency in the implementation and from the current state of ICT investment and usage by the enterprises, which traduces the willingness to drive business online. But the main opportunity seems to come from the actual strong competition environment, which is expected to force companies to the adoption of virtual enterprise models, and this shift may represent an opportunity for services as the one provided by the Market of Resources.

Emerging A/VE Organizational Model

As demonstrated on the previous chapter, the Market of Resources environment is more efficient in coping with the A/VE model than the traditional ways.

With the predictable evolution of the organisational models, services as the one provided by the Market of Resources will appear as the previewed/projected evolution towards a new generation of B2B e-marketplaces and support services.

Technological Development

The rise of Internet-based B2B marketplaces (from catalogues to auctions, spot exchanges or automated request for quotations) is progressing rapidly. At the same time, we are assisting to the fast appearing of networked enterprises, extended enterprises and VE. However, the developments or solutions still do not respond to the A/VE model requirements.

Several enabling technologies are living significant developments, from electronic payment to security. Electronic payment systems will further lower transaction costs in *Internet* marketplaces. Technologies like public key cryptography can provide security and authentication of transactions, while intermediaries like Bizrate[13] will use information from consumers to keep track of merchant reputations. Credit bureaus and credit card companies will provide credit information or guarantee payment for consumers. Intermediaries like Verisign[14] are *certificate authorities* that match legal identities to the possession of cryptographic keys. Finally, the emerging standards for information representation will be a major requirement for efficiency and integratability in e-business.

Investment in Information and Communication Technology

A survey report undertaken by Boston Consulting Group (2002) on internal corporate communication trends in large companies in United States of America, European and Asian revealed some striking trends in the adoption and use of new communication technologies. One finding is that the economic downturn has increased companies' appetite for new communication technologies, especially among U.S. firms. Most companies reported a substantial increase in the use of new communication modes.

The survey reported that a confluence of factors — including the maturation of communication technologies, pressures to reduce costs associated with the economic downturn, and sustained spending on new internal communication technologies — has led to a very favourable corporate environment for the adoption and use of new communication technologies within companies, and for the launch of corporate initiatives that deploy new communication mechanisms. The study concluded also that companies are pursuing an "invest-to-reduce-costs" model. Many companies are following a model whereby they invest in new communication technologies in order to drive down other costs and increase productivity.

The data suggests that there is a very favourable environment for the adoption and increased usage of new value-added services, as enterprises have invested in the enabling technology and are looking for reducing costs and increasing productivity, which means that it could be understood as potentiating the acceptability for the Market of Resources.

Competitive Pressures

We feel that enterprises of all sectors perceive the threat of competition and see, both in the emergent virtual enterprise organisational models and in the Internet-based applications, a possibility to improve productivity and reduce some type of costs. This is pushing traditional business to adopt B2B e-commerce practices, and represent an opportunity for the deployment of new applications, being one of these the Market of Resources.

At the same time, companies providing e-business services (as e-marketplaces), represent a competitive pressure towards the success of the Market of Resources (while competition is simultaneously a threat).

Technology Accessibility to Small & Medium-Sized Enterprises

A key driver of growth of B2B e-commerce will be the increased adoption of e-commerce initiatives by small and mid-size (SME) companies. The *application service provider* (ASP) model of providing software as a service over the Internet will facilitate the rapid adoption of B2B e-commerce among SME companies. Many SME companies have been shut off from robust B2B e-commerce technology due to high costs, such as heavy up-front license and consulting fees, as well as high ongoing systems maintenance costs. While the ASP market remains in its early stages, we note that the signs are very positive with leading software companies, such as Ariba, Clarus, Commerce One, Microsoft, and Oracle all offering their software via the ASP model. Open Source applications should be appearing at every moment, and should make these B2B solutions more accessible to SME.

Threats

By delivering standards and simplifying access to global trading partners, e-business technologies introduce more competition — and more efficiency — into markets. Threats come both from technological developments and from concurrency of other emerging services, however, according to the SWOT analysis principles, threats should be transformed into opportunities.

Technological Developments

At the same time that technological developments represent opportunities, given the fast pace of technology change, the Market faces the risk that technologies will develop that could make services offering obsolete. To be successful in the long term, the Market of Resources must remain on the cutting edge of technological change and continue to make substantial internal investments in the adoption of state-of-the-art technologies and standards or ally itself with leading-edge partners.

Emerging Services/Concurrency

Electronic marketplaces enable price discovery, partners search, electronic negotiation, etc., to be employed in different markets. For example, intermediaries like Priceline[15] allow buyers to specify product requirements and their willingness to pay, and then make corresponding offers to the participating sellers, reversing the traditional functioning of retail markets; industry marketplaces as for example Global Sources[16] provides a list of potential providers of a given product; Thomas Register[17] directory, offers search of suppliers and electronic negotiation within a large pool of registered providers; Manufacturing Quotes[18] is helping to identify enterprises able to respond or to develop to specific engineering products.

Finally, agents (several still under development applications) that can negotiate purchases on behalf of buyers and sellers can contribute to a future restructuring of e-marketplaces.

But a question remains. Are these tools possible enablers of the A/VE model? Or are they simply enablers of electronic procurement? Are they real competitors? Or are they examples of a previous generation of the Market of Resources competitors?

Critical Success Factors

The Market of Resources is made of participants (A/VE Owners, Resources Providers and Brokers), and hence the Market's success or failure is dependent on their success or failure. The success depends on the ability to deliver value to the core businesses of participants, all must get valued added.

There exist, in our opinion, a set of guiding principles to drive the deployment of successful services to support to the A/VE model, as the Market of Resources. In Table 2 it is presented the set of critical success factors for the Market of Resources, their definition or explanation and the competitive advantage that each critical success factor confers.

Targeted Users of the Market of Resources

Classes of users of the Market of Resources are Resources Providers, Clients and Brokers. In this section we present the user groups identified and targeted by the Market of Resources, for each of these classes.

Resources Providers

Resources Providers can be:

- SME and larger companies from all the economical activity sectors (either industrial or business oriented, consultancy, research or technology transfer-based), related to the focused markets of the Market of Resources,

Table 2. Market of Resources implementation: Critical success factors

Critical Success Factor	Definition	Competitive Advantage
Critical mass	- The Market of Resources must attract and retain a critical mass of members and answer to their transaction needs and supporting functions. The volume of requests must satisfy scale considerations for Resources Providers and Brokers, as well as A/V E Owners must find a set of resources providers able to provide satisfactory solutions to their requests. - The Market of Resources must bring the larger possible number of market participants together and as fast as possible.	- Larger volume of requests and of business opportunities for the participants (resources providers, clients and brokers). - Larger economic return.
Content	- The Market of Resources must offer capabilities beyond simple transaction matching, such as trust, integration, coordination, etc. Besides the common services already assured by e-marketplaces, the Market of Resources must provide knowledge to drive A/V E design and integration; management and evaluation mechanisms to ensure that the goals of participants and contracts are met; mediation mechanisms to effectively resolve disputes among members in case of unaccomplishment of contractualised tasks, etc., to assure the desirable reconfigurability dynamics and business alignment.	- Attraction of members. - Better satisfaction of members' needs.
Responsiveness and quality	- Since the only certainty is change, a Market of Resources must be flexible enough to respond to internal and external changes, itself supporting agility. - The Market must be efficiently supported by a suitable information system and technology, assuring the capability of organising and accessing the information.	- Better response than the competitors.

willing to provide resources (primitive or complex) for integration in an A/VE.

- Universities, polytechnics, technological and research centres willing to disseminate research and technological development (RTD) results, to provide knowledge, services, skills, or to participate in RTD consortia.
- Individuals, who can be service providers, private consultants or researchers.

Clients

A Client can be anyone, individual or collective, willing to create an A/VE or to reconfigure an existing A/VE:

Table 2. continued

Critical Success Factor	Definition	Competitive Advantage
Security and privacy assurance	- Participants may be reluctant to provide critical data about products or processes, which is indispensable for the A/V E design, unless the Market is able to assure security and privacy of data, preventing from leakage of private knowledge.	- Members' confidence.
Usability and interaction	- The effort towards a useable site, well assisted by the broker, able to track the user difficulties.	- Members' satisfaction, which find it easy to use.
Price sensitivity / cost-benefit relation	- Awareness of competitors pricing *versus* service quality, to be always competitive.	- Members' loyalty.
Commitment	- A strong motivation towards a high quality service and towards the broker's skills.	- Members' satisfaction and loyalty.
Integration with other services and strategic partnerships	- The coverage of a domain of activity as large as possible relies on the integrability with other similar services,that is, on the translation mechanisms or on the adoption of the most convenient (emerging) standards for information representation. - The establishment of partnerships is also essential to enlarge the coverage.	- Better satisfaction of members' needs.
Demonstration capability	- The potential benefits of the Market must be largely disseminated, so that their targeted users are able to identify the new range of opportunities and potential benefits.	- Attraction of members.
Technology	The use of technology is a horizontal success factor that underpins all the others. - Integration technologies, collaborative applications make it easier to coordinate business. - It must remain on the cutting edge of technological change and continue to make substantial investments in the adoption of state-of-the-art technologies and standards.	

- SME and large companies from all the economical activity sectors (either industrial or business oriented, consultancy, research or technology transfer based), related to the focused markets of the Market of Resources, willing to create or reconfigure an A/VE, or to complement its activity with a set or resources providers, due to a market opportunity for a new product or service or to the redesign of an existing product.

- Universities, polytechnics, technological and research centres willing create an A/VE to develop an RTD project, a research spin-off, or to implement a teaching or training project, in consortium with other organisations.
- Individuals, “owners” of a business opportunity.

Brokers

The Broker is an individual, a consultant, an expert, someone of recognised knowledge and skills in a given area, willing to make his capabilities available (to sell its capabilities), to advise and to support A/VE design, integration and performance monitoring.

Analysis of Opportunities and Potential Benefits

The main objective of the Market of Resources consists of the support to the implementation of the virtual enterprises organisational models, presenting benefits to all their participants, otherwise its existence would not be justified. The fact that all the elements participating in an A/VE are permanently under evaluation causes the mutual responsibilisation and implication of all in the accomplishment of the contractualised functions, and thus increasing quality, efficiency and trust.

In this section we reflect on the opportunities and expected benefits presented by the creation of the Market of Resources to its targeted users and to the implementation of the A/VE organisational model.

Opportunities and Benefits to Resources Providers

The deployment of services as the Market of Resources can alter the basis of competition in the addressed business areas or economic sectors. If it can offer new business opportunities, access to a large pool of subcontractors, it brings in increased challenges and increased competition among providers.

Under the traditional organisational models, with more or less static supply chains, the search of responsiveness, quality, accomplishment of agreements, lean profit margins are not so pressing as under the A/VE model. The possibility of implementing dynamically reconfigurable partnerships (A/VEs) increases the level of the exigency by the A/VE owners towards its resources providers' performance, given the universe of eligible candidate substitutes.

Resources providers will live under strong competition, but on the other side, resources providers can benefit from a wider range of business opportunities, in a safer environment, through contract enforcement and historical information, protecting them from opportunistic behaviour or doubtful situations.

The impact on the resources providers is traduced by an increased importance of concentration in core areas, specialisation, and implementation of efficient management techniques, such as TQM, Just-In-Time, and be supported by accurate information systems and decision support systems.

Opportunities and Benefits to A/VE Clients

Client benefits include: (1) organisational aspects — the support to the implementation of A/VE model (the main contribution of the Market of Resources environment) and support to A/VE creation and reconfiguration — and (2) managerial aspects — quality and efficiency in the operation of the created A/VE (or A/VE instantiation) and increased competitiveness.

The first aspect has been demonstrated previously, correspond to the possibility of implementing highly reconfigurable partnerships, which represents an alteration on the basis of competition, a shift towards new organisational models.

The second aspect corresponds to: (1) the trust and confidence associated to the partnership's performance, given the permanent track and monitoring of A/VE operation results and possible reconfiguration whenever justified, and (2) the possibility to increase the A/VE performance as a whole while decreasing transaction and operation cost, given the existence of a critical mass of potential resources providers (representativity or concentration) to negotiate the best combinations.

Opportunities and Benefits to Brokers

Mainly, the Market is responsible by the creation of a new profession and new work opportunities to be carried out by highly specialised individuals. The broker is required to dominate all the aspects of interaction with the Market of Resources and is also required to keep actualised in its field of expertise in order to be contracted or selected (i.e., to have more work opportunities).

The service provided by the broker is essential to the implementation of the Market as support to the A/VE model, also according to the *BM_VEARM*.

Conclusions and Future Trends

The search for competitiveness is pushing towards the proposal of new organisational models, namely the virtual enterprise models, of which the A/VE model seems to be a promising one, characterised by permanent business alignment through increased virtuality and agility (or fast reconfigurability). But, this model requires that the emerging Internet-based environments are able to cope with these new requirements of competitiveness.

We have proposed a new environment that, as validated, is possibly implemented with the existing technology and techniques, presents more efficiency in A/VE creation and reconfiguration than the existing environments and is capable of responding the requirements of the A/VE model.

We have mentioned several times along this book the critical importance of permanent alignment between enterprises and the market. Within the Agile/ Virtual Enterprise concept, *it is not the enterprise that makes the product; it is the product that makes the enterprise*. Hence, as a dynamic configuration, the A/VE aims precisely to keep the product aligned with the business opportunity, by means of adopting as many instantiations as necessary.

If the existing solutions do not address the present e-business needs, as demonstrated by the studies and reports of e-marketplaces failure and clients dissatisfaction, hardly they could address the A/VE model. The Market of Resources makes possible to reduce creation/reconfiguration time, as demonstrated, and this way, is able to answer to increased reconfigurability needs, which characterise the A/VE model.

The A/VE model is relevant only under the support of a market of resources, like the one proposed. Also the VE life cycle, as presented in literature, does not correspond to the requirements that the economic environment presents, for which we have proposed an extended life cycle. The Market enables an extended Virtual Enterprise life cycle, and is intrinsic part of it.

This is a potential project for investment. It is a huge project, but the required technology exists or is emerging, knowledge exists, and there exist market for it. From the aspect of relevance, the Market of Resources is able to reduce A/VE creation and reconfiguration time, and hence, to allow increased reconfigurability dynamics towards business alignment.

Even if we do not consider its application to the A/VE model, the Market of Resources can be generalised and adopted within products' supply chains. Considering the existence and viability of the adoption of the A/VE model, we have demonstrated its dependency on the Market of Resources.

If the existing solutions do not address the present e-business needs, hardly they could address the A/VE model. The Market of Resources makes possible to reduce creation/reconfiguration time, and this way, is able to answer to increased reconfigurability needs, which characterise the A/VE model. It is also expected that the new generation of electronic marketplaces will implement the functionalities required by the A/VE model, which means that this new generation will be of Market of Resources alike solutions.

Technological solutions are pulled by the needs. The dialetic between organizational model requirements and technology solutions drives innovation in this domain. New competitiveness requirements dictate the paradigm shift towards the Agile/Virtual Enterprise model, and the implementation of this model claims for technological support, pulls the development of new solutions, new answers as the Market of Resources. Elemica and Manufacturing Quotes are good examples of new concepts of e-marketplaces, but only a fully integrated environment offering all the functionalities incorporated in the Market of Resources can fully respond to the competitiveness requirements and cope with this new organizational model.

References

Anders, J. (2000, October 23). B2B: Yesterday's darling. *The Wall Street Journal*.

Ávila, P., Putnik, G. D., & Cunha, M. M. (2002a). Brokerage function in agile/virtual enterprise integration — A literature review. In L. M. Camarinha-Matos (Ed.), *Collaborative business ecosystems and virtual enterprises* (pp. 65-72). Boston: Kluwer Academic Publishers.

Ávila, P., Putnik, G. D., & Cunha, M. M. (2002b). A contribution for the classification of resources selection algorithms for agile/virtual enterprises integration. In L. M. Camarinha-Matos (Ed.), *Balancing knowledge and technology in product and service life cycle* (pp. 65-72). Dordrecht: Kluwer Academic Publishers.

Berryman, K. (2002, June). B2B: Back to basics. *Zdnet.com*.

Bichler, M., Beam, C., & Segev, A. (1998). Services of a broker in eElectronic commerce transactions. *International Journal of Electronic Markets, 8*(1).

Boston_Consulting_Group. (2002, February, 2002). *Company communication trends: Growth of new communication technologies demands rethinking of companies' internal communication strategies: A survey report*. The Boston Consulting Group, Inc. Retrieved April 2002, from http://www.bcg.com

Christiaanse, E., & Markus, M. L. (2003). Participation in collaboration electronic marketplaces. *Proceedings of the 36th Hawaii International Conference of Systems Sciences (HICSS)*.

Cunha, M. M., & Putnik, G. D. (2003a, June 10-13). Market of resources versus e-based traditional virtual enterprise integration — Part I: A cost model definition. In G. D. Putnik & A. Gunasekaran (Eds.), *Proceedings of the First International Conference on Performance Measures, Benchmarking and Best Practices in New Economy* (pp. 664-669). Guimarães, Portugal: University of Minho.

Cunha, M. M., & Putnik, G. D. (2003b, June 10-13). Market of resources versus e-based traditional virtual enterprise integration — Part II: A comparative cost analysis. In G. D. Putnik & A. Gunasekaran (Eds.), *Proceedings of the First International Conference on Performance Measures, Benchmarking and Best Practices in New Economy* (pp. 667-675). Guimarães, Portugal: University of Minho.

Davenport, T., Brooks, J., & Cantrell, S. (2001, April). *B2B eMarket survey: Summary of findings* [A Working Paper from the Accenture Institute for Strategic Change]. Accenture and CommerceNet. Retrieved March 2005, from http://www.commercenet.com

ebXML. (2001). *Technical architecture specification v1.0.4.* United Nations Body for Trade Facilitation and Electronic Business (UN/CEFACT) and Organization for the Advancement of Structured Information Standards (OASIS). Retrieved from http://www.ebxml.org/specdrafts/ebXML_TA_v1.0.4.pdf

Forrester_Research. (2001). *eBusiness propels productivity* [Forrester Research Press Sources]. Forrester Research, Inc. Retrieved March 2002, from http://www.forrester.com

Franke, U., & Hickmann, B. (1999). Is the net-broker an entrepreneur? What role does the net-broker play in virtual Webs and virtual corporations? In Sieber & Griese (Eds.), *Proceedings of the 2nd International VoNet Workshop*. Zurich.

Gartner_Research. (2001a, August). Management update: The Gartner 2001 Hype Cycle — Emerging trends and technologies. *Point to Point — Gartner Review of the Telecommunications Industry, XVI,* 5-8.

Gartner_Research. (2001b). *Private marketplaces: What is the value proposition?* (White Paper). McLean, VA: Gartner Research.

Gartner_Research. (2001c, May). Top issues in Gartner Research. *The Monthly Research Review,* 10-26.

Hands, J., Bessonov, M., Blinov, M., Patel, A., & Smith, R. (2000). An inclusive and extensible architecture for electronic brokerage. *Decision Support Systems, 29*, 305-321.

Holzmuller, H. H. (2002). Delphi study about the future of B2B marketplaces in Germany. *Electronic Commerce Research and Applications, 1*(1), 2-19.

Johnson, G., Scholes, K., & Sexty, R. W. (1989). *Exploring strategic management*. Ontario: Prentice Hall.

Mullaney, T. (2003, May 12). *Special Report — The e-Biz Surprise*. BusinessWeek online. Retrieved March 2, 2005, from http://www.businessweek.com

Pearce, J. A., & Robinson Jr., R. B. (1998). *Strategic management. Formulation, implementation, and control* (6th ed.). Chicago: Irwin.

Premkumar, G. (2003). Perspectives of the e-marketplace by multiple stakeholders. *Communications of the ACM, 46*(12).

ProjectLink. (2003). *Collaborating design chain: The next wave of opportunity for B2B trading exchanges* (White paper): Parametric Technology Corporation. Retrieved from http://www.ptc.com

Raczkowski, G. (2001). *B2B marketplaces: The long road to success*. WorldCom, Dash30 Inc. Retrieved April 2002, from http://www1.worldcom.com/resources/whitepapers/pdf/B2BMarketplaces.pdf

RosettaNet. (2003). *RosettaNet and Web services: An executive-level view of RosettaNet and an emerging model for application-based B2B commerce* (White Paper). RosettaNet. Retrieved from http://www.rosettanet.org/rosettanet/doc

UDDI. (2001). *The universal description, discovery and integration (UDDI) Specification*. UDDI. Retrieved from http://www.uddi.org/

Endnotes

[1] Strengths, Weaknesses, Opportunities and Threats.

[2] http://www.gartener.com

[3] http://www.forrester.com

[4] http://www.aberdeen.com

[5] http://www.dc.com

[6] http://www.amrresearch.com

[7] http://www.commercenet.com

[8] http://www.bcg.com

[9] http://www1.worldcom.com

[10] http://www.leggmason.com

[11] A taxonomy of brokerage functions can be found in Ávila, Putnik & Cunha, 2002a; Bichler, Beam & Segev, 1998; Franke & Hickmann, 1999; Hands, Bessonov, Blinov, Patel, & Smith, 2000. A classification of resources selection algorithms can be found in Ávila, Putnik & Cunha, 2002b.

[12] For example the frameworks RosettaNet (RosettaNet, 2003), Web Services Description Language – WSDL (UDDI, 2001), ebXML (ebXML, 2001).

[13] www.bizrate.com

[14] www.verisign.com

[15] http://www.priceline.com

[16] http://www.globalsources.com

[17] http://www.thomasregister.com

[18] http://www.mfgquote.com

About the Authors

Maria Manuela Cunha is currently an associate professor in the Higher School of Technology, Polytechnic Institute of Cávado and Ave, Portugal. She holds a DiplEng in the field of systems and informatics engineering, an MSci in the field of information society and a DrSci in the field of virtual enterprises, all from the University of Minho. She coordinates the scientific domain of organizations and information systems in the Department of Information Systems and Technologies, and teaches subjects related with information systems, software engineering and organizational models, to undergraduate and postgraduate studies. She supervises several PhD projects in the domain of virtual enterprises. Her scientific and engineering interests are electronic business, agile and virtual enterprises and information systems. She regularly publishes and participates in international scientific conferences. She serves as a member of the editorial board for several international journals and has served in several scientific committees of international conferences.

Goran D. Putnik received his DiplEng, MSci and DrSci from the Belgrade University, both MSci and DrSci in the area of intelligent manufacturing systems. His current position is an associate professor with the Department of Production and Systems Engineering, University of Minho, Portugal. He teaches the subjects of CAD/CAPP, CAM, FMS and virtual enterprises in undergraduate studies, and CAD/CAPP/CAM systems, concurrent engineering, enterprise organization, IMS and design theory in postgraduate studies. He served as director of the Centre for Production Systems Engineering (CESP) for 4 years and its deputy director for 5 years. He is director of the Master and Postgraduate Course on CIM, and is responsible of the Laboratory for Virtual Enterprises (LABVE), Department of Production and Systems Engineering, University of Minho. His scientific and engineering interests are production systems and enterprises design and control theory and implementations: CIM, CAD/CAPP/CAM systems, intelligent production systems and enterprises, machine learning as a design theory model, design engineering, information systems management, formal theory of production systems and enterprises, and distributed, agile and virtual enterprises. He is supervising a number of PhD projects as well. He regularly publishes and participates in international scientific conferences. He serves as a member of the editorial board for several international journals and has served in more than 40 scientific committees of international conferences. He was also invited lecturer on a number of universities.

Index

Symbols

A

B

W

Y

Z