

# Virtual Organizations

## Systems and Practices

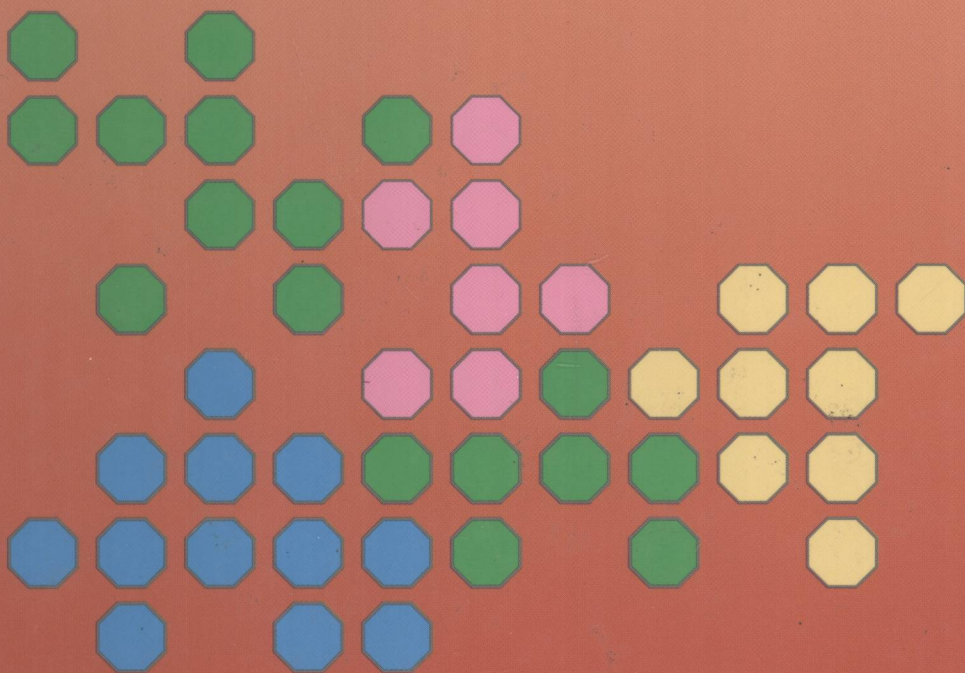
*Edited by*

**Luis M. Camarinha-Matos**

**Hamideh Afsarmanesh**

*and*

**Martin Ollus**



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**Systems and Practices**

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E200501464



**Springer**

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Library of Congress Cataloging-in-Publication Data

A C.I.P. Catalogue record for this book is available  
from the Library of Congress.

VIRTUAL ORGANIZATIONS: Systems and Practices/ edited by Luis M. Camarinha-Matos, Hamideh Afsarmanesh, and Martin Ollus.

p.cm.

Includes bibliographical references and index.

ISBN: (HC) 0-387-23755-0 / (eB00K) 0-387-23757-7 Printed on acid-free paper.

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Printed in the United States of America.

9 8 7 6 5 4 3 2 1

SPIN 11342908 (HC) / 11343028 (eBook)

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# **VIRTUAL ORGANIZATIONS**

## **SYSTEMS AND PRACTICES**

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**TECHNICAL SPONSOR:**

European Commission IST-2001-32031 Project  
Virtual Organizations Cluster

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# FOREWORD

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## **Towards a consolidation of empiric knowledge on virtual organizations**

**Purpose.** During the last decade, considerable investments have been made worldwide in a large number of research projects fostering new organizational forms. These projects have on one hand produced an abundant variety of specific solutions and on the other hand broad awareness about the necessary organizational changes. The area of *Virtual Organizations* as a main component of the new discipline of *Collaborative Networks* has been particularly active in Europe where a large number of R&D projects have been funded. The fast evolution of the information and communication technologies and in particular the so-called Internet technologies, also represents an important motivator for the emergence of new forms of collaboration. However, the research in many of these cases is highly fragmented. Each project is focused on solving specific problems and, by applying Information and Communication Technology, partially designs and develops its proprietary minimal business-to-business interaction mechanism according to its basic needs. As such, there is no effective consolidation/harmonization/continuity among them in order to have an effective impact. Trying to improve this situation, this book represents an attempt to contribute to a consolidation of existing empiric knowledge and experiences in this area.

**Intended audience.** Given the nature of the book, focused on the consolidation of the state of the art, it is mainly intended for researchers, PhD students, engineers, and managers entering the field of virtual organizations. It can also be useful for those already involved in specific areas of virtual organizations and those who want to get a broader view of the field of collaborative networks.

**Style.** This is a multi-author book and therefore, although an attempt is made by the editors to achieve minimal uniformity, the reader should expect to find different styles of writing along the various chapters. Furthermore, the reader needs to be aware of the fact that the VO paradigm is a highly multi-disciplinary area for research, and comprising contributions from a large number of experts from different research communities. This situation by itself introduces a new level of heterogeneity in the styles, as different communities have different ways of expressions, different literary styles, and different inherent semantics are associated to the terminology used in each discipline.

**Sources.** This book was prepared in the context of VOSTER, the European Virtual Organizations Cluster project. The overall aim of VOSTER was to collect, analyze and synthesize the results from a number of leading European research projects on Virtual Organizations, i.e. “geographically distributed, functionally and culturally diverse, dynamic and agile organizational entities linked through ICT”. In addition to the European projects, and although constrained by the limited resources available, VOSTER also made an attempt to consider results from some relevant

projects from other geographical areas (e.g. USA, Canada, Australia, Mexico, Brazil, Japan).

**Book structure.** In summary, the book sections include the following:

Section 1 presents a summary of the main concepts, definitions, and models used in this area. Section 2 introduces the ICT requirements and support infrastructures. Section 3 is devoted to implementation aspects such as legal, socio-organizational, and performance measurement issues. Section 4 includes a collection of case studies in various application domains. Finally, Section 5 presents some concluding remarks. Additionally, an Annex presents a brief summary of the main projects considered in the VOSTER study.

The editors would like to thank the large community of experts involved in this work – authors and referees - for their many valuable opinions, suggestions, and recommendations. On behalf of the VOSTER consortium we also thank the European Commission, the Commission's project officer Joel Bacquet, and the review team, Alberto Bonetti and Olivier Rerolle, for their valuable support and suggestions.

We hope that the result of this work can constitute a valuable input for those who want to get a better understanding of virtual organizations and collaborative networks.

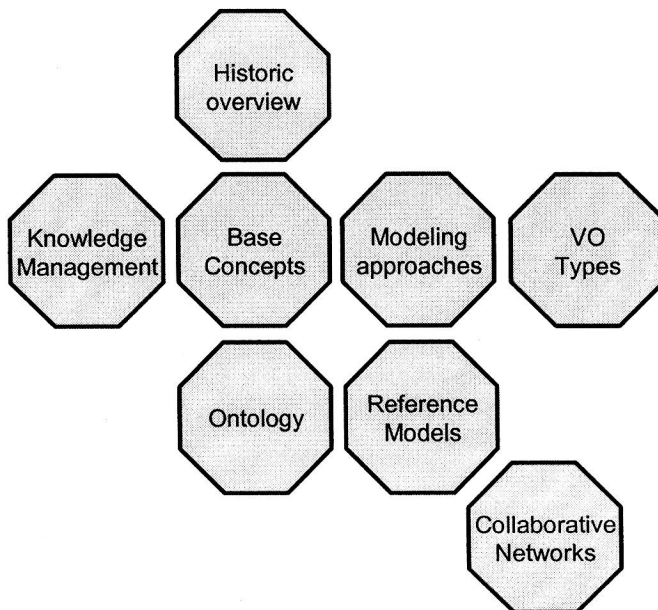
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# BRIEF HISTORICAL PERSPECTIVE FOR VIRTUAL ORGANIZATIONS

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*Emergence of the virtual enterprise / virtual organization paradigm falls within the natural sequence of the restructuring processes in traditional industrial paradigms that is enabled by advances in information and communication technologies. In parallel with the outsourcing tendency, another transformation observed in large companies is their reorganization as a “federation” of relatively autonomous departments. The idea of VE/VO was not “invented” by a single researcher; rather it is a concept that has matured through a long evolution process. The history of industrial enterprise integration, as well as the integration technologies and paradigms in the last three decades are briefly introduced. The position of the VE/VO in the e-movement is identified.*

## 1. INTRODUCTION

Several new industrial paradigms have emerged in recent years as an answer to the fast changing socio-economic challenges, such as the virtual manufacturing, lean enterprise, agile manufacturing, fractal company, and holonic manufacturing. Introduction of these concepts in enterprises has made them face successive “waves of restructuring” during the last decades. Emergence of the virtual enterprise / virtual organization paradigm falls in the natural sequence of these restructuring processes, enabled by the “explosive” developments in the information and communication technologies. The need to remain competitive in the open market forces companies to seek “world class” status and therefore, to concentrate on their core competencies while searching for alliances when additional skills / resources are needed to fulfil business opportunities.

Some authors see the roots of this paradigm in early works of economists like Oliver Williamson in the 1970s. Along his very prolific work, and in particular in the “Markets and Hierarchies” (Williamson, 1975) Williamson established the study of Transaction Cost Economics as one of the first and most influential attempts to develop an economic theory of organizations. He defends that manufacturing firms should make much greater use of externally purchased goods and services, rather

than those internally supplied. Williamson discusses the business transaction costs at the same level as the production costs. While production costs are considered as being analogous to the costs of building and running an "ideal" machine, transaction costs covers those that incur by deviation from perfection. For instance he argues that the lack of information about the alternative suppliers might lead to paying too high a price for a good or service. Through identifying the important variables that determine the transaction costs, the work of Williamson contributed to the better understanding of business interactions among enterprises.

These ideas had a more evident impact with the booming of the "outsourcing" wave in the 1980s. Outsourcing became very attractive when managers had to reduce the organization overheads and eliminate the internal inefficient services, the so called lean manufacturing, as it transfers the problem to the outside, namely other efficient service providers. For many enterprises, outsourcing some services allows them to concentrate on their core competencies. For others, outside contractors simply provide complementary services for which the company lacks adequate internal resources or skills.

Among many factors that justify the outsourcing strategy, the reduction of costs, and elimination of poor performance units, can be pointed out, particularly in the case of those units that do not represent core capabilities or when better and cheaper alternatives can be identified in the market.

In parallel with the outsourcing tendency, another transformation can be observed in large companies that reorganize themselves in terms of their production lines, leading to some "federation" of relatively autonomous departments.

These transformations, putting the emphasis on networking and partnership / cooperation have raised a large interest for new disciplines such as the coordination theory, organizational theory, and sociology of the industrial organizations.

The idea of virtual enterprise (VE) / virtual organization (VO) was not "invented" by a single researcher, rather it is a concept that has matured through a long evolution process. Some of the early references first introducing the terms like virtual company, virtual enterprise, or virtual corporation go back to the early 1990s, including the work of Jan Hopland, Nagel and Dove, and Davidow and Malone [3,4]. Since then a large but disjoint body of literature has been produced mainly in two communities, the Information and Communications Technology community and the Management community.

However, concepts and definitions related to the VE/VO paradigm are still evolving, and the terminology is not yet fixed. There is still not even a common definition for the VE/VO that is agreed by the community of researchers in this area. Nevertheless, many real examples of VE/VO are already available and functional in different regions of the world, which indicates the importance of this area and the need for stabilizing the terminology and definitions for this paradigm, as well as research in developing a model of their life cycle, behavior, and evolution.

The area of VE/VO is particularly active in Europe, not only in terms of research and development, but also in terms of the emergence of various forms of enterprise networking at regional level. This "movement" is consistent with the process of European integration, which represents a push towards a "culture of cooperation", but also with the very nature of the European business landscape that is mostly based on small and medium size enterprises (SME) that need to join efforts in order to be competitive in open and turbulent market scenarios.

## 2. VIRTUAL ORGANIZATIONS AND SYSTEMS INTEGRATION

The emergence of virtual enterprise / virtual organization paradigm can also be seen as another step in the systems integration process. As an example, let us consider the context of industrial companies. Systems integration can be addressed and instantiated at different levels of complexity and abstraction (Fig. 1), as follows:

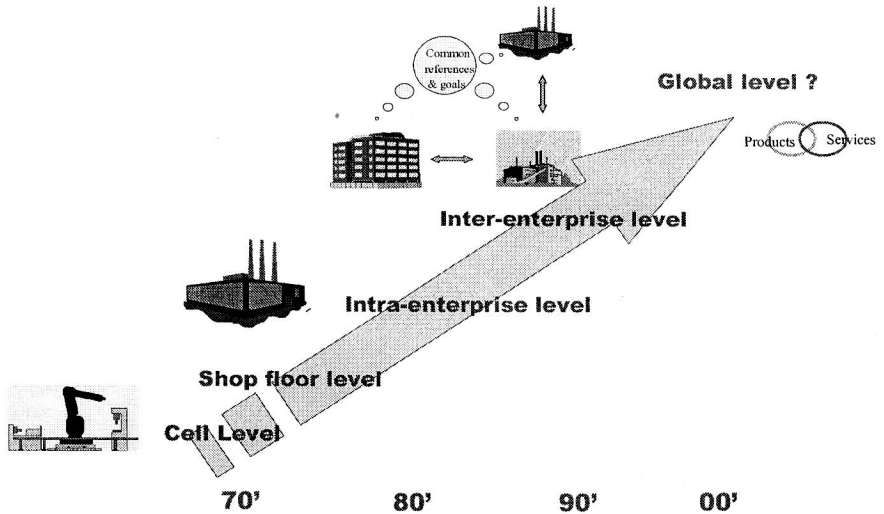


Figure 1 - Levels of integration in manufacturing enterprises

- Cell level – when basic resources (robots, NC machines, conveyors, etc.) and their local controllers need to be integrated in order to build a cell dedicated to a specific function or a set of functions (assembly, painting, inspection, etc.).
- Shop-floor level – when various cells, transportation subsystems and warehouses are integrated within one manufacturing system.
- Intra-enterprise level – when the objective is to integrate all areas of the enterprise, including not only the shop-floor but also other departments e.g. marketing, planning, engineering, etc. and their interactions.
- Inter-enterprise level – when cooperation among various enterprises is envisaged. The manufacturing processes or complex services are not performed by isolated companies. On the contrary, in a network of collaborating enterprises (virtual enterprise) each node contributes with some value to the value chain. The materialization of this paradigm requires the definition of a reference architecture for the cooperation process and the development of a support infrastructure, including the protocols and services for information exchange, communication and cooperation.

Furthermore, the need for a new level of integration (integration at global level) is emerging, emphasizing the role and opportunities for collaborative networked environments. The inclusion of processing capabilities (local intelligence) is many components is spreading all over the living environments, both in the professional environment and at home (Fig. 2), leading to the idea of pervasive or ubiquitous computing. The working methods change, making it possible to perform professional activities from different locations (tele-work).

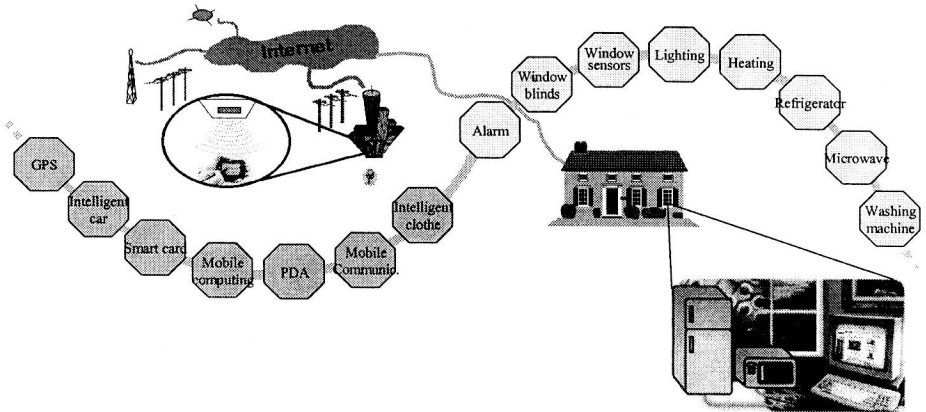


Figure 2 – Ubiquitous computing and global integration

This tendency is reflected by the proliferation of intelligent devices such as: PDAs, mobile phones, smart cards, embedded networks in the car, processors embedded in clothes of athletes or patients to monitor their status, elevators, safety and surveillance systems, traffic control systems, intelligent and Internet-enabled home appliances, among many others, which open new opportunities for collaborative networks. An important challenge is the interoperability among all these components and the development of appropriate integration approaches among their processing capabilities.

Systems integration, even if under different names, has been a major topic of research and development during the last three decades.

A simplified vision of the “history” of industrial enterprise integration can be the one shown in Fig. 3, where in fact the integration work at the various levels of abstraction continues through the three decades. This picture is not intended to be complete showing all the paradigms and development areas in systems integration. Neither it is strictly accurate in terms of the exact time span for each paradigm. Rather, the purpose is instead to provide a general and simplified overview of relative relationships among different integration developments. For instance, the ellipsis representing CIM does not mean that this topic “finished” in the early 1990’s, rather representing the fact that it has received less attention since then and the developments slowed down or was replaced by more appropriate concepts. Similarly, the idea is to show that the second half of the 1980’s were the most active years for this paradigm.

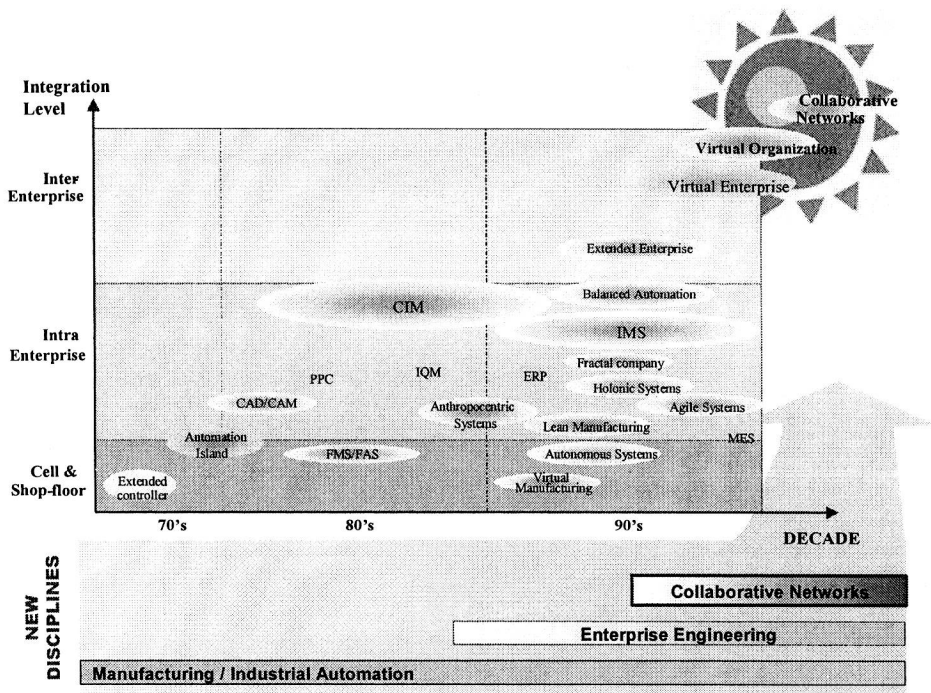


Figure 3 – Main phases in manufacturing systems integration

Also, as can be seen in the same figure, in recent years increasing attention is being devoted to the integration of more complex systems towards the creation of a global system. However, meanwhile the integration issues at the cell or shop-floor levels still remain in the agenda and not resolved.

A similar picture could be drawn for other areas such as the service industry or governmental organizations.

The paradigm of virtual enterprise / virtual organization, and more generically collaborative networks, appear naturally in this sequence of “systems integration”, addressing the most comprehensive scope of integration of autonomous, heterogeneous, and distributed entities.

As illustrated in Fig. 3, the emergence and evolution of paradigms and concepts is also leading to the foundation of new scientific disciplines that try to capture the essence of this domain of study and build the foundations for further progress.

The actual implementation tools used for systems integration depend on the technologies available during each historic phase both for components development and for integration support. A very simplified overview of the main paradigms and technologies used in industrial systems integration during the last three decades is shown in Fig. 4.