VIRTUAL ORGANIZATIONS SYSTEMS AND PRACTICES

VIRTUAL ORGANIZATIONS

Systems and Practices

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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.

The editors

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CONCEPTS AND MODELS



1.

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

- <u>Cell level</u> 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.).
- <u>Shop-floor level</u> when various cells, transportation subsystems and warehouses are integrated within one manufacturing system.
- <u>Intra-enterprise level</u> 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.



Figure 4 – Some integration technologies and support paradigms

It should be noted that the increase in systems' complexity and the foreseen integration scope results an increase and diversity of the potential available paradigms and technologies. Today, we are in fact facing a scenario of too many technologies suggested and produced by different developers, which also corresponds to too many promises! In fact, each new paradigm and technology tends to promise most capabilities of other similar products as well as solving all problems of their previous generations, that in reality hardly materializes! On the contrary, the multiplication of all tools by the fast introduction of new versions and generations of those tools greatly increases the incompatibility ratio among components, which in turn justifies the question "To what extent are these technologies and tools enablers, or are they in fact disablers of systems integration and cooperation among distinct entities?"

In addition to the diversity of paradigms and technologies available at a given historic phase, in each enterprise or network of enterprises there is also always a coexistence of diverse technology generations and components with different life cycles and in different phases of their life cycles. Therefore, systems integrator must not only master the tools and technologies of the current time frame, but also take into account the legacy systems and how to promote their technologic migration.

3. VIRTUAL ORGANIZATIONS IN THE e-MOVEMENT

Generalized access to Internet that is available through multiple channels and the fast developments around the world-wide-web has led to the proliferation of many terms such as the e-commerce, e-business, e-work, e-government, etc. To put it in a more emphatic way it seems that in the first years of this decade everything became *e-something*. Similarly, Business-to-customer (B2C) and Business-to-Business (B2B) are other examples of popularized terms.



Figure 5 – Virtual Organization vs. e-Commerce

So the question remains: since virtual organizations are also supported by the Internet and the web, where do they fit in this "e-movement"?

Fig. 5 shows an attempt to put things into perspective, showing that e-Commerce is mostly about B2C relationships and mainly concerned with buy-sell **transactions** among the involved entities. Virtual organizations on the other hand, go far beyond simple transactions, and are focused on **collaboration** *among a number of enterprises* and *doing things together*.

4. VIRTUAL ORGANIZATION AND RESEARCH PROJECTS

During the last 10~15 years a large number of R&D projects tried to establish some technological foundations as well as operating practices for the support of Virtual Enterprises /Virtual Organizations. This effort is particularly visible in Europe through the European Commission funded programs (e.g. ESPRIT, IST, INCO), but also in the USA and other geographical regions (Australia, Brazil, Mexico, Japan, to name a few). Programs such as IMS (Intelligent Manufacturing Systems) also supported various projects in this area involving organizations from various continents. Fig. 6 gives some examples of this R&D effort.

All these initiatives, together with practical realizations of many variations of virtual organizations, have generated a large amount of empiric knowledge that is however still disperse and fragmented. The IST VOSTER project, whose main results are synthesized in this book, represented an attempt to consolidate some of this existing knowledge.

ESPRIT IST INCO ALFA IMS NIIIP National programs	FP4 VE & SCM CE-NET CHAMAN COBIP COVE COVE COWORK DELPHI ELSEwise EVENT FREE GLOBEMAN 21 ICAS LogSME MARVEL OUS MASSYVE PLENT PRODNET II SCM+ SPARS VEGA VENTO VIRTEC V CIETUC	FP5 Virtual Organizations BIDSAVER Business Architect ECAMP JASMINE STARFISH eLEGAL VIVA SOSS E-ARBITRATION-T ENTER AESOP B-MAN MARKET MAKER OBELIX PLEXUS GLOBEMEN	Accompanying Measures THINKcreative VOSTER CE-NET II ALIVE VOSTER UEML VOmap Collaboration EXTERNAL ECOLNET E-COLLEG DYCONET WHALES SCOOP LENSIS	Supply Chain Management ADRENALIN APM CHAINFEED DAMASCOS CO-OPERATE SMARTISAN Others SMART SMARTCAST PATTERNS SOL-EU-NET DISRUPT IT TeleCARE FETISH-ETF	
Some	examples		LINK3D	FP6 ATHENA ECOLEAD INTEROP TrustCOM VE Forum	

Figure 6 - Examples of VO-related projects

More recently, in part as a result of initiatives such as the THINK creative and VOmap projects among others, the need for investing on more fundamental research towards the creation of a sound theoretical foundation for virtual organizations became more evident. The 6^{th} Framework research program of the European Commission also includes in its objectives to pursuing more integrated and fundamental research in the area. The ECOLEAD project is an example in this direction.

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In literature numerous definitions and characteristics of virtual organizations are available. A large number of research initiatives and industry cases have been developing concepts, methods and enabling IT for virtual organizations. This chapter presents a synopsis of results from more than 60 national, European, and global research projects (including IMS), as well as US research and road-mapping activities (IMTI and FIATECH). The first part describes common definitions, characteristics and core concepts for networks and virtual organisations. In the second part expectations, potentials and management issues in virtual organizations are discussed.

1. INTRODUCTION

In the past years a large amount of new virtual organization (VO) concepts and approaches have been developed. The motive is based on the changing business situation of companies and customer needs. Main drivers for the rise of organization networks are mass-customization, extension of products, globalization, and agility (cf. Saabeel et al, 2002).

There are basically two different types of concepts for the inter-enterprise organization. Different terms have been used for both of them:

- Network / source network / support network / breeding environment is a more stable, though not static, group of organizational entities which have developed a *preparedness* to co-operate in case of a specific task / customer demand.
- Virtual organization / virtual enterprise is a temporary consortium of partners from different organizations established to fulfill *a value adding task,* for example a product or service to a customer. The lifetime of a VO is typically restricted: it is created from the network for a definite task and dissolved after the task has been completed.

Both of these concepts thus presume the participation of different organizations, for example different enterprises. The main features distinguishing them are the temporal nature and the operational mode of the organization. A network operates developing, maintaining and managing the preparedness for value creation and setting up a VO/VE for a customer delivery. The timeframe of the VO/VE is restricted by its task it has been set up for, but may extend from a few hours to some years. As the base concepts have been developed simultaneously with the development of information technology, the utilization of modern ICT is often seen as an enabler for the VOs. Figure 1 presents a description of the core concepts and their relations.



Figure 1: Core concepts of VOs

2. VIRTUAL ORGANIZATION -DEFINITIONS AND CHARACTERISTICS

In literature numerous definitions and characteristics of virtual organizations are available. Important definitions and characteristics are manifested in the following sections.

2.1 Definitions of virtual organizations

2.1.1 Virtual organization and virtual enterprise

A virtual organization is a set of co-operating (legally) independent organizations, which to the outside world provide a set of services and act as if they were one organization¹. The set of co-operating organizations can change with time; it can be

1

Supported by a computer network.

a dynamic configuration depending on the function / service to be provided at that point in time. It can also be a more stable configuration with a sizeable time span and a stable set of services and functions.

A virtual organization consists of semi-independent entities with separate core competencies, who band together to achieve a prescribed or subscribed business objective supported by information and communication technologies. The most common industries for virtual organizations are information technology, manufacturing and consulting, but VOs can exist in any industry where the marketplace desires multi-faceted services or products that require very costly logistic or infrastructure investments (cf. MBDA, 2001).

A virtual enterprise is a "customer solutions delivery system created by a temporary and reconfigurable ICT enabled aggregation of core competencies" (Globmen-Project, 2000). Camarinha-Matos, Afsarmanesh (1999) defines a virtual enterprise as "a temporary alliance of enterprises that come together to share skills or core competencies and resources in order to better respond to business opportunism, and whose co-operation is supported by computer networks".

Filos, Ozounis (2004) define a virtual enterprise as a "particular case of virtual organization. An example of a virtual organization could be a "virtual municipality", associating via a computer network, all the organizations of a municipality, e.g. city hall, municipal water distribution services, internal revenue services, public leisure facilities, cadastre services, etc.".

A virtual enterprise may hence be seen as a subset of virtual organizations. In the following the two terms are not distinguished.

2.1.2 Extended enterprise, virtual teams and workspaces

The concept of extended enterprise (EE), the closest rival term to virtual enterprise, is usually applied to an organization in which a dominant enterprise extends its boundaries to all or some of its suppliers and / or customers² [Camarinha-Matos, Afsarmanesh (1999)]. In some cases, it is used for continuous manufacturing collaborations (mass production). Sometimes, extensions cover geographical constraints and creation of distributed, virtual teams is associated with extended enterprises.

The extended enterprise collaborates with suppliers, partners and customers to streamline business processes - going beyond traditional boundaries and enhancing benefits for all. The traditional workplace is no longer bound to a physical location. Offices give way to cubes, cubes become open spaces, and open spaces are turning into a network of distance workers. A workspace is the virtual version of a workplace. And a natural consequence of working anywhere and anytime is working for anyone, hence, the virtual organization, virtual teams and virtual workers. Vitality is associated with activities that can take place anytime, anywhere and anyway one desires, without physical, geographical or structural constraints. In short, the virtual organization is becoming a strategic characteristic applicable to any organization. The new possibilities provided by virtual workspaces in the communication web are realized through use of communication and IT. In an electronic environment, new social structures can appear, be modified and

² A typical situation in the automotive industry.

experimented on with a speed and to an extent that was not possible in the traditional organization (Karlsson, Eklund; 2002).

2.1.3 Smart organization

The concept of smart organization brings new perspectives to management decision making through an organization. It identifies the key practices that enable successful organizations to deliver a stream of winning products and services. Matheson (1998) describes in his book "The smart organization" that smart organizations have internalized nine interlocking principles essential for creating corporate cultures emphasizing on making the right strategic decisions at the right time. These principles - among them, embracing uncertainty, disciplined decision making and value creation culture - enable companies to make appropriate choices about their R&D planning, portfolio management and product strategies. As far as we know, the leading companies in any industry today are the "smartest" organizations. They absorb knowledge like a sponge from the work they do, the customers they see and the suppliers and partners they deal with. Smart organizations collect and use information. An organization can concentrate on mass production but it cannot stand still as an organization. If a company figure out how to do things better, and those ideas can be shared throughout the company, this company will become smarter and smarter. Matheson also writes that the most effective way to get the return on investments is to present real life conditions and generate conversations where managers can see for themselves what it is they need to do.

Comparing these descriptions of smart organizations with VOs, it may be concluded that VOs supported by networks (see next chapter) enable the realization of the smart organization concept, but do not guarantee it.

2.1.4 The Source of VOs - Networks / Breeding environment

The long-term supporting network forms the underlying environment enabling efficient collaboration in virtual organizations. The term "breeding environment", introduced by Camarinha-Matos, Afsarmanesh (2003), is used for a long term network to emphasize its importance as a basis for VO activities. Typical preparation actions for a network are the development of procedures, standards, common processes and ICT to support the customer deliveries. This preparation is necessary to be able to react quickly to potential business opportunities; that is, to set up a virtual organization to fulfill a customer task.

In addition of configuring and creating virtual organizations, the preparation is needed for the smooth operation and lean management of the VO. Preparation and previous experience contribute to the building of trust between the VO partners. Trust - again - enables faster operation in the inter-enterprise relationships.

Networks or breeding environments are partly created around a specific product / product family / brand and a leading enterprise. Another type of networks, is the case in which the network is formed by organizations located in a common region, although geography is not a major facet when co-operation is supported by computer networks. Nevertheless, the geographical closeness has some advantages for co-operation, as it may facilitate better adaptation to local (culture) needs and an easier creation of a "sense of community". Cultural ties, even particular human

Base concepts

relationships, are motivating factors to form such networks which represent in fact the VO breeding environments (VBE) for the dynamic formation of VOs. For each business opportunity found by one of the VBE members, acting as a broker, a subset of the VBE enterprises may be chosen to form a VO for that specific business opportunity.

2.2 Characteristics of virtual organizations

Even though the definitions for virtual organizations and virtual enterprises vary in several senses, some basic characteristics of the virtual organization are often referred to (cf. Eckstein, Albiez, 2002):

- Dematerialization
- Delocalization
- Asynchronization
- Integrative Atomization
- Temporalization
- Non-Institutionalization
- Individualization.

2.2.1 Dematerialization

The term "virtualization" relates to the dematerialization process. With increasing virtualization products become *potential immaterial*. Dematerialization has the following virtual manifestations along the development of the virtualization. A virtual organization has forms such as virtual products and services, telework, virtual teams, virtual workspaces and virtual communities.

Potentially immaterial

Potentially immaterial in this context means, that all object areas are immaterial. An ideal VO defines itself by,

- Common Characteristics
 - uniform manner towards the customer
 - total optimization of the whole value chain
- Absence of physical attributes
 - no common legal roof
 - no common administration/head office
- Special auxiliary specifications
 - matured information technology
 - absolute mutual confidence
 - presence of individual core authority
 - no internal competition
- Utilization effects
 - flexibility and adaptability
 - use of a common synergy potential

2.2.2 Delocalization

Delocalization is one of the most important developments in the globalization process and relates to the dimensions of virtuality. The delocalization is potentially space independent - beyond the decentralization efforts - as virtual areas (the cyberspace) replaces physical locations. Enterprises become independent off space / capacity. It eliminates the need for a particular location.

2.2.3 Asynchronization

The release of time, which takes place in the context of innovations in an organization and is used innovatively for more communication and interactions, is called asynchronization. Asynchronization makes a contribution to the uncoupling of temporal and spatial conditions (virtualization). Traditional enterprises use asynchronization, in order to increase flexibility and stability in their organization.

Potentially time-independent (24-hours organization):

The information technology has paved the way to form an organization for the production of "economy of speed" under the criterion of competitive advantage in the global market. Time has become an important accelerating factor in the context of product innovation, production times, logistics processes etc. These times, which are set free here, can be used for the interaction with the customers (temporal asynchronization). For example, development times of vehicles and software can be reduced substantially by utilizing different time zones. Leading companies like DaimlerChrysler and Hewlett-Packard are thriving on globalization through working "in three shifts" between Europe, America, and Asia. This asynchronous division of labor enables the necessary flexibility. For common communication and coordination information and communication technologies (such as email, voice mail, conferencing systems, etc) are deployed.

2.2.4 Integrative Atomization

The consequent focus on core competences entails the atomization of the value chain. For each individual task in the enterprise a specialized bidder can be found, who often offers a world market standard. The difference to the classical outsourcing is, that here, the integration of all atomized and out-differentiated value-added activities is considered to create processes achieving customer satisfaction - and this not only up to the next customer within the value chain, but up to the last customer, the final consumer. Such initiatives are often made by the enterprises, whose core interest consists of central coordinating of the external value chain.

Physical and virtual creation of value added networks

The virtualization dimensions regarding the optimization of the value-added network have three important consequences in relation to the outsourcing:

- 1. Focus on core competences
- 2. Threatening risks and avoiding the fast, unproductive end of the enterprise
- 3. Integration of the value chain of the customer.

Vertical disintegration and virtual reintegration

Vertical disintegration and virtual reintegration refers to the relationship of supplier and manufacturer. The suppliers were traditionally regarded as "supporters" or as "extended work benches". The virtual revolution now makes them to value chain partners. Manufacturers are forced to assign exclusive manufacturing rights to supplier. But suppliers again are also increasingly dependent on their customer, the manufacturers. This bond of trust is expressed world-wide, in the increase of virtual cross-linking. The information technology compatibility, in particular via Internet, creates more confidence, because of the increase of communication and limited restrictions.

2.2.5 Temporalization

The term temporalization is named with the aspect of time and the temporal limitation of intra- and inter-organizational virtual organizations. The interdependence is described in the life cycle stages of virtual organizations as a circular process of creation, operation, evaluation and dissolution.

The temporalization refers thereby to the inter-organizational relations and to the internal process organization, in the sense of the modular and fractal organization.



Figure 2: Life cycle stages of a virtual enterprise (Camarinha-Matos, Afsarmanesh, 1999)

2.2.6 Non-Institutionalization

By the renouncement of headquarters and by increasing relocation of the work from office work to telework, the typical physical attributes of an enterprise is becoming virtual. Virtual enterprises, to a large extent, waive the costly and time-intensive institutionalization of their inter-organizational relationships.

2.2.7 Individualization

Individualization is the idea of combining low cost mass production with personalization of products and services. The main reason for this is increasing consumer demands: the consumer requires more and more individualized products, satisfying their personal needs and desires. Mass Customization is one approach for manufacturers to fulfill customer demands, improve competitiveness and capture

new markets or market sectors by introducing new products. But, this re-orientation from mass produced to mass customized (individualized) products are challenging. Such a radical change in the product nature forces a revision of the product itself, the processes/organization and the supporting ICT systems within an 'Extended Mass Customizing Enterprise'.

3. VO CORE CONCEPTS – STATE-OF-THE-ART

Within the VOSTER project more than 60 national, European, and global research projects (including IMS), as well as US research and road-mapping activities (IMTI and FIATECH) with focus on state of the art approaches and concepts of virtual organizations/virtual enterprises have been analyzed and consolidated. The main purpose of surveyed VO concepts is to understand the basic elements in the co-operation between enterprises.

The level of preparedness of a network and the tightness of the linkages between the organizations may vary, ranging from an almost open market setting with just some knowledge about the entities between them to entities within a large company or other organization. The preparedness includes defining core competences, harmonizing procedures and interfaces, creating and sharing common knowledge etc. The preparedness makes it possible to set up a VO/VE quickly and operate efficiently over organizational borders. To achieve the preparedness an investment to the network development is needed. In case of different companies the co-operating network can be called an "enterprise network". Other terms sometimes used are enterprise constellations and enterprise associations.

The practical purpose of concepts has in many projects been the business process redesign in the inter-organizational environment. Different projects have addressed different product life cycle phases, different environments and different issues (organizational, human, business, legal, ICT).

Many surveyed research projects present the expected benefits of operating in VOs compared to more traditional forms. It is not analyzed if there are differences between the divergent (outsourcing) and convergent (coming closer) creation of VOs. The implementations do not go far enough to get empirical data of the benefits. As the objectives of the projects have mainly been in developing the tools, processes and methods, there is no sufficient analysis of the prerequisites, realization or dependencies of the success factors in the projects. Thus it is not possible to make a synthesis of them based on the cluster projects. A critical study of the success factors and business drivers of VOs can be seen as a requirement for further VO research.

In the surveyed VO concepts and approaches, the characteristics of virtual organizations (section 2.2) are identifiable. But, the listed characteristics are not alike. Part of them link to the product/ service characteristics (dematerialization, individualization), part of them are linked to the environment or conditions of the VO (delocalization, asynchronization). Atomization and participation are linked to how the VOs operate. It seems that all these characteristics are important in the VO environment, as they have quite commonly been considered. It is easily understood that the requirements of regional distribution and customized products may be better solved by VOs. However, it is not to be interpreted, that these characteristics and

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VOs exclusively belong together. That is, the characteristics may appear also in case of non-VO forms and VO-forms may appear without all of these characteristics.

3.1 Management concepts for source network

The main process considered at the source network level is the inclusion of a new partner to the network (rules, policies, tools). Typically in the industrial cases (chapter 4.1) the source network has already existed at some level of co-operation and thus there has not been a need to create the network from the beginning. Another process is the development of the network preparation: procedures, tools and services for the existing network. Product development within the source network is also mentioned.

Nearly all the surveyed projects address the development of information sharing and ICT infrastructures at the source network level. Typically web-based tools and services like organizational models, cost and performance monitoring, have been created for sharing different kinds of information: documentation, product information within the total life cycle. In addition the support for teamwork, design, partner management and tools have been developed.

The main modifications for the implementation of VO management concepts for source network of the VO enterprises were the redesign of business processes, organizations and roles, human resource development and dissemination of quality standards. It has been clearly understood, that it is not enough to develop the IT tools, to make them beneficial also process improvements and redesign are needed.

3.2 VO management concepts

At the VO level the processes considered are set up and configuration of a specific VO and operation and management of VOs (including project management). At this level information sharing is developed for a specific task and VO; supporting also the coordination, people and relationship management. The modifications needed are similar to the source network level: socio-organizational, process and technological redesign. Evaluation and dissolution of VOs were only minor issues.

3.3 VO operational Concept

Concerning the VO operation there is an overlapping with the VO management. This relates to VO phases, the modifications required and ICT infrastructures. The operational processes considered cover the total product life cycle from sales and marketing, product development, engineering, manufacturing (including scheduling and order management) to product operation, service and renewal.

A special question analyzed within VO operation was how individualization correlates with VO operational processes. The main forms of individualization are the mass customization and one-of-kind products, in which not the same resources and capabilities are needed in each project. Thus the VO must be configured separately for each case. In addition individual considerations are needed in different market areas and regionally and culturally distributed environments. The analysis does not clearly explain how these one-to-one features are handled in the surveyed concepts, but probably they must be taken into account in the configuration phase of the VO.

3.4 Structures of virtual organizations

The structures of the source network and VO have been viewed using three different types of topologies: "supply-chain topology", "star/consortia topology" and "peer-to-peer topology". For VOs the structure is viewed separately for operation and governance.

Part of them addressed only the structures of source network or VO, which is depending on the scope of the surveyed projects. The projects, which address all the three types, mainly have the same topology for all of them. In some of the projects more than one topology is possible and even configurable.

The "peer-to-peer" topology appears most often in the projects closely followed by the "Star/consortia" topology while the "supply-chain topology" seems to be less used. At the source network level the "star"-topology refers to networks, which are lead by a strong enterprise. This is often the case in product-centric networks, which are built around a specific product or product family. In "peer-to-peer" networks the enterprises are typically more equal. However, the management structure of a VO created from a "peer-to-peer" network may be "star-like". The equality of the partners means that not always the same company is the leader of the VO.

It looks natural that distributed operations, which aim to a common objective (for example a product), cannot achieve the goal without centralized management. Most used is a hierarchic structure, in which at each level, the level below is managed in the "star"-topology.

3.5 Management roles of source networks and virtual organizations

Management roles are addressed for different product life cycle phases as well as for different network and VO lifecycle phases. Most of the surveyed projects have not considered the management roles at the source network level. This may be the result, because the networks operating in the "peer-to-peer" topology do not have so clear management roles. In the network of "star-like" topology a management role is more stable. Some of the projects mention brokers and broker services supporting the management of the VO.

In the management of source networks and operational VOs the organization or department has a management role. In addition a single person is mentioned in most cases. In some cases an individual is in the background of an organization and in some cases the organization is in the background of a single person. Though a single person seems to be important in the VO management, it cannot live alone without the background support of an organization especially in cases, where high responsibilities and risks exist.

4. VIRTUAL ORGANIZATION CONCEPTS VERSUS TRADITIONAL ORGANIZATIONAL CONCEPTS

4.1 Reasons for and potentials of virtual organizations

Co-operation between enterprises or organizations is not a new phenomenon. For example manufacturing companies have been purchasing raw material, equipment

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and components from other companies. In some industrial fields, like construction, it has been typical to subcontract also part of the work / tasks to external companies, even within the same job site. This has happened far before the terms network and VO were launched.

Networking can be seen as a more systematic way to build up co-operation with other organizations. In companies it has been seen as an answer to tightening requirements of competitiveness relative to cost-effectiveness, time and quality. In addition it is expected that networking contributes to flexibility, agility, customer orientation and management of risks.

For complete comprehension of collaboration in the virtual organization, it is essential to understand the reasons and motives for the decisions to form cooperation or the building of a VO. Approaching business problems or seeing business opportunities – both can lead the way to the establishment of networks. The motives can come from within the company or from outside, for example internal cost problems versus new market developments. Reasons for collaborating in a VO may include (Büchel a.o., 1998), (Bullinger, 2002), (Balling, 1997), (Harrigan, 1985), (Sell, 2002):

- 1. Tie down resources which are hard to get on the market
- 2. Save time, for example reducing development process, time to market
- 3. Spreading costs and risks with partners
- 4. Improving access to financial resources
- 5. Benefits of economies of scale and advantage of size
- 6. Access to new technology and new customers
- 7. Access to new markets through partnership
- 8. Access to innovative managerial practices
- 9. Diversification, approaching new product or market segments with the help of partners
- 10. Improve capacity utilization
- 11. Know-how exchange and sharing of information
- 12. Creation and exploitation of synergies
- 13. Ease political tension (overcome trade barriers)
- 14. Gain access to global networks

In most cases a mixture of these will be the driver for operating and doing business in networks. But the partners' reasons do not need to be the same. This leads to different expectations on all sides of the partnerships. Therefore the definition of the goal of the alliances is essential to the success and the satisfaction of the enterprises involved. There are competitive goals like cost saving, outrival competitors, influencing structural evolution of the industry or the creation of stronger competitive units. Strategic goals can be the creation of synergies, the transfer of technology or diversification.

Potentials of networks are not self-fulfilling; they must be developed and fostered. Thriving on the virtual organization necessitates an efficient management of collaborative tasks and business and a basic, common foundation of the virtual organization.

A virtual organization is always a form of a partnership. Managing partners and the handling of partnerships is crucial, not trivial. There are certain attributes which are very basic for working together with other people and those have to be considered. The first two of them are derived from a business perspective and the following six are basic principles of human interaction. Business partnerships are partnerships – interacting individuals – and therefore the same patterns apply. The important attributes for good partnerships are (Mariotti, 1996):

Business perspectives:

- 1. Self-interest of both partners there must be "something in it" of an economic or otherwise beneficial nature for both partners
- 2. Balance of rewards vs. risks and/ or resources required the partnership cannot be too lopsided

Basic principles of human interaction:

- 3. Character the combination of qualities of features that distinguishes one person, group, or thing from another
- 4. Integrity steadfast adherence to a strict moral or ethical code
- 5. Honesty marked by or displaying integrity, upright; not deceptive or fraudulent, genuine; characterized by truth, not false, sincere, and frank
- 6. Trust firm reliance on the integrity, ability, or character of a person or thing
- 7. Open communication a process by which information and ideas are exchanged freely between two parties
- 8. Fairness having or exhibiting a disposition that is free of favoritism or bias, impartial; just to all parties, equitable

These are essentials of networking and the foundation for a collaborative edge. We may say, these are the ethics and policy layer of virtual organizations. The following chapter discusses strategy, organization and management of virtual organizations.

4.2 What is new? – Issues in managing virtual organizations

One of the most debated questions about virtual organizations is "What replaces hierarchy". As far as the analyzed partnership is a co-operative organization of parity, the linking type is contractual and every hierarchy is banned. The agreeing on the same policy mostly consists of mutual support and advantage, therefore the alignment of actions and stated values requires a common agreement, even if not always completely explicit.

Hierarchies should not exist among the collaborating partners because (Martin, 1995):

- Hierarchies *tend to build barriers* between functional areas, so that a cross functional communication raised in one branch, is channeled into the bottleneck of the high level hierarchical branch and only then can flow down the other branch.
- Hierarchies tend to filter and *distort information* as it is passed upward
- Hierarchies tend to create rules and controls that *increase complexity*. Often the hierarchies multiply themselves creating obsolete heavy mechanisms that are against the peculiar agility of the VO