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The virtual organizing process--A critical tool for enterprise competitiveness in the information era

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ABSTRACT

The term virtual enterprise has generated considerable confusion because of its rather liberal interpretation. This paper argues that the successful establishment of a virtual enterprise is mainly dependent on the virtual organizing processes of an enterprise's strategies (VOPES), rather than on the actual manifested transformation of the whole into a single virtual organization. A three-dimensional dynamic framework for VOPES is presented, with the aim of providing a coherent model for positioning the various virtual organizing strategies, and at the same time giving VOPES dynamic tendencies towards market negotiation, co-operation, co-ordination and collaboration. To achieve a competitive advantage, the top management of an enterprise operating in an intense information environment can organize their enterprise virtually by using the three-dimensional framework of: virtual customer relationship, virtual out-sourcing, and virtual knowledge and expertise. The generic IT architecture of VOPES is also described and discussed.
INTRODUCTION

The process of establishing and managing a virtual enterprise (VE), or the transformation of an existing enterprise into a VE can present considerable difficulties to both researchers and practitioners. Even though the notion of VE was put forwards some ten years ago (Davidow & Malone 1992), successful examples of VE in the industrial field are rather difficult to find. While the features of VE have been well described from different points of view by many researchers and strategic experts, in many industrial situations there is no fundamental difference between a VE and a typical traditional enterprise. This is because concepts such as decentralized network manufacturing, out-sourcing, and task orientation are employed in VE and are a direct translation of their equivalents in traditional enterprises, i.e. the VE in these situations is just a simple abstraction from the traditional model. It seems that traditional enterprises cannot normally be considered to be bona fide VE's. Despite the fact that it is hard to conclude firmly that VE is practically viable in practice in certain traditional industries, many successful enterprises have, rightly or wrongly, been assumed to be VE's. Such enterprises can include well-known names such as Dell Computers, Amazon, and Cisco, and from an earlier era, IBM, Nike and Motorola. In recent years, Dell seems to have occupied the number one position in sales of personal computers, achieved, perhaps, by a virtual integrated strategy. Amazon, another good example, is the most successful Internet-based bookstore. The company has successfully generated a worldwide virtual market. Cisco, on the other hand, is a provider of networking solutions, and its Internet sales have reached some US$1.8 billion, again attributed to its virtual organization. These companies share common features because they all use virtual strategies to varying degrees.

As Dell's chief executive officer (CEO) pointed out: had the company not made use of the virtual integrated strategy, it could not have become a company whose assets had reached US$12 billion in 13 years, see Magretta (1998). So, it appears that VE must have its worth, and outright rejection is obviously not appropriate. On the other hand, it is also obvious that more research effort is required to find better explanations, and so place VE on a firmer theoretical footing.

When faced with changing market demand and intense competition, the fundamental questions that all CEO's must address is how to implement VE and how to manage it effectively. A solution will require the establishment of an ideal VE that incorporates features proposed in the literature. This will in turn require the study and then the abstraction of these features from the management point of view, and then the formulation of the major principles and policies required for the management of VE. However, as mentioned above, no VE has been identified that completely qualifies for such a general study. To identify the existence of a practical VE, one must first return to the fundamental questions of how a VE is defined, and then reassess and thoroughly re-evaluate the concepts involved. This will present a paradox because the objects to be studied are in fact the traditional enterprises, which have different organizational structures from a genuine VE. So, the features abstracted from these traditional companies cannot be considered as the features of an ideal VE per se. However, if the ideal VE does not exist, then
we must ask what is it that makes the companies such as Dell and Cisco successful? Answers to this paradoxical phenomenon will point to a path that will help us traverse the mire.

MEANING OF VIRTUAL ENTERPRISE

Since Davidow and Malone (1992) published the first book on the virtual corporation, many different concepts of VE have been proposed. Byrne (1993) considered a VE as a temporary network of independent companies – suppliers, customers, even rivals - linked by information technology (IT) to share skills, costs, and access each other’s market. It is also accepted that this new, evolving corporate model should be fluid and flexible – a group of collaborators that are quickly united to exploit a special opportunity, and once the opportunity has been explored, the venture disbanded. Malone and Davidow (1994) considered a VE: “as corporations temporarily joining together into a meta-enterprise, with manufacturers, suppliers, distributors and even customers linking together in an enduring relationship built on mutual trust.” Jin (1998) sees a VE as a temporary and dynamic enterprise that is made up of many independent firms. However, this enterprise must still remain a real entity from the end user point of view. He also advocates that managers of the VE’s should try their utmost to sub-contract operations to other collaborative members. The enterprise will then become smaller and more decentralized, and better placed to achieve a global competitive advantage.

Mowshowitz (1994) stated that: “The essence of virtual organization is management of a goal-orientated activity in a way that is independent of the means for its realization.” This implies a logical separation between the conception and planning of an activity on the one hand, and its implementation on the other. VE realizes its tasks through the optimal combination of input resources, although the processes of combination are separated in space and time. In fact, when one looks at VE from the analytical perspective, the phenomenon described in the introduction will help to put the related concepts in perspective. The following attributes are often associated with VE.

* Project orientation.
* Partners from different firms or organizations.
* Temporary organization.
* Interaction of companies with each other forming a loose or unformed enterprise.
* Collaboration to overcome the barriers of space and time.

However, these characteristics are not entirely the monopoly of VE. First, we note that none of the successful enterprises mentioned above are not project oriented. Second, none of these enterprises is entirely independent and that some co-operation with external enterprises is always involved. Third, there is no radical distinction between the supply chain and co-operation relationship described above. Child and Faulkner (1998) conclude that the major distinction between VE, strategic alliance, and JIT supply-chain lies in whether or not the enterprise uses
electronic networking. An analysis based on this premise can be very difficult, if not impossible, to undertake, since practically all modern enterprises rely on computer networks to control operations. It is, therefore, inappropriate to conclude that these are or are not VE's simply by their use of electronic networking. Fourth, the temporal definition seems to be rather arbitrary and imprecise to be of any value in defining a VE.

From the point of view of the need to identify successful VE's, companies like Dell, Amazon and Cisco can be considered as VE's. Dell's feat in overtaking IBM and Compaq in the sale of PCs in the past few years is attributed by many observers to the adoption of virtual integration. Amazon, the biggest Internet-based bookstore, is also considered as the most successful VE without a physical address - an address that can be identified by its customers, but none can dismiss Amazon because of its relative invisibility. Cisco is also considered to be a successful networking solutions provider. Compared to its huge business, its staff number and its physical size are disproportionately small because of its out-sourcing.

In addition to these companies that are generally labelled as hi-tech enterprises, there are two other industries that face hostile external environments, and are organized in the manner similar to the VE's mentioned. They are the construction industry, (Kornelius & Wamelink, 1998) and movie making industry (Defillippi & Arthur, 1998). The common features of these two industries are that they are project oriented and rely heavily on out-sourcing. After successfully bidding for a project, substantial sub-contracting activities begin. Different kinds of organizations with different core competencies are networked based on some demand and some specified procedures required to complete the different activities of the project. Of course, effective co-ordination is necessary in such undertakings. Movie making is project oriented and involves a number of independent producers. Compared to other industries, the movie industry relies much more on temporary resources. When a movie production is finished the crew will be disbanded but company still exists. So the movie companies and construction companies continue to exist after the project is over, and they cannot be regarded as a VE's in the true sense of the definition. The two examples suggest a VE does not exist as an organized structure. This conclusion is reinforced by Venkatraman and Henderson (1999), who also pointed out that: "we reject a virtual organization as a distinct structure (like functional, divisional, matrix). On the contrary, we treat virtualness as a strategy characteristic application to every organization".

Research on organizational aspects of VE does not seem to have made much progress, perhaps because the focus has been on the organizational structure. The key to exploring this problem is to clearly distinguish between the two aspects of VE: as an organization, and as an organizing process in which outer resources are marshalled for a temporary common purpose. It is the latter aspect of VE - the virtual organizing process - that makes Dell, Cisco, and Amazon successful. The authors feel that only by stressing this point can research into the management theory of VE's make useful progress. This suggestion provides useful clues for solving a series of problems concerning the management and organization of VE. For example, Wu et al. (2000), see the different roles that the CEO's play in a real enterprise and a VE enterprise as an area requiring a major research effort. No useful results in the area have as yet been obtained,
possibly because no well-qualified VE can be identified at this stage of development. Research efforts have assumed the existence of a true virtual organization, while in reality organizations may have only possessed partial characteristics of genuine VE’s. The organizational aspects of a VE may suggest that the VE essentially plays the role of broker, but this is also misleading. The worth of virtual enterprising for existing firms is the adoption of the strategy of VOPES to achieve a competitive advantage in the information era. All this leads to the central questions posed in this study:

1) As an effective adaptive strategy in the modern economy environment, what is the content of VOPES?
2) What is the significance of this strategy for the CEO’s of an existing enterprise?

THE VIRTUAL ORGANIZING PROCESS AND EFFECTIVE STRATEGIES

Many attempts have been made to answer the question of how to successfully implement a VE on a real enterprise that shows some virtual attributes. These attributes may be a crossing of time and space, a crossing of organization boundaries, large amounts of out-sourcing and extensive subcontracting. Many authors see the virtual elements from an IT point of view. In this respect American Online uses an expert system (SMART) to realize its business, which includes ticket reservation function on the Internet. Hewlett Packard uses a reasoning tool based on cases to provide technology support services. Venkatraman and Henderson (1999) point out that in the absence of an effective IT infrastructure, it would be impossible to effectively build the architecture of a virtual organization. All this suggests that transforming an enterprise into a virtual one will be considered from the different strategies that the enterprise is likely to adopt to achieve a competitive advantage in changing markets. It follows that the common questions posed by the CEO’s of existing enterprises are concerned with the use of the strategies in the virtual organizing process.

The term “virtual strategy” as used above has different objectives with different degrees of complexity. These relate to the need to retain a company’s core competence and at the same time out-source its subsidiary operations. Some studies focus on the IT that can impact on an enterprise’s business model. Such studies focus on the manner by which customers discover and obtain the product(s) and service(s) by virtual approaches, i.e., e-business, e-manufacturing and virtual stores. Of course, different enterprises have different operational characteristics, and their strategies may be different. However, for the top management of an existing enterprise what is crucial is to obtain a system concept of the virtual strategies, and to select appropriate strategies. Venkatraman and Henderson (1999) put forward a matrix that coherently embodies different virtual strategies. They categorize most virtual strategies into three dimensions according to their different attributes. The three dimensions are:

* Customers’ exposure to products and services
* Supply sources of the resources involved.
* Knowledge leverage.
They further divided the dimensions into three stages based on the scale of organization in which the virtual strategies were applied, focusing on task unit, organization and inter-organization. The framework of virtual strategy of Venkatraman and Henderson (1999) is valuable in demonstrating the outline of various virtual strategies that can be used successfully by different enterprises. However, they do not deal with the multi-level and complex relationships that exist between collaborating enterprises, yet collaboration is the core feature of virtual strategy. In addition, their model is a static one, since they do not consider the dynamic process of development of the multi-level relationship, going from a very loose level to one of close collaboration. The virtual strategies can be realized and implemented effectively and efficiently only if the collaborative members integrate closely as one unit.

With the focus squarely on the collaborative relationships between enterprises, a three-dimension framework for VOPES is proposed. The choice of the three dimensional framework is justified by the model of Venkatraman and Henderson (1999), except that the virtual product dimension now becomes the customer relationship. The proposed framework consists of the virtual source, virtual knowledge and expertise, and virtual customer relationship axes. This modification is proposed because the customer relationship manifests itself in the products or services provided to customers. The major contribution of this model or framework is the identification of the content of each dimension, with the focus always being on the aspects of collaboration.

Collaboration is a specific view of the general notion of relationship between enterprises. As mentioned above, this kind of relationship is multi-level and complex. Spekman et al. (1998) divided the relationships between enterprises into four categories based on the degree of integration from weak to strong: open market negotiation, cooperation, coordination and collaboration. Open market is a price-based and adversarial relationship; co-operation is a kind of long-term contract relationship; co-ordination deals with the electronic data interchange (EDI) exchange and WIP linkage; and collaboration is a kind of integration, joint planning and technology sharing. The model of VOPES was built by combining the classifications of enterprise relationship with three types of virtual strategy. This model is presented in the form of a framework with a three-dimension structure as shown in Figure 1.
The Virtual Customer Relationship of VOPES

The virtual customer relationship of VOPES, dealing mainly with products and/or services, can be divided into four stages. The first stage concerns the open market negotiation relationship between enterprises and their customers. Buying and selling and price-based relationships are the foundation of the interactions. At this stage of VOPES, the main tasks of the enterprises are to maximise their efforts in attracting the customers and increase the chance of customer contact. The aim of the first stage of a virtual customer relationship is to create an opportunity for a first contact between potential customers and the enterprise. This is done by providing a channel that lets the customer find the products relatively easily in a virtual environment. This in turn provides an opportunity for the enterprise to obtain the customer’s information using the same channel. In contrast to the traditional channels, the virtual methods at the early stage of contact can be divided into two groups, one group covers the regular media, such as the telephone, and call centre customer support centre; the other group covers the more modern
internet channels such as websites, virtual shops, and electronic web advertisements. Such information ranges from types, styles, performance parameters, and appearances, all done across space and time world wide 24 hours per day. This must be the initial and basic step towards VOPES. These normally do not present any difficulties in terms of technology. The crucial problem, however, is how to facilitate product discovery world wide using the virtual approach. Some e-market place solutions such as e-shop, homepage or website, mobile phone sale's messages, etc., have been proposed to solve this problem.

The second stage, called co-operation, concerns the long-term contract relationship between an enterprise and its customers. There are always some regular customers for any enterprise, and these are considered in the business-to-business models.

The third stage is semi-customization. By using virtual means, customers will be able to put forward their requirements for products and/or services. Richer requirements often proposed by customers will generate new challenges as well as opportunities. Based on the customers' requirements and suggestions, useful marketing information can also be extracted. The richer the requirement, the more difficult it will be to satisfy the customer, but this, however, will lead to higher product value and better competitive advantages. In contrast to the regular approaches, the virtual approach will encourage customers to specify richer product requirements, since the customer is able to interact more easily and more widely with the supplier. For example, if a customer who has discovered a supplier's website has requirements that cannot be met by existing products and services, he/she may be more willing to specify his/her special requirements when using email or other electronic means. If a supplier has an electronic virtual channel that has been designed to encourage customers to request special product or service features, it is logical to expect that the supplier will get a wealth or richness of new information on possible extensions to its product or services.

The fourth stage is complete customization. In order to enrich and satisfy the customers, it is necessary to combine the R&D personnel of an enterprise and the customers. For example, Dell Computers dispatches its engineers to the IT departments of large customers such as Boeing, Shell and the Government. These engineers then work together with customers, and follow the customer's requirements closely, see Magretta (1998). Dell's strategy is therefore based on its motto: one customer, one Dell person. This kind of seamless virtual integration is the ultimate stage of VOPES from an organizational perspective.

**Virtual Source of VOPES**

It is a special characteristic of the virtual organizing process that enables it to accumulate complementary core competence through the network resources of suppliers and sub-contracts. There are many and varied opinions on this concept. Davidow and Malone (1992) suggest that if a virtual company wishes to be successful, it must be closely connected with the suppliers and share the common objects so that the boundaries between them are blurred. Goldman, Nagel and Preiss (1995) emphasize the importance of the close relationships between suppliers and sub-contractors to realize agile organization effectively. Quinn (1992) describes the model of Nike, i.e., Nike is a company of research, design and sale. Its capability in manufacture relies
totally on sub-contracted manufacturers in Asia.

The virtual organizing process of resources also has four stages.

* The first stage can be the frequent or occasional subcontracting in an out-sourcing relationship. For example, according to Magretta (1998), a large number of part-time sale and service engineers worked for Dell and at the same time worked for others companies, but if the user is asked who worked for you just now he will answer “the Dell’s person”

* The second stage is a co-operation stage with few suppliers and long-term contracts.

* The third stage is a close coordinated relationship, where EDI exchange exists between enterprises. A Just-in-Time inventory system is typical of a closely coordinated relationship. A good example here is Wal-Mart’s EDI network, which it uses to leverage its supplies and radically reduce inventories.

* The fourth stage is a coalition relationship between internal resources and external resources. The final aim here is virtual integration, joint planning, and technology sharing.

The shift from the third stage to the fourth stage requires levels of trust and commitment that are beyond those typically found in both JIT and EDI relationships, see Spekman (1998). For example, in Dell’s case, The Sony Corporation supplies the flat-panel displays, building a high level of trust and a long-term commitment relationship between the two, i.e. the supplier effectively becomes a partner.

**Virtual Knowledge or Expertise of VOPES**

A significant outcome of the information era is a knowledge economy in which knowledge is a major commodity. Knowledge can be employed to create value and therefore can be treated as an asset. Drucker (1993) points out that a typical company has shifted from a command and control organization with departments and divisions, to an information-based organization, i.e., the organization of knowledge specialists. Having the basic productive and financial resources is not sufficient; knowledge and intellectual capital are also a necessary requirement. It is a new issue for the top management of an enterprise: how to create and manage knowledge in the era of the knowledge based economy.

The main problems in the virtual organizing process of the knowledge dimension are the getting of, making use of, and managing external knowledge/expertise. Usually knowledge can be divided into two categories: explicit knowledge and tacit knowledge, see Nonaka and Takeuchi (1995). Expertise usually belongs to the latter category. It includes intelligence, experience and knowledge of synthesis and creation; the type of knowledge explored in this paper is mainly of this category. The virtual organizing process of knowledge or expertise can be divided into four layers: the knowledge and expertise transaction under the market environment amongst independent entities; exchange of knowledge or expertise under long-term contract relationship; exchange and sharing of knowledge and expertise under the coordination environment; and the sharing of expertise at a high level of trust between collaborating enterprises.
The first stage of knowledge or expertise in the dimension of a virtual organizing process focuses on the virtual approaches to an open market environment. The main approach in gaining knowledge and expertise from outside an enterprise is to find, encounter and transact by means of negotiation via traditional approaches or by the Internet. The major difficulty of this stage is to assess the value of knowledge and expertise in relation to the characteristics of knowledge product. If this cannot be done, it will be difficult and probably expensive to acquire. Further, it is valuable for enterprises to know where the required knowledge or expertise can be found. The best way forward with this type of problem is to share knowledge and expertise with outside people.

The second stage is long-term contract relationship that can lead to a reduction of the cost of acquiring knowledge and expertise. Teltech (Davenport, 1997) is a knowledge-intensive company, helping other companies to get access to external technical expertise and information. Teltech maintains a knowledge network of thousands of experts in various technical fields. The experts, over 3000, can be found in Teltech’s online system. These people are typically academics, recent retirees from industry, or consultants; and they supply their expertise to seekers of expertise. Teltech also offers over 1600 online databases, and searchers are assisted by Teltech’s knowledge analysts.

The third stage is the co-ordination of knowledge and expertise. Knowledge providers communicate with their customers via information linkages and EDI exchanges. For example, experts at the British Petrol Corporation communicate by a remote video system with their users on sea oil-drilling platforms, and they diagnose and deal with possible accidents some 5,000 miles away.

The fourth stage is an integration and collaboration of knowledge and expertise. Sharing vision, technology and expertise among the members of a collaborating group are major features. The strategy adviser, law consultants or other closed related experts of enterprises are the ones that work in this kind of organization style.

The critical new insights of virtual organizing process on customer, sourcing and expertise are various relationships within the four stages. When viewed from the traditional organization governance structure theory, the relationships between enterprises can be classified into several types depending on the degree of control required. These include joint ventures, collaboration and consortia as determined ownership structure. The tighter the control requirements are, the closer the relationships must be. Furthermore, relationships between enterprises are often long-term and evolve gradually. In the virtual organization, the approaches to control are not equity based, but are based on degrees of trust. The relationships are often short-term or temporary. The higher the degree of integration between players within a virtual organization, the more effective the enterprise virtual strategies will be. The relationship ranges from looseness to closeness and is determined by the working requirements. In order to use virtual strategies effectively, enterprises should aim to move their relationship from a low or loose level towards a high degree of integration or closeness. In other words, in order to effectively practise virtual organization, the level of virtual relationship must progress from stage 1 to stage 4 of the model.
This in effect is the virtual organizing process. In summary, the virtual organizing process needs to be viewed in terms of the virtual relationships, and, as first step, one needs to distinguish the simple from the complex virtual scenarios. Because of the fact that the core of the virtual organizing process is integration and that the actors need to work together in a close relationship, we have put forward the degree of information or knowledge sharing and interaction between the virtual organizations as the critical indicator. We have therefore proposed four stages in the dimension of degree of complexity of the internal relationships of virtual organizations; the relationships at the four stages of a virtual organizing process imposed on the customer, on the sourcing, and on the expertise are shown in Table 1.

### Table 1. Relationships of virtual organization process

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Relationship (Example)</th>
<th>Minimal Open Market Negotiation</th>
<th>Low Cooperation</th>
<th>Middle Coordination</th>
<th>High Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Customer</td>
<td>Knowledge Sharing</td>
<td>Customers passively receive existing product information</td>
<td>Sharing basic product information, e.g. products' function, quality, types and styles</td>
<td>Sharing part of detailed product information &amp; knowledge, semi-customized product R&amp;D; Reciprocal information flow, middle interaction, e.g. digital software product R&amp;D via internet/extranet</td>
<td>Full sharing of product knowledge, full customization &amp; integration, and product's R&amp;D</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>-Unidirectional information flow, minimal interaction</td>
<td>-Reciprocal information flow, low interaction; Simple trade, e.g. price, quantity, shipping &amp; delivery date via -EDI</td>
<td>-Sharing part of detailed product information &amp; knowledge, semi-customized product R&amp;D; Reciprocal information flow, middle interaction, e.g. digital software product R&amp;D via internet/extranet</td>
<td>Full sharing of product knowledge, full customization &amp; integration, and product's R&amp;D</td>
</tr>
<tr>
<td></td>
<td>-IT Utility</td>
<td>-TV, radio, mobile phone and fax</td>
<td>-Sharing basic product information, e.g. products' function, quality, types and styles</td>
<td>-Sharing part of detailed product information &amp; knowledge, semi-customized product R&amp;D; Reciprocal information flow, middle interaction, e.g. digital software product R&amp;D via internet/extranet</td>
<td>Full sharing of product knowledge, full customization &amp; integration, and product's R&amp;D</td>
</tr>
<tr>
<td>Virtual Sourcing</td>
<td>Knowledge sharing</td>
<td>One or few times trade, sharing</td>
<td>Fix supply relationship, sharing part of information or knowledge reciprocally</td>
<td>-Sharing expertise or knowledge widely and deeply</td>
<td>-Full integration, sharing expertise or knowledge</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>simply purchasing information</td>
<td>-Limited interaction</td>
<td>-Sharing expertise or knowledge widely and deeply</td>
<td>-Simultaneous and concurrent interaction and online collaboration</td>
</tr>
<tr>
<td></td>
<td>-IT Utility</td>
<td>-Minimal interaction; Regular approach, fax telephone</td>
<td>-EDI</td>
<td>-Simultaneous and concurrent interaction and online collaboration</td>
<td>-Integration intelligent agent software</td>
</tr>
<tr>
<td>Virtual Expertise</td>
<td>Knowledge sharing</td>
<td>Customers gain fixed and previously provided explicit knowledge unidirectional from enterprises, such as FAQ</td>
<td>General consulting expertise, or explicit and tacit knowledge</td>
<td>-Sharing deep consulting expertise &amp; knowledge</td>
<td>-Integration partnership, full sharing knowledge and expertise</td>
</tr>
<tr>
<td></td>
<td>Interaction</td>
<td>-Minimal interaction</td>
<td>-Limited interaction, e.g. via e-mail or telephone (call center)</td>
<td>-Deep and reciprocal interaction, via intranet/extranet, e.g. Groupware and BBS or telephone, e.g. Teltech consultant Co. Knowledge management model</td>
<td>-Simultaneous and online interaction via intelligent agent software or via virtual reality approach</td>
</tr>
<tr>
<td></td>
<td>-IT Utility</td>
<td>-Information obtained from bulletin or through website browsing</td>
<td>-General consulting expertise, or explicit and tacit knowledge</td>
<td>-Limited interaction, e.g. via e-mail or telephone (call center)</td>
<td>-Integration partnership, full sharing knowledge and expertise</td>
</tr>
</tbody>
</table>

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I.T. IN THE VIRTUAL ORGANIZING PROCESS OF ENTERPRISES

IT Support for Effective Implementation of the Virtual Organizing Process of Enterprises

Amongst the early definitions of VE presented above, none seem to deal in any reasonable depth with the role of IT role in the VE. An exception is Byrne (1993), one of earliest workers to put forward the concept of a VE. Although virtual strategies can be implemented without IT, from the view of the concept of virtual strategies, it is impossible to achieve effective operations without adequate IT support. Goldman, Nagel and Preiss (1995) describe an imaginary case of the operation of a VE. The whole process of the case presented, from the idea of the product derived from the customers to delivery of the product to customers was completed within 6 working days. It is obvious, from the case study presented, that without IT support, it is impossible to perform such complex and challenging tasks in such a short period. The IT involved in this case study includes two parts. One part is IT basic infrastructure, and the other is the application of solutions such as ERP, DRP, SCM, MPS, EDI, CAD and so forth. It can be concluded with certainty that IT is a prerequisite and the technology enabler for VOPES, and that it is also a facilitator in the implementing of VOPES efficiently and effectively.

The Component Technologies Contributing to the Virtual Organizing Process of Enterprises

The design and implementation of a supporting infrastructure for VOPES rely on an amount of component technologies. Camarinha-Matos et al. (1999) summarise 6 component technologies, which include information management systems, multi-agent systems, collaborative engineering applications, multimedia worldwide web teleconferencing, workflow systems and OS networks. Each component will be based on the communication technologies and application software.

The Infrastructure of IT in VOPES

As three kinds of IT due to EDI can be considered, only two IT platforms are introduced: internet/intranet, and intelligent agent software. Figure 2 shows the internet/intranet architecture, while Figure 3 shows the full intelligent agent software integration. A general infrastructure for IT in VOPES includes a multi-layer structure: interface layer, access and authentication layer, collaborative filtering and intelligence layer, application layer, transport layer, middleware and legacy integration layer and repositories. This structure was proposed by Tiwana (2000) and is shown in Figure 4. These layers have the following functions.
Figure 2. Internet/Intranet architecture

- Internet
  - Expert Database
  - Expert Browser
  - Customer Browser
  - Customer Database
  - Supplier Browser
  - Supplier Database
- Intranet
  - Route
  - Fire Wall
  - Data Server
  - E-mail/proxy Server
  - Application Server
  - Hub
  - Station 1
  - Station 2
  - Station 3
* The interface layer is the means by which users come into contact with information systems.
* The access and authentication layer includes authentication, recognition, security, firewall, and tunnelling. It enables members of the partnership and VOPES to efficiently share resources to accomplish common goals such as information exchange, collaboration, invoicing, electronic funds transfer, supply chain management, document exchange and communication.
* The collaborative filtering and intelligence layer enables interactions between related tools, content personalization, search, indexing and meta tagging to take place.
The application layer is involved in skills directories, yellow pages, collaborative work tools, video conference, digital whiteboard, electric forums, rationale capture tools, and DSS tools.

- The transport layer embeds web and TCP/IP deployment, streaming audio, document exchange, video transport, virtual private networks (VPN) running on Windows 2000 or Windows NT, electric mail and POP/SMTP support.

- The middleware and legacy integration layer contains wrapper tools (such as TCL/TK or scripts to integrate legacy or cross-platform data). The legacy integration layer provides connections between legacy data and existing and new systems. Meanwhile, the middleware layer provides the connectivity between old and new data format, usually via a Web front end. Middleware technology, distributed object framework, such as CORBA, JAVA/RMI, Microsoft/DCOM, or CGI-based extensions to DBMS, can be used to support this integration process.

**Figure 4. Generic IT architecture of the virtual organization process (Tiwana 2000)**

![Diagram of IT architecture](image)

The repository is the bottom layer and includes legacy (e.g., the internal information systems or internal enterprise management software), data warehousing, discussion forums and document bases.
CONCLUDING COMMENTS

The competitive advantages of an enterprise are derived from supplying value-added products/services and satisfying customers. There are three value propositions that may be used for this purpose: customer relationships, minimum time from product-to-market and operational efficiency. Different enterprise types can select different value propositions. Service industries, for example, may focus on developing and strengthening the relationship between the customers and the enterprise, while Hi-tech and R&D companies could focus on speeding new products to the market. In a traditional manufacturing enterprise the emphasis may well be on improving the production processes and reducing production costs. But no matter what the specific strategies are, knowledge innovation, team co-operation, information communication, and information infrastructure are of fundamental importance to all enterprises.

Depending on enterprise type and strategies, the senior management can identify appropriate value propositions and then, by means of the VOPES proposed in this paper, identify the right virtual strategies and organizing processes. The link between the value propositions of an enterprise and the use of VOPES can be summarized by the following 6-step process:

i.) Analyze the enterprise’s environment and identifying the right value propositions.
ii.) By using the proposed VOPES, identify the corresponding dimension of the virtual organizing strategy.
iii.) Assess the levels of the existing virtual strategies of the enterprise.
iv.) Based on the status of the enterprise (technology, information, culture), identify the virtual organizing aim.
v.) Implement the identified virtual strategies and shift to aim identified.
vi.) After using the VOPE model, monitor the performance and initiate further improvements.

These six stages form a closed feedback loop, and after the virtual strategies have been implemented, the outcome can be assessed and the next loop initiated. The level of the virtual organizing process will thus be dynamically improved.

This paper has attempted to elucidate the role of VE by placing emphasis on the virtual organizing process rather than on the organization itself. There is no total VE in the real world, therefore, top management may become reluctant to build or transform their enterprise into a VE. However, a lot of virtual strategies can be used to make enterprises virtual organizing and more competitive. These enterprises need not only be the hi-tech enterprises, but can also be the traditional enterprises, such as mechanical manufacturing and chemical engineering. Existing virtual strategies are rather prolific and not well understood by top management. A three-dimensional framework of virtual strategies was presented in this paper from the perspective of VOPES, and thus reducing some of the confusion associated with virtual strategies. The three branches of the framework are virtual customer relationship, virtual source, and virtual knowledge or expertise. Any enterprise can, to varying degrees, improve its competitive advantage by
using the virtual organizing process framework presented, and thereby shifting from open market negotiation towards collective collaboration. The IT infrastructure and solution applications software are two necessary vehicles in the effective implementation of VOPES. The generic architecture of IT presented in this paper can further help with the effective implementation of the various virtual strategies.

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