

Information Technology as an Enabler of Virtual Enterprises: A Life-cycle-oriented Description

Wolfgang Faisst

Department of Information Systems I

University of Erlangen-Nürnberg

Lange Gasse 20

D-90403 Nürnberg

Phone: ++49/911/5302-264

Fax: ++49/911/536634

Email: Wolfgang.Faisst@wiso.uni-erlangen.de.

1 Introduction

On the one hand, information technology (IT) enables the advent of virtual enterprises (VEs)¹. On the other hand, requirements for information systems research can be derived from characteristics of VE (see *table 1*). The aim of this paper is to show how new organizational forms might benefit from IT. Beside general topics concerning standards and levels of IT coupling, we follow the idealistic life cycle of a VE. We also identify the key role "broker" (e.g. Bill Epstein [KaFM97] from our field studies) helping for example to find the right partners in the formation phase and accompanying them in the progress of the VE.

¹ For a short tutorial see for example [MeFa95], [AFHS95].

Table 1: Characteristics of VE and Requirements for IT

Characteristics	Requirements for IT
Partnership in networks	Information network infrastructure like the Internet or corporate networks, (highly automated) end-to-end electronic connectivity
Independent enterprises	Interoperability between the heterogeneous information system architectures, ability of coupling
One face to the customer	Unified view of interface to the customer, e.g. user interfaces as well as shared data and knowledge bases
Core competencies	Finding best partners
Short-living and mission-oriented character	Rapid establishing (and terminating) the communication channels by using open standards and uniform protocol paradigms Temporary integration of the partners' IT Highly adaptable organizational and IT structures
Slight bureaucratic overhead	Planning, decision, execution, and control systems

In the VE context, the management of organizational memories and knowledge gains more and more interest [Fais96]:

1. In a VE are no institutionalized central management functions (see [AFHS95]). Therefore, VEs are "lean" and no middle management is available as a carrier of meta-knowledge and connection link between the different entities.
2. Often, partners hardly have any information about each other. Thus, they cannot exploit the others' capabilities to fulfill the mission. Tapping mutual knowledge assets should be possible without asking personally.
3. The involved parties are steadily arranged in new constellations in terms of team composition. Therefore, they are often set back to the initial point of their learning curve. This is even more obvious for a VE that is even created for a single customer order.
4. The VE appears as a problem solver to the customer, i.e. it has to offer one-face competence.

Companies might benefit from using so-called organizational memory information systems (OMIS) like know-how and competence databases, when persons as carriers of organizational memory leave the VE with its dissolution and cause a knowledge gap. According to this, the statement of Swanson [Swan96]: "*The new organizational knowledge will be increasingly more system based compared to person based.*" is even valid for a VE.

2 Types of VEs

VE can be distinguished in three types. VE type A consists of legally independent companies (see *figure 1*). They often cooperate in form of a stable network or pool. This type benefits from high mutual trust built up and enlarged by repeated cooperations. Entities of the pool

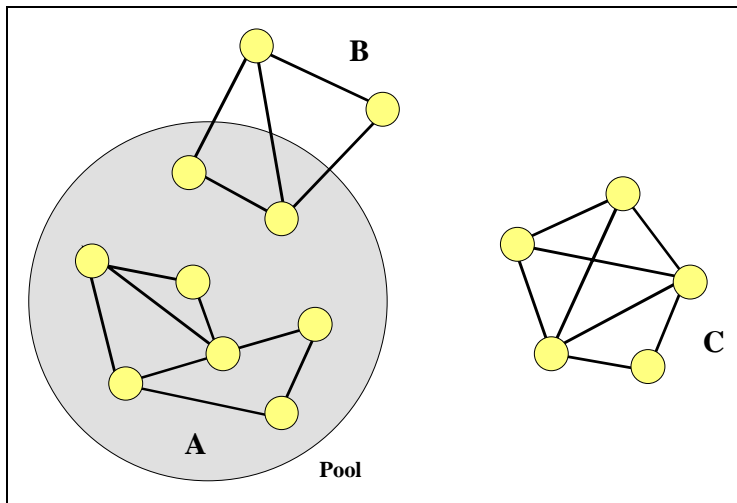


Figure 1: Types of VE

also better realize the standardization of enterprise interfaces (to each other in the pool), because due to the repetition they amortize their investments more easily than with a single cooperation (sunk costs). A VE of type B consists of a mix of "pooled" entities and companies drawn from the market (see *figure 1*). This type appears when the pool in itself lacks the core

competencies needed. During the mission this new external partner is temporarily integrated in the pool. The pool often picks up that external entities when they are proved in the VE. Beside these VE types, mainly based on long-living relations, VE type C is a combination of enterprises coming spontaneously together and dispersing after the opportunity is grasped (see *figure 1*). Main task of the broker in a VE of type A is opportunity identification, VE configuration, and pool maintenance. In type B and C, the broker's main job is to identify the partners that fit.

Another dimension is the network history. On one side, the network might be created by former big enterprises (quasi externalization). On the other side, small and medium enterprises create a pool or network (quasi internalization). See *table 2*.

Table 2: Types of VE and Examples (see [FaBi97])

	VE Type A	VE Type B	VE Type C
Quasi Internalization	Coopers & Lybrand, NEWPLAN, Rösinger & Associates, TCG	Dauphin, Epstein's Enterprises	AMBRA, Galoob Toys, TelePad, Walden Paddlers
Quasi Externalization	ABB, SNI	Getzner, Nike, PUMA	

3 The Role of the VE Broker

3.1 Sub Roles of the Broker

The broker [KaFM97] in a VE is first and foremost a member of the enterprise. He acts as an information broker, but his activities go far beyond. He serves as an **initiator**; i.e., he is the driving force for the formation of the VE. He executes this by searching for and recognizing market opportunities and by searching and choosing appropriate, competent, complementing partners. He is the **coordinator** of the VE, through defining the business arrangements and assignments (roles) of the VE members. He **moderates** during the execution/operation of the VE's mission by resolving conflicts between VE members. He is the **primary point of contact** for customers of the VE.

3.2 Tasks of the Broker

Figure 2 helps to clarify the role of the broker during the various development phases of a VE. During all phases, the broker is continuously involved in a number of activities including: a) the evaluation of partner competencies both before and during the VE development, b) acting as project care-taker, c) building and maintaining of trust between the VE members, and d) acting as the point of contact for the VE members.

During the first phase of the development of a VE, the "*Identification*" phase, the broker is the driving force for searching for and recognizing market opportunities, planning and drafting the value chain that will eventually comprise the VE, and estimating costs and revenues. In the "*Formation*" phase, the broker is engaged in finding and selecting the organizations/individuals who will make up the VE, in assigning the functions that must be performed in general, and in developing the needed financing. During the "*Design*" phase the broker acts as the architect for the design of material and information flows, any controlling systems (quality, cost, etc.) needed, the legal framework which specifies the contractual arrangements between VE members, the design of the *mission database* (what mission information is to be stored and how), the *business rules* which guide the operation of the VE, and the financial arrangements among the VE members. During the "*Operation*" phase, the broker serves as project moderator. He is not directly involved in the day-to-day running of the enterprise but rather stands ready to be called upon for advice and/or to settle disputes among the VE members. Finally, during the "*Dissolution*" phase, the broker archives and distributes all mission information to the VE members, acts as the agent for selling any residual interests of the VE to a third party, and takes the role of the *residual representative* of the enterprise when, for example, after-sales customer service is required.

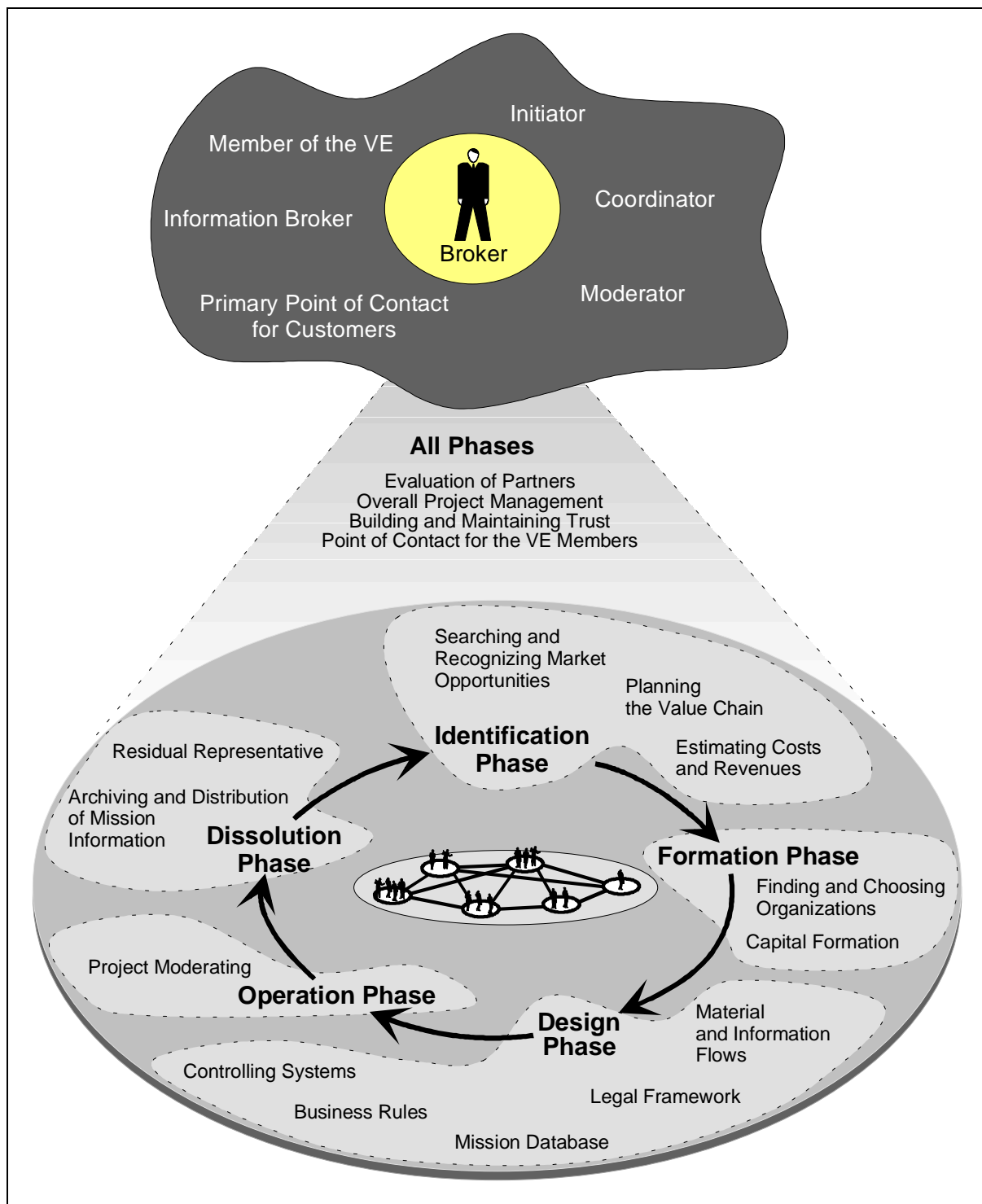


Figure 2: The Role of Broker in the Life Cycle of a VE

4 Phases of the VE life cycle and Support by IT

According to Malone and Rockart (see [MaRo93]), a virtual enterprise without IT is conceivable in special cases, but the implementation of IT makes it possible to improve speed and quality of the information exchange by orders of magnitude. IT enables the coordination of activities previously thought to be too costly to synchronize.

4.1 VE Life Cycle: All Phases

During all phases of the VE life cycle **communication systems** play a major role. In the case of Epstein [KaFM97], many of his partners are distributed around the world in different time zones, so systems such as Email might be well warranted. The advantages could be: lower costs, less time wasted when establishing the contact with partner(s), and better documentation and organization of communication history (especially important when the number of contacts is large). **Groupware** such as Proshare™ video conferencing might reduce the required travel cost and time. Combining Proshare™ conferencing with group text processing systems can be useful for developing common documents (e.g. contracts, plans) without meeting personally.

For VEs, where partners are often dispersed geographically and do not work under the same formal organization, it might be more critical to use data and document management systems to assure document access to all partners as well as reliable archiving of files.

One of the tasks of the broker is to influence the partners towards mutual trust. Certainly IT cannot be the sole driver for instilling a sense of trust in the partnership of a VE, but it can well help. For example, when partners are widely dispersed, **allowing open access** to others' mission-related information systems without case-wise permission can serve to build trust in the same way an "open-door policy" might work in a typical office setting.

Throughout the course of a VE, the broker could make good use of **project management systems** providing group scheduling functionalities. Similarly, the broker may need to keep a running evaluation of partner capabilities. Electronic checklists for partner evaluation stored in the partner database could serve this purpose very well.

As soon as the broker initiates a VE, he dynamically checks the mission premises. VE goals and strategies might change when for example the market is moving towards another direction. So, following the results of his strategic monitoring, the broker has to adjust the VE

during its operation or even dissolve it. According to section 2, the broker evaluates the partner pool enterprises and new partners during the missions (see figure 3).

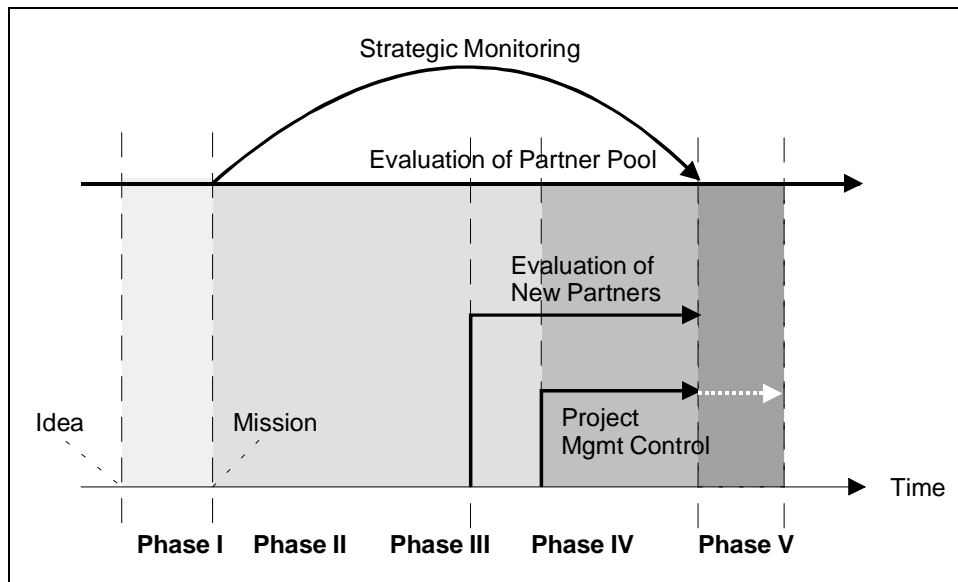


Figure 3: Strategic Management of VE

4.2 VE Life Cycle: Identification Phase

During the identification phase of a VE the broker can make good use of tools such as **online databases** (user interfaces needed), newsgroups and the WWW within the internet. For example, online databases could be useful for Epstein's Quantum Group to search worldwide patent information (see [KaFM97]). Within the internet there are interest groups with their own newsgroups. Such groups might be particularly useful for identifying ideas for new ventures.

Newsgroups and the **WWW** are important for both identifying new ideas for ventures as well as making offers for them. For example, Epstein could design his own homepage and use it for soliciting offers to become a distributor of high-chair pads (see [KaFM97]).

Strategic planning software supports the VEs mission definition, e.g. by electronically checking the activities needed in a VE. For example, a type of "value chain editor" might be useful to develop the requirements for potential partners and the associated partnership architecture.

During the identification phase it is important to be able to **quickly estimate the costs and revenues** of a potential venture. Here IT might provide effective support through simple spreadsheet and accounting software packages.

4.3 VE Life Cycle: Formation Phase

During the formation phase, a key activity is to identify suitable partners as specified by the partnership architecture. Nowadays, partners are found using your personal relations or social networks ("Good Ol' Boy Network" [Kru196]). However, this method does not ensure the required market transparency. Increasing competition urges companies not to take *any* partner, but the "best" one. This is only possible with global sourcing, and therefore one needs IT support. So, you might benefit from online services that guarantee the required actuality. Finding potential partners can be facilitated either through an **internal partner database** of the broker or through **internet search of enterprise presentations**.

An **internal partner database**, i.e. a network of entities (potential partners) including an inventory of partner capabilities and capacities, could be constructed. Upon definition of a particular mission, the network could be searched for specific recommendations for possible partners.

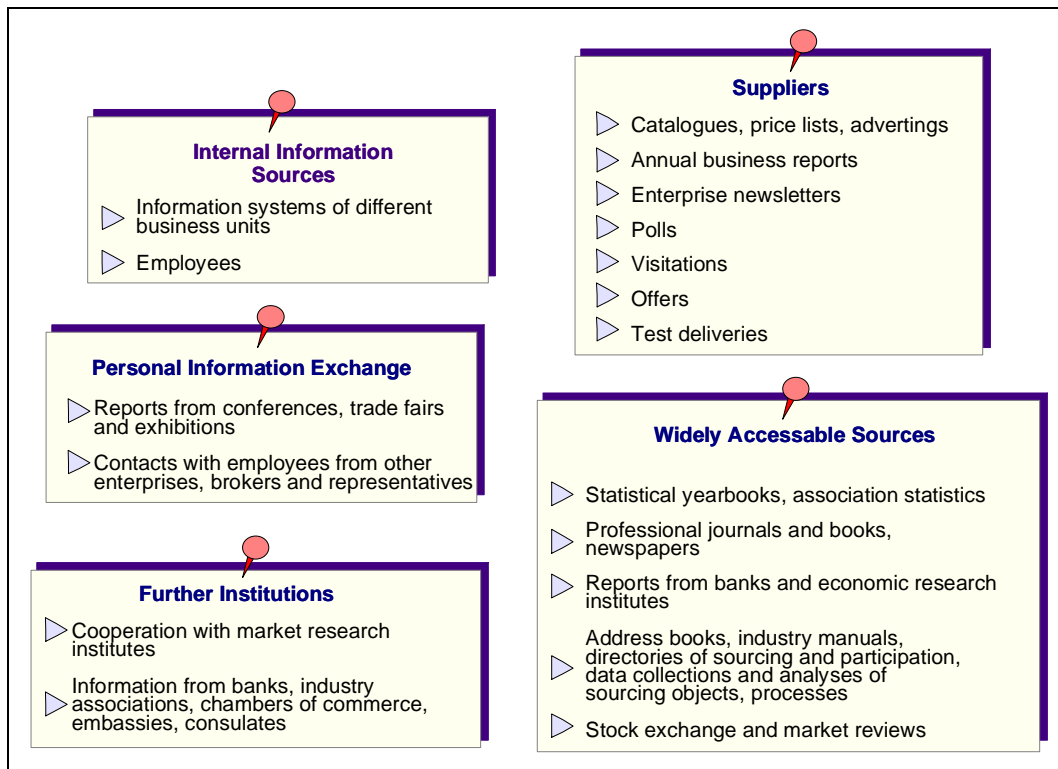


Figure 4: Classical Sources of Partner Information

Beside classical sources for partner retrieval (see *figure 4*), enterprise presentation in online services (above all WWW) gains importance. Our explorative study shows a very heterogeneous view of **electronic enterprise presentations** (EEP) (see [FaSp96]). There are still neither any uniform expressions nor any presentation guidelines. Because of this, one cannot uniformly search in the existing catalogues. A reference model for an EEP as a kind of ideal presentation is a way to get the needed pieces of information (see *figure 5*). Survey pages or industry indices of common online services still offer only little information for the partner retrieval. Due to high dissolution, you hardly find a suitable problem solver. An index related to activities and core competencies might strongly focus the search.

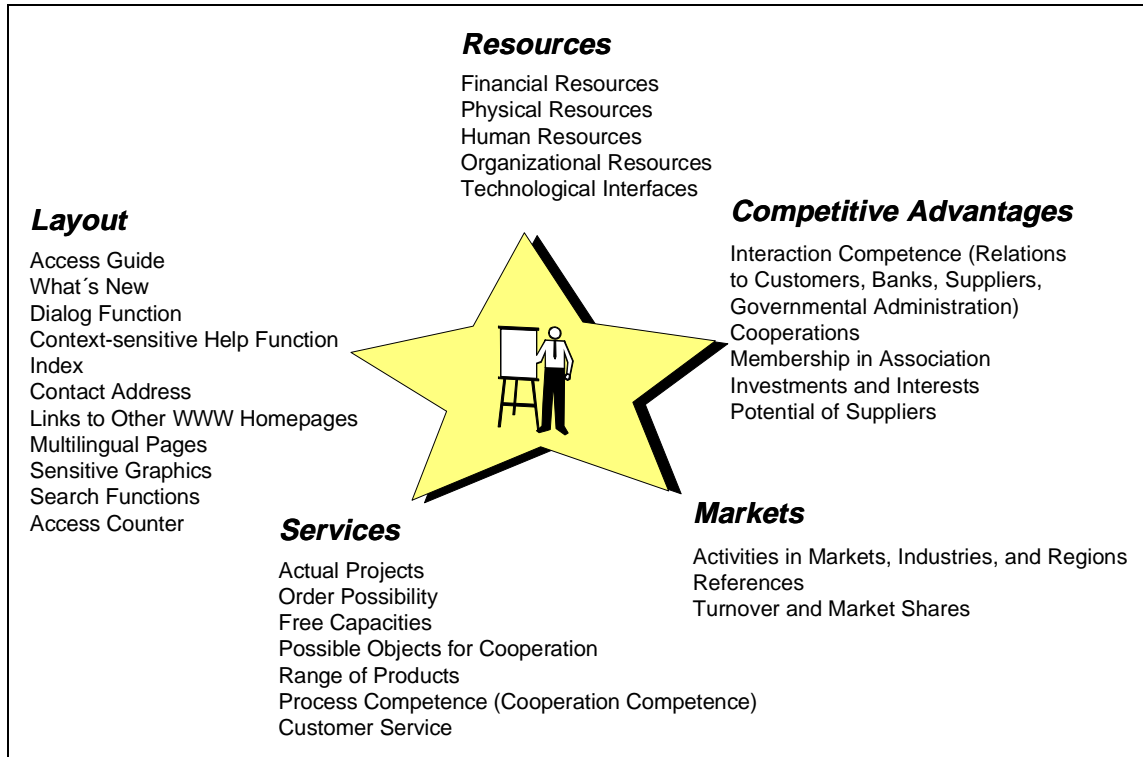


Figure 5: Elements of an Ideal Electronic Enterprise Presentation

An internet search of enterprise presentations could be facilitated by so-called "**intelligent software agents**" for organizing and systematically filtering "hits" (see *figure 6*). An intelligent agent comprises a meta search engine (for parallel use of different search engines), and modules from artificial intelligence such as one for domain knowledge (e.g., a thesaurus or semantic network) and a user model (e.g., to personalize the ranking of "hits").

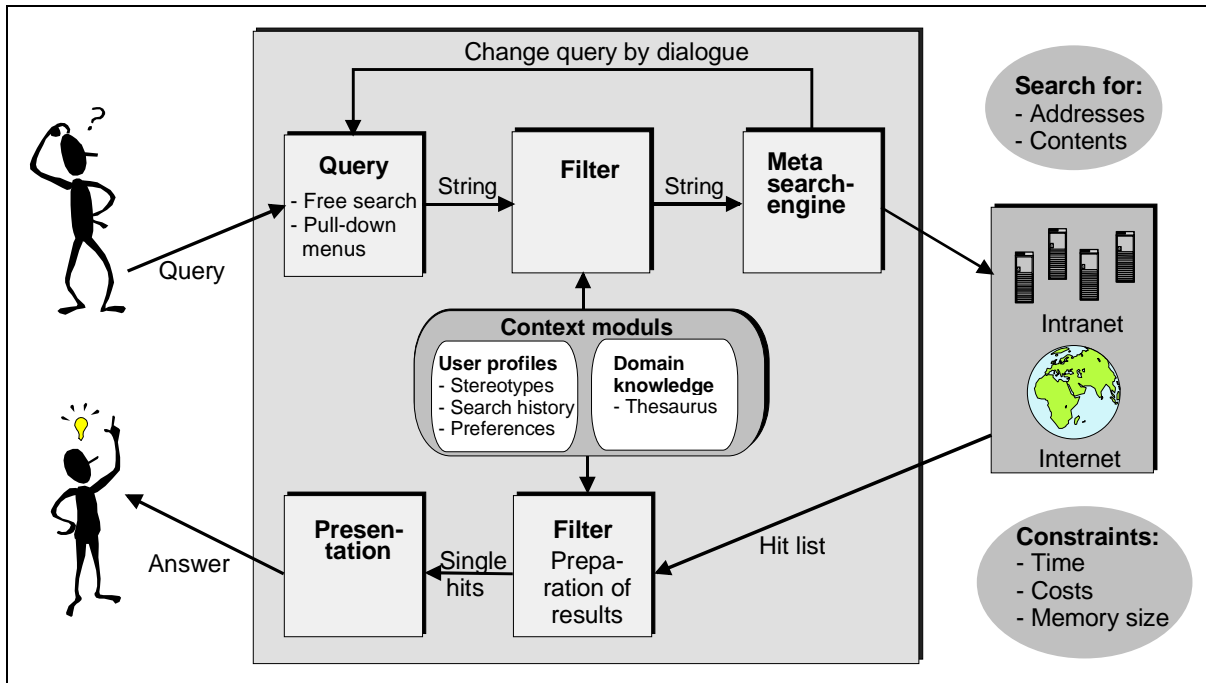


Figure 6: Architecture of the Agent-Based Enterprise Finder

Figure 7 shows how to combine external and internal information.

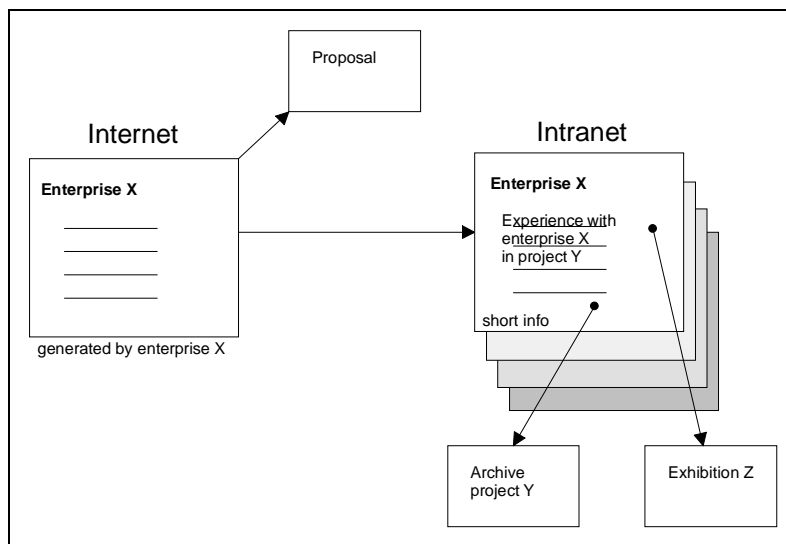


Figure 7: Links Between External and Internal Information

An Internet search would similarly turn out to be useful in locating sources of venture capital (e.g. government funding opportunities or private investors).

4.4 VE Life Cycle: Design Phase

Given the partner entities and their specified relation (architecture), the design phase specifies the detailed rules for carrying out the mission. During this phase, organization tools might be useful for designing material and information flows.

To speed up the creation of any needed legal documentation, the broker could make good use of legal software (which typically includes a library of reference contracts, forms, etc.).

To guarantee sufficient documentation during the course of the VE, a mission database has to be designed. Such a database would include all mission-related information and be accessible to all partners. Any needed mission-related reports and their reporting frequency must be decided.

Expert system software could be useful for resolving any inconsistencies between the different partners' business rules.

4.5 VE Life Cycle: Operation Phase

During the operation phase, to get information needed for the **moderating task**, the broker could benefit from a partner monitoring software system. Such software should include features like signaling of any deviations from plan, milestone tracking, and the like.

Workflow management systems are used for controlling and monitoring cross-company business processes (see [WeFa96]). Significant adjustments to organizations claim to develop support (for example learning workflow systems [Warg96]) for highly adaptable organizational structures and unpredictable tasks.

An **Electronic Organizational Manual (EOM)** is like an electronic product catalogue including information about structure, processes, employees, business rules, products, and services of an enterprise (see [ChRW91]). Each partner of a VE should have access to the others' EOMs. This system might be combined with workflow systems to pass document folders through the VE (e.g. the EOM Consult-Info from Siemens-Nixdorf).

IT makes it possible to get central information from a decentralized position and to combine dispersed expert knowledge. Therefore, the knowledge (technical know-how, knowledge about customers and markets, organizational knowledge) could be shared. In the network,

employees can find know-how in databases as well as in human knowledge bases (experts) by **knowledge-on-demand systems** (see [Fais96]).

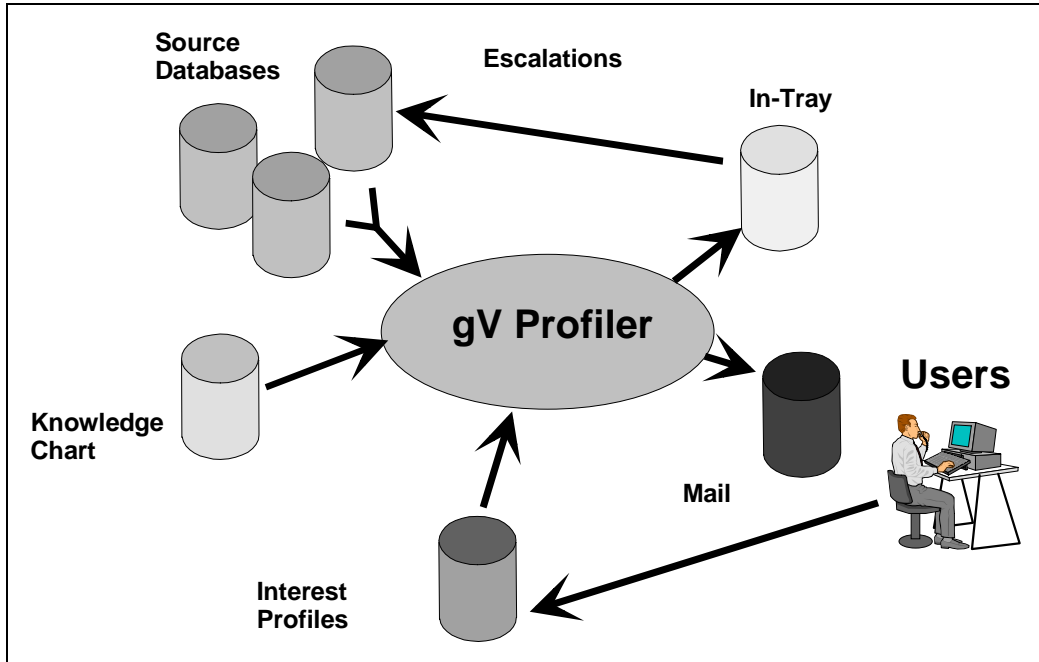


Figure 8: grapeVINE

Example: grapeVINE

Documents from external and internal source databases were filtered with the help of grapeVINE Profilers (see [Mars95]). To assign key words it uses the Knowledge Chart. The Profiler compares this key words with the users' interest profiles and reports them the fitting documents via Email or grapeVINE In-Tray. The user can read these and add new key words or increase the documents' value of importance. The Profiler evaluates users' comments and opinions, new key words, increased values, and compares them with users' interest profiles. Therefore, grapeVINE makes it possible to find common interests (see figure 8).

4.6 VE Life Cycle: Dissolution Phase

Dissolving the VE may require the broker to archive and distribute mission-related information. In the case of after-sales service, the collection of FAQs and the help desk enable the broker (or other responsible agents) to perform the task of the residual representative.

Figure 9 summarizes the IT "toolbox" for VE, and especially for the VE broker.

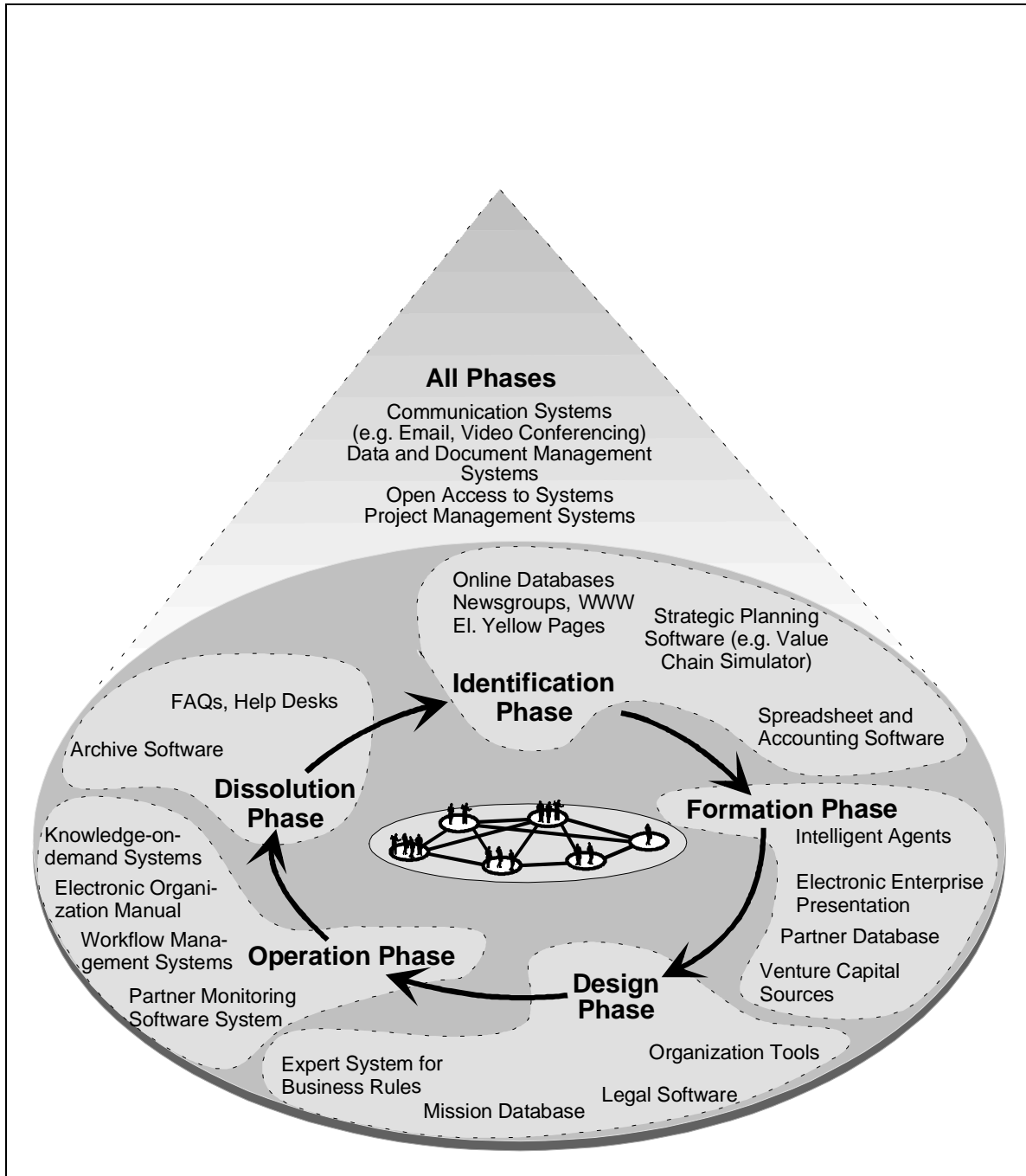


Figure 9: Potential Applications of Information Technology for VE

5 IT Architecture of a VE

Above all, IT should not prevent the "best fitting partner" from taking part in the VE. So, tying up new partners your IT must be flexible in the sense of re-design (ability to re-configure and to parametrize) in order to achieve a rapid docking resembling the "plug-and-play"-principle known from hi-fi systems.

Lengthy discussions, what data will be exchanged when and in what format, about coordination, data protection, and security are contrary to this goal. Reducing set-up times and costs, the capability to rapid couple with previous unknown partners is increasing.

Before a company invests in its IT potential, it has to take into account the short planning horizon in a VE. Other influences for the investment are firm size and change rhythm of the used technology.

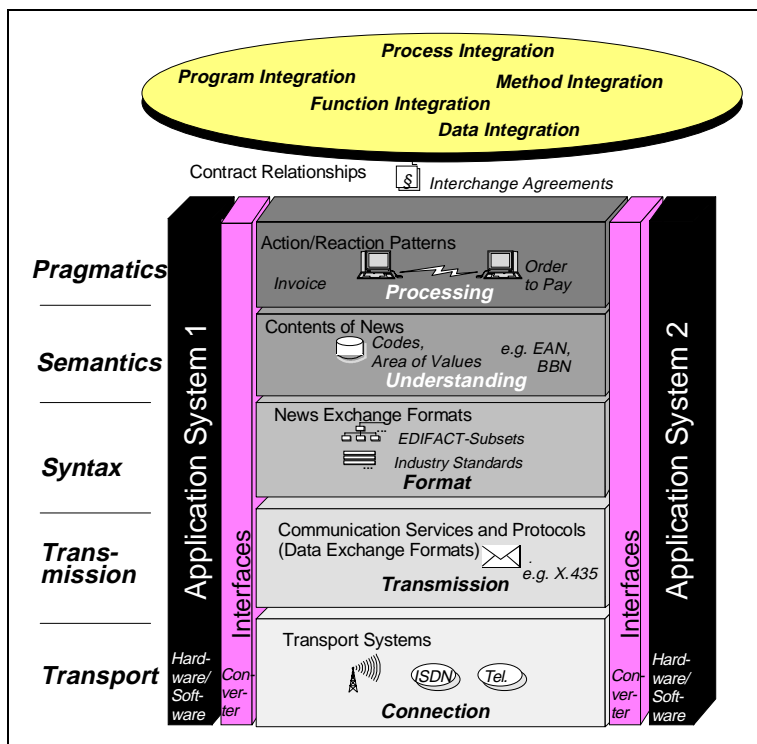


Figure 10: Ways of Integrating and Degrees of Coupling

Following the ISO/OSI model, figure 10 shows different ways of integrating and different degrees of coupling application systems of two companies. In order to cope with this, you need some kind of "architecture of interfaces". When changing the companies' structures the re-configuration of corporate application systems might run more or less automatically using knowledge-based or, more generally speaking, computer-based tools.

Today, the widespread solution for coupling application systems is to program an individual interface between the companies' systems. EDI editors show the way to a transparent and efficient administration of application system interfaces. Figure 11 is a screen shot from our interface visualization tool "VUWizard". The system represents the structure of a VE with its partners, their application systems, the interfaces, coupling, and converter rules.

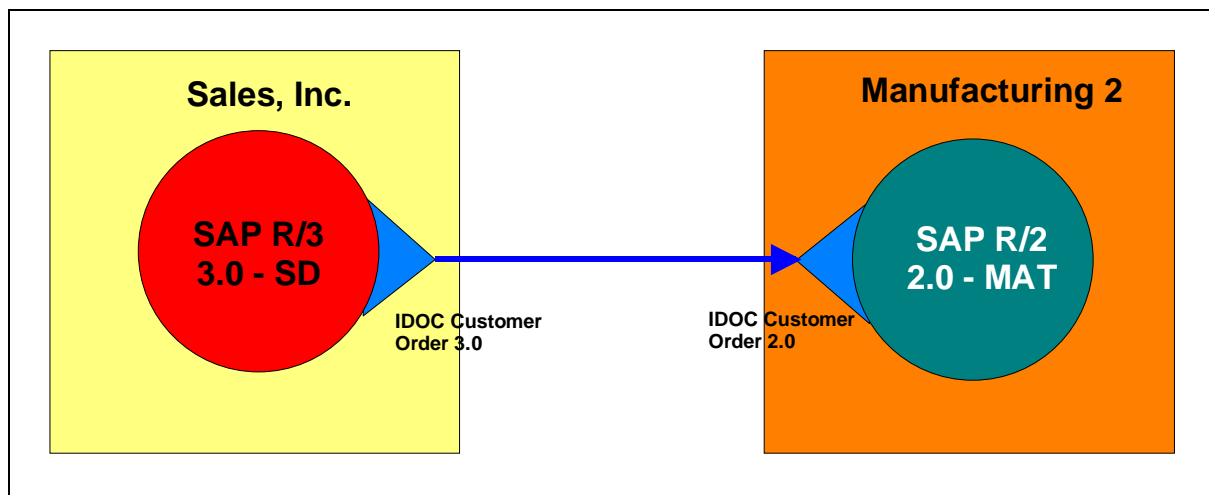


Figure 11: VUWizard

The widespread use of (modular) standard software and of the object-oriented programming paradigm (data and method encapsulation) supports this flexibility. For transferability of the information stored in application systems (by filters or converters), a certain kind of harmonization of the underlying application logic is necessary. Examples are electronic product presentations and configurations, product databases, calculation methods, cross-enterprise clearing, part numbering, project management systems, or CAD systems with surface and volume modeling. Data dictionaries and semantic resolvers lay the foundation for the cooperation with different syntax and semantics.

Long-standing efforts to define comprehensive standards (e.g. CORBA, EDIFACT, or STEP: see [Fais95]) come along with arising elements of virtualization, so that we see an interaction between them. Especially CALS (**C**ontinuous **A**cquisition and **L**ife Cycle **S**upport) started with the idea to support VEs. It is not a totally new concept, but a collection or toolbox of still existing guidelines, exchange rules, technical, and business standards. In the first phase, CALS has the intention not to overburden the temporary cooperation with hard requirements, so CALS I only includes the transmission of all project documents using suitable standard formats. CALS II might overcome the redundant data storage that exists in CALS I by installing an integrated project database, the so-called CITIS (**C**ontractor **I**ntegrated **T**echnical **I**nformation **S**ervice) (see [Schi96, p. 206] and [Bund95]). In the full extension, the intended product model includes a customer, market, environment, industry, supplier, usage, quality, process, construction, product concept, and requirements model (see *figure 12*).

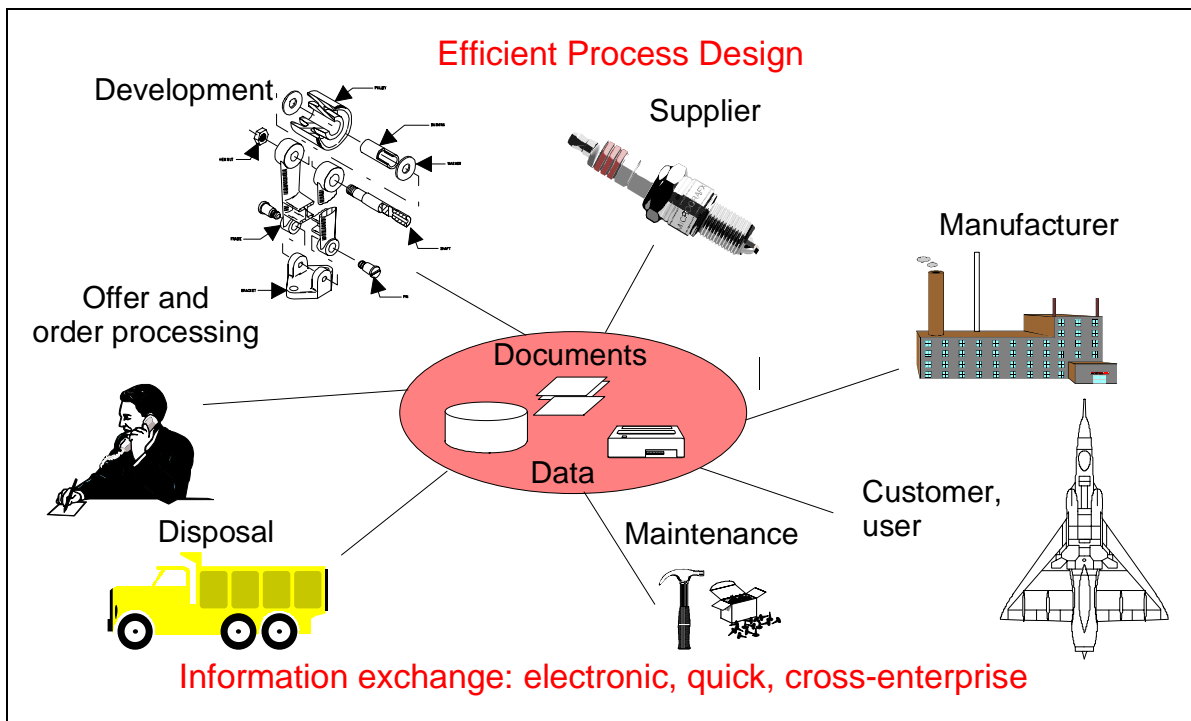


Figure 12: Integrated Product and Process Model of CALS

Upton and McAfee summarize the requirements for an IT architecture of VEs in three points [UpMc96]:

1. Integration of partners in all degrees of coupling ("dating", "engaged", "married")
2. Integration of partners with all degrees of IT sophistication ("naive", "experienced")
3. Providing all needed functions from simple data transmission over data access to tele-presence.

6 Conclusions

For a successful virtual organization you should not let yourself blind by fashion-oriented consultants or high-tech freaks. You should consider that virtuality makes no sense if, for example, your potential partner might eat you up or suck you out. Sometimes the technical process or legal risks prevent you from building a VE. Other contra arguments are a stable demand or your preference for corporate over mission identity. VEs also have disadvantages that might be reduced by IT (e.g. dependence on the sourcing and the selling side, redundant work, diseconomies of scale and scope, unclear face to the customer, no social security in short-living missions, etc.). A real win-win-situation, trust, and fit are essential for the success of a VE. Only having the systems mentioned before, without a proactive alignment between information management, corporate strategy, and mission goals, does not make sense.

References

- [AFHS95] *Arnold, O., Faisst, W., Härtling, M., and Sieber, P.*: Virtuelle Unternehmen als Unternehmenstyp der Zukunft? In: HMD - Theorie und Praxis der Wirtschaftsinformatik 32 (1995) 185, pp. 8-23.
- [Bund95] *Bundesverband der Deutschen Industrie e.V.*: Informationsmappe zu CALS. Köln 1995.
- [ChRW91] *Chrapary, H.-J., Rosenow-Schreiner, E., and Waldhör, K.*: Das Elektronische Organisationshandbuch. In: Lutze, R., and Kohl, A. (Eds.): Wissensbasierte Systeme im Büro. München 1991, pp. 295-312.
- [FaBi97] *Faisst, W., and Birg, O.*: Die Rolle des Brokers im Virtuellen Unternehmen und seine Unterstützung durch die Informationsverarbeitung. Working paper of the series "Informations- und Kommunikationssysteme als Gestaltungselement Virtueller Unternehmen". No. 13/1997. Bern, Leipzig, Nürnberg 1997, in preparation.
- [Fais95] *Faisst, W.*: Welche IV-Systeme sollte ein Virtuelles Unternehmen haben? Working paper of the series "Informations- und Kommunikationssysteme als Gestaltungselement Virtueller Unternehmen". No. 1/1995. Bern, Leipzig, Nürnberg 1995.
- [Fais96] *Faisst, W.*: Wissensmanagement in Virtuellen Unternehmen. Working paper of the series "Informations- und Kommunikationssysteme als Gestaltungselement Virtueller Unternehmen". No. 8/1996. Bern, Leipzig, Nürnberg 1996.
- [FaSp96] *Faisst, W., and Spiegel, H.*: Unterstützung der Anbahnungsphase von Virtuellen Unternehmen durch elektronische Firmenpräsentation und Partner-Retrieval. Working paper of the series "Informations- und Kommunikationssysteme als Gestaltungselement Virtueller Unternehmen". No. 7/1996. Bern, Leipzig, Nürnberg 1996.
- [KaFM97] *Kanet, J. J., Faisst, W., and Mertens, P.*: "Application of IT to a VE Broker: the Case of Epstein Enterprises". Internal paper presented at the German National Science Foundation Annual Review Meeting. Berlin, February 25, 1997.
- [Kru196] *Krulwich, B.*: The Good Ol' Bot Network. URL: http://www.ac.com/cstar/hsil/agents/framedef_art_cf.html. March 5, 1997.
- [MaRo93] *Malone, T., and Rockart, J.*: How Will Information Technology Reshape Organizations? In: Bradley, S., Hausman, J., and Nolan, R. (Eds.): Globalization, Technology and Competition: The Fusion of Computer and Telecommunications in the 1990s. Boston 1993.
- [Mars95] *Marshak, D.*: Tackling the Knowledge Management Problem. In: Workgroup Computing Report 18 (1995) 1.
- [MeFa95] *Mertens, P., and Faisst, W.*: Virtuelle Unternehmen, eine Organisationsstruktur für die Zukunft? In: technologie & management 44 (1995) 2, pp. 61-68.
- [Schi96] *Schinzer, H.*: CALS - ein Konzept für den überbetrieblichen Datenaustausch. In: Wirtschaftswissenschaftliches Studium 25 (1996) 4, pp. 205-208.
- [Swan96] *Swanson, E.*: The New Organizational Knowledge and its Systems Foundations. In: Nunamaker jr., J.F. und Sprague, R.H. (Eds.): Proceedings of the 29th Hawaii International Conference on System Sciences, Vol III. Los Hamitos 1996, pp. 140-146.
- [UpMc96] *Upton, D., and McAfee A.*: The Real Virtual Factory. In: Harvard Business Review 74 (1996) 7/8, pp. 123-133.

- [Warg96] *Wargitsch, C.:* Ein Organizational-Memory-basierter Ansatz für ein lernendes Workflow-Management-System. Working Paper of the Department of Information Systems I, University of Erlangen-Nürnberg 1996, to be published.
- [WeFa96] *Wewers, T., and Faisst, W.:* Kooperierende Workflow-Management-Systeme für Virtuelle Unternehmen. In: Uellner, S. (Eds.): Proceedings of the GI workshop "CSCW in großen Unternehmungen", May 9-10, 1996 in Darmstadt.