Chapter 4

Knowledge Management through IT support in Distributed Organisations

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4.1 Executive Summary

Part of the goal of the ISES project was to identify new business processes based on energy services. In other chapters of this book some of these services, such as load balancing and energy saving have been identified. We have also a separate chapter on new business processes and precision marketing itself. In this chapter we focus on information systems supporting high level interactions between customers and utilities as service providers. One key message is the importance of developing information systems in alignment with existing and emerging business processes. Another key message is that structures and standards are basic pillars on which we have to build a common understanding of the purpose of the business processes. Last, but not least, there must be a common task or added value which drives the business process. A challenge is to automate these kinds of driving forces.

4.2 Introduction

The ISES project started in 1996. At that time the Web-based parts of Internet had just taken off by showing the attractiveness of web-based publishing. The next wave of Internet applications, that is Net-based transactions such as electronic commerce, is much in focus today. Even more interesting net-based applications, such as smart equipment communicating on the electric grid in an Internet compliant way, can be foreseen in the near future. Our own ISES system of Homebots is but one example, [2]. In short, even during the short lifetime of the ISES project, that is three years, we have witnessed an emergence of technologies enabling complete changes of the ways we have perceived and done business processes.

Given the rapid pace of enabling technologies, foremost in distributed computing, and new web-based applications, it is fruitful to reassess some of the early project goals of the ISES project and extrapolate some of the lessons learned onto a present day understanding of suitable infrastructures for new businesses.

The key objectives of the ISES project were to investigate the impact on utilities due to two major forces. Firstly the deregulation of the energy sector, secondly emergent IT solutions. The deregulation of the energy sector could mean that the utilities face a transition from having a monopoly selling a commodity, kWh, to being players in a highly competitive market with very low profits on the commodity. Emergent technologies such as using the electric grid as a communication channel, gave on the one hand, the utilities a communication network for free. On the other hand, customers of the utilities could easily go other suppliers of the commodity unless they felt that the relation with the old supplier also gave some added value. In short, utilities should aim at getting out of the “kWh trap” by substituting selling a commodity with providing added-value services to the customer. Of course, this change of business strategies is not easy to do. It requires among other things a strategy for knowledge management of own and customer intellectual capital. A means to achieve this goal is to tailor suitable infrastructures of systems and teams. In the following sections we revisit some of the ISES projects and make some assessments of results as well as pointers to ‘Lessons learned’.

4.3 Background

4.3.1 Some ISES projects revisited

In the ISES project we identified the following subprojects, aiming at understanding and demonstrating necessary infrastructures supporting new business strategies.

– Information kiosks
– Databases and Standards in Information Networks
– Virtual organisations
– Distributed Autonomous Decision Islands

Our interest in *Information kiosks* reflected a holistic system view expressed in the acronym of the project ISES, i.e., Information / Society / Energy / Systems. This view can be summarised as follows. In order to have cost-effective infrastructures they have to be used for several new services as well as integrated with other societal networks connecting people. In retrospect, it was perhaps too early to aim at that kind of integration, at least in Ronneby where we have our test beds and pilot studies. Given these findings, the project itself was terminated early in the ISES lifecycle. However, the basic motivation is still valid and the time seems now to be mature for these kinds of network integration supported by a common browser interface for citizens to public services.

The other ISES subprojects mentioned above have however prevailed throughout the ISES project. The goals and approaches in the subprojects have been adapted during the years. Furthermore, the insights that *databases, standards and networks* enable *virtual organisations* and hence new business strategies have been re-enforced during the ISES project. It is equally clear that in order to build and maintain *enterprise wide information system* we have to avoid stand-alone 'stove-pipe' applications and aim for reuse of components and utilise horizontal integration in applications.

In our retrospective analysis of these subprojects it is fruitful to look at 'Lessons learned' from the standpoint of our present understanding of the issues addressed. We will accordingly in the next chapter introduce a 'learned' framework reflecting our present understanding of appropriate infrastructures. By this back-mirror approach it is easier to reflect on some 'obvious' failures or early 'successes' in the three subprojects.

4.3.2 Some ISES goals revisited

In retrospect an important goal of ISES was to investigate and demonstrate technical support for new business processes replacing selling tariff-based kWh by selling *services and functions*. The internal business of creating and distributing a high quality power supply was not directly addressed in the ISES project other than in the important issue of load management. The results of this sub project, *Distributed Load Management*, are discussed in another Chapter of this book. In this context we will only focus on the fact that the customer can have smart equipment, *Homebots*, connected to and communicating with each other as well as with a smart action agent at the utility side, [2]. The Homebots knows the *customer preferences* and his / her willingness to buy or sell energy at any given moment in time.

In this setting we can summarise the results of that subproject as that we have demonstrated that the utility can offer a basic *energy saving service* to the customer. Besides obvious energy savings the utility can benefit from a smooth demand and possibilities to extend the service to include for instance *safe and secure homes* or smooth production in case of an industry. Properly handled, it is obvious that utilities in this way can make higher profits by selling less kWh.

Equally obvious, the utility has to *establish and maintain a relation to the customer based on services and trust* as well as offer new *customised services* in the *right form* and in *the right way*. Obviously the electric grid can serve as part of the physical communication infrastructure but this should be transparent to the customer, [15].

Since 1994 there have been a tremendous evolution of web-based applications. As a consequence, Intranets and extranets have complemented the concept of Internet. These concepts are more than buzzwords since they capture the facts that the open standardised Intranet technologies, including a common browser interface to all applications, can be profitable implemented as in-house networks or as networks connecting customers and their counterparts in the enterprise. The Internet technologies have their own push and pull forces. In the ISES project it was more important to design and evaluate a higher level infrastructure in alignment with existing and emerging business processes. In retrospect, the ISES goals for some of the subprojects can be reformulated as follows:

– Databases and Standards in Information Networks. *Models for customised electronic platforms for utility services.*

– Virtual organisations. Models for knowledge creation and sharing in task oriented groups.
– Distributed Autonomous Decision Islands. Models for enterprise wide applications supporting businesses and business creation.

These re-formulations reflects both a deeper understanding of the issues under investigation, based on 'Lessons learned' and are elaborated in the next section, as well as pointers to future work.

4.3.3 Models of interactions with customers: A summary of Lessons learned

The basic model of interaction with a customer in a monopoly situation and in the case of a commodity is basically that the customer buys the product or service without any further interest from the supplier. As an example: A customer decides that he/she wants to buy electricity from a utility. The utility responds by setting up a meter at the customer site and delivers the needed power. The customer then gets a bill referring to the amount of consumed kWh as well as tariffs and other rather technical information. Furthermore the bill is often based on predictions of consumption which makes it difficult to have a clear picture of the potentials of for instance energy saving or avoidance of expensive peaks in the consumption.

Having this in mind, it is quite clear that a first mean to create a better interaction with the customer is to design and implement a suitable form of an *Interactive Bill*. As a matter of fact this was also a first attempt in the ISES project, [10]. However, the attempt did not become a full-fledged prototype mainly for three reasons. Firstly, it turned out that the infrastructure, that is a sufficient smart meter at the customer site allowing a bi-directional communication was not in place in time to set up a real pilot study. However, the meter functioned excellent as a re-mote metering device meaning that the local power distributor had real-time access to a database containing a complete and automatic updated history of power consumption at individual meters in the test. The second reason, or obstacle, was that at that time we did not have a clear picture of the factual content nor of the presentation style of the Interactive Bill. The presentation styles, decision styles, as well as users expectations of an Interactive Bill have, however, been investigated in another ISES project on New Business Processes, [15]. Thirdly, it turned out that the local power distributor did not have a clear view of how to handle the billing in the new situation. Issues such as security and trust in electronic information exchange were not properly understood at that time. In retrospect, it was

thus very premature to aim at a real, useful and functioning Interactive Bill during the ISES project. However, the lessons learned highly influence our mindset of future models of interactions between customers and service providers. We will return to this point later on.

The ISES project was itself a distributed project and hence it seemed natural to use the project as a test bed for ideas and techniques that seemed appropriate to support future business processes. A *Virtual organisation* was such an idea, [11]. Another idea was an *ISES web site*,www.enersearch.se. The main thought was that the web site should support a virtual organisation of researchers and people from participating companies in information exchange and hopefully knowledge creation and knowledge sharing. The results should then be reusable in future models of customer-utility relations.

Our findings on virtual organisations are presented in a separate chapter in the book. In this context we can state that in order for a virtual organisation to function it must have very clear objectives as well as clear roles for the participants. It is not sufficient to set up a technical infrastructure! Furthermore the electronic based information has to be *structured* (also including information about the information, meta information) in a way that *guarantees* (obligations and trust) that the *right information* (content and amount) is delivered to the *right persons* (teams and rights) to access it at the *right ti*me (part of a process). The remarks within parentheses are the important points to address and we will return to these issues in our reflections on the ISES subproject on *Databases and Standards in Information Networks* in a separate section 4.4, [3].

The ISES web site has not been the kind of information source it meant to be. Basically it have most of the time only included project descriptions and a few references. This despite the fact that we have had at our disposal state of the art data base technology such as Informix-Illustra and collaboration tools such as BSCW and ICQ. Furthermore, we have made several attempts of teambuilding and decisions to use the tools without any greater success [5], [6]. A reason for this is that a collaboration tool, such as BSCW, takes some efforts to learn and to use. Furthermore, it takes time and efforts to design and build up a sufficient rich and structured database. Since no explicit time was devoted to these activities in the subprojects, there was a lack of incentives or added value for the individual team members to take onboard these extra efforts. Of course, everyone, at the end of the project, would like to have such a knowledge base!

At the final stage of the ISES project the site have been reorganised and relevant points of reference have been added. This makes the site an example of a good information source. Nevertheless, search and notification-of-change facilities can be significantly improved. An important lesson learned, however, is that the design of such facilities requires careful consideration of demands posed on the providers of the information (mainly the project researchers). Too high demands, e.g., imposing too detailed and specific document style rules, can make the effort too big for the informant, implying that important information may not be submitted. Too low demands on structure, on the other hand, disables efficient information management to the benefit of users. Thus, design of technical facilities must carefully consider the social and individual factors in a distributed and virtual organisation. Furthermore, virtual organisations require clear and explicit management. Having sufficient structured information available, in an easy to use manner, will eventually create a useful information sources supporting re-use in other (business) processes.

A drawback, from a business process point of view, with the ISES web site is that, as most web-sites, it is a browser-based information source. That means a passive source in the sense that the user has to do the entire search, and waiting, at every access. Future business processes have evidently also to be supported by active mechanisms such as 'Active documents' and 'Active billboards' to become real processes, [12], [16]. We have developed prototypes of these mechanisms in the ISES project. These will be described in section 4.4 on *Databases and Standards in Information Networks.*

As we have earlier said, we can simplify a goal of the ISES project as a mechanism replacing selling kWh with services of added value to the user. Such a mechanism could be an electronic market where user needs are captured and met by service providers. In figure 4:1 we will discuss such a model of an electronic market place for selling and buying services based on an energy component. We have already concluded that a bare-bone technical infrastructure would not suffice as a platform for new business processes. What will be needed is a closed infrastructure including customers and service providers, i.e., an *extranet*. The degree of closure depends, among other things, on the trust and integrity needed in the processes. In order to add support for service identification as well as service delivery and creating value for the customer we also need an explicit *context* and *context based services*. As an example, the concepts of *offer*, *bid*, *auction*, and *bill* have to have a common meaning or *semantics* (depending on the context) in order to become a basis for electronic sup-

ported business processes. A common name for this kind of context is a *community*. In summary, the kind of infrastructure we are aiming at can be described as follows. An extranet supporting several communities, which each is an environment enabling user-centric services.

Furthermore, in order to reuse business component in several applications we should have a *service oriented ar*chitecture rather than a traditional client-server architecture, [12]. In a typical client-server application the business rules are hardwired as code on the client and server side making it difficult to change or extend applications. Furthermore, some business data such as customer profiles are needed in several applications and typically have to be duplicated in client-server type of applications. In a service oriented, or component based, architecture there are a set of common and re-usable 'business components' providing services to active objects, agents, and thus creating applications. An example of this type of architecture and adaptive services is 'Active documents', which we will return to in section 4.4. Let us take an other example. In the ISES project have we developed two kinds of agent based applications: Distributed load management and Value added customer services in intelligent buildings, [2], [4]. Integration of these applications is not straightforward since we might have conflicts between the goals of the services *energy saving* and, e.g., *comfort of living*. The integration will be simplified by defining and using common components and active components (agents) as a basis for the two applications in a service-oriented architecture. Additional components or agents can then be added to resolve or highlight potential conflicts to the user.

The following figure 4:1 captures the main components of a community-based infrastructure mentioned in the previous paragraph. Of specific interest to us are *communities of smart equipment*, e.g., communities of equipment and services in smart homes, e.g., Homebot based services.

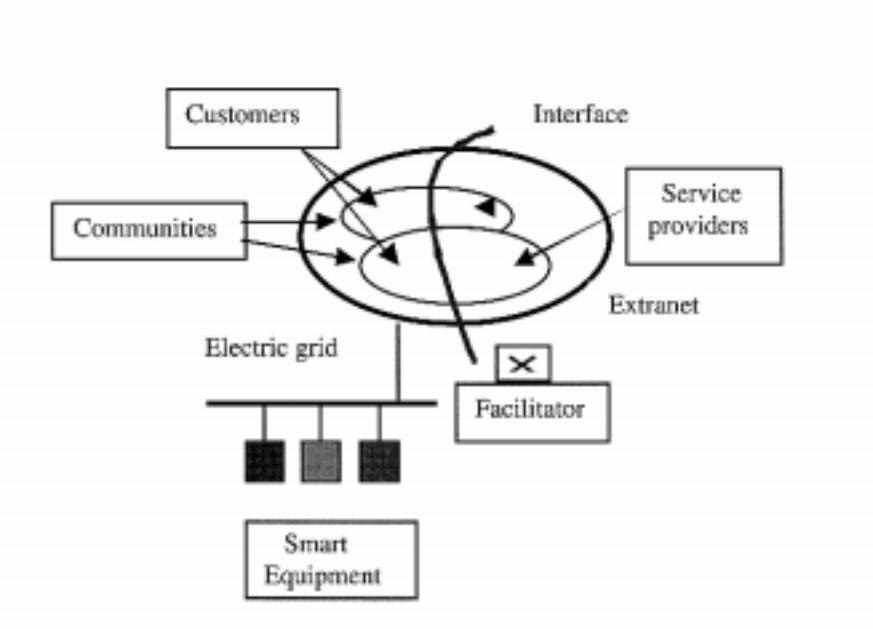

Figure 4:1. Basic components of a service oriented electronic market place.

Our findings of some characteristics of models of interactions are collected in the following table 4:1.

Interaction Model	**Support for real-time customer-supplier interaction**	**Support for process creation and execution**	**Support for knowledge management**
Commodity market	No	No	No
Interactive Bill	Yes	No	No
Communities	Yes	Yes	No
Virtual organisations	Yes	Yes	Yes

Table 4:1. Characteristics of some models of interaction.

In the table 4:1 we compare four interaction models. The first model, a *commodity market*, could be a stand, among many other similar stands, offering a commodity (e.g., kWh) for locally the same price and with usually low profit to passers-by. The interaction model *Interactive Bill*, reflects

an electronic interaction window (typically a frame in a first generation of catalogue based web sites) where a user can read information and answer or put questions in a pre-defined style. The third interaction model, *communities*, pre-supposes a common vocabulary and support for business processes and business creation. In the latter case we mean support for matching customer needs with business opportunities. The last model of interaction, *virtual organisations*, also have explicitly defined roles for the team members and also explicitly defined business rules, social rules, commitments, contracts, team formation methods and rules, and goals and methods for knowledge creation and knowledge management.

The yes / no entries in the table indicate that it is possible or impossible to implement the three tasks, mentioned in the headings, in the different interaction models. The bottom line is that an interactive bill approach would not suffice if we intend to create an electronic service market with potential. On the other hand, a full-fledged virtual organisation is overkill as a market model. A virtual organisation is more properly based *within* an organisation, i.e., supported by an intranet. In summary, a proper infrastructure for a flexible service based market between customers and their service providers is a community.

In the following section 4.4 we evaluate our efforts in the ISES subproject Databases and Standards in Information Networks and also, as illustration of services, the efforts of the subproject Distributed Autonomous Decision Is-lands, [4]. Occasionally, we will refer to figure 4:1 or figure 4:2 in order to highlight dependencies.

4.4 Databases and Standards in Information Networks

The content and sub goals of this subproject have changed throughout the life span of the ISES project. The overall insight that standards and databases are a core technology supporting business processes has however remained invariant.

From figure 4:1 we find that customers and service providers are interconnected in communities supported by extranets. As an example we can have a community based on services related to power consumption. In this context we can easily implement the concept of an *Interactive Bill* mentioned in section 4.3.3, [10]. Members of the community have a clear and common understanding of all the concepts and their use in the interaction.

Assume now that the service providers (utilities) somehow can identify a new service possibility by being told by customers or by inference from customer behaviours. The next step for the service providers would be to identify relevant competence and knowledge within their companies. From that point the service providers could assess the new business case and eventually offer a new customised service to the community. There might also be possibilities to adapt the service to needs in other communities. This is an example of knowledge management where we have used and strengthen the customer intellectual capital (more value-added relations) as well as utilised the intellectual capital in companies to meet new business opportunities, [14].

The example above might seem farfetched but reflects what is now happening in many parts of the financial sector, e.g., quicken.com, or in eCommerce, e.g., amazon.com.

Obviously, in order to develop information systems based on communities, we have to understand and model the content and purpose of the information exchange as outlined in the example above, [3]. Clearly this mean that we have, as we discussed in relation to figure 4:1, to bring ‘semantics’ or context to the technical infrastructure provided by extranet standards, [13]. The technical infrastructure can be seen as scaffolding for communities.

We will now present our work and lessons learned from the ISES subprojects mentioned above under the following two headings.

– Standards for information structuring, use and re-use.
– Active components in information networks.

In the first section, section 4.4.1, we focus on information structuring as a base for creating content with meaning and hence possibilities for knowledge sharing. The next section, section 4.4.2, addresses the need for supportive information nets going beyond present day time-consuming browsing for information.

4.4.1 Standards for information structuring, use and re-use

Key factors for the success of web-based publishing, the first wave of Internet applications, are the standards HTML and http. The Hypertext mark up language, HTML, is used to define, or mark up, the structure of the content of a 'document' and http is the hyper text transfer protocol. The use of the URL addresses makes it possible to create hyperlinks, a web, of interconnected documents. Standardised browsers and search engines make it possible for a wide audience to access and search websites for information in HTML-documents.

Besides the mark up of the content, the HTML standard also specifies the layout and presentation of the document. The browsers, e.g., Netscape or Explorer, can then fetch a document with a given URL-address using the hypertext transfer protocol http and parse and display the HTML document The strengths of the HTML-http standards are also key reasons for their weaknesses. Currently, most developers provide a mixture of content information and display information, and this makes it very difficult to search HTML-documents based on content. These difficulties are manifested in all efforts to create efficient search engines for Internet. In short, if you do not have explicit content information it is difficult to access that kind of information! Merely *syntax* information creates the explosions of hits we now experience in searching the Internet. As an example, an AltaVista search of 'Power' gives you in the order of 7 029 606 web pages to look at! The Internet is too underdefined with respect to semantics or meaning.

The standard HTML was established in 1993 and is based on the ISO standard SGML. The SGML standard is used to describe tags, content, in a (generalised) document. The definitions or SGML tags are then specified in DTDs, *Document Type Definitions*. Presentations are also specified using a style standard DSSSL.

At the beginning of the ISES project we aimed at using SGML together with other standards to specify ISES documents. The purpose was to have a clear separation between content, meta information and presentation for reasons discussed earlier. At that time there was very little tool support for this attempt, so we postponed our efforts of having SGML documents in an Informix-Illustra database web-accessible through DTD-based data-blades.

Meanwhile, the W3C consortium made efforts to define a new standard, based on the SGML standard, supporting advanced web-publishing and other web-based applications. The standard proposal was named XML, Extensible Markup Language, and was released in the beginning of 1998. The XML family of standards includes DTDs and a standard RDF for translation between DTDs as well as a hyper linking standard, XLL, for combining XML documents. Furthermore we have the style standard XSL, a subset of DSSSL (Prescod) and a Meta Content Framework (MCF) to provide information about information. Major vendors support the XML family of standards and new tools are developed continuously.

The rapid development of the XML family of standards is of course due to a general understanding that we need methodologies and tools to support structuring of web-based documents. In fact the XML standards are rapidly becoming the default choice for information structuring as well as for high-level message passing between smart software, e.g., as an agent communication languages (ACL). The XML approach to high-level message passing in electronic media is under investigation in standardisation bodies such as FIPA and in several EC funded projects. In the EC funded network of excellence AgentLink there is also a special interest group on Intelligent Information Agents where the XML approach is a key technology.

We have in the ISES project focused on a methodology, *decision style theory*, as a means for precision marketing, [11], [15]. In our context we can say that decision styles provide a methodology to judge how *much* information is suitable for a person in order to provide just enough information in a given decision context. Given this information a trained human being could ideally provide that kind of information from a given information source. A challenge is, of course, to *automate* this process. This is *far* from a simple task as we have learned from our experiments, [3], [12]. We can, using the XML family of standards, of course 'hand-code' the content of small information sources to reflect *a view* on different decision styles. In order to make advancements we have to, at least, include *meta-*

information and settle on semantics. That is to establish a suitable set of concepts and relations, ontologies (e.g., specifications of shared conceptualisations of persons and of agents in a context or organisation), which are shared among users in a *community*. That kind of effort is under way at HK/R in several master projects, e.g., [3], [12], [16]. A key methodology supporting these efforts of knowledge requirement engineering is the de facto standard CommonKADS, [17].

Given that we indeed can provide a community-wide ontology, we still have to embed the information exchange in a context dependent dialogue. A promising technique in this direction is adaptations of *situation semantics*, [8], [9], [13], which are in the research focus at HK/R.

To summarise: The decision style approach addresses one important view on information exchange. It is still an open question how much of the underlying technique can be automated. Technologies such as the XML family extended by meta-information technologies and supported by community wide ontologies are necessary but not sufficient conditions. In order to have a full-fledged dialogue as in the example above we also have to understand the purpose and context of the information exchange, [1].

4.4.2 Active components in information networks

Information and knowledge exchange is hampered if we only rely on a passive information net. That is a browser style of 'clicking and waiting'. The general situation would not change even if we had at our disposal suitable meta information telling us in advance what kind of information the URL address is providing.

In the ISES project we have addressed some problems with a passive information net by designing and implemented demonstrators on 'Active billboards' and 'Active documents', [12], [16].

The main idea behind an active billboard is to create a well-known meeting place in a (virtual) organisation or in a community. That is a place where you always know that it contains information of general interest. The active part of the billboard is a *mechanism* that allows you to subscribe and unsubscribe information on a topic attached to the billboard. Of course, you can also, if you have the right authority, add new topics. In that case, the billboard automatically informs subscribers of 'semantically near' topics about the new service. The design of the demonstrator

was a nice example on development of ontologies and use of models in CommonKADS on organisations, tasks and agents.

The active billboard illustrates the theme ‘information available’. Our design and efforts on ‘Active documents’ have an other focus. In this case we have a known group participation in knowledge sharing on a specific topic. As an example, we can think of documents needed and created during a meeting or documents needed for project management. The idea is that the documents ‘knows’ when and where to go, i.e., they support a business process. Again we have done some exercises on ontologies and CommonKADS knowledge engineering. Based on this information, we have also made, as we have mentioned above, some structuring supporting different decision styles. The active documents are built of reusable components managed by smart facilitators in a service-oriented architecture. Service-oriented architectures are basic requirements in building enterprise wide information systems, where major business objects can be re-used.

4.5 Conclusions and pointers to the future

To summarise, we have the following list of lessons learned from the infrastructure projects of the ISES project.

- Going from selling of a commodity to creation and selling of value added services to customers is a knowledge intensive task.
- The supporting infrastructure has to be designed to support the business relation and process between customers and service providers.
- There are emerging standards, the XML family of standards, which provide means for structuring of information which allows for intelligent support of electronic information sharing.
- A suitable framework seems to be an extranets supporting a community of customers and service providers.
- Social and organisational aspects play and important role in virtual organisations. These aspects might be difficult to specify and implement in systems.
- The ISES project has given valuable insights on these topics.

In an ongoing Ph.D. project at HK/R is Nasrin Biglari modelling the ISES project as a community creating and presenting information on demand from other members of the ISES team or from ISES sponsors. As a first step she has used the CommonKADS methodology in a requirement analysis of a supporting 'smart information system'. The findings support our earlier discussion and can be summarised in the following message.

In a distributed and virtual organisation people have different interests, styles and are (relatively) difficult to co-ordinate because they are distributed in space and time. So, common processes are (and must be) relatively limited. Thus the social aspects of a virtual organisation pose rather strong and specific demands on the design of technical infrastructures for knowledge sharing and management! These findings are also confirmed by lessons from the ISES subproject on Virtual organisations as reported in an other chapter of this book.

It is often said today that IT systems have to be in alignment with business processes. We agree but add that the systems also have to be in alignment with people's needs hand habits. These demands are daunt-

ing if we aim at support for virtual organisations. However, if we limit

ourselves to business communities, as we have discussed earlier (table 4:1), it is quite feasible that we can in an evolutionary way develop very useful and profitable support systems for new business processes.

Our next steps in this direction will be in the *It in Energy* project, which is the planned continuation of the ISES project.

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