Information Technology at Work

The Agenda for Applied Research and Development at SISU

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SISU • SWEDISH INSTITUTE FOR SYSTEMS DEVELOPMENT

Table of Contents

1 An Agenda for R&D

1.1 Motivation

This document outlines the content and direction of applied research and development in the information and communications technologies to be performed by SISU. Our time framework is the next 5 years.

The overall objective is to advance the application of Information and Communication Technology (ICT) in areas important to Swedish industry and public authorities. This applied research will be directed by guidelines from industry, technical trends and current research.

SISU has a well-documented history of research in information systems development, notably in requirement engineering, interactive systems design and applied database technology. The current research program is based on these results, focusing on the applications of ICT.

1.2 Structure and Content

The agenda consists of three inter-related parts: industrial dissemination, application areas and scientific dissemination.

Fig. 1.1 Application areas form the central part of the agenda indicating the direction of SISUs efforts.

- Application areas provide a common ground for focusing on problems and opportunities foreseen in the current and expected development of ICT. Important considerations for application areas include requirements from the perspectives of both the individual and the organisation as well as the use and effects of emerging technologies. The set of application areas prescribes SISUs current direction.
- Industrial dissemination, includes the transfer of technology and knowledge to industry, based on contributions made to application areas. This transfer is mutual and is based on a continuous dialogue with industrial partners. This part of the agenda will be subject to periodic modification to meet the demands of industry.
- Scientific dissemination includes a number of research areas. Their role is to provide research results for the use of application areas, and conversely, to provide channels for the scientific publication of original research results. The areas include internationally established research topics for which SISU has and will maintain competence.

The application areas form the central part of the agenda. It is in producing contributions to these areas that new research results are made use of and new research issues formulated. The concrete results are transferred to industry. We have selected three application areas which taken together cover the most significant potential and problems for ICT development and use in the coming years. Application areas include,

1. *Business Process Improvement*, in which ICT is seen as facilitating technology for changing the ways in which organisations and individuals collaborate and organise their work.
2. *Business Intelligence and Decision Support,* where applications are focused on the collation, management and analysis of information from the environment external to organisations.
3. *Exploitation of Information Markets*, which focus the use of emerging global computing and communications platforms for the delivery and consumption of new IT-based services and products.

Although these areas are by necessity broad and to some extent overlapping, they represent different perspectives on and expectations of ICT.

For the scientific dissemination we have chosen to address the following research areas,

- *Software Process Improvement*: which focuses on the software design process in relation to the organisation and its products.
- *Cooperative Information Systems*: where research aims at improving the interoperability of loosely coupled distributed information systems, including the elaboration of the architecture of such systems.
- *Multimedia Information Retrieval:* retrieval and acquisition from large multi media information spaces.
- *Usability*: which deals with methods for assessing the quality of software artefacts with respect to user needs and working practice.
- *Human Communication and Technology:* which takes a socio-technical view of communication in organisations.

Research on improving the software design process emphasises the whole of the development process in which software is an important part of the product or service to be supplied. Whereas traditional software engineering research has focused on the software process alone, process improvement research also tries to include other aspects such as innovation and change management. Various process metrics and concurrent engineering methods are studied in this context. Successful business process improvement and applications for information markets, require a better understanding of this overall software process.

Many applications in the two areas previously mentioned, have a central aspect in common in that these systems have to be generally based on loosely coupled configurations of components. Cooperative systems research deals with the inherent conflict between the need for integration and the control of resources on a local level, e.g., with respect to sharing information and transactions.

As a consequence of the increased distribution and connectivity of systems, their content in terms of data becomes ever more complex and diversified. The management of large or complex, and possibly distributed, information spaces based on multiple media, is still technically difficult. Key issues include the

indexing of such heterogeneous information sources and their meta data descriptions. Advanced business intelligence applications will require these issues to be resolved.

Usability is one important component of quality assurance for information systems artefacts. An important problem is the integration of criteria for usability analysis in the design process.

Finally, communication and interaction are inherent aspects of all our application areas. Research in the area of Human Communication & Technology aims to elucidate and explain patterns of communication within and between organisations.

SISU is committed to maintaining the necessary academic competence to exploit results from these areas as well as the skills needed to produce and publish original results within corresponding scientific fora.

The third part of the agenda refers to industrial dissemination, i.e., the way in which contributions to application areas are put to practical use. This dissemination is also intended to capture requirements and guidelines. Dissemination is based on a number of result areas derived from the above application areas. Each such result area is maintained for a specific period of time. The current set of result areas are described in part 4 of the agenda.

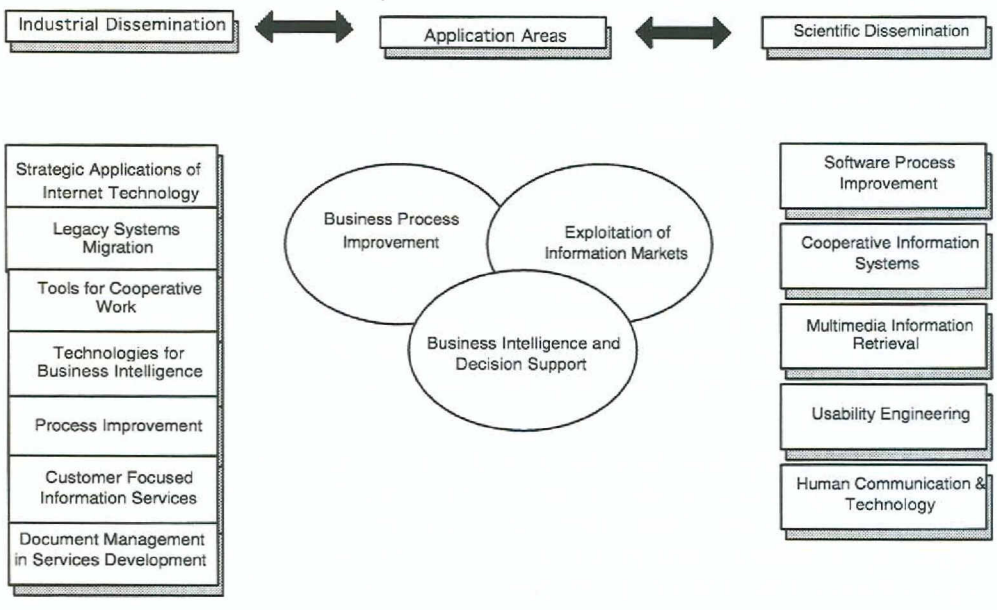

Fig. 1.2 Framework for the agenda.

The agenda is implemented by means of individual projects. Projects work towards contributions to one or more of the application areas.

2 Application Areas

2.1 Business Process Improvement

2.1.1 Rationale

The way business is being done is changing radically, transformed by intense global competition, rapid technological advancements, ever-changing markets, and more diversified and sophisticated customer demands. The effects, among other things, will be shorter product life span, shorter time-to-market, quality and service improvements, and increased business flexibility and adaptability. Furthermore, businesses tend to be more geographically dispersed and to apply more decentralised management and control. Increasingly, processes and information are distributed as well as inter-organisational. Efforts to establish different kinds of information marketplaces are underway.

Since nothing is more crucial for an organisation's competitive success than its ability to develop new products and services and deliver them to customers or beneficiaries, the improvement of manufacturing, product/service development and the delivery processes are important applications for information technology. In this application area we define *business process improvement* as the improvement of general organisational efficiency through deployment and use of information technology.

The rapid development of information technology and its application areas have resulted in many new approaches to increase customer value and improve the organisation of work including *Business Process Re-engineering*, *Concurrent Engineering*, *Total Quality Management* and *Continuous Acquisition and Life Cycle Support.* These approaches for improving business processes are both abundant and diverse, but have altogether changed the way we look upon the business application of information technology. Most importantly, these approaches have resulted in the common acceptance of a "process perspective" on business development and the realisation of the facilitating role of computers, software and network technology to improve time-to-market, reduce costs and increase customer value through better products and services.

Traditionally, computers have been used in rationalisation and as support for old, relatively stable business processes, typically the back end or the supporting processes. Now they are increasingly used in changing and supporting drastically new processes, which are flexible, dynamic and inter-organisational. One related development is the quest for more flexible forms for how people can work in groups in pursuit of common goals. Therefore a commonly accepted view is that information technology should be able to support the management of change, while at the same time keeping organisations together. As an example, current technology (such as network services in combination with mobile computing) may allow for businesses to be supported by ad-hoc organisations, or *virtual organisations*, providing flexibility in both customer interaction and the organisation of work.

2.1.2 The Role of IT

The challenge in the *Business Process Improvement* application area is to integrate changing human and organisational communication patterns and the design of new business processes, with the change and adoption of new information technology, the development of new information infrastructures and computer systems. The application of the new methods and technologies in the following areas are the most crucial for Business Process Improvement.

Component frameworks and configurable standard applications

Given this new reality, we might expect substantial changes in the way we analyse, design, implement, and deploy new computer systems. Speed, accuracy, quality, flexibility and low cost are concepts we immediately recognise. Generally, new business opportunities will be supported by reconfiguration, specialisation, and small increments of an already existing framework rather than by the development of fully new systems. To this end, the most significant developments will be in:

- High-level component frameworks for customised business applications.
- Component software and object technology.
- Methods for systems assembly and reuse.

Computer Supported Collaborative Work

The advanced use of information technology allows for new, more efficient work forms, services and changing professional roles. This development will be driven by the expected growth in exposure of new networked multimedia technology that enables the members of a project team to work together on a common task despite differences in geographical location. They will be able to collaborate and communicate more efficiently than ever, both synchronously and asynchronously, with shared software tools, electronic documents, sound and video. Identified key technologies are:

- Shared electronic workspaces and broadband network services.
- Mobile computers and wireless communication services.
- Application sharing with real-time audio video communication.
- Group computers and software tools for meeting support.

Change management and business design

The existing circumstances in terms of information systems and associated work procedures are the most difficult obstacles to change in organisations. The normally huge inventory of existing, or legacy, systems – each representing a massive investment of time, money, and experience – must be integrated with the new environment or migrated to it. Tools exist that assist in the description and analysis of existing systems, but these must generally be combined with software tools for mapping and simulating business processes. These tools enable an analysis of the consequences of change to be made before changes are introduced, and also provide an opportunity of finding new forms for the organisation of work through new technology.

2.1.3 SISU Contribution

Contributions by projects addressing this area shall include:

- Approaches to component based systems development and (re-)use.

- Methods and technology for legacy systems integration.
- Models for inter- and intra-organisational information exchange and co-ordination.
- Models and technology for co-operative work.
- Models for IT strategy planning and corporate infrastructure development.

2.2 Business Intelligence and Decision Support

2.2.1 Rationale

Business intelligence, i.e. gathering and analysing information about the organisations' external environment, is becoming increasingly important for the business objectives and strategies of an organisation. Up until now, business intelligence has often been collected manually either by individual experts or by one or several separate business intelligence departments. This process is often slow and inefficient, intelligence observations are seldom shared within the organisation. Business intelligence is also often collected on an ad-hoc basis rather than being motivated by the business objectives of the company. Now a number of new information technologies and services exist which, if integrated and applied in an innovative way, promise to radically improve the business intelligence process. Examples are Internet/WWW, on-line database services, filtering agents, advanced retrieval tools, multimedia databases etc.

Business intelligence has to be distinguished from internally generated performance data or data on customer buying patterns provided by data warehousing systems. The development of information tools is currently focused on these internally generated sources, and their structuring and analysis, and on data provided by micromarketing techniques (data warehousing, data mining, OLAP). It is imperative that, while the market is focused on these tools and data sources, RTD addresses the next generation of intelligence requirements – i.e. the external information environment.

Organisations want their business intelligence activities to be carried out in a controlled and systematic way and to have them closely related to their business strategy. They require information to be collected, classified and interpreted in line with their own strategic business models. The essence of a business intelligence system is that it provides a potential advantage, in that it can provide superior data collection and interpretation options. The company needs to define and own this process. In this applied research area we therefore look beyond the data warehousing phase at the new generation of requirements.

Business intelligence is part and parcel of the new requirement for companies to be infinitely flexible in their choice of markets and technologies. Companies that top their industry in terms of sales growth and profitability often get a major share of their revenues from products introduced in the past five years. Any new service or product development today has to take into account the technological competition strategies of rivals in a global environment and an extremely rapid period of change. In addition, the new emphasis on networked organisations requires the management of many thousands of external relationships and the ability to seek out the most competitive suppliers. The

company's external environment has become a crucial arena for competitiveness.

In the context of rapid change in the external environment, a strategy can never be reliable if it does not have access to the best intelligence. That intelligence needs to be filtered and structured so that it can be used in real time. There is a cyclical element to this structuring. Decision tools are needed which allow business analysts to set the right parameters for filtering and data acquisition tools; intelligence has to be processed so that its relevance to strategy is clearly indicated.

In short, systems to support intelligence on the external environment are necessary to support industrial competitiveness at a time when organisations are restructuring and facing increasing demands. The demand is already visible, but tools have to be designed with ease of use, high functional performance and low life-cycle costs in mind.

The objectives of work in this domain are therefore:

- to develop a framework for business intelligence gathering, processing and related decision making procedures.
- to develop methodology and organisational implementation guidelines.
- to define, develop and evaluate a suite of business intelligence software tools.
- to develop methodology and guidelines to help organisations implement business intelligence systems.
- to test and evaluate the business intelligence framework in pilot applications to demonstrate how business intelligence can be carried out systematically and in relation to the strategies and business objectives of the organisation.

2.2.2 The Role of IT

There are a number of established and emerging technologies that can provide a platform for business intelligence applications. The following key technologies are identified:

- Multimedia storage
- Information retrieval
- Information acquisition
- Classification and categorisation
- Intelligence modelling

Multimedia database technology is an emerging technology available in different forms. Extended relational database technology is now about to make a commercial breakthrough. Under the ESPRIT project INTUITIVE significant advances have been made in the representation and retrieval of multimedia objects.

Currently, almost all retrieval systems use a text-based retrieval method. Images are usually indexed by giving a descriptive text or a set of keywords which are then searched in a traditional text-searching manner. Hypertext technology for information retrieval has experienced an enormous uptake

through the advent of World Wide Web which makes hypertext information available over the Internet.

It is imperative that new developments in on-line information acquisition are incorporated into a business intelligence system. The growth of on-line services and the extension of the Internet to corporate users means there is already a global electronic library of information accessible. On-line services are a necessary part of a business intelligence suite. Current search techniques in the on-line industry are still in need of development. They offer no guarantee of the reliability of the searches. Current estimates indicate that the precision of on-line retrievals, i.e. the proportion of relevant retrievals, is approximately 5% of total retrievals.

Agent-based software are currently being tested in the context of information retrieval and searching. Although promising, the agent-based techniques are still in their infancy and not yet stable. Experiments are taking place on Internet with so called WWW robots, that travel the net and extract indexing information about Internet documents in order to provide search facilities for end-users.

Tools and techniques for classification and categorisation have been a research theme in the AI field for many years. The approach taken has been to try to provide machine support for classification. Two approaches have been favoured; *analogical reasoning* and *similarity-based classification*. Analogical reasoning applies existing knowledge to a new problem on the basis of similarities, while similarity-based classification addresses the problem by fitting an individual case within existing generalised cases, using techniques like case-based reasoning and inductive learning.

Tools and methods for intelligence modelling are closely related to the issues of classification and categorisation. In fact, the forms chosen for representing the business intelligence information will reflect how classification and categorisation can be done. It will also influence the power and precision of the search and retrieval tools. Intelligence modelling is where information modelling exists in conjunction with decision support modelling. Examples of modelling approaches for intelligence purposes are *focus matrix analysis* and *network analysis*. Focus matrix analysis means that a matrix is defined, one axis represents the environment objects to be monitored, while the other axis represents different aspects of the monitoring. Network analysis focuses on structuring the environment of the organisation into some form of semantic network.

2.2.3 SISU contribution

Projects addressing this area should contribute to the following:

- Models for business intelligence databases.
- Architectures for business intelligence systems.
- Methods and tools for computer supported surveys.
- Prototype tools for structuring, classification, filtering and retrieval of business intelligence.
- Reports on best practice in business intelligence.

2.3 Exploitation of Information Markets

2.3.1 Rationale

Trade and service delivery by means of information and communications technology will definitely increase with the emergence of a global information infrastructure composed of a variety of networks for the delivery of any kind of information. The various national and international initiatives for the promotion of an Information Society reflect the desire to grasp this development, and the importance attributed to it.

The information and communications industry, dominated by the computer, telecommunications and entertainment industries, is currently a driving force in this development. As connectivity increases, any organisation, public or private, commercial or non-commercial, now has the chance of becoming a supplier or user of information based services. Although personal services have been in focus, services for commercial use by organisations and businesses will become equally important.

Whereas, up till now, the notion of a global information infrastructure has been equated with connectivity and communication in terms of networks, much of the future development will be focused on content in addition to the continuous improvement of the technology for delivery. The first generation of information services have been on-line versions of current services (banking, travel reservations, digital journals etc.). The new services must, from a consumers view, provide increased utility, lower cost and ease of use compared to current practice, and enable shortened lead times and increased market reach for the producer.

Thus, many of the new products and services developed partly as a result of improved business processes and a proficiency in business intelligence, will be specifically designed for trade and use by means of global networks. We now see the emergence of electronic information markets involving a variety of different sectors in business and society, possibly also integrating previously separate ones. Current computerised trade procedures, such as those based on EDI, are complemented by new network-based trading scenarios involving a variety of products and services, where information in itself is one important commodity.

We can only speculate as to the variety and scope of the services provided through future information markets. They will include a vast range of commercial services, public services, e.g., for health-care and education, as well as refinements of existing personal information services. The actors in these information markets will require different tools in terms of technology and software applications, depending on their roles as producers, providers or consumers.

- Producers will need various design applications, such as tools for multimedia authoring and product modelling, including standards for information exchange.
- Providers may offer value-added services based on the aggregation and the refinement of existing services, where various tools and systems for classification and directory management are central. Providers will increasingly play the role of brokers for network based services.

- Consumers, on the other hand, will need tools for navigation and content selection, and possibly protocols for filtering and negotiating the terms of sales.

Central to novel applications in this area is the development of protocols through which actors in information markets can interact in their different roles. Global trading scenarios require access to secure and reliable financial services. Once such services are deployed, organisations are not only able to interact but also to transact in new and reliable ways. All such services will be dependent on and demand an adequate level of privacy and reliability.

Legal considerations for electronic trade and public services, security and privacy are pertinent issues in this context. So is the usability of services from the consumers perspective; how consumers can find existing services and learn to use them as well as to judge the reliability and quality of a service offered.

2.3.2 The Role of IT

There several emerging applications and technologies which all contribute to the growth and establishment of a global information market. New technology will play an important role for developments in the architecture of networked information systems, electronic payment systems and technologies for visualisation and explanation.

Networked Information Systems Architecture

It is expected that a current infrastructure like the Internet will evolve from being a network for global browsing through digitised documents, to an infrastructure for global computing. With global networks seen and used as platforms for systems development, a key issue for information market applications will be opportunities for designing information systems as networks of communicating components.

For this purpose it is important to exploit a federated approach to information systems architecture, which, such as those applied in federated databases and in object management systems. A federated architecture focuses communication and co-ordination among components, such as applications or information systems, where autonomy with respect to execution, design and management is emphasised.

Another key issue is the management of mobile software components, i.e., programs that can move around and operate in different locations in a network. This is in contrast to the static client-server models based on remote invocation or message passing dominating current distributed systems designs. Novel approaches to software design and implementation such as agent-based software, are key technologies for mobile software.

In anticipation of large future profits from the exploitation of information markets, a number of new players have entered the arena with increased competition as a result. The market for on-line information services has until recently been dominated by a few American services, most notably America Online and CompuServe. Among the information services recently deployed and announced we note Europe On-Line and Microsoft Network as well as numerous smaller services providing local profile and content.

While many of the more established information services have been using private network resources and in many cases continue to do so, the emergence of the Internet as a truly global network infrastructure has made it the number one choice for access to the information services.

Although much attention has been paid to large multinational information services, the current introduction of numerous small and medium sized services will have more impact on future information markets. Aiding and stimulating these services is the recent arrival of a "killer ap" for the Internet: the World Wide Web.

The combination of Internet and the World Wide Web will make the exploitation of information markets possible by providing consumers with global access to information services through an intuitive user interface, and service providers with a standardised technical platform.

Electronic transaction systems

A prerequisite for the establishment of a global information market is that transactions can be operated securely over open networks, such as the Internet. Intensive research and development is underway and a set of competing protocols have been proposed for various electronic payment instruments to be linked into the existing financial systems and services.

These include protocols for secure credit card payments as well as protocols managing digital representations of currency. Digital currency can provide the same anonymity as when paying by cash, over an open network. The digital currency technology also has the advantage of low cost compared with credit card transactions. Low cost transactions are important since they enable large scale *micro transaction systems*, i.e. numerous small payments.

Visualisation and explanation

Limited network bandwidth is an economic rather than a technical problem today. With the rapid advancement of network technology, more and more bandwidth will become available for the information market permitting the incorporation of multimedia technologies in user interfaces as well as in the products themselves.

Companies are exploring the provision of packetised video, video conferencing, and a packetised voice that will enhance communication and co-operation. Databases are handling multimedia documents, both document and image database systems as well as relational databases. All major database developers will offer Internet/WWW connections for their products in the near future and thus provide an important tool primarily for information providers.

2.3.3 SISU Contribution

The main objective for projects in this area is to explore the architecture and technology for network based information services. Contributions will include:

- Models for consumer-producer interaction over networked information infrastructures.
- Reports on the development and usability of protocols for electronic commerce.
- Usability analyses of network services.

3 Scientific Dissemination

As a basis for research and development related to the above application areas, the following research areas are considered:

- *Software Process Improvement*: which focuses on the software design process in relation to the organisation and its products.
- *Cooperative Information Systems*: where research tries to improve the interoperability of loosely coupled distributed information systems, including the elaboration of architectures for such systems.
- *Multimedia Information Retrieval:* retrieval and acquisition from large multi media information spaces.
- *Usability*: which deals with methods for judging the quality of software artefacts with respect to user need and work practice.
- *Human Communication and Technology*: which takes a socio-technical view of communication in organisations.

The following sections describe each research area and indicate SISU's focus with respect to our application areas.

3.1 Usability

3.1.1 Overview

The purpose of research into design and evaluation methods for human-computer interaction (HCI) is to enhance the quality of the interaction between humans and computer systems. Today, this quality is mostly referred to as the quality of *usability*. To achieve usability, we need to apply knowledge about human goals, human capabilities and limitations. Furthermore, this knowledge must be related to understanding the social, organisational and physical aspects of the users' work environment. This points to four key factors which need to be taken into account in interaction design, namely:

- People
- Work
- Technology
- Environment

Thus, usability is a complex concept referring to an attribute of the interactive process between humans and computers, as well as to a methodology for the achievement of this attribute. According to the ISO-standard for "guidance on usability" (ISO9241–11, draft version), usability is defined as "... the extent to which a product can be used by specified users to achieve specified goals effectively, with efficiency and satisfaction in a specified context of use".

The components of the definition are in turn defined as follows: "*Effectiveness*: The accuracy and completeness with which users achieve specified goals. *Efficiency*: The resources expended in relation to the accuracy and completeness with which users achieve goals. *Satisfaction*: The comfort and acceptability of use. *Context of use*: The users, goals, tasks, equipment

(hardware, software and materials), and the physical and social environments in which a product is used".

The essential difference between the linear waterfall model used in traditional software engineering and the HCI design model is that the latter is based on the premises that design should:

- be user-centred
- integrate knowledge and expertise from the different disciplines that contribute to HCI design
- be highly iterative so that testing can be done to check that the design does indeed meet users' requirements.

A user-centred design approach is based on a number of principles systematically involving intended users throughout the design process. Users are not there simply to comment on a designer´s ideas. They are intimately involved in all aspects, including how the implementation of a new system will affect their jobs.

3.1.2 State of the Art

There are different approaches to HCI design, but what they all have in common the emphasis on the usability of the system throughout the process. One model of the life cycle is the star model proposed by Hartson and Hix, which centres around the process of usability evaluation (see fig).

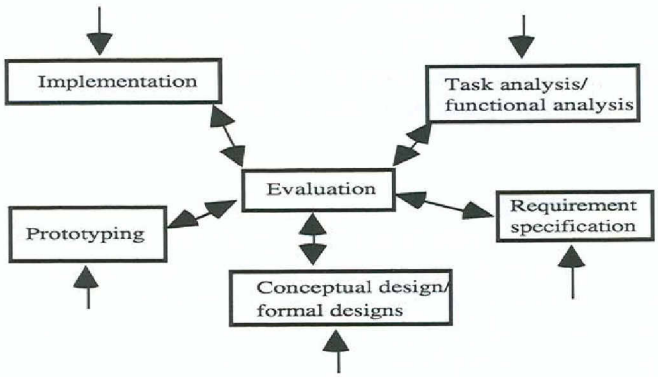

Fig. 3.3 The star life cycle.

Approaches to user-centred design

The *usability engineering* approach to HCI design starts with an analysis of the intended users, their tasks and their needs. Based on the analysis, a set of usability goals for the new system are formulated. These goals have to be measurable by means of usability testing. Then, a prototype of the system is designed. Finally, the usability of the prototype is tested and the system is redesigned until the goals are met. The goals determine when to stop the iteration.

There is an underlying assumption concerning the usability engineering approach, that a design problem can be stated before it is solved. Usability goals are set before the design phase is started. As a reaction to this limitation, the alternative approach of *contextual design* has been formulated. Contextual design starts off with contextual inquiry, a process including spending time in

the users' environment, studying their work, discussing it with them and trying to form as broad an understanding as possible of the whole work context. The new system is designed along with and tested by the users. An important aspect of this approach is that it probably motivates the users in using a system, the design of which they have influenced.

The aspect of user influence is even more central to a third approach to HCI design, often referred to as the Scandinavian school or *participatory design.* This approach includes a process of mutual learning, where the developers learn about the users' world while the users learn about the possibilities and limitations of information technology. There is a close connection between participatory design and the law of co-determination in Scandinavia, and thus this design approach contains more work politics than the previous two.

Techniques supporting different phases of the design

Independently of which ever approach is taken towards a user-centred design, each design phase demands different types of activities. Today, a fair amount of research is directed towards developing techniques supporting these activities. During the early phases, techniques are being developed for carrying out user and task analyses, e.g. user questionnaires, observational techniques, interviewing techniques, contextual inquiry, task modelling and scenario analysis. Further, prototyping techniques and tools are being tested.

Usability evaluation, playing such a central role in user-centred design, has attracted a lot of attention both from academia and from industry. The aim of the MUSiC (Metrics for Usability Standards in Computing) ESPRIT project is to develop methods for specifying, measuring and certifying usability. Low-budget requirements from industry have resulted in a collection of techniques referred to as usability discount techniques and in different types of walk-through techniques.

Cost-justifying usability

As a result of extensive efforts usability professionals are forced to invest in arguing for the potential of usability in their organisations, a new area of research has emerged dealing with the economics of usability. Different studies of the costs and benefits of usability in different contexts are being carried out and formulas for how to calculate values are being developed.

Conditions for HCI design in practice

The direction of this research is concerned with organisational factors facilitating or inhibiting the practice of user-centred design methods. For instance, results from action research studies in large software product development organisations, indicate that obstacles to effective design include the inability of system designers to obtain access to users and a resistance to iterative design.

3.1.3 SISU Focus

The research at SISU within the area of HCI design focuses on the application of methods for user-centred design in industry. Continuous work is carried out in surveying both the extent to which user-centred methods are used in Swedish industry, and the level of acceptance of the concept of usability.

Application areas supported by this research area are:

- Business process improvement

- Business Intelligence and Decision Support
- Exploitation of Information Markets

Field studies involving the active participation of the researchers in usability development projects are carried out. Efforts are also made in formulating strategies for relevant industrial research into HCI.

3.2 Software Process Improvement

3.2.1 Overview

The improvement of our ability to develop IT-based products and services faster, with better value and quality for customers, is important for an increasing number of companies. A stronger emphasis on product development is mandatory, as well as the ability to change the organisation and its products rapidly.

The product's life-time is shorter, but technological development is faster, which means that new technologies must be integrated more quickly into the new products. Software plays a more important role in the development of new products and services. The products and services tend to be a more complex combination of different kinds of technologies and knowledge.

Not only need the software development be improved to match the demand for shorter lead time and quality, but all aspects of the efforts towards development must be integrated. This research area thus does not only focus on the improvement of the software process but on the entirety of the development process where software is an important part of the product and service development.

Improvement of the development process

When improving the development process it is important to distinguish between the continuous improvement of existing processes and more radical changes to the processes including organisational change, new working practices, new methods, new tools, etc. The first approach focuses on learning from and mastering the existing processes, the second approach on designing and implementing new processes that partially or completely replace the old processes.

These two approaches towards process improvement are complementary. If the objective for process improvement is to drastically reduce cycle time it is likely that a radical process improvement is needed with the implementation of a new process, which in turn, when stabilised, will be subject to continuous improvement activities. This kind of process change is likely to co-exist over a period of time in a company.

The radical change of a development process is a difficult task. It demands simultaneous changes in organisation, the application of methods, technology and changes in people's attitudes and organisational culture. To bring about these changes involves new roles for developers, a new organisation, calls for a balanced strategy for implementation.

3.2.2 State of the Art

Software process assessment

Traditionally this research area has been focused primarily on the software process in itself. Research in this field has been focused on assessment methodologies for the assessment of the level of maturity of the software

process organisations. This has resulted in a number of different methods. An example of this is CMM (Capability Maturity Model), which has gained wide acceptance in software companies. These approaches are based on a maturity model which describes the different levels of control of the software process, from the lowest level of chaos to the highest level where there is control over the change of the software process itself. Until recently these approaches have not emphasised or even contained organisational aspects and even less cultural aspects.

Other aspects of the process such as flexibility, efficiency, and innovation, are included in other assessment methods which also include the whole development process. These assessment methods are usually based on a new development paradigm and include a reference model based on this. These assessment methods provide a basis for developing a change strategy and a vision for the future development process to be established.

Software process improvement as a learning process

Linked to the approaches mentioned is a strong quest for using different kinds of metrics, both on process and product, in order to have a quantifiable and statistical basis for controlling the process, but also as a basis for continuous improvement and learning (see the Experience Factory approach by Basili).

Other methods taken from the quality improvement field, such as FMEA (Failure Mode and Effect Analysis) used in industry, is an example of a method which could be applied for improving processes and which is based on an experience approach.

Process capture and definition

Strongly related to process improvement activities of different kinds, is the application of methods and languages for process capture and definition of present and new processes. They are useful in a process improvement framework.

The capture and definition of development processes poses particular problems because they are less standardised, more knowledge and communication intensive, more informal and less predictable compared to highly repetitive production processes. Process models that describe communication patterns, knowledge intensive communication with high interaction is a challenging research problem. How methods for process capture in a process improvement framework are used is an important issue.

Software process improvement through new development paradigms – Concurrent Engineering

Many approaches to software process improvement focus on the continuous improvement of already existing processes and do not usually prescribe any methodology or work practice that would drastically shorten the cycle time.

Concurrent Engineering (CE) or Integrated Product and Process Development (IPPD) is an approach for changing practice and methods in development that have been successfully applied in many industrial sectors in order to reduce lead time and increase quality. This has been done in sectors where the competition is strong and there is strong globalisation of the markets.

Related approaches are Total Quality Management, Process Management, Just In Time, Lean production. The point of departure for CE is product

development, while the other approaches usually focus on the whole organisation or the production.

Concurrent Engineering includes organisational aspects (cross functional teams, cross functional development processes, empowerment of project and teams, communication in project and teams, etc.) as well as methodological (predictive engineering, Design for X, Life cycle considerations) and computer based support (Product data management, information sharing, prototyping, simulation, visualisation, work flow co-ordination, support for virtual teams, etc.).

Concurrent Engineering concepts (or closely related ones) have been applied in most industrial and, increasingly, in software development (telecommunication, PC software).

Development of software for services and products in banking and insurance, as well as in telecommunication, is an interesting field of application for this approach. The adoption of the view of seeing software development as part of a service and product development will increase the opportunities of applying CE to improving the software process.

Design Co-ordination

Design co-ordination (DC) can be seen as a dynamic activity and relations which involve the co-ordinated organisation of multi-disciplinary groups, design activities and product information. DC aims to support the performance of the product design process and to control the complexity of design activity; artefact activity, decision making, participants, and aspects of knowledge. DC encompasses issues such as decision support, design management, product management and team engineering. In order to have an IT-based support for the design process, you need a framework to handle the complexity of the product, the design activity and the design team. The research into DC aims at providing this framework.

Reuse, legacy systems and systems integration

There is an increased demand for reusable components and a more flexible and modularised product which could suit more varied customer demand. An evolutionary approach to systems development needs to integrate new systems with old. The approach towards system integration of component and system into a product, rather than building from scratch, is more important today. The involvement of subcontractors as active partners in the development process is increasing.

All this will focus research on areas and developments of standards for reuse, migration and integration of legacy systems with new technologies and products, on modularisation of system components, etc. Different views on architecture will be raised and a common framework for managing a complex integration and interaction of systems is an important research area (see the section on co-operative information systems).

Change management

Real world business processes, particularly those which are highly knowledge- and information-intensive, are based on human, organisational and technologically based communication patterns. In order to achieve the genuinely sustainable change of a business process, it is necessary to have a balanced approach to change or adaptation in these aspects of the communication pattern. There is a need to involve several perspectives and

skills to reshape the development processes and balanced change within organisations, methods/technology and people.

Assessment methods for the development process maybe useful in the change process. It can help you to understand where you are, to point to relevant change areas, to assist in creating a vision of the future process, and to monitor the change in the processes. Most of the assessment methods still only encompass the software development phase and do not consider much of the cultural and climate aspects, or even organisational aspects in general.

3.2.3 SISU Focus

Research in this area will focus on two issues:

- Methodology for process assessment and change management.
- Requirements for information technology support for the development process.

The results are mainly related to applications in Business Process Improvement and shall include:

- Methods for assessment, capture and definition of processes.
- Component based approaches to systems design and migration.

3.3 Cooperative Information Systems

3.3.1 Overview

The coming generation of information systems will involve large numbers of applications dispersed over and connected by global communications networks. Users and organisations interact and transact using systems that include components under the control different organisations, and which may be heterogeneous with respect to technical platforms, information and services. This research area deals with the methodological and technical issues related to the design and operation of such *cooperative* information systems.

A basic observation in this area is the difficulty in viewing an information system as an overall control system requiring completeness and global consistency, in organisations with even modest requirements for decentralisation and change. An information system is no longer one system, but a *federation* of many possibly heterogeneous services or applications.

The issues for research include both the technical and methodological problems of systems interoperability, as well as the organisational aspects of group working and communication. Some of the research issues can be grouped under these headings:

- Information systems architecture and inter-organisational computing.
- Information and service sharing.
- Principles and protocols for transaction and interaction.
- Software design for interoperable applications.

Cooperative information systems form the supporting infrastructure for organisational communication and collaborative work. Basic support for *communication* and *coordination* may imply common syntaxes and rules for synchronising the exchange of information. This is a basis for *co-operation*

implying shared knowledge based on a mutual understanding of the semantics of information and services. This may in turn support *collaboration* in terms of shared responsibilities and common goals for the execution of joint activities.

3.3.2 State of the Art

Architecture

Cooperative systems are co-operating systems, i.e., distinct information systems that operate jointly and possibly parallel. Cooperative information systems can also be characterised by the concept of open systems, i.e., systems composed of components developed at different times, for different purposes and possibly based on different technologies. Hence, a fundamental trait here is interoperability, which at the most basic level implies being able to share data and function. A distinction can be made between such *interoperable systems* and *distributed systems*, in that interoperable systems are always distinct either in terms of existing (legacy) systems or systems controlled by different organisations. Interoperability to support inter-organisational computing is an intrinsic property of cooperative systems.

It can be argued that any computer supported information system supports "interoperability", since it is bound to interact in some way with other systems, at least indirectly. Although there are many existing successful interoperable systems for practical applications (banking, air transport, manufacturing etc.), there is no consensus on the architectural characteristics of cooperative systems. An important issue for research is the elaboration of suitable concepts and terminology for architecture that takes into account the interoperability of the system and the organisational context. Some approaches to the architecture of information systems employ the concept of *federation* as a model for characterising a structure within which autonomous information systems co-exist and interoperate. This approach has been applied in the area of multi databases and to inter-organisational systems, but is, as yet, not sufficiently elaborate for general information systems.

Information and services sharing

One facet of interoperability is the sharing of data and function. On a higher level this is a basis for the sharing of information and services across system and organisational boundaries. Interoperability requires that we can manage heterogeneity, i.e., differences in technologies and in designs resulting from the open systems property. Current technology provides a certain degree of implementation and platform independence, but heterogeneity, with respect to information and services, is still the major obstacle to interoperability. Research around information sharing has primarily been conducted in the areas of databases and information modelling. Research to manage the heterogeneity of information (or semantical heterogeneity), has lead to theories and methods for schema and database integration. Some of these efforts are now starting to address heterogeneity in services. Lately, research efforts are also being made to define and manage the domains of common knowledge for cooperaitve systems in terms of so called shared ontologies.

Transaction and interaction

An important issue for the design of cooperative systems is the ability to distinguish the model of coordination from the computational model of systems. Coordination is of course inherent in any system, referring to the synchronization of multiple activities and the use of shared resources. In the

context of cooperative information systems, a model for coordination is intended to describe a set of principles that can characterise different forms interactions among inter-connected systems, and the technology that support these interactions. We refer to this model as a cooperation model, implying that it may not only be focused on synchronization issues. Such a model is a basis for defining and managing transactions and interactions among the components in cooperative systems.

The importance of making the principles explicit for cooperation among systems or components in different systems has been recognised both in research and, to some extent, in practice but they are still not well understood. In practice, most methods for systems design provide poor support for the development of cooperative information systems, although distribution may be considered in terms of client-server protocols and data replication.

Software design for interoperable applications

Current software engineering practice, with respect to information systems design, is still very much focused on a database or data storage paradigm. Agent based software design has emerged as a software engineering approach applicable to systems with distributed and mobile components, which will compose cooperative information systems. An important aspect is that equal emphasis is placed on the model for coordination and on the computational model. This approach is, in many ways, a natural development of object-oriented system design and actor-based models.

Autonomy, encapsulation and communication are time-honoured principles here. Since we cannot expect to excerpt global controls to the same extent in cooperative systems as in centralised systems, individual computational elements must exhibit sufficient local self-determination as to be able to make decisions and take action on a peer-to-peer basis. To this end, certain research is concerned with the study of the intelligent behaviour of agent-based software components. Principles for negotiation protocols have been studied in that context.

3.3.3 SISU Focus

The research in this area will be focused on:

- Information systems architectures.
- Information and services sharing.

One focal point will be on sharing and integration in cooperative systems, combining schema architectures with ontologies and domain models.

Results from this area are primarily related to the application areas of Business Process Improvement and Exploitation of Information Markets.

3.4 Multimedia Information Retrieval

3.4.1 Overview

This research area focuses on aspects of finding and retrieving information from various types of information sources. This covers purely text-based sources but more recently multimedia information sources. Retrieval from structured information sources such as a relation database and hypertext navigation is also part of multimedia information retrieval research. Typical issues studied are:

- Information content representation formalisms.
- Meta data management.
- Methods to improve precision and recall.
- Knowledge-based assistance for information retrieval.
- Visual query interfaces.
- Content-based retrieval methods.
- Cognitive aspects and usability design of information retrieval systems.

3.4.2 State of the Art

Currently almost all retrieval systems use a text based retrieval method. Content representation is well understood for text documents but less explored for other types of media objects. Images are usually indexed by giving a descriptive text or a set of keywords which is then searched in a traditional text searching manner. On the Internet, WAIS-technology (Wide Area Information Servers) is being used to implement full-text retrieval systems supporting the Z39.50 standard. Experiments are taking place on Internet with so called WWW robots which travel the net and extract indexing information about Internet documents in order to provide search facilities for end-users. Experiments are also taking place with information brokering approaches. This allows a more loosely coupled architecture.

Content-based retrieval is currently being explored for different media types. Content-based retrieval means that a search is performed on the actual content of an object rather than on a description of the object. The need for this arises in many different applications such as facial recognition for crime investigation, electronic fashion and other product catalogues, press archives and brand image management to mention but a few. So far content-based image retrieval has had the most progress and the first commercially available products have been announced. For other types of media such as video and animation, there is no commercially available or standardised solution for content-based retrieval.

Multimedia resources suffer from a variety of different indexing conventions and may require content directed searching. A novel solution that overcomes many of the shortcomings described above is to focus instead on information representation – i.e. to expose more semantics to the user. This has been achieved in the ESPRIT Intuitive Project. Intuitive introduced the concept of a Meta Data Dictionary. This is composed of three inter-related information and presentation schemes: it provides a dictionary of information described at the data level; and at the conceptual level (i.e. from the user perspective) and it provides descriptions of how information should be presented, depending on the users needs.

Another line of research is to incorporate machine intelligence into the retrieval system, i.e. to use expert system technology to provide the user with intelligent dialogue facilities. Focus here has been on trying to represent the user himself as well as the user's task and based on this, to design intelligent software that guides the user in the retrieval process, for instance by giving advice on how to formulate a query or how to reformulate a query.

Approaches to improve the accuracy of a search, i.e. precision and recall, include relevance ranking, statistical approaches, concept searches and the use of a thesaurus. The concept of ontologies is also being explored as means of providing search agents with a representation of a structured domain to reason about, in order to resolve retrieval requests.

Over the past years, research on innovative and easy-to-use *DBMS front-ends* has been very active. Both visual interfaces and natural language interfaces have been proposed. The most common approach has been to use a visual query system based on the Entity Relationship Model (ER), to achieve more user-oriented user interfaces. Also other data models have been suggested for this purpose, e.g. the universal relation model, extensions of the ER-model and object-oriented data models.

Cognitive and usability research in this area has been focused on problems relating to overview and navigation in large information space. Different means have been suggested to provide users with information overviews such as 3D-interfaces, perspective walls and cone trees to mention a few examples.

3.4.3 SISU Focus

Our research is focused on visual query systems, especially architectures and usability aspects, and multimedia content representation formalisms. This includes visual query user interfaces, formal visual query languages, meta data management, multimedia information models. This research area will contribute mainly to the application areas of business intelligence and the exploitation of information markets. SISU expects to produce the following results:

- Models for representation, management and retrieval of vague and incomplete information.
- Semantic based retrieval techniques rather than text based.
- Visual query languages for multimedia information.
- Meta data management tools and ontologies for Web-based applications.
- Architectures for information brokering systems.

3.5 Organisational Communication & Technology

3.5.1 Overview

While the previous research area departs from the technology, this research area departs from the organisational communication relating it to technology. While some previous research and application areas start with technology and relate it to an organisational context and business strategy this research area starts with the organisational-communicative context. While technology in previous research areas is seen as the supporting, enabling infrastructure for trans- and interactions, in this research area communication is seen as an infrastructure for utilisation and the development of technology. While, for example, Cooperative Information Systems emphasise interoperability for the sharing of data and functions, in this research area the sharing (management) of common meaning via coordination is the main criteria for "interconnectiveness". While Business Intelligence and Decision Support emphasises corporate intelligence in terms of ability to utilise trends, technology, market opportunities, etc., this research area highlights the

organisational communication patterns that affect and are affected by intelligence "injections".

This research area is predominantly an interface between three subject areas; organisation, technology and communication. These areas are mutually dependent but still largely unaware of each other. The issue here is not so much to match, but to relate, these previously separated areas of human activity. When the "technological" is related to something non-technological, positive synergy effects will usually result.

The core area represents an integration of human communication and technology on a collective (organisational) system level. Organisational communication is the starting point, the foundation. The technology is seen as "the figure on the ground". Relating technology and human communication helps to detect limitations and possibilities in both and avoid possible counterproductive results in systems and organisational development. This research area attempts to define the relationship between technology and (organisational/human) communication. This relationship has been studied on different levels; intra-, interorganisational and global.

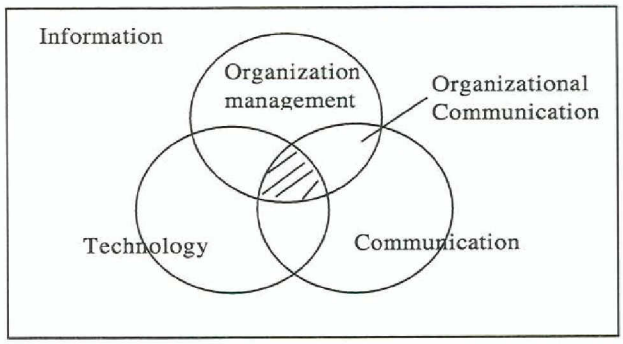

Fig. 3.4 Area of research.

General Approach

In this research area the "technologically driven" system approach is replaced by the "human driven" technology approach. Instead of the currently dominant human-computer framework the focus is on mediated human-to-human communication. Computer Mediated Communication (CMC) is the term that is often used to connotate this type of research.

Instead of IT (information technology), the focus of attention is on CT (communication technology). The function and purpose of the technology is perceived more as a medium than a tool.

Technology in this research approach is conceptualised as an extension and externalisation of human communication capacity. Communication is the clue that holds organisations together, the basic coordinating mechanism.

The problem today is not so much the concept of technology as the concept of communication, which is used in a variety of meanings and often described in technological terms. Communication here is defined as on ongoing process and transformation of information by living systems.

In brief, this research area conceptualises communication primarily as a dynamic pattern of relationships as a foundation for technological development

and implementation from the perspective of receptivity and responsiveness (rather than that of source, external message, dissemination and the exchange of information) as a very basic strategic/managerial process, out of which all organising takes place (rather than being the result of organising).

Problem Area at Large

1. The Problem of Effectiveness

At the same time when a lot of resources are being spent on technological improvements in information and communication systems in and between organisations, these efforts are often neutralised or undermined by existing organisational communication patterns.

Problems of usability arise when the technological system, while expanding the human communication capacity, simultaneously fails to reflect its solutions back to human communication problems. The better the technology fits into variations in human communication, the more usable it is. The opposite is also true, better usability increases the compatability of technology and human communication. Today there is a gap between technological potential (what could be done) and communicative actuality (how we communicate). The gap between the potential and the actual is the problem of effectiveness.

2. The Problem of Receptivity and Responsiveness

Networks become increasingly global and transnational. Information providers and receivers become more integrated in interactive information markets. This means that acquisition, reception, interpretation and response become equally as important as sending and delivering information. In global communication there is variation in business practices, policies, responses, etc. Different individuals, functions, organisations and cultures collect different information for similar purposes and code the same information differently. Receptivity and responsiveness become important communication qualities.

The importance of receptivity and responsiveness becomes even more crucial when we can technologically exchange different kinds of simulations (images, voices, dynamic models etc.) as easily as we exchange words today. The more we can use all our senses at the same time technologically to acquire and receive information, the more holistically we must be able to respond. The greater the complexity, the more and better the responsiveness required of the system. The more time shrinks in trans- and interactions the more important dialogue becomes (receptivity and responsiveness) in communication. Increased time competition must be met by increased quality in communication.

3. Collaboration and Cooperation Rely on Communication

Collaboration across different organisational, functional, national and cultural boundaries places an extremely heavy burden on organisational communication. When the communication patterns exclude or ignore some information, the technology cannot convey that information either. The effects of facilitating technology depends on how it is perceived and used. Communication patterns that effectively alleviate cultural, functional, educational and language barriers, thus enhancing cooperation, are vital to the successful implementation of information technology.

3.5.2 State of the Art

Technology and communication started to converge in the research world, especially in the USA, in the 1980s. Until recently, there has been an abundance of empirical and methodological communication research but a lack of theoretical integration. In Sweden research combining technology, organisation and communication is still uncommon.

In communication research, the traditional communication models (Shannon-Weaver 1949, Lazarsfeld 1948, etc.) have been criticised for not taking into account the semantics or creation of meaning in human interactions. They emphasise sender, message and channel, i.e. the external aspect of communication. Communication is conceptualised as control or influence (to make other people do something) or as an exchange of information (as in a market place). Lately, receptive communication has received increased academic attention.

Receptive communication might be more basic in a human world. Technology that facilitates, expands and develops natural communication tends to survive longer. The problem is to distinguish between natural and artificial because human communication has, for a long time, been conceptualised in terms of a mechanical model.

3.5.3 SISU Focus

This research highlights the role of human communication in the technological development on different organisational levels. Presently, the global level is in focus. The purpose of the research is also to contribute in building up a conceptual framework for how collective (organisational), receptive human communication is related to technological development.

Results from this area can be of relevance to all three application areas:

- Changes of business (or organisational) processes inevitably imply changing communication patterns.
- Organisational communication patterns that affect, and are affected by, the management of business intelligence data in an organisation must be highlighted and understood.
- Emerging information market applications will, to a considerable extent involve inter-organisational communication.

4 Industrial Dissemination

The results contributing to the application areas are funnelled into Swedish industry through specific dissemination and demonstration programmes. A programme is defined for a specified time period and contains a number of result areas and a set of projects.

These areas are used to initiate new projects, and are also the means of presenting the results of projects. Any single project may contribute one or more of the result areas. The following is the programme for the period 1995-1996.

4.1 Strategic Applications of Internet Technology

This area investigates the application of Internet-related technologies as strategic resources in the IT-infrastructure of organisations. This effort is motivated by the current growth and impact of services and technologies related to the Internet as witnessed during recent years.

The Internet is now well-established as a medium for inter-organisational communication, primarily in terms of electronic mail and information provision using architectures like the World Wide Web. Organisations also see the potential of internal applications of Internet technology, improving work flows, document management and customer services. We now see the emergence of new design tools, standards and information services that extend and integrate existing technology and services. This gives us new instruments for systems development which may provide the seamless integration of inter-organisational systems with the local IT-infrastructure of organisations.

This SISU area monitors and reports on this development. Projects contributing to the area apply the emerging technologies and services in the context of architectures for novel information systems and in different application domains.

4.2 Legacy Systems Migration

This area investigates methods and strategies for the renewal and replacement of existing information systems in organisations. This requires an understanding of the potential provided by new architectures for information systems and of the factors affecting decisions to replace or renew an existing system.

Most organisations are dependent on a large number of information systems for their daily operations. Many of these systems have been maintained over decades and organisations frequently find themselves in a situation where changing business requirements and new technology calls for the replacement of such systems. Many of these systems may be crucial to the business requiring a careful analysis to be made before a renewal process can be started. Such a process may include the replacement of existing (legacy) systems by using different migration methods and techniques for re-engineering and reverse engineering. A prerequisite for decisions on migration is the ability to assess the value of systems. This requires improved methods for evaluation and cost estimates of existing systems.

In this area, particular emphasis is placed on the relationship between the business activity and the supporting information systems, in order to describe the effects of migration processes on the business.

4.3 Tools for Co-operative Work

The overall aim of this area is to develop and disseminate knowledge of how advanced use of information technology facilitates new, more efficient work forms, services and changes in professional roles. The perspective in this area is best summed up in the concept of a *virtual corporation*. Virtual corporations exist in cross-organisational project teams, supported by networked computers. In this environment people can:

- Meet, see and talk to each other (formally, informally, casually).
- File and access material of mutual interest.
- Work together on documents, jointly and separately.
- Have access to co-ordinating facilities and assistance.
- Be aware of each other and of each others' work.

This development will be driven by the growth in exposure of new multimedia technology in the years to come, that enables the members of a project team to work together with a common task despite different geographical locations. They will be able to collaborate and communicate more efficiently then ever before, both synchronously and asynchronously, with shared software tools, electronic documents, sound and video.

Our intention in this area is to present and demonstrate new usage models of emerging technologies for collaboration and teleworking like *desktop conferencing*, *group computers*, *mobile systems* and architectures for *shared workspaces*.

4.4 Technologies for Business Intelligence

Results in this area are focused on demonstrations of new technologies that can be applied to business intelligence applications. Our intention is to develop a set of demonstration tools and to integrate them with existing and emerging tools to provide a comprehensive set of tools:

Business environment modelling tools that allow a business intelligence user to describe and model his view of the business environment in a mind-map like fashion.

Classification and categorisation tools that allow a business intelligence user to easily classify information objects according to his model of the business environment. A first prototype already exists, it is called SICO Server.

Retrieval tools that allow a business intelligence user to retrieve information from the common business intelligence database. A solid base-line here would be the end-user retrieval tools for querying, navigation, browsing and the presentation of multimedia information, such as that developed in the Intuitive project (P6593).

Filtering tools that allow the real-time filtering of incoming information streams. Such tools allow users to construct their own information filters. Filtering tools are still in their infancy which calls for efforts to demonstrate their applicability.

Acquisition tools. These are software tools that actively search for information in external information sources, such as WWW robots or other types of agent-based software.

Decision support and analysis tools. Here there are a number of commercial products that can be used, such as Pablo, IA Agent, Crosstarget etc.

Enterprise-wide business intelligence database. Commercially available technology from companies like Oracle or Sybase provides a platform for implementing business intelligence databases. We intend to build an enterprise-wide knowledge and business intelligence database and to use that in our own work. The experiences and analyses from this large scale demonstration will be disseminated to Swedish industry.

4.5 Process Improvement

Results in this area are directed towards methods and support for the shortening of lead times and to improve quality in product and service development. The approach Integrated Product and Process Development (or Concurrent Engineering) has been adopted and adapted to improve the development process which contains a large portion of software development. The best practice model of Concurrent Engineering will be further developed and applied to case studies in Swedish industry.

4.6 Customer Focused Information Services

This area focuses on various computer and telecom based services intended to support and improve different types of customer relationships in organisations. Network based information services are of specific relevance. Results in this area shall contribute to an increased understanding of IT use for customer management and to the identification of new business opportunities for organisations in the information and telecom sectors.

4.7 Document Management in Services Development

Results in this area shall contribute to more efficient use of digital data during the life cycle of product or a service. The stages in this life cycle may include the initial definition or idea for a product, requirements specifications, design, production and marketing. Current technology and product management standards offer a number of opportunities for managing the information related to these stages in an efficient manner.