Developing the Information Systems of Tomorrow

-competencies and methodologies

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-required competencies and methods

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I hereby certify that all material in this dissertation which is not my own work has been identified and that no work is included for which a degree has already been conferred on me.

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Abstract

Information systems are getting more and more multimedia-based as well as network-based. This evolution, as well as an increased rate of change, put new demands on methods and competencies required for developing future information systems. In this work, we give an overview of the different types of information systems and methods for information systems development, especially with respect to multimedia aspects. Multimedia systems development is discussed particularly with respect to the dual processes of software engineering and content development. Possible future directions are pointed out, in which information systems development seems to become an even more multidisciplinary effort. As a result we present a list of competencies required for multimedia information systems development as well as possible research areas of interest. These research areas cover the following issues regarding the development of multimedia information systems: project management, conceptual modelling, content maintenance, requirement treatment and development approaches.

Keywords: Multimedia, information systems development, web-development, change, content.

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1 Introduction

In this chapter current and possible future trends in information systems development are briefly discussed. Aims, objectives and research method are presented. We also give a brief account of some related research. Fundamental information systems engineering problems and central concepts are presented as well. Finally the thesis outline is given.

1.1 Background

The conditions for information systems engineering has changed a lot since the first beginning back in the sixties. At that time, information systems had become important administrative mean in civil organisations. The overview in Table 1.1 demonstrates the development of information systems engineering through 35 years of progress.

Table 1.1: Trends in information systems development. (Bubenko, 2000)

	Year 1965	**Year 2000**
Type of problem	Well-defined	"Wicked"
Developers	Formally trained	"Anybody"
Users	Few trained	"Everybody"
Time to implement	Years	Hours, days

Through the last decade, new types of information systems applications have emerged. We believe these new application types will add new opportunities as well as problems to information systems engineering. Primarily, multimedia applications and the web seem to be of interest. The trend in information systems engineering of today is towards network-based, interactive multimedia applications. Through this we will hopefully get more functional information systems with better usability, but at the same time the future information systems will probably get more complicated. The increased complexity of information systems will presumably be of both technical and human character.

Technically, interactivity and multimedia raise new challenges in several areas. For instance, new techniques are needed for storing and manipulating new data types (e.g. pictures, movies, audio) and not to forget transmission of huge data collections over

different networks. Representation of knowledge and experience in information systems is an adequate challenge as well. More expressive media opens up new opportunities to create effective visual applications. Building interesting multimedia applications is also a question of dramaturgy (Wiman, 1999; Laurel, 1991). Well-proven concepts from traditional storytelling, music, literature, drama, art etc. are important as well, because multimedia presentations are fundamentally not different from any other human communication (Tannenbaum, 1998). Tannenbaum claims that the best way of making good multimedia applications is to consider what is critical for effective human communication regardless of media. He emphasises that mankind has a long history of communicating that multimedia developers have a lot to learn from.

Developing applications of this kind generates information systems properties that will require various new competencies and new ways of working. Which are the competencies that are needed and how should they be organised and applied in information systems engineering projects? Will this presumed trend in information systems engineering make maintenance and adoption of information systems more difficult due to increased complexity and multidimensionality? Do the information systems engineering philosophies and methods of today cope with these challenges and if not, how will they develop in the future?

The aim of this research proposal is to search for the problems that seem to be of central interest for the development of the information systems of tomorrow.

Below we present some tendencies that constitute a starting point for our search for to the information systems of the future and the competencies and methodologies required for developing and maintaining these systems:

- *The future information systems will be more and more interactive and several media will be integrated in these systems.*

  As various IT-based systems get easier and more “natural” to interact with, more and more work is carried out by, or with support from, various IT-solutions. It is no longer a question of only building information systems in order to automate and rationalise certain work processes. The use and development of different IT applications and information systems is becoming more and more a question of support for information search and provision as well as entertainment and education. An example of the new generation

information systems is the integration of newspapers, TV, radio and "traditional" information systems applications that have already taken place in several services and portals on the web. E-business is an example of an area that must rely on this new generation of information systems in order to succeed. People will require easy and rich interfaces and direct feedback. If shopping on the net is to compete with ordinary shopping, it must as far as possible offer possibilities to feel, test and study products that are for sale. Easy and interactive communication and support must be available as well.

- *Future information systems will in general be based on a common platform.*
  The trend is towards platform commonality and demand on easy access and access independent of location or specific technical application standards. This can be argued by pointing out the success of the Internet and the web. Access to the web will also probably be possible through far more channels than PCs and ordinary network terminals. Mobile phones, digital-TV and other electronic accessories are examples of possible future web-accesses.

- *Component-based development will become more common.*
  This is essential due to the need for fast development and standardisation of software applications. The trend towards platform commonality will probably stress this progress because it is getting more and more common that single software components, services and even generic programming classes, can be bought and integrated with various applications.

- *Information systems engineering will demand larger variety of competencies compared to today.*
  Due to the merge of many media, new competencies are needed for developing the future information systems and the content of those systems. Together with systems designers and programmers, we will probably see people from the areas of TV, movies, newspapers, theatre, advertisements etc (AMIT Consortium, 1996; Tannenbaum, 1998).

- *Increasing bandwidth and new mobile technology will make the use of various information systems more common and essential as integrated parts of*

different products, for information provision purposes.

An example of this is for instance Internet connections in automobiles, which increase the opportunities for the drivers to obtain various services. It can be a question of road maps, traffic guidance, entertainment services etc.

Altogether, this will make information systems more complex and multidisciplinary than ever before. This means that development and maintenance of information systems will meet new challenges that demand new methods and techniques.

There is probably a need to merge traditional methods for information systems development with new ways of working evolved from other disciplines to find a way of integrating all the competencies that are needed to create future multimedia information systems.

1.2 Aim

The aim of this work is to investigate which competencies and methods that are needed to develop the new generation of multimedia information systems.
This investigation is primarily aimed to serve as a basis for further research within the area of multimedia information systems development.

1.3 Objectives

The objectives of this research proposal are to:

- *Survey the area of information systems development and outline current trends in the area, especially according to the convergence between different media.*

  Web-based newspapers are an example of a new form of information systems. Not only the text from the traditional newspaper is presented, but also it is integrated with pictures, video and audio presentations as well as various interactive services. Further, the newspaper site is often an interface to a database including articles and related pictures as well as video and audio files. The web-based newspapers are not only updated once a day, but normally as soon as news arrives to the editorial staff. Such information systems will put new demands on the design of the systems. The reason is frequent updates with several different data types involved and the mixing of media requires

know how and techniques from areas that traditionally do not belong to the information systems area.

- *Study and describe what demands the development of the new generation of information systems will put on working methods and interaction between different competencies that are needed.*

  It seems obvious that the development and maintenance of the web based newspapers is not only a task for journalists and traditional newspaper producers. Experience from TV, radio and computer science is needed as well.

- *Study how new competencies in the IT-business have already changed methods and work practice.*

  This is important because structured ways of working converted from other disciplines may be of great importance to further evolution of methods for information systems development. Experiences already made should therefore be of interest to study.

1.4 Research method

The research method applied in this work is of an exploratory character in order to seek for new insights and knowledge about use of methodologies and work practice in the development of modern multimedia information systems. The study will be performed in form of a literature study and interviews.

The aim of the literature study is to:

- Outline the area and the state of the art in modern multimedia development for the web.
- Identify related work.

The ambition is not to perform a total scanning of the area. We use some core research papers and literature that is frequently referred to as a starting point to get a general summary of the information system development discipline in general as well as the multimedia and Internet area. Of course, a literature search will be performed through

libraries, article databases and on the Internet in order to broaden the study and identify references of great interest.

The aim of the interviews is to:

- Study and describe what demands the new generation of interactive and web-based information systems put on work practice and methodologies for information systems engineering.
- Identify the competencies needed for developing these systems and how these competencies interact.
- Outline how new competencies affect the work practice and use of methodologies in information systems development

The interviews are based on open questions without any fixed answer alternatives. The questions are presented in a similar structure from interview to interview to facilitate the analysis of the material. The questions can differ a bit from one interview to another depending on different respondent's specific knowledge and experience. If possible we have performed personal interviews by visiting the respondents, but in the case of great geographical distances or lack of time, a telephone interview has been performed.

The interview results are presented on basis of a number of themes that we identify as important in order to get an understanding of the trends in modern multimedia web-systems development.

The interview material, as well as a discussion and motivation for the performance of the interviews, are found in Chapter 5.

1.5 Related work

There is a lot of material found that treats multimedia and multimedia design. Material covering Internet and web-design is common as well. Papers or books specifically treating methodologies and required competencies needed for developing multimedia-based web-systems are not easily found.

Below we briefly present examples of related work that is strongly related to the core issues of this work.

Theoretical foundations of multimedia by Tannenbaum (1998) is a comprehensive work covering several aspects of multimedia. We have generally used Tannenbaum as a reference point regarding multimedia development.

AMIT Consortium (1996) is a proposal for an interdisciplinary graduate school and research centre for art, media and information technology. Several interdisciplinary partners from various academic institutions in Stockholm write the proposal. In the proposal it is stated that design and creation of quality content for multimedia is a multidisciplinary case, and that there is a need for computer science tools and methods for multimedia design.

Molin (2000) has compared information systems development and multimedia development. This work is interesting as information systems will probably be more multimedia-based in the future and there must be several things to be learned from both sides.

Interactive planning is a research area of great interest to development of multimedia web-systems. Active research groups in that area are for instance found at Malmö högskola and University of Linköping. In an international perspective, MIT Meda Lab is the best-known research institute.

1.6 Fundamental problems of systems development

According to Langefors (1995) there are six fundamental problems of systems development that are true regarding all nontrivial information systems. Below, these fundamental problems are presented and related to this work.

- *Human beings have narrow cognitive limitations.*
  Because all nontrivial information systems surpass human cognitive limits, there is a need for tools and methods for overcoming these limitations. Models and methods for information systems development are examples of this.

- *Information systems are complex.*
  Information systems are almost by definition difficult to overview and understand because they surpass human cognitive limitation. Information systems themselves are complex, as well as developing and building information systems is a complex task. In order to be able to overview

complex systems, they are divided in a set of defined interrelated parts (can be seen as subsystems and components). The work of building information systems must be supported, controlled and analysed by some scientific methodology in order to achieve a good system. According to Langefors (1995), in a work such as information systems development, this cannot be carried out by intuition and assumptions, because these assumptions tend to be inconsistent. There are several examples of new Internet-companies that have started to build web pages that have not required the use of any comprehensive systems development methodologies. Simple web pages have evolved and new features have been added and the pages have been connected to other systems. This has caused serious problems have occurred because increased complexity cannot be dealt with, without a methodological support.

- *Information systems are multidisciplinary.*

  There are several stakeholders of information system. These stakeholders do have different interests, needs and skills related to the systems. This problem can both be related to the use of and the development of a system. The users of a system may have various needs, so it is important that the system can be adapted to various user profiles. While the system is developed, different stakeholders may have problems to communicate because of lack of a common language and focus on the problems at hand. While developing multimedia information systems, this problem should be of great interest because of the mix of engineers and actors from various humanistic disciplines in such a project.

- *Information systems are dynamic.*

  If information systems are supposed to be a support to their users, it must be possible to re-design them quickly. Changes in the environment continuously put new demands on the users, and thus their need for system support changes. Huge and complicated systems tend to be hard to change. This problem gets probably even more serious as the number of media integrated in the systems increase. According to Langefors, a simple system design and use of powerful design tools in order to develop small and decentralised information systems is

needed to deal with this problem. The system architecture is critical but the trend towards reuse and use of standardised components is the most promising trend at the moment (Allen and Frost, 1998).

- *Information systems are infological.*
  The relevance of an information system depends on every single user's view on the system and what it contains, which makes user participation necessary in the process of designing a system.

- *There are human as well as social aspects of information systems.*
  Information systems affect both human and social systems in the environment were they operate. Human and social systems are subjects to service and support from the information systems. It is not an overstatement to claim that system developers often ignore this fact. As the character of information systems is getting less a matter of automation and rationalisation, the human and social aspects are becoming more important to take in consideration while developing information systems.

The six fundamental problems above are of great interest while studying information systems and their impact on people and organisations.

It is a challenge to develop an information system and at the same time take care of ongoing changes in the organisation the information system is supposed to serve. This becomes especially difficult if the developers have to take in consideration all the fundamental problems Langefors (1995) as presented above. In latter times, information systems applications have become more expressive by the introduction of multimedia, interactive media and the Internet. Our hypothesis is that future information systems will be distributed, net-based and more interactive and multimedia based compared to the traditional information systems. Internet opens up new opportunities regarding integration of organisations over geographical distances, as well as development of new communication tools where IT, telecommunication and media merge. This should give us an opportunity to create information systems that are adoptable (infological) to the needs of each user. By this we will also get information systems that are more complex, dynamic and multidisciplinary than ever before.

1.7 Central Concepts

In this section some concepts of central interest to this work are presented.

Actor: An agent (a person or an artefact) that triggers or performs an activity.

Aesthetic: In this work we define aesthetic as opinions and view points regarding outfit and expressions in art, nature and the environment in general. (Nationalencyklopedin, 1995).

Competency: Knowledge and skill required to perform a certain task. Can even be of a formal character comprising education or experience demanded for a certain position or duty (Nationalencyklopedin, 1993).

E-business:" The process of using web technology to help businesses streamline processes, improve productivity and increase efficiencies. Enables companies to easily communicate with partners, vendors and customers, connect back-end data systems and transact commerce in a secure manner" (IBM, 2000).

E-commerce: "The ability to buy and sell products and services over the Internet. Includes online display of goods and services, ordering, billing, customer service and all handling of payments and transactions" (IBM, 2000).
E-service: "An electronic service available via the Net that completes tasks, solves problems, or conducts transactions. E-services can be used by people, businesses, and other e-services and can be accessed via a wide range of information appliances" (Hewlett-Packard, 2000).

Function: A set of tasks needed to fulfil some purpose (achieve some goal) of an organisation.

Information systems engineering: An interdisciplinary approach to enable the realisation of successful information systems. All involved disciplines are integrated into a team effort with the goal of providing a quality product that meets both business and technical needs of all stakeholders.

Knowledge: "Acquaintance with facts, truths, or principles, as from study or investigation" (Webster's, 1989).

Medium: In the context of this work, medium is means for creating, delivering and storing information. Means can be material and artefacts for storing and transmission of information as well as methods for representation of information.

Method: A method is a detailed description of the way of solving a certain problem (Andersen, 1994).

Methodology: "A set or systems of methods, principles, and rules for regulating a given discipline, as in the arts or sciences" (Webster's, 1989).

Model: "..a simple and familiar structure or mechanism that can be used to interpret some part of reality" (Boman et.al., 1997)

Multimedia: "Multimedia is defined as an interactive computer-mediated presentation that includes at least two of the following elements: text, sound, still graphics images, motion graphics and animation" (Tannenbaum, 1998).

Practice: "Habitual or customary performance; the action or process of performing or doing something" (Webster's, 1989).

Procedure is a prescribed way of solving some task.

Process consists of a set of interrelated procedures contributing to the realisation of some function. A process transforms some resources into some products.

Requirement: 1) A condition or capability needed by a user to solve a problem or achieve an objective. 2) A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents. 3) A documented representation of a condition or capability as in (1) or (2). (IEEE, 1990)

Skill: "Competent excellence in performance" (Webster's, 1989).

Task (activity type): specifies the work needed to achieve some goal of an organisation.

Technique: Purposeful or practical way of carrying out an activity (Nationalencyklopedin, 1995).

Tool: An artefact created and applied in order to perform and facilitate various activities.

1.8 Thesis outline

The introductory chapter covers background, aims, objectives, description and presentation of the chosen method. Central concepts and fundamental problems of information systems development are presented as well.

In Chapter 2, a description of the information system concept and various concepts related to it is given. Further on in the same chapter, we give a brief overview of the history of information systems development and various categories of information systems. The concept of multimedia is presented and the use of information systems in organisations is slightly overviewed and elements of multimedia in these systems are discussed.

In Chapter 3, information systems development and methods are overviewed and problems related to development of systems in a dynamic environment are discussed.

Chapter 4 gives an overview of traditional multimedia production and a comparison to traditional information systems development. A discussion about the concept of content is included. New information systems application types and actors are presented. Examples of increased multimedia functions in traditional information systems are given. Possible benefits from multimedia use in mission critical systems are discussed.

In Chapter 5, the interview study is presented. It comprise presentation of the respondents, the implementation of the interview study as well as a presentation of the respondents answers according to eight problems of main interest to this work.

Chapter 6 includes synthesis of the work where we present competencies needed for the development of future multimedia web-systems as well as an example of methodology us by developers of these systems.

Chapter 7 contains suggestions to further work as well as concluding remarks and a brief discussion.

2 Information systems

In this chapter an overview of the area of information systems will be given. The information system concept consists of the terms, *information* and *system*. These concepts will be briefly discussed. The role of information systems in organisations is presented as well as the concept of multimedia. Finally a categorisation of information systems is presented.

2.1 Data, information and knowledge

The concept of *information* is complex and various definitions and interpretations found are (Malmsjö, 1999). Moreover, there are different views on how the concept of information relate to those of data and knowledge. In this work, information is regarded as a phenomenon that depends on interpretation of data. Data is in this view only symbols and signals that express and encompass information. This is a quite common interpretation of the concept in the information systems society (see for instance Langefors (1973; 1995)). The concept of knowledge is even fuzzier and it is difficult to find an unambiguous definition of the concept. Authors such as Andersen (1994) regard information and knowledge more or less as the same thing.
Figure 2.1 illustrates our view on the connection between these concepts.

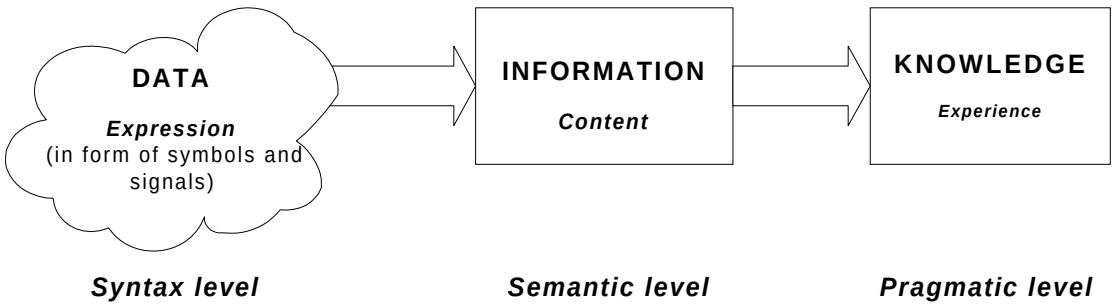

Figure: 2.1 The relationship between data, information and knowledge

- Data is an expression in the form of symbols and signals of some kind. An example of data is the sequence of letters on this page. Data is in this context on a syntactic level.
- Information is the interpretation of data by a receiver (Andersen, 1994). The interpretation is depending on the representation of the data as well as on the frame of reference of the receiver. Information has some kind of content and

semantics depending on the representation as well as the interpretation by a receiver.

- Knowledge depends on personal experience and is on a pragmatic level. Knowledge is generated while information is applied and related to other information and the knowledge is used to adapt and adjust behaviour to new situations.

2.2 Systems

Definitions of the *system* concept appear in several books (e.g. Langefors, 1995; Ackoff, 1981; Klir, 1991). These definitions can be synthesised as follows: *a system is a collection of related elements organised into a whole to perform a particular function and/or reaching a goal*. A thorough discussion of the nature and characteristics of systems can be found in both Miller (1978) and Checkland (1981).

Despite different definitions, the main characteristics of systems in our meaning are the fact that it is up to the observer of a system to view the system. This means, of course, that two different observers can view the same system in two different ways depending on what purpose the system has in their minds. As Beer (1979) says, "*the facts about the system are in the eye of the beholder*" (p. 9). This may cause some problems if the system has several stakeholders with different interest both according to usage as well as design and implementation.

2.3 The nature of information systems

An information system can briefly be defined as a system that manages information by: collection, manipulation, storage, transmission and display of information (Andersen, 1994).

As most information systems are used to support some kind of an organisation, a brief discussion about the relationship between these two concepts is necessary.

In Euromethod (1996) an *organisation* is defined as follows:

> "Organisations are human systems, i.e. structured groups of people possibly using machines (including computers), co-ordinating their efforts towards certain goals."

Organisations as systems are ordered in different hierarchy levels depending on the type of work carried out at each level. Figure 2.2 illustrates the main hierarchical levels of an ordinary business organisation.

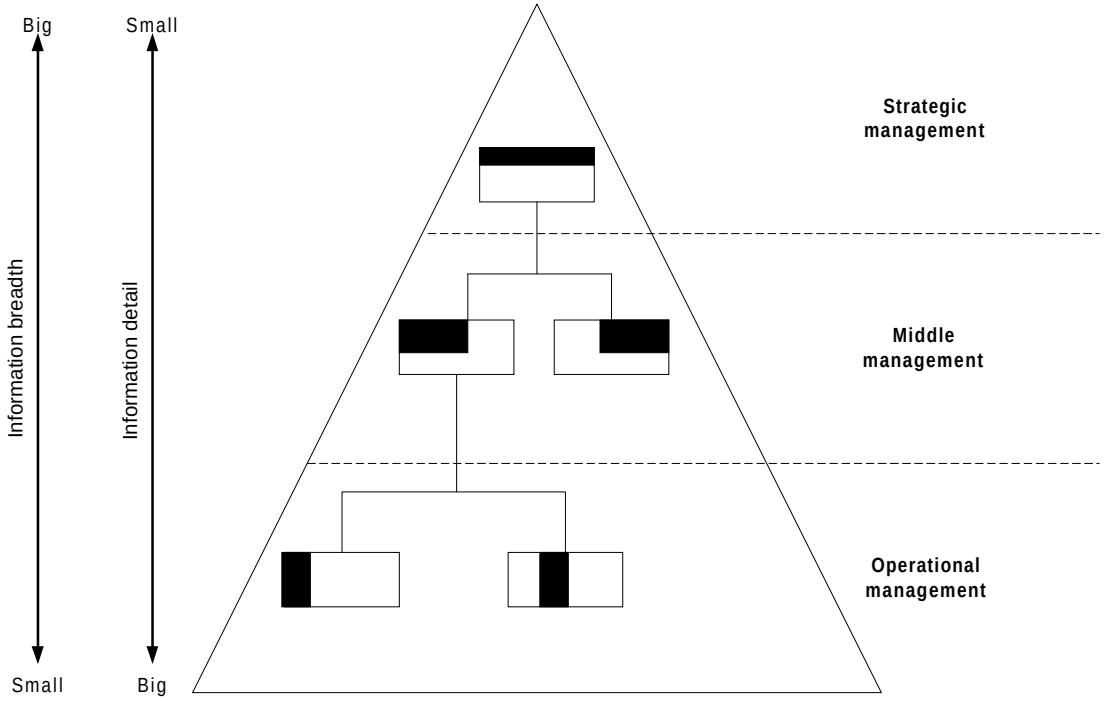

Figure 2.2 Different levels of management in business organisations and their different categories of information needs. (Based on Sandholm, 1995)

Each of the levels below the leadership of an organisation is ordered in various functions, specialised towards specific tasks. The strategic management level is the one where the organisation as a whole is directed. At the middle management level, tactical management such as planning and coordination is carried out. The direct value adding work of the organisation is carried out at the operational management level. The information need of each level differ a lot. Decisions are primarily made at the strategic management level. Broad and comprehensive information from the whole organisation is needed for decision-making at that level (Sandholm, 1995). On the lower organisational levels, the information needs get more specialised and detailed.

Business information systems are created in order to support the organisation they belong to. According to Avison (1995), the support the information system is supposed to give an organisation can be in form of efficient operations, support to business analyses and monitoring of goals and goals achievement.

Information systems comprise both formal and non-formal aspects. The non-formal aspects are primarily oriented towards phenomena and activities that are hard to formalise, such as social skills, experience and knowledge about different people's reactions in different situations. In addition to this categorisation, an information system can be divided in a computerised part and a non-computerised part. The computerised part of an information system consists according to Andersen (1994) mainly of those aspects of the system that can easily be formalised and by that are possible to automate. This concerns mainly repetitive operations (routines) that can be rationalised by automation. This means that an information system is not a single and simple object, but has several components and stakeholders. The relation a stakeholder has to an information system depends on the view of interest at each time. In this work, we will relate to the information system concept as the computerised part of an information system.

Alter (1999) considers information systems as particular working systems. A work system is a collection of related activities performed, as well as use of resources by humans in order to create benefits for an organisation. Figure 2.3 describes Alters view on information systems as a subset of a working system as well as the context of information systems regarding to an organisation, information technology (i.e. hardware and software) and a business environment.

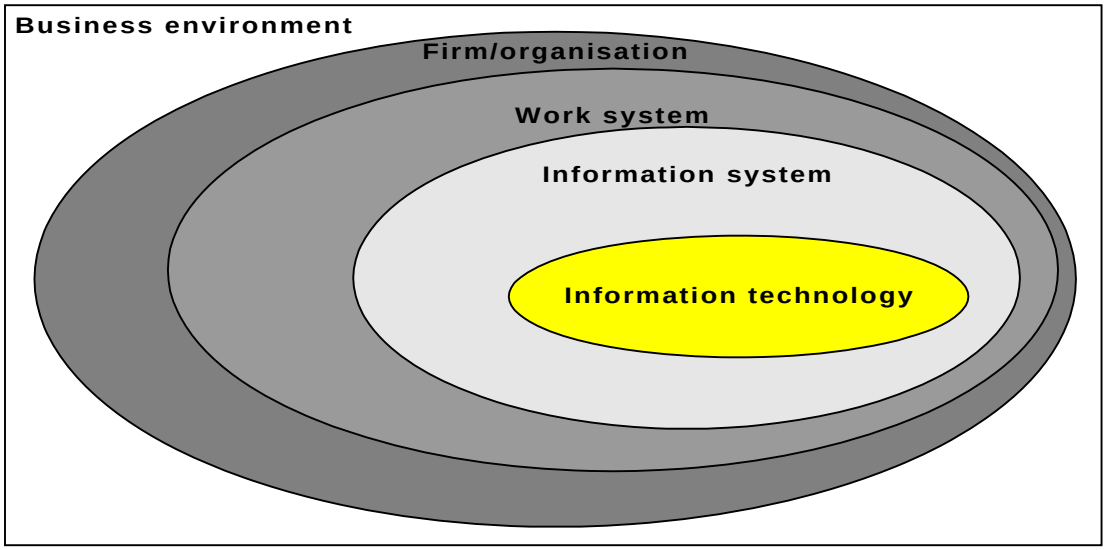

Figure 2.3 Information systems in organisational and technical perspective (after Alter, 1999)

The nature of every information systems depends on its purpose, but a general categorisation may be of interest. The categorisation in Table 2.1 is based on Avison (1995) and Alter (1999).

Table 2.1 Types of information systems according to Avison (1995) and Alter (1999)

Avison (1995)	**Alter (1999)**
Transaction processing systems	Transaction processing systems
Office automation systems	Office automation systems
Decision-support systems	Decision support systems
Expert systems	Execution systems
These aspects are covered by Decision-support systems in (Avison, 1994)	Management information systems (MIS) and executive information systems (EIS)
(Covered by “office automation systems” in (Avison, 1994)	Communication systems

The categorisation in Table 2.1 shows two slightly different views. The interesting thing to notice is that both authors are directed towards business information systems, which is common in the information systems literature.

Different levels of an organisation require various types of information systems support and representation of information. Figure 2.4 is an attempt to give an overview of how different types of business information systems (according to Alter (1999)) roughly relate to the different organisational levels presented in Figure 2.2

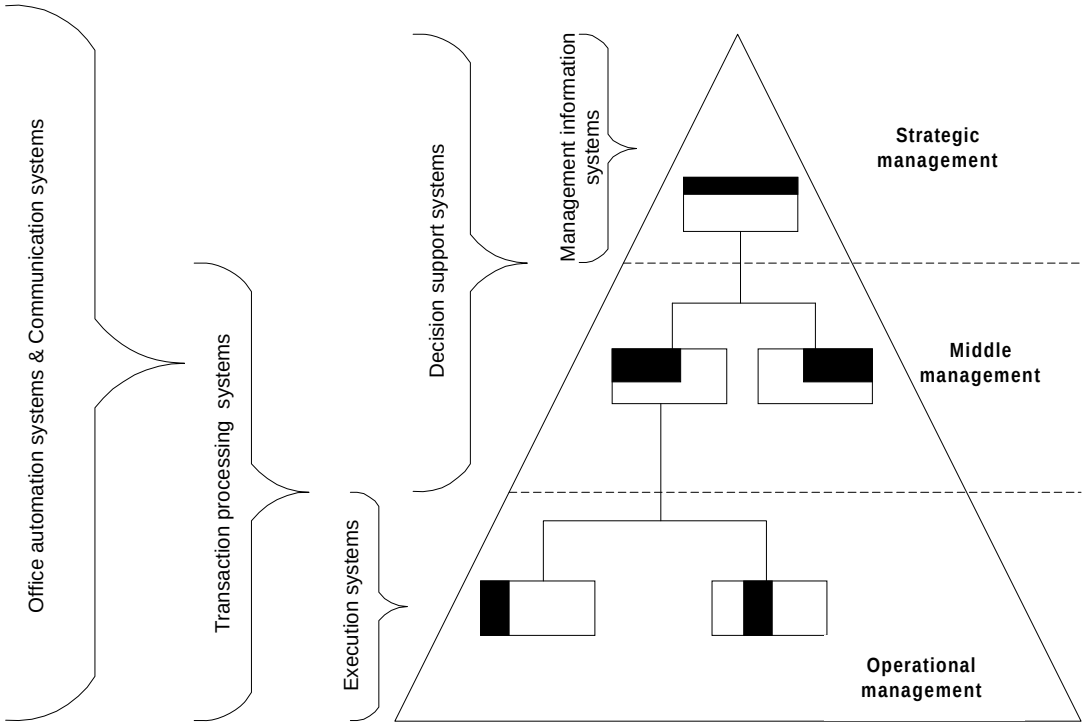

Figure 2.4 Different types of information systems related to different organisational levels.

Below a short description of the usage of each system type is given and each type is related to possible multimedia support as the focus of this work is towards multimedia information systems development. Increasing multimedia in business information systems is interesting in order to make more efficient use of the systems. The goal must be to create information systems where the effort of the user is directed towards solving a problem at hand with support from a system in stead of struggling with the system itself. The use of information systems is lot a question of communication between humans. Multimedia and virtual reality offer possibilities that may facilitate computer-based communication. The communication can be made more like ordinary human-to-human communication. This can be achieved by use of more senses in parallel than is possible in the computer-supported communication of to day. A strive towards business information systems with high usability must be of a great interest in order to better meet the needs of organisations and their stakeholders.

Below possible multimedia use in business information systems is briefly discussed.

- *Office automation systems* are wieldy used on every level in an organisation in order to facilitate ordinary office work, such as calculations and word processing. Modern office automation systems such as Microsoft Office are in

fact quite multimedia-based in order to facilitate work and make the systems more attractive to use. Interfaces are interactive and the use of graphics, text and even sound is common. The Office-assistant is one example of the types of guidance that probably will be more usual in software, i.e. an intelligent agent that gives users guidance in a personal manner.

- *Communication systems* are all devices and means used to facilitate and enable communication. The communication effort is a critical activity in order to coordinate and control activities that are carried out in an organisation. Even this area is a promising for multimedia applications, such as video and voice mail (Laudon and Laudon, 2000).

- *Execution systems* are support systems that directly add value to an organisation. These systems are mainly used on an operative management level. Multimedia can be successfully used as a teaching mean for different processes at this level. Examples of teaching media are simulations for training (Laudon and Laudon, 2000). Another possible area of interest is the use of multimedia animations to illustrate for instance processes and workflow management.

- *Transaction processing systems* are both used for control of transactions as well as for collecting information about transactions. Normal users of these systems are found on an operational management level. We have even chosen to relate these systems to the middle management level as well, because they are used there as well. These systems are used on the middle management level and the requirements on these systems are mainly formed on this level. Data in this type of systems is usually represented in tables, but there is an increasing need for visualising huge data stores in order to make it easier to navigate and find data and relate different data.

- *Decision support systems* are used to analyse data and to build models for evaluation of different alternatives in a decision situation. Users are both analysts and managers. Analyses of huge amounts of multidimensional data can be improved by visualisation of data. Examples of this are for instance tools for data mining (OLAP) that can represent three-dimensional graphs and

other models that can be manipulated in order to find patterns in huge and complex data collections.

- *Management information systems* are used to summarise information from other systems in order to measure performance of various activities and provide mangers with necessary background information about various operations. This information is on a high abstraction level and is usually combined from various sources. Each source can contain huge amount of data. The information must at the same time be easy to overview and it must be possible to drill down in it to make specific analyses if necessary. Such operations put demands on the representation of data, especially as some managers may not be to good at SQL. A database can for instance be represented as a library or a stockroom in order to ease search and navigation with the help of a virtual realty environment that is spatial and possible to relate to well known real life situations.

2.3.1 Information systems categories

The view on information systems presented in Alter (1999) is useful to put information systems in context, but we find it interesting to complement and extend this view. The reason is the trend towards closer cooperation and integration of organisations as well as increased public use of various information systems. Different information services and even information systems are shared to an increasing extent, e.g. in form of strategic extranets. The increasing use of Internet is even an example of a different focus in information systems. Its no longer question of an isolated information system related to one single organisation, but more of a common sharing of information and resources. An example of this is the use of search sites on Internet. These sites are an important part of every researchers “personal” information system, even if they are shared with millions of other people and are not situated in the organisation where the researcher carries out his/her work.

The question is if applications such as computer-aided learning media, computer games and web-applications in general can be placed in a categorisation like the one in Table 2.1. The question is if these systems can be defined as information systems at all? Alter (1999) states that software products are not information systems because

"they are not work systems in their own right". According to this view, computer games and some computer-aided learning media are for example not information systems. In this work we will use the definition of computerised information system in a broad sense, so an information system does not have to be a work-system. By that we will consider computer games, web-applications, and multimedia-applications in general as information systems as long as they full fill all the criteria's for information systems presented in the beginning of Section 2.3.

This broad definition demands a categorisation based on the use and intention of every system. Business information systems are in general mission critical, as well as systems used to control various critical processes. If such type of systems failure, they can affect their environment and stakeholders in a negative and sometimes a drastic way. It can be a question of delayed goods deliveries or failure in a nuclear power plant. Computer games and other software for entertainment are not mission critical in the same way. This difference may affect the methodologies for developing of these systems.

A categorisation of business information systems has already been presented in Section 2.3. This categorisation, based on Alter (1999), more or less states that information systems are related to, and used in, certain organisations. Below, a categorisation of information systems is made from a viewpoint where the information systems concept is expanded. An important reason to expand the concept of information systems is the fact that an increasing number of different software products have all the typical characteristics of information systems presented in the beginning of Section 2.3. Many of these systems are aimed for private persons only or for use by private persons in connection to various business systems (for example e-commerce systems and systems for Internet banking).

We have chosen to divide information systems in three main categories: *Business information systems*, *computer-aided learning media* and *entertainment media*.

- *Business information systems* are developed in order to serve and support an organisation. These systems are in some literature called management information systems. The different types of business information systems are presented in Section 2.3.

- *Computer-aided learning media* (may be replaced with the term *e-learning*) are multimedia systems that can be used as a complement to both ordinary education as well as for training and guidance of employees in different organisations as well as private persons. Computer-aided learning media can be made available both off and online. The main advantage of these systems is the various opportunities multimedia offers according to guidance and representation of various materials. The user is also free to use the systems whenever he/she wants to, choose a level of difficulty and to repeat certain issues.

- *Entertainment media* is getting more important as its commercial potential increases. Computer games are examples of a medium that in the same way as movies and novels can be used for explaining and expressing various aspects of the world around us (Ingvarsson, 2000). Music and movies are already distributed on Internet both legally and illegally. The Internet will probably be the normal distribution channel for these media in the future. Digital books as well as digital newspapers and magazines will likely be an alternative or complement to the traditional ones. Interactive television is also an example of future applications that will depend on information systems support.

There are already information systems found for delivering digitalised products and services. Examples of these systems are for example systems for e-commerce and so called ‘intelligent homes’. The tricky ting according to these systems is the fact that the companies delivering a service based on the use of these systems can regard the systems as a part of their business information system, while the customer regards it as something private. An e-commerce application is for instance integrated to the information system of the organisation of interest. The private person using the same e-commerce application does not necessarily regard it as a business information system, but only as a service application. Every system can by this be said to be in the eye of every stakeholder.

In Table 2.2, an overview is given of different categories of information systems and where their typical user categories are found.

Table 2.2: Categories of information systems and their typical users

	Business information systems							
	OFFICE AUTOMATION SYSTEMS	Communication systems	Execution systems	Transaction processing systems	Decision support systems	Management information systems	Computer-aided learning systems	Entertainment systems
Organisations	X	X	X	X	X	X	X	
Private persons	X	X					X	X

We want to emphasize that it can be important to use various views in order to categorise information systems. The categorisation in Table 2.2 is based on both the types of services offered by the systems and the typical users of the systems.

2.3.2 Multimedia

The development of both hardware and software has enabled integration of various expression modes in computers, usually called multimedia. There are various definitions of multimedia found. In this work, the definition of Tannenbaum (1998) is used:

> "Multimedia is defined as an interactive computer-mediated presentation that includes at least two of the following elements: text, sound still graphics images, motion graphics and animation". (p. 4)

The word interactive is a key word in this definition that differs from several other definitions. The concept of interaction states that the user has a possibility to react on the material presented and the reaction causes some kind of a selection among alternative actions by the program. Interaction opens up possibilities to engage the user through participation, i.e. by letting the user affect the communication process. Greater engagement normally leads to enjoyment that in turn facilitates learning (Norman, 1993). Mixing expression modes is also critical in order to make impression on the user. This is a well-known fact from all human communication. In the AMIT

Consortium (1996), it is for example argued that the success of the Church through the centuries can be explained by skilful and clever mixing of various artistic techniques to bring out its message in an efficient way. Theatre and movies are other examples of media that mix different expression forms into a whole in order to create an illusion that makes an impact on the audience (Laurel, 1993). Virtual reality attained by multimedia is a parallel to this (Tannenbaum, 1998). The use of virtual reality can be very effective for various purposes, as it provides the user with a controlled environment that gives an illusion of being real. By this, the challenge of multimedia can be said to be to develop applications that offers more and more reality like visions.

Examples of areas for multimedia (and virtual reality) applications are: simulations, entertainment and education. The use of multimedia for simulations for the purpose of training is common in many areas where mistakes by a user would be expensive or hazardous. Examples are flight simulators, simulators for surgery etc. Simulations can also give the user opportunities to visit both “real” and fictive environments that are not reachable in any other way. Education is an ideal application area for multimedia because of the possibilities to illustrate problems and guide the user through a study material in a pedagogic manner. Last but not least, the use of multimedia for entertainment is well exploited, mainly in form of computer games. The border between the areas mentioned above is quite fuzzy, since simulations are commonly used in multimedia-based education material as well as elements of game playing. Computer games can in turn can be considered a simulation of possible realities and are an important factor for all other multimedia development because of their great commercial and expression potential.

There are several challenges in further development of multimedia and its applications. It is both a question of hardware and software development as well as development of distribution channels for multimedia. The hardware demands are both in form of increasing and improving computing capacity as well as on the development of different devices that constitute the physical interface between the user and the application. So far, the interaction has normally been delimited to output in form of vision and sound and in some cases to devices that react on position changes and affects the user by stimulating the skin (an example of this are VR-

gloves). The devices for input are mainly restricted to keyboard, mouse and different forms of joysticks. It would be desirable to be able to interact with these systems in a more flexible manner, for instance by voice recognition. As the interaction between man and machine gets closer to human-to-human interaction, applications will get more and more useful (Ehn and Gärdenfors, 2000).

The creation of multimedia software has lot in common with software development in general, but there are several other skills needed for the creation of the content part of the application itself (Tannenbaum, 1998). According to Tannenbaum, the development of the content part depends on both inter-personal and mass communication as well as on several skills and design techniques from fine arts. Development of other software applications, such as operating systems and design tools, are also of great importance because they affect both the design process and the performance of the applications when they are in use. Further discussion about this is found in Chapter 4.

Finally, distribution channels are of interest. Traditionally, multimedia applications have been distributed on CD-ROM, i.e. offline. In recent years, the Internet has become an important online distribution channel for multimedia as the bandwidth has increased. The online distribution seems to be the road ahead. It offers opportunities for both frequent update and direct person-to-person interaction, which is impossible via the CD-ROM medium. An alterative is a hybrid web/CD where the advantages from the storage and fast delivery of the CD are combined with the online facilities of the web (England and Finney, 1999).

All information systems serve, in our opinion, as a medium for communication and interaction between people over space and time. In several systems, this interaction is over a long time span while it is a question of direct interaction in other systems. These systems can be categorised as synchronic and asynchronic systems. The usual mode of interaction in multimedia applications is that the system reacts on different actions of the user. These reactions are based on predefined situations that can possibly occur and actions related to those. This can be made more flexible and adaptable through the use of learning systems (artificial intelligence). Another mode is the use of a multimedia system as a communication media that two or more persons interact through. Examples are network-based games where a person controls some of

the reactions the system. Developing intelligent multimedia information systems that can be used to enrich communication between people over space and time is a challenge worth to investigate.

3 Information systems development

In this chapter, a brief overview of the history of information systems engineering and trends in information systems engineering is given. The nature of methodologies for information systems development is discussed as well. The chapter also includes a discussion about information systems engineering in a dynamic environment.

3.1 Information systems development – history and methodology

Computerised information systems have been developed in various forms for more than 40 years. The development covers everything from simple applications developed in order to support a single process or function, to company wide ERP (enterprise resource planning) applications of today.

In the early days of information systems development, programmers where the developers and the task therefore became primarily a technical issue (Avison, 1995). These early systems were normally of a scientific or military character. When information system development became a more regular feature in the business environment, a need for practical guidelines emerged. According to Avison (1995) the early systems were poorly documented and the programmers that created them were the only ones that had knowledge about how the systems were constructed and how they worked. This situation became untenable when the systems were to be maintained, further developed and combined with other systems. As development techniques improved, opportunities to develop more advanced and complex systems increased. The need for structured working methods became more and more urgent.

Since the sixties, the ultimate methodology for developing information systems has been searched for (Nilsson, 1995) and several hundreds of research-based methodologies have been introduced (Bubenko, 1992). The methodologies differ a lot, but in general, they give guidelines for how to control and coordinate the process of developing and implementing information systems.

All business information systems have a lifecycle that stretch from a business and feasibility study through development to usage, maintenance and liquidation. The information systems development methodologies have a reference point in a so-called life-cycle model. Usually the main attention and means are put on the development

phase that result in a new application, i.e. operation and maintenance are more or less seen as ”daily work” done by non system development specialists. Maintenance and various adjustments can be as critical to the system in a long-term perspective as the development phase, but it has unfortunately not reached the same status in general (Brandt et. al., 1998). An illustration of a system lifecycle is given below in Figure 3.1.

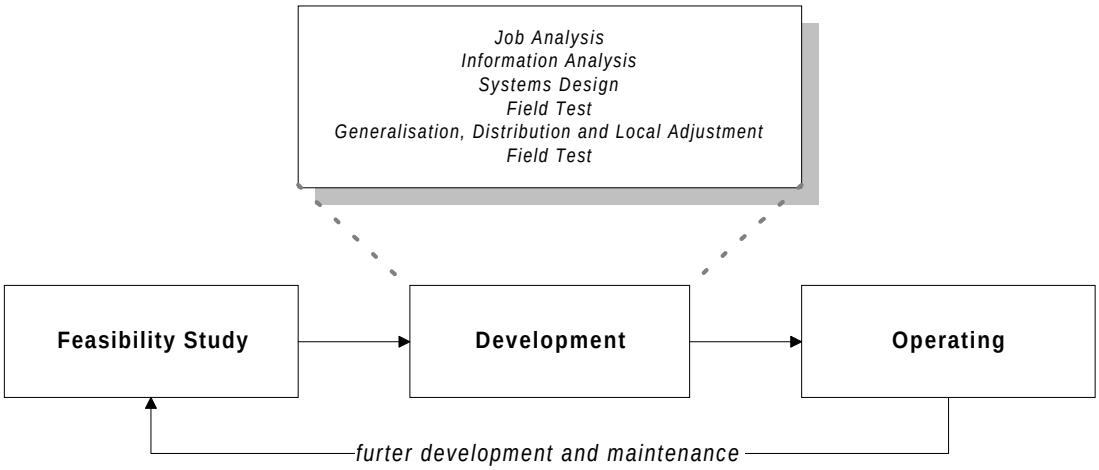

Figure 3.1 Information systems lifecycle. The steps of the development phase are adapted from SIS (1989).

The information systems development phase is generally seen as a complex task that demands a lot of work and methodological support. It is common to talk about *the systems development life cycle*, often related to as *the waterfall model*. The philosophy of the Waterfall approach is derived from other engineering processes (Summerville, 1992) and aims to divide the systems development into different steps in order to make the process as a whole easier to handle. The number and naming of the steps differs from case to case, but generally it comprises: feasibility study, systems analysis, systems development, implementation, validation and sometimes operation and maintenance as well. This approach and refinements from it that often are of a more iterative character has become a foundation to a great number of information systems development methodologies. These methodologies may be appropriate for programming and software engineering, but information systems development is no pure engineering problem, but rather a multi-discipline problem (Langefors, 1995; Hirscheim and Klein, 1989). Topics covered range from social sciences and business administration to engineering. If this fact is not taken into consideration while

developing information systems, various problems are guaranteed (Bubenko, 1992; Loucopoulos and Karakostas, 1995). As a consequence of the engineering paradigm, a lot of information systems have been ”manufactured” without satisfying the organisations they are aimed to support. One of the classical problems is that needs and requirements from several actors in the organisation of interest are not taken care of in the information systems. The focus is often towards activities that easily can be automated; instead of on what should be automated (Bubenko, 1992).

In the short history of information systems development, methodologies trends have shifted from decade to decade.

In the sixties, methodologies were function-oriented. This approach is based on a top-down view where the organisation is analysed in terms of hierarchal levels, from high abstraction to detailed activities (Nilsson, 1995).

The seventies were the era of data-centred approaches. Information systems were built on stable entities and their related data (Nilsson, 1995). Modelling came in focus and information systems development was highly influenced by the database community (Bubenko, 1992).

In the eighties, the event-driven approach was introduced as a reaction to the static nature of both function and data-oriented approaches (Nilsson, 1995). As organisations are dynamic, there was a need for methodologies that took care of those aspects of organisations. Routines and events that trigger different actions came in focus (Nilsson, 1995).

The nineties have been the decade of object- and process-oriented approaches. Reuse of code, and later of software components, has been receiving great interest (Allen and Frost, 1998).

As the methodologies have evolved, the strategy of how to develop and build information system has changed from time to time. From the first beginning, information systems development was mainly a question of automation and rationalisation of routines and processes. The information system has with time become a more and more critical issue in every organisation. As the information system is supposed to support the organisation at every time, it must be known how the organisation is going to evolve. This is important in order to enable system

development activities that really contribute to the organisation and to its progress. Examples of methodologies that views information systems development as a matter of business development process, is Direct (Axelsson and Ortmann, 1990) and SIM Method (Goldkuhl, 1994).

Several methodologies do not take usability aspects into account and several methodologies have poor support for requirements engineering. Political and cultural issues are also rarely taken into account in information systems development methodologies (Eriksson, 2000). Different methodologies account for these aspects in different ways, if accounting for them at all.

There has been a tendency towards development and use of separate methods for covering these aspects. It is also quite usual that the methodology used, does not fit the problem at hand. According to Nilsson (1995) there are three different strategies to cope with this problem.

- *Multi-scope methodology*

  It can be a question of developing a basic methodology for comprehensive situations and the developing of a mini-version for smaller problems and rapid systems work. It can also be a question of developing a simple and generic methodology for a “normal” case. Such methodology can then be adapted to various special cases.

- *Combination of various methodologies*

  Several methodologies are included in a toolbox. From this toolbox, different methodologies from different phases of the lifecycle are picked and combined into so-called methodology chain. The methodologies can also be combined in a methodology alliance by connecting different methodologies from the same phase in the lifecycle model.

- *Component based methodologies*

  A methodology is constructed from a set of definable components. The components must be generic and flexible in order to be exchangeable and adaptable to different methodological contexts.

3.1.1 Aspects and views in information systems development methodologies

There is no unity about which parts of a life-cycle model such as the one in Figure 3.1, that should be described by an information systems development methodology. Methodologies are however in general addressing objectives that motivate methodology use. Possible objectives for using them in general are according to Avison (1995):

- An aid to record requirements for an information system in a proper way.
- A systematic method of development that facilitate a continuous monitoring of the process.
- A support for time and cost estimation.
- Creation of a well documented system that is easy to maintain.
- Facilitation of changes in early stages, so the right things will be done in a right manner from the start.
- A support to provide a system that has a good acceptance by its users.

Nilsson (1995) considers methodologies for information systems development as in general consisting of three main parts: *perspective*, *working model* and *interest group model (stakeholders model).*

The *perspective* part in each methodology constitutes how the development is supposed to be carried out regarding working approach, concepts and criteria's for different choices that must be made.

The *work model* is the core in every methodology, including division of work into steps as well as vision of considered tools, techniques, documentation framework etc.

The *interest group model* is pointing out who is going to do what, describes the responsibility of each and every stakeholder, and suggests how they should cooperate.

The chosen *perspective* does of course affect the *work model* and the *interest group model* as well as the interplay between the *work model* and the *interest group model*. This interplay is very important as the *interest group model* defines who is going to do what and when in the *work model*. Usually, the *work model* is well defined while the *perspective model* and the *interest group model* are not formalised to the same extent.

The reason may be that developers find the *perspective* to obvious, and thus a formal description may not be considered necessary. Most methodologies do not include an interest group model, as the development is often seen as an issue for a narrow group of specialists.

There are several other perspectives found according to what a methodology consists of, but we find the one presented in Nilsson (1995) distinct and useful for a reference point.

3.1.2 Digging into the details vs. getting an overview

This section is quite philosophical and contains an anecdote in order to explain the need for different approaches while developing information systems.

Computerised systems are highly formalised and so are often the methods applied in order to develop them. Several methods have evolved from engineering science and are by definition quite deterministic and mechanic. An organisation is analysed by division of the organisation into functions, processes and activities. By understanding the function of each part, an understanding of the whole can be achieved.

A contrast to the deterministic worldview is the system view. According to the system view, a system is regarded as a whole that cannot be divided into different parts, since each part of a system affects the behaviour of the system as a whole.

The episode below is based on (Berens, 1988) and (Caton-Thompson, 1971)

In Zimbabwe great ruins of an ancient city are found. The place was given the name Great Zimbabwe. When the Europeans started to explore and exploit this part of Africa and discovered the ruins of Great Zimbabwe, a myth of an ancient white civilisation in the south of Africa was created. The whites denied that black Africans could have built such great buildings. In the 19th century, several expeditions were at the ruins of Great Zimbabwe, searching for items (primarily gold-items) that could provide proof that a white ancient civilisation (usually related to the queen of Zaba) had existed in the southern part of Africa. There was no evidence found of such an ancient white civilisation.

In 1929 a British archaeological expedition under the command of Gertrude Caton-Thompson (1889-1985) came to the ruins of Great Zimbabwe to scientifically study the story of Great Zimbabwe. The archaeologists started digging in a traditional manner, but they soon found out that the whole place had been “archaeologically destroyed” by former expeditions. Gertrude Caton-Thompson realised after several weeks of digging, that the ruins of Great Zimbabwe would not give any hints about the people that once built it.

Before the expedition returned from the place, Gertrude Caton-Thompson managed to borrow an aeroplane in which she flew over the ruins and the surroundings of it. From the air she noticed signs of a path from the ruins through the jungle to a hill nearby. The day after, the expedition moved to the hill where ruins never discovered by any Europeans were found. At that place Gertrude Caton-Thompson and her expedition found a great amount of items that gave answers to the mysteries of Great Zimbabwe. A picture of a highly developed empire of Bantu speaking people appeared. Between 700 ac. to 1200 ac. there was a period of a global trade network where ivory and gold was exported from the inner of southern Africa to the east coast, and from there to Arabia and Europe. Great Zimbabwe seems to have been the capital of this empire.

The story of Gertrude Caton-Thompson is a fascinating story of a scientist that did not give up when the ordinary methods did not work. We use this story as an allegory to explain our view on the relationship between the system approach and traditional engineering science. These two disciplines should not be seen as contrasts or antagonists. Instead they should be seen as necessary complements to each other. The system approach emphasises holism and should be used as a framework when large and complex problems are to be solved. Just as Gertrude Caton-Thompson studied the area around the ruins of Great Zimbabwe from the air, the system approach can be used to get a general understanding of a problem.

As soon as we have got a general understanding of a problem and its environment, the “good old” traditional scientific methods can be applied. Then we can start digging inch-by-inch, teaspoon-by-teaspoon, observing every stick. It is necessary to find out where to do the job. That cannot be done with a teaspoon, just as little as digging can be done with an aeroplane. Dealing with large and complex problems requires various

tools and methods. Let us see the system approach and the engineering science as two equals that must lean on each other in order to succeed. Of course, these two approaches must be run together continuously. It is not only a question of starting with the system approach and then apply engineering science. We must at all times relate what we do in a micro perspective of the engineering science to the macro perspective of the system approach.

3.2 Information systems development in a dynamic environment

The challenge of developing information systems is to a great deal a question of how to deal with an ever-changing environment. We start with an overview of the context in which information systems operate, and also the impact information systems have on this context and vice versa. We discuss different types of changes, and information systems engineering in a dynamic environment.

3.2.1 An ever changing world

We life in a world that continuously changes. In the late centuries, new technical inventions in various areas have solved many of our problems, but have also given us new problems. By various technical inventions, we have expanded our world out to space as well as into atoms. In this ever-changing world, companies compete in a global market where it is critical at all times to adapt to different situations and to unexpected events. In order to survive in such an environment, it is necessary to identify new circumstances and act properly according to those. A good business concept, well-defined objectives and qualified a staff supported by an efficient information system are of crucial importance.

Most organisations in the industrialised part of the world depend more and more on computerised information systems for automating and rationalising various processes. These computerised systems can perform many processes faster and a greater amount of information can be handled and organised in order to gain increasing knowledge. Increasing the amount of information and knowledge, expose more and more possible alternatives of action in different situations. By this, different managers get more freedom of choice, but every situation of choice may get more complicated than ever before. The question is if this development speeds up the rate of change in the world around us, or if it is some kind of a reaction because of an ever-changing world? The

only thing that seems to be sure is that the world around us is changing faster than ever before (Ackoff, 1981) and we meet new challenges every day.

Both Toffler (1970) and Ackoff (1981) argue that a faster rate of change increases the complexity of the problems we deal with, and it also takes longer to solve the problems. We think it is no controversy to state that complex problems require both knowledge and tools to be solved. According to this evolution, there is a big expectation found on the development of information technology. By IT-based applications, information acquisition and information arrangement can be made more efficient in order to gain knowledge for problem solving. It should be reasonable to assume that increasing problem solving skills makes it possible to deal with more complex problems than ever before. This development gives us constantly new experiences and knowledge that increase the rate of change and the complexity that follows. By this argumentation we want to point out the role of computer-based applications in a complex and volatile world. These applications are of greatest importance as support while dealing with complexity and change, but at the same time it is possible that these applications more than anything else carries on this development. This is illustrated in the Figure 3.2 below.

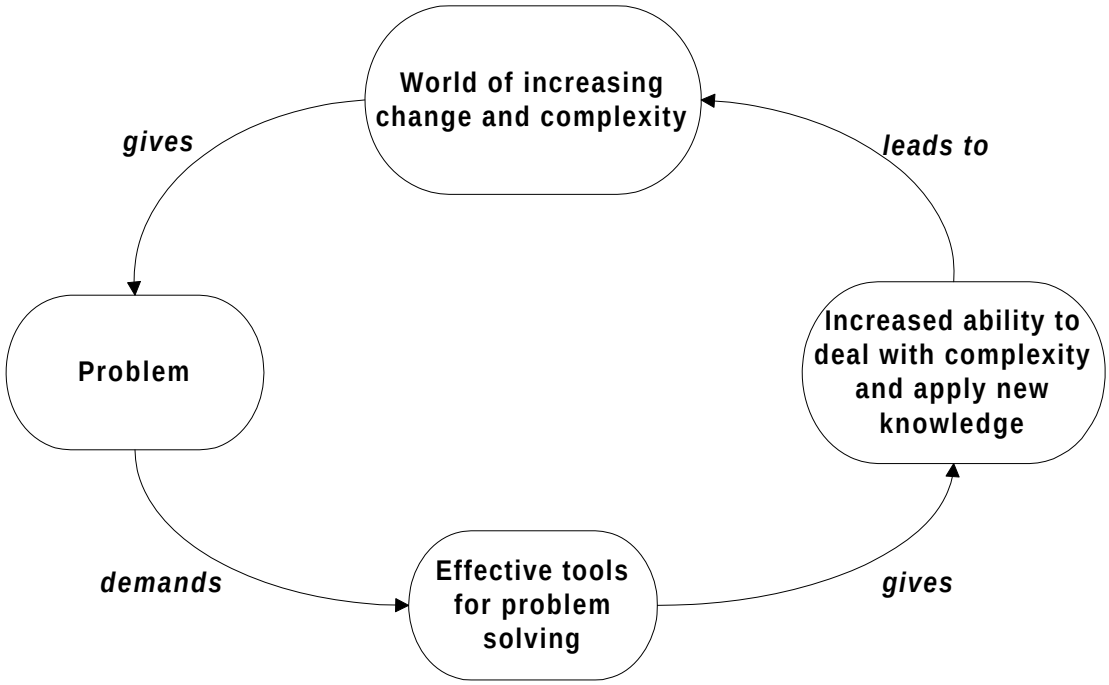

Figure 3.2: The ”bad” circle of increasing rate of change and complexity

In Figure 3.2, we try to point out the relations between advanced tools for problem solving and the increasing rate of change and complexity. Complex and constantly changing situations generate problems that in many cases are impossible to solve without advanced methodologies and tools for problem solving. The benefits from the methodologies and tools are increased ability to deal with complexity and the generation of new knowledge. This development on the other hand opens up new areas to explore. That kind of challenge just calls out for new problems to solve and the circle starts over.

Every modern business organisation is a complex system relaying on both humans and artefacts. In order to control such an organisation, information systems are required and in fact they can be seen as ”organisationally embedded” and ”mission-critical” (Bubenko, 1992). The fast change rate of today puts the adapting ability of every organisation on trial in order to survive and stay in competition. An information system is of a critical interest because of its role in decision support. The information system is also a conceptualisation of the organisation of interest, i.e. the information system is a representation of the organisation. This means that changes in the organisation affects the information system and by that the information systems must adapt to these changes and at the same time serve as support to the organisation. Adaptation of information systems towards new or changed conditions can be a task of small and continuous development (maintenance) or more radical change (systems development). Because of the complex nature of organisations, neither information systems maintenance nor development is an easy task. One of the main problems in developing information systems is the fact that the organisation of interest is like a moving target. It may not look the same when the development is finished, as it did when the development started. There are many examples found of huge information systems development projects where the result is an information system that is suited to an organisation that does not exist any more in the shape the information system was specified for (Land, 1982).

The fast rate of change affects organisations and their environment all the time. This problem becomes serious because of the ”engineer-like” nature of traditional information systems development methodologies. After the feasibility study and systems analysis the problem situation is usually ”frozen” and the design and

implementation is made on the bases of that. This becomes especially serious while developing huge systems during a long time span. The result will under no conditions be an information system that serves the organisation as it intended at the ”freezing-point” (Land, 1982). This problem is well known and different efforts have been made to solve it. One solution is the use of standard software (off the shelf software) in order to shorten the development life-cycle and by that shorten the time span between the time points when requirements are settled to the time when the system is ready for use.

3.2.2 Changes in organisations

In the system development literature, change processes are normally seen as controlled activities performed in order to solve problems and improve objects or processes. We would like to give a more balanced picture of the change concept and the consequences associated to different situations of change.

First of all, we would like to identify some main categories of the concept of change according to a specific organisation. We have chosen to start with six main categories being: *internal change*, *external change*, *expected change*, *unexpected change*, *controllable change* and *uncontrollable change.*

- An *internal change* is a change that takes place inside the border of an organisation. It may be caused only by external events, only internal events or both. Hiring and firing employees in an organisation is an example of an internal change.
- An *external change* is a change that takes place outside the organisation border. An example of external events to most organisations are for example changes at the stock market.
- An *expected change* is a change that is supposed to happen at some point in time. The change is expected from former knowledge and experience. Expectation of a change has some kind of a lifetime, from the time it is defined as an expected change, to the time it takes place or not. If there were, for instance series of burglaries in our neighbouring area, we would not be too surprised if we would also get unwelcome visitors.

- An *unexpected change* is a change that occurs suddenly without any possibilities to predict or prepare. An example of an unexpected change is a failure in a new machine.
- A *controllable change* is a change that can be steered or affected by the organisation. More employees can possible be hired if the demand for the services of the organisation increase.
- An *uncontrollable change* is a change that an organisation or individual is not able to steer or affect at all. A normal organisation is e.g. not able to do anything about a decision about devaluation, taken by the government.

It is important to point out that the definitions above depend on the system (organisation) beholder at any time. Organisation A can e.g. maybe foresee and control changes that are unexpected and uncontrollable for organisation B

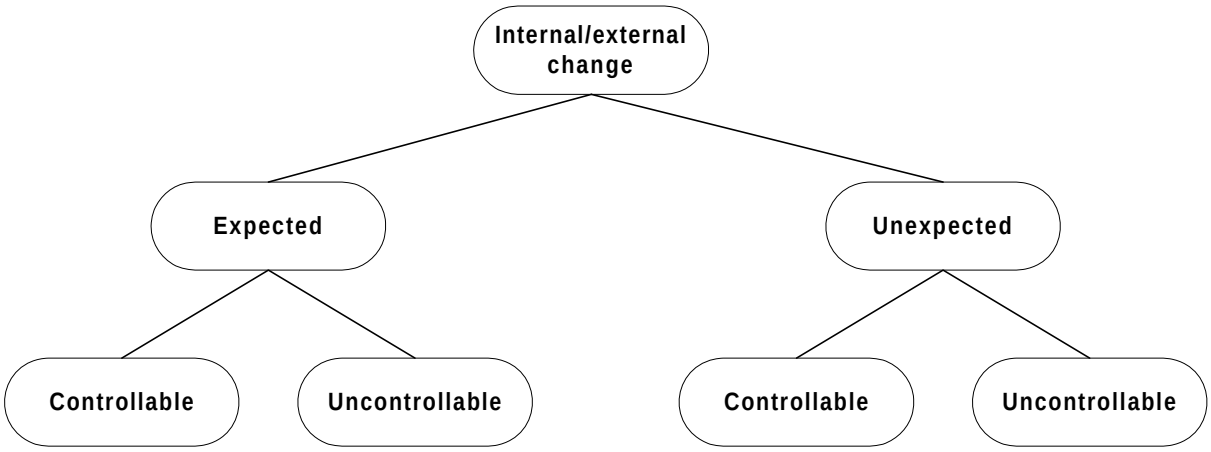

Figure 3.3 Different types of change

In Figure 3.3, we illustrate the connection between the main categories of change that we have identified. Both *internal* and *external changes* can be divided into expected and *unexpected changes* and each of those can be divided into *controllable* and *uncontrollable changes*. It should be easier to deal with *expected changes* than *unexpected changes*, because the first of these two can be planned for. If planning is possible, *unexpected* and *uncontrollable changes* could be compensated for if these were expected. The most difficult changes for an organisation should normally be those that are external, unexpected and uncontrollable. Examples of such changes are various nature catastrophes.

All the changes above could be divided into good and bad changes. For an organisation this categorisation must depend on how a certain change affects the ability to reach the goals of the organisation. A nature catastrophe can of course be hard for a company in the area of the catastrophe, while the same catastrophe can mean good news for the competitors of the companies that have been hit. This means that the change is good or bad depending on the interest of every stakeholder. The ethical discussion this may lead to will be left out of this dissertation.

3.2.3 Business information systems and change

The purpose of business information systems is to support organisations in their strive to support various processes in the organisation of interest and the achievement of the organisational goals. The concept of an object system is used to represent the aspects of the reality of interest. In information systems development perspective, the object system is normally the organisation of interest together with its environment. In order to define and create an information system, a conceptual model must be built. It should be noted that only a part of the organisation is implemented in the information system.

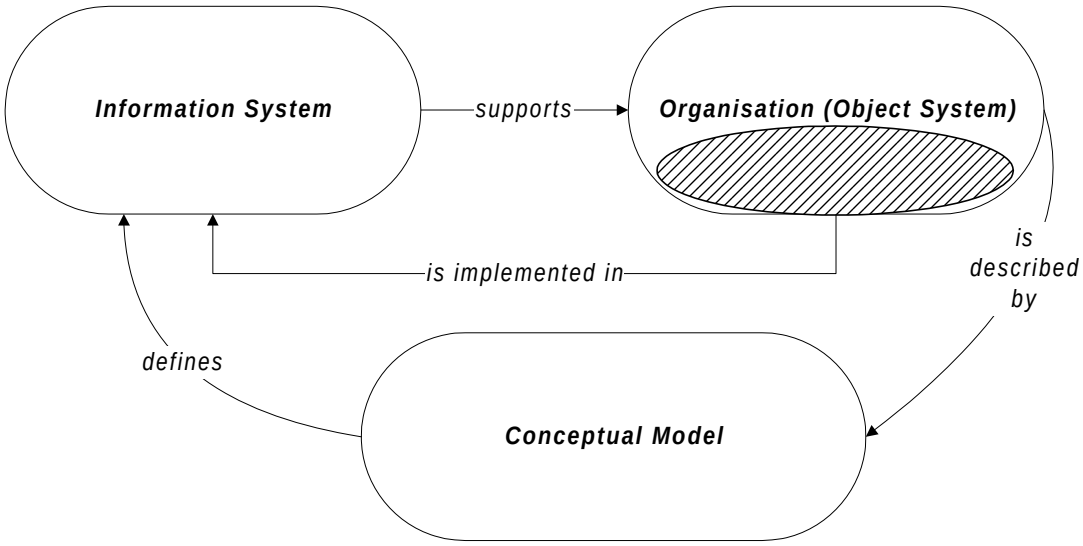

Figure 3.4 An overview over the connection between the information system, the organisation and the conceptual model.

Information systems development is initiated by the identification of objects and phenomena in the object system that shall be represented in the information system. Primarily, identification of requirements related to various actors and objects must be done, as well as identification and definition of requirements of data and information

that are to be produced, manipulated, stored, distributed and displayed. Information regarding different processes, objects and actors in the organisation, must be defined as well. If the representation of the factors mentioned above is to be meaningful and goal directed, different problems and goals in the object system must be identified and related to the ongoing work. All this must be represented in a structured way in a conceptual model – the enterprise model. An enterprise model represents those phenomena in the object system that is of interest according to the information system to be developed. An enterprise model is, according to Bubenko (1993) created in order to get an understanding of the business and document the goals, problems, concepts, actors and activities found in the business.

The enterprise model is used as a starting-point for the creation of the requirements specification. The purpose of the requirements specification is to describe the business demands as well as functional and non-functional requirements of an information system that is to be developed (Loucopoulos and Karakostas, 1995). The authors claim further that the requirements specification shall work as a communication aid for the stakeholders involved and become a framework for validating the final product.

Bubenko (1993) adds another important property to the requirements specification concept. The requirements specification should be a model and description that works as a reference point for changes that must be made to the information system due to changes in the object system.

The information system in turn can, in a way, be regarded as a dynamic model representing those aspects of the object system that are represented in the requirements specification.

Figure 3.5 is a rough simplification of the development process that is carried out when computerised information systems are developed in organisations. Even if the figure is a simplification, we believe it can support the description we present below.

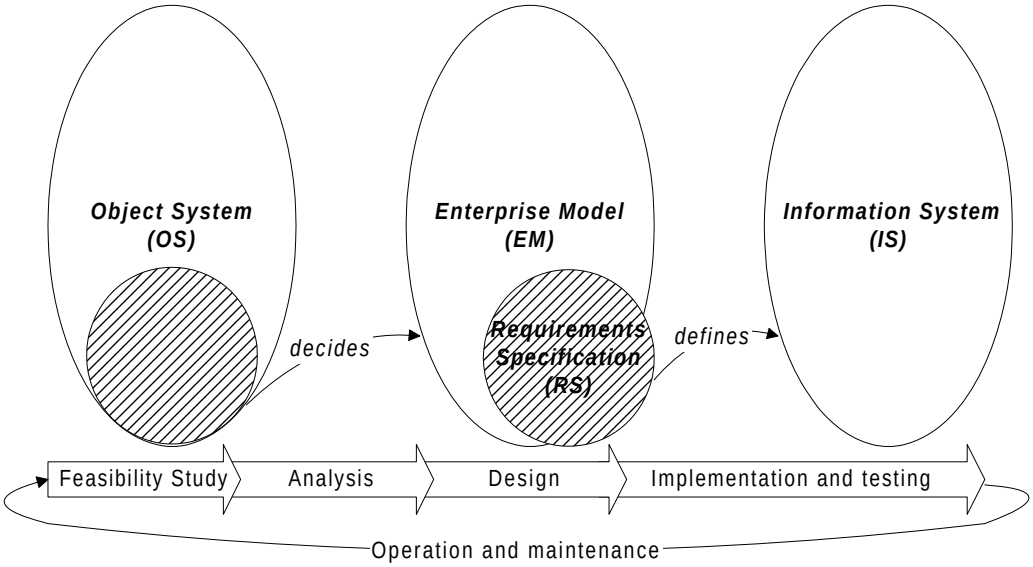

Figure 3.5 The main steps in the development of a computerised information system in relation to a lifecycle model.

We want to point out some important issues that are essential for the process of information system development and the problems associated to it. Figure 3.5 illustrate that a view where an enterprise model does not cover the whole of an object system. This is natural since the enterprise model is like any other model, a simplification and interpretation of reality in order to better understand the reality and some specific aspects of it (Bubenko et.al., 1984). The requirements specification in turn represents not the enterprise model as a whole, but only the requirements for the planned information system. In Figure 3.5, we have chosen to place part of the requirements specification outside the enterprise model in order to point out that some requirements are of a non-functional character and do not have to be expressed in the enterprise model, but may come from an external system supplier.

We use Figure 3.5 as a reference point in order to point out some issues that are of great interest for the process that is needed while developing traditional information systems.

- The persons that produce the conditions for an information system are situated in the object system or in the closest environment of the object system. The role of these persons is to study the object system in order to capture the aspects that are to be included in the enterprise model, the requirements specification and the information system at last. This is mainly a question of

defining data, information, goals, problems, actors, objects, processes and functions (Bubenko, 1993).

- The purpose of the requirements specification is to represent those aspects of the object system that are to be supported and in which way these aspects should be supported in an information system. An important criterion for the success of this process is, according to Persson (1999), an active cooperation among different stakeholders, as well as methods and tools that support the cooperation. Persson (1999) especially points out modelling as an important tool to work out a good requirements specification. Modelling is defined in Bubenko (1993): ”Modelling means essentially to describe a set of abstract or concrete phenomena in structured and, eventually, in a formal way.”
- The user interface must be taken into account in the requirements specification. The user interface design becomes more and more critical for the benefits of the information system offer to the users and the business of interest. The interface aspect is discussed thoroughly by for instance, Norman (1989, 1992). It is also very important while developing a requirements specification to be conscious about how an information system is affected by other systems. The problem of badly compatible information systems is far to common.
- The presumptive users of an information system are situated in an object system and the information system will operate inside the object system. This puts demand on the development of not only the presumptive information systems, but also of the presumptive users and the organisation itself (the object system). To make it clear, the users, the system and the organisation must develop in parallel (Andersen, 1994). This will initiate some changes in the object system that must be conveyed in the enterprise model, the requirements specification, and in the information system.
- The quality of an information system depends on how well an information system supports and serves certain issues in the actual object system. The systems stakeholders will judge this in the object system. This statement is in

line with several definitions of the concept of quality, such as those by Sandholm (1995).

- An information system development process like the one described in Figure 3.5 must be continuously validated. Before the enterprise model and the requirements specification is conveyed into an information system, the enterprise model and the requirements specification must be validated towards the object system. Validation means that it is checked if the enterprise model and the requirements specification describes the reality it is planned to describe and if the right requirements are treated in a proper way. The validation can be problematic since the specialists that create the enterprise model and the requirements specification may use a set of concepts that are not known to the stakeholders in the object system. This uncertainty demands a comprehensive model representing all the concepts used (Bubenko, 1993), because requirements cannot be validated without involving the stakeholders of interest (Loucopoulos and Karakostas, 1995). The information system must also be continually validated towards the enterprise model and the requirements specification. An information system can also be validated towards the object system by prototyping. Indirectly, prototyping is also a validation of the enterprise model as well as of the requirements specification. The information system reflects the enterprise model and the requirements specification and if the requirements of the object system are met in the information system, the enterprise model and the requirements specification should be of a good quality.
- One of the major problems throughout the information system development process is the volatility of requirements. Harker et.al. (1993) discuss this problem thoroughly and identifies various types of volatile requirements. According to Harker et.al., requirements can change for several reasons. One reason may for instance, be changes in the organisation’s environment or increased understanding and knowledge by the stakeholders as the requirements are elicited and/or the information system is taken into use. Stakeholders simply become more demanding as they see what is possible to do. The fact that requirements are volatile is important because a requirement

that is identified early in a development process may be changed or even terminated when the system is taken into use. A way to avoid this is to apply an iterative working process inspired by the Boehm's model (Sommerville, 1992).

An information system constitutes a kind of a model of the object system that conceptualises a view of the object system and some specific properties of the object system from time to time. According to this, problems occur when the object system changes. That means that the view the information system gives of the object system does not correspond any longer to the actual object system. The development process described in Figure 3.5 is obviously demanding several resources in form of time, people and money and may become sluggish – maybe far too sluggish. Object systems are dynamic, and the representation and transmission of various aspects from an object system to an information system is carried out through a conceptual model (represented in form of an enterprise model and a requirements specification in Figure 3.5) of a static character. This problem is illustrated in Figure 3.6.

An environment that affects the organisation in various ways surrounds every organisation. The inner status of the organisation and the environment of greatest interest are monitored by the organisation's information system. Those aspects in the organisation and its environment that shall be represented and monitored by the information system must be described and formalised. A static conceptual model usually does this. The information system receives and delivers information from and to both the organisation and its environment. The view of an organisation (and its environment), represented by an information system, is continuously affected by the actual flows of information and data at every point in time. The conceptual model affects and is affected by the information system's view in a similar manner. The greater and more frequent the changes in an organisation the more difficult it will be to transform these changes to an information system through a traditional conceptual model. This problem may result in an information system's view that is not representing the situation in the organisation at a certain time.

This is problematic because what we describe above is the relationship between an ever changing object system (an organisation and its closest environment) and a model

(the information system) that is created in order to represent and control a certain object system. Most of the models used to represent various aspects of the reality in the information system, are of a static character. Using these models while building large systems is problematic, because there is a risk that the object system and requirements are changing while the conceptual model is created. This means that there is a risk that the conceptual model constitutes wrong conditions for the information system it is supposed to build a foundation for. This risk is especially high in cases of large system development projects over a long time span (Land, 1982). Continuous validation can of course be performed but it will become more demanding while the projects get larger and more complex. While building small information system's applications, most of the formal development methods do not fit because only learning how to apply the method demands far too much resources and time.

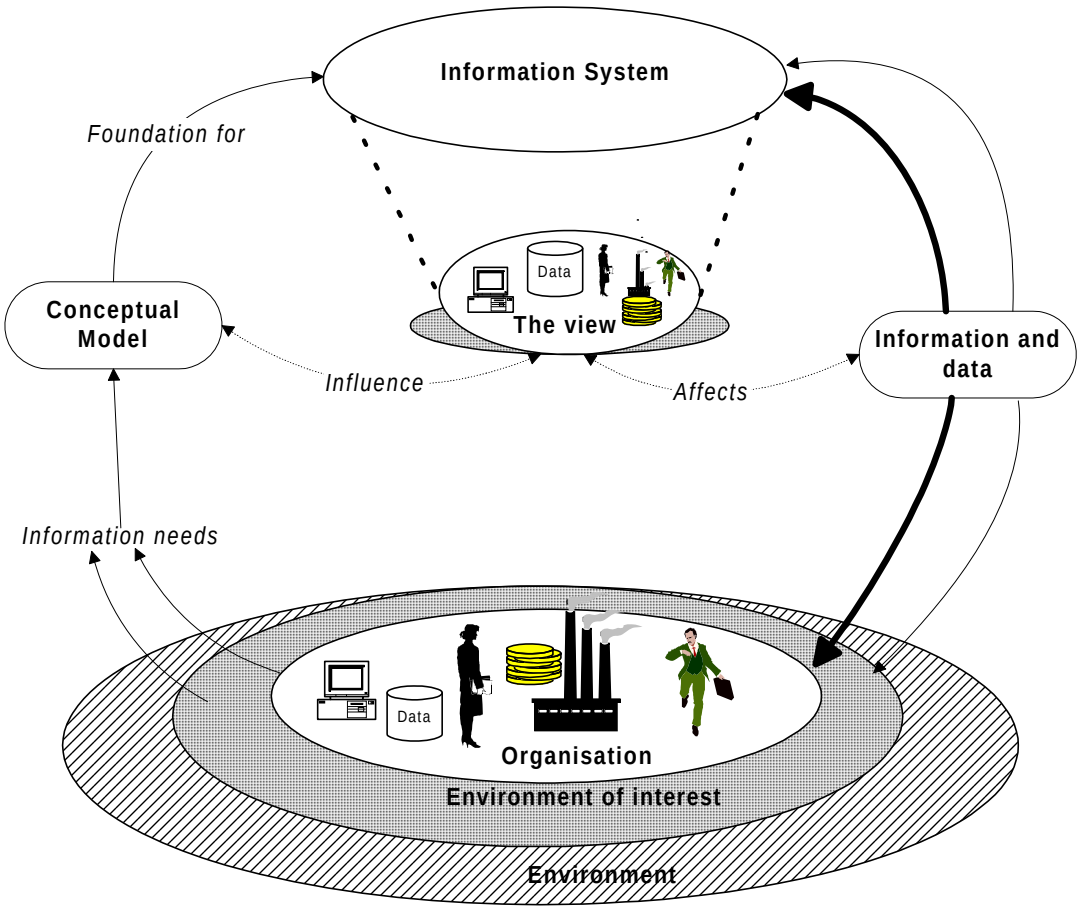

Figure 3.6 Illustration of a traditional information systems development process in a dynamic environment.

The question is how to develop methodologies that solve the problem of developing information systems that, in a satisfying manner, mirror the reality they are supposed to support. These methodologies must support information system development that continuously react to changes in the object system and adapt the information system to these changes. Because of the complexity typical for information system in general, this will be difficult. Change in one part of an information system may affect other parts of a system in an unpredictable manner (Mathiassen et. al., 1998). To avoid unpleasant experiences of that kind, the design of an information system must be of essential importance for the systems ability to adapt to new circumstances. Change of an information system design demands update of the system documentation, in order to facilitate further maintenance, verification and validation in an efficient manner. In fact, the system documentation is in many cases not updated, and in some cases it does not exist at all (Gustavsson, 1998), which makes efficient adoption of an information system to its object system difficult. The use of CASE-tools has in recent times been introduced to facilitate development and maintenance of information system and their documentation. These tools are often very complex and generate huge amounts of information that also requires efficient management.

Developing information systems is no easy task, but some improvements may be done by new ways of working. It may for instance, be the case that we have to regard the information system's development process as something that cannot be carried out in a project form, but must be worked out in a more continuous manner. It may, for instance, be regarded as an editorial process with periodic updates and releases. See further discussion in chapters 5 and

4 Developing future multimedia information systems

In this chapter, we discuss the nature of multimedia development, especially according to the concept of content. A comparison of the lifecycle of multimedia applications and traditional information systems is made. A brief overview of computer games development, development of computer-aided learning media and the web-revolution is presented as well. Finally a short discussion about possible application areas for web-based multimedia information systems is performed.

4.1 The concept of content

In this section we start with a short discussion about communication from the data-information-knowledge perspective and how this relates to the concept of content. We will then discuss the concept of content as well as development of content in relation to software engineering in multimedia projects.

4.1.1 The content of a message

The concept of content is hard to define. Below we discuss content in an information-data-knowledge context, similar to the one represented in Section 2.1.

We regard a message as an important fundament in all human communication. All messages have a sender and a receiver and message is expressed in the form of a data. Data can be in form of various signals and symbols. The information that the message carries can be regarded as the content of the message. The content of a message can vary since information depends both on how data is represented and how a receiver interprets it. Interpretations can vary from receiver to receiver and even from time to time for the same receiver. The reason is that the interpretation of every message depends on the frame of reference of the receiver as well as the sender. The frame of reference is representing knowledge, experience as well as social and biological heritage. All of this together defines the capability to both formulate/code messages and to interpret messages.

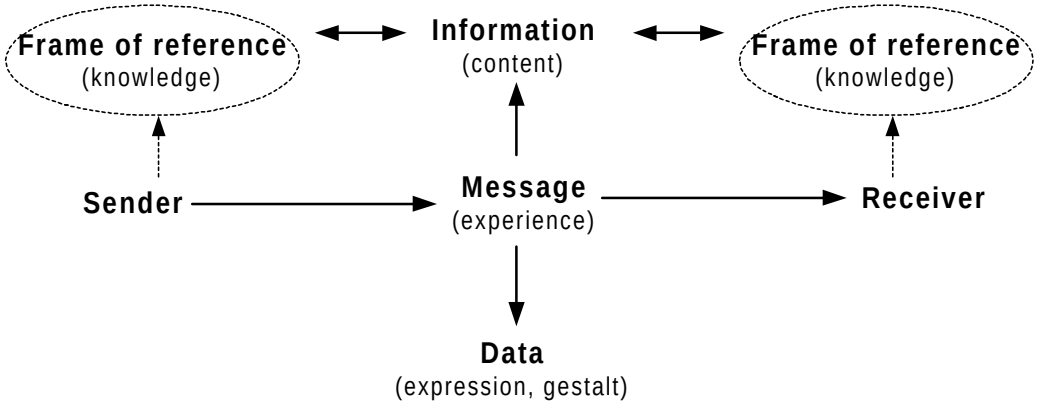

Figure 4.1 A message is expressed in form of data and the content of the message is depending in the frames of reference by a sender and a receiver.

These issues above are critical in information systems development as well as in all human communication. The symbols (text) written on this page are a form of data. The symbols are coded in English and constitute a message to the intended receivers. The information (content) this message manages to convey depends on the sender (the author) as well as the receiver (the reader). How the sender formulates the message is critical for how well the receiver manages to interpret the message in order to get information out of it. Every interpretation depends on the frame of reference for both the sender and the receiver. Message from a sender to a receiver may comprise a single symbol with a commonly agreed meaning. This is a common way to make communication more effective (Fiske, 1982). A single symbol with an agreed meaning between sender and receiver can be regarded as a message. As an example, the use of standardised icons for different functions in MS-Windows makes the communication between the user and the applications easier, provided the user knows what the icons stands for. An icon can be regarded as a message to the application user that, for instance says, ‘click on for saving the document’. As the user clicks on the icon, he/she sends a message to the application commanding it to save the document.

We regard a thorough discussion about the message concept as an important issue in order to get a deeper understanding of how to create good information systems and especially good multimedia information systems. That discussion will not be included in this work, because of the overview character of this work.

4.1.2 The content of an information system

As multimedia systems are computerised information systems, their development has much in common with traditional information systems development. However there are some differences.

The core idea of multimedia systems is to handle information that requires various types of media to be expressed and accessed in an efficient way. It is, for instance, reasonable to claim that one key factor of increased public Internet use is a multimedia interface in the form of the web. Compared to text-based system, multimedia applications attract users by offering various types of media, such as graphics and sounds. But that is usually not enough. There must be some content in the system that makes the system exciting to use. Using the system is often a challenge, where the user has to struggle with various problems in order to move on in the system. It is also common to create an interface representing an environment that the user has to investigate. The motivation to use the system is often excitement and curiosity, even if the goal of using the system may be learning or training. In order to gain these motivation effects in multimedia systems, a lot of effort must be put on creation of the content of the system. It may, for example, concern embedded scenarios in order to make the system attractive and interesting to use. While developing multimedia systems it has been common to create the biggest part of the content of the system before the system is taken into use. In order to create content, competencies are needed from various fields of practice, as the content is often of a graphical and narrative character. Since software engineering people perhaps are not the best creators of aesthetic content they have to seek content providers in museums, publishing houses, television and movie studios (Druin and Solomon, 1996). Recently, the term content industry has become common in media, referring to providers of aesthetic content of any kind. Various multimedia solutions are (now primarily on the Internet) are receivers of aesthetic content production. The merge between America Online and Time Warner (Okrent, 2000) is maybe the clearest sign of a development towards close cooperation between content providers such as Warner with a broad range of movies, music, magazines etc. and an IT-provider such as America Online.

The content of information systems varies concerning the purpose and nature of a system. A traditional stock control system does, for example, probably not include much aesthetic content, but rather pure facts. Even multimedia systems contain content of a non-aesthetic character. In order to be able to relate the concept of content to the concept of information systems, a distinction between various types of concepts is necessary. We illustrate this by giving an example of an imagined system for providing movies over the Internet (video on demand). Such a system offers the customers several movies in a digital format for downloading at any time. The movies are of course what people would count as the content of the system, but that is not enough. The system must also contain functions for downloading, searching, messaging etc. In order to make the search meaningful, searchable facts related to each movie must be identified as well. The customers probably want to get information about titles, actors, categories, and length etc. before they decide to download a film. For the best result functions and the facts of the system must be presented in an attractive form in order to make customers secure and comfortable in their use of the system.

We have chosen to suggest a division of the concept of content into the following categories: *facts*, *functionality* and *form*:

- *Facts* are data, manipulated by an information system throughout its lifetime. An example of *facts* in the online movie system above is a title of a movie, names of actors and other facts about the movie. Each movie itself is a *fact* in this respect according to the system, even if the movie as such is an aesthetic work.
- *Functionality* refers to the functioning of a system. It is the code that realises the application functions including things such as data integrity and navigation in the graphical user interface. Examples in the system above are for instance functions such as downloading and searching.
- *Form* are various means such as text, sound, still graphics images, motion graphics and animations that are used and arranged in order to present facts and to visualise available functions. The form is expressed in the user interface and constitutes the ‘stage setting’ of the system. Examples of *form* in the video

on demand example above are menus and dialogues presenting the *facts* and the *functionality* of the system to the user. A parallel can be made between the different types of a content described above and different information systems architecture levels in a three-tier client server system (Allen and Frost, 1998), see Figure 4.2.

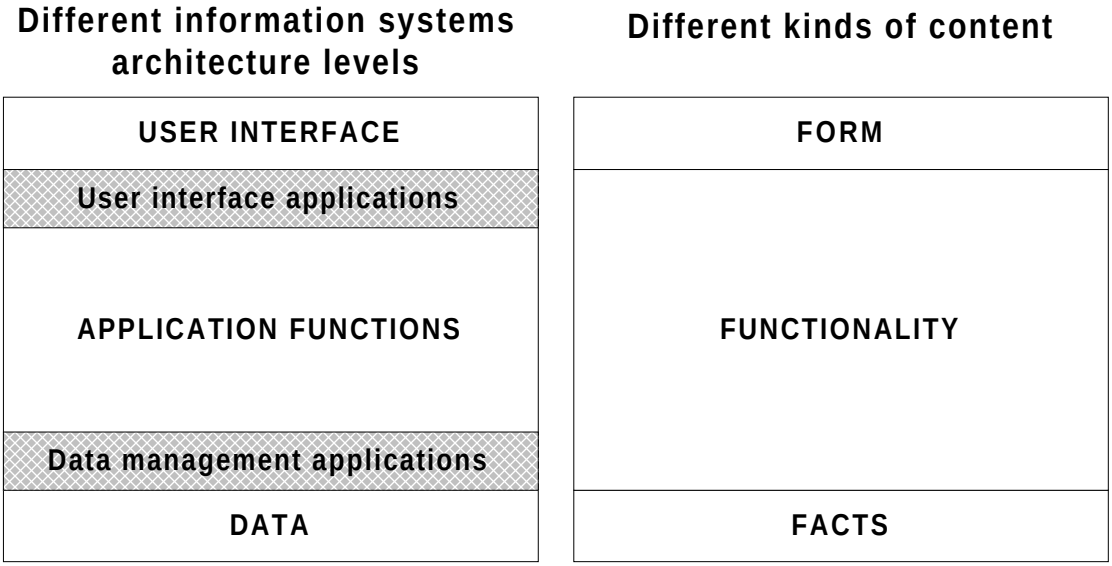

Figure 4.2 Comparison between information system architectures levels and different types of content.

Facts must be processed by the *functionality* of a system in order to be expressed in a *form* suitable for the system users. The other way around, a *form* of a system may allow input of *facts* that can be manipulated and stored by different functionalities. There is a clear parallel between the different types of content to the levels of services in information systems architecture. The difference is that in the information systems architecture, are functional applications are found at all levels. There is for instance code at the user interface level in order to control the stage setting – the form. At the data level application functions are found for managing the data in order to serve the application functions with data.

Figure 4.3 below is a simple illustration of the three content types and their main interactions. The figure is far from complete, but only thought to serve as an attempt to distinguish between the different types of content.

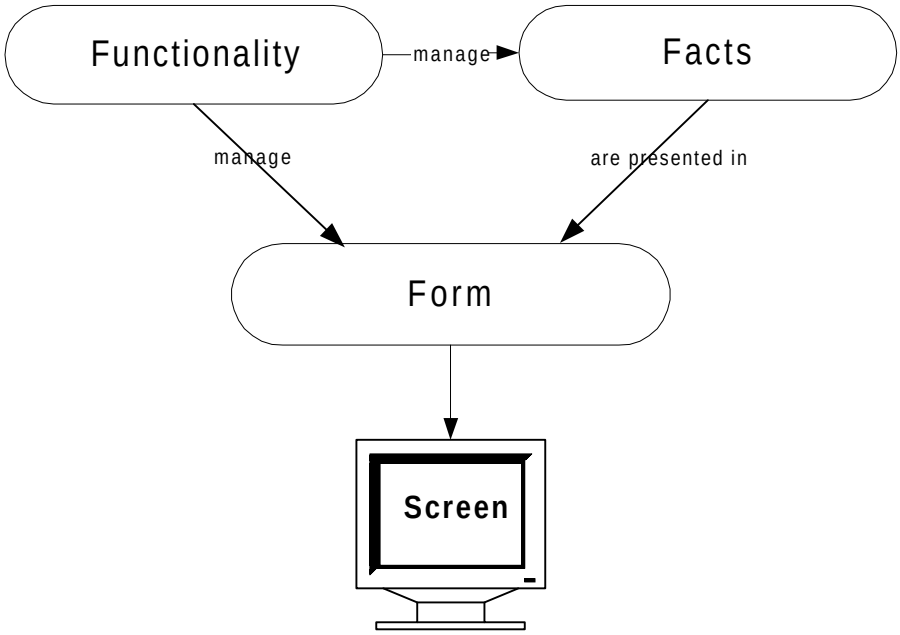

Figure 4.3 Some fundamental relations between functionality, facts and form.

The *functionality* manages both the *facts* and the *form*. The *form* constitutes the interface for the presentation of both *facts* and *functionality* on a screen. How the form is expressed is critical for how the users experience the functionality of the system. Let us imagine that we are searching for a recipe for a cake. The text describing how to bake the cake as well as a picture of the cake are *facts* that are picked from a fact base by the *functionality*, and presented on the screen in a certain way decided by the *form*. The *form* can be compared to the 'stage setting' in theatre. The role of the 'stage setting' is to support the representation of the *facts* in order to make a certain impact on the receivers of the *facts*. This activity could be called *screenography* in an information systems context. Figure 4.3 does only present a one-way direction through an interface. Possible input of *facts* to the system is expressed by the *form* and controlled by the *functionality*. It can, for example, be a writeable field, where a user can type his/her name.

The difference between the different types of content is clearer in the development phase. The *functionality* then concerns how the system performs and the *facts* are about what kind of information the system is supposed to contain. The form is more about means for attracting, facilitating and motivating people to use the system. Development of both *form* and even some *facts* usually requires competencies from

non-software engineering domains such as fine arts and communications, in order to adjust to needs and expectations of the intended users.

Multimedia systems are based on computer software and hardware. From that point of view, their development does not differ from any other computerised information system. Common software engineering techniques and development methods can be applied on the software process in a multimedia project (Tannenbaum, 1998). The difference is that significant part of the creation of both *facts* and *form* are of an aesthetic character. The development of the *functionality* also affects and is affected by the development of *facts* and *form*. How to integrate the aesthetic content in the software is an interesting challenge. A multimedia project can be viewed as two parallel activities, a software engineering process and a content development process.

Several methods and techniques are used for managing and controlling software engineering processes, and the competencies needed are well defined, even if they differ slightly from methodology to methodology and from project to project. When it comes to content development, the competencies needed vary from project to project. A great part of the content is of an aesthetic character. The aesthetic content often exists in other forms, so the main work of the content people in a multimedia project can be to translate the original content to an electronic form (Phillips, 1997). Each competence of the aesthetic production belongs to a discipline that has its own methods (Omarsson, 2000). Even facts of a non-aesthetic character must be created or collected as input to the system. Normally, the system collects and manipulates fact through the entire runtime of the system as well. One major challenge is to coordinate all the involved disciplines and various ways of working into a homogenous process. A parallel to making a movie is maybe the most natural comparison, because multimedia production is a cost and time demanding group effort (Holsinger, 1994).

In Figure 4.4 multimedia development is illustrated as three main processes, software engineering and what traditionally is regarded as content development. The third process is the overall management of the whole project. In the content process the *facts* and *functionality* are created or retrieved from various sources and prepared for realisation. The software engineering process is about formalising and coding the content and making it run as defined in the content process.

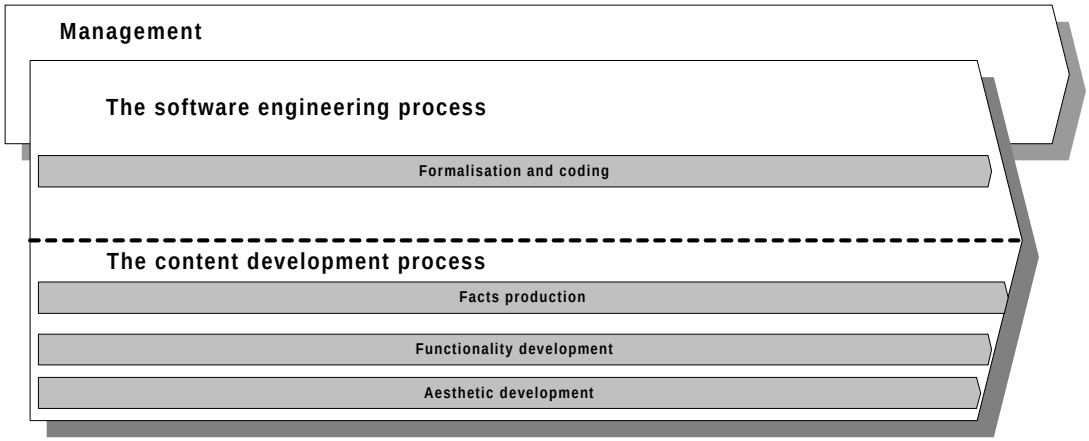

Figure 4.4 Developing multimedia information systems can be regarded as three parallel processes; a software engineering process and a content development process and an overall management process.

Results of the aesthetic development can both be design of the *form* of the system and *facts* that outside the system would be regarded as aesthetic issues, such as graphics and photos. Stories are also a matter of aesthetic development, and they and the characters in the stories can define or have great impact on the *functionality* of the system. The development of *facts* is a question of defining and generating types of *facts* and/or instances of these types that can be manipulated and stored by the system, such as alphanumeric information of non-aesthetic character. As long as the system is in use, *facts* can be added, deleted or manipulated in other ways.

The software engineering and the content development processes can start simultaneously, which is quite common in the computer game business (Omarsson, 2000), but normally the "content" part is planned and partly developed before the software engineering activity starts. The two activities run of course in parallel through implementation and testing, as the "content" activity is often affected by different technical issues and vice versa.

Below, we give an example of an imagined system for municipal street administration and maintenance. The aim is to give an example of the development and use of different types of content in a multimedia information system. The aim of the system is to support different employees of the municipality in their maintenance of streets and parks. The system contains maps, drawings, animations and models of streets, parks and even terrain in the municipality. There are various types of maps for different purposes. Of course, there are maps showing all cables and pipelines, their

coordination and depth. These maps are related to pictures and information about the different types of cables and pipelines as well as *facts* and information about how they can be repaired in case of an accident. The system has various active functions. It can, for example, be a mandatory to have a communication device for both data and telecommunication (similar to the one described in Cardenas (2000)) in all excavators used in the municipality. With the help of the communication device the driver of every excavator can get information about cables and pipelines while he/she is digging. The coordinates of cables and pipelines are stored in a database containing position data. Each communication device has a position instrument that continually while digging compares the location of the excavator to the position data of the system with help from position sensors that are located in a network all over the municipality.

It is easy to identify *functionality* in the system, such as the active comparison of the position of the communication device in each excavator to coordination data of cables and pipelines reached from the system. *Facts* in the systems are for example position-coordinates, models of different environments, photos of various cable types etc. Examples of *form* are both visual interface representations and audio signals warning the excavator driver when he is digging close to a cable.

The position coordinates are alphanumerical facts generated by collection of *facts*. Models and photos of streets and pipelines are aesthetic creations as well as the *form* used to present the *facts*. The *functions* of the system are realised in the software engineering process.

4.2 Multimedia production vs. traditional information systems development

In this section a short overview of multimedia production is given and a comparison between multimedia production and traditional information systems development is made.

4.2.1 Traditional multimedia production

Below, the main phases in multimedia production are presented. The description is directed towards multimedia production for CD-ROM as a distribution medium. The basis for the presentation is Lopuck (1996) and the interviews presented in Chapter 5.

A typical multimedia project is divided into a design phase and a development phase, totally counting 7 main activities, see Figure 4.4.

DESIGN			DEVELOPMENT			
Brainstroming & Stroyboarding	Flowchart & Paper design	Protityping & User Testing	Media Production	Programming & Media Production	Programming & Debugging	Programming & Final Debugging

Figure 4.4 The phases and steps of multimedia production. Based on Lopuck (1996)

- Brainstorming & Storyboarding.

  Each project is supposed to start with brainstorming, where the vision and the idea of the product, as well as a target group, are identified. A storyboarding follows up the brainstorming. Storyboarding is a technique that has its origin in the film industry. It is used to roughly outline different scenarios and concepts. It can be useful in helping people to think about possible solutions. Phillips (1997) emphasis that the entire development team should go carefully through the storyboarding because there may be inconsistencies that the content people have not recognised. It may also be the case that there are things found during the storyboard that are not feasible. Sörensen (1997) points out the storyboard as a useful means for giving both customers and team members a good understanding of the project and the content of the planned system.

- Flowcharts and paper design.

  The flowchart shows the structure of the concept, as well as navigation and interaction possibilities. A simple way to create the flowchart is to describe the hierarchical structure of the storyboard. The paper design consists of the storyboard documents, flowcharts and a functional description. The functional description is a detailed walkthrough of each scenario of the product where all possible actions are described. The paper design is by that equivalent to a requirements specification.

- Prototyping and user testing.

  These are the last steps in the design phase. The prototyping is necessary for reliable user testing. The prototype does not have to be developed in the same tool as the final version of the product. The most important thing is to present

the vision of the product to get feedback from the users. After the prototyping and user testing, no major changes should be made.

As the design phase is finished, approximately 30% of the work should be finished according to Lopuck (1996). The development phase contains media production, programming and debugging. The media production is about developing graphics, sounds, animations, text, etc. The programming is about assembling all media into the structure and functions, defined in the paper design.

The process is very product-oriented. There is some iteration found (programming and debugging), but the process seems to be very waterfall-like.

4.2.2 Information systems development and multimedia development – a comparison

Molin (2000) has compared information systems development and multimedia development, se Figure 4.5. The comparison is based on a lifecycle model for information systems presented in Andersen (1994).

The lifecycle model for multimedia systems has much in common with the design and development process presented in Section 4.2.1, even though it is not equally detailed. The main difference is that Molin extend the model to even cover follow-up and termination.

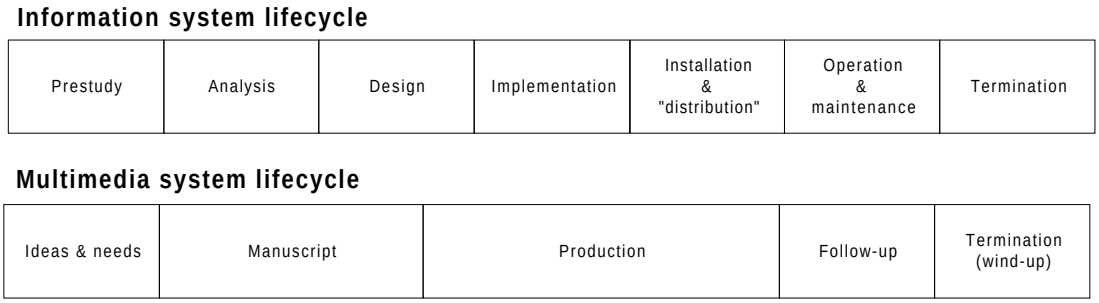

Figure 4.5 Comparison between the lifecycles of information systems and multimedia systems.

The steps *ideas & needs* and *manuscript* correspond more or less to the design phase in Lopuck (1996) and *production* in Molin (2000) corresponds to the development phase in Lopuck (1996).

Comparing the lifecycles of information systems and multimedia systems, Molin (2000) points out several interesting issues. First of all, the lifecycle for information

systems is more directed towards organisational needs, while the multimedia system lifecycle is more product oriented.

The first step in Figure 5 is quite different, because in information system content, the first pre-study is usually free from different presumptions. The starting point is a particular organisation and its problems, and various solutions can be discussed. It is not sure that developing an information system is the solution to the problem at hand. The multimedia system development is a process that from the beginning is directed towards a certain product.

The manuscript step corresponds quite well to *analyses* and *design* in the information systems lifecycle, but the focus is different. In information systems development, information and functions are in focus, while interactivity, navigation and possibly some kind of a story are emphasised in multimedia development.

Implementation, installation and *distribution* are mainly questions of programming and testing in both system categories and also media production in multimedia systems.

Until recently, multimedia systems have mainly been run and distributed on CD-ROM. Because of that, there has not been any operation and maintenance work on multimedia systems. The reason for this is the static character of the CD-ROM medium. Some producers have made *follow-ups* in order to improve new versions or releases.

At last, Molin (2000) points out the different conditions for *winding-up* the different types of systems. The multimedia product is terminated as the user stops using it, while the information system often contains information that must be taken care of in one way or another.

Both the model presented by Molin (2000) and the one presented by Lopuck (1996) have their reference point in multimedia products for CD-ROM. Future and current multimedia solutions seem to be developed for Internet in form of websites or services that enable access over the web. This means that multimedia applications can be continuously updated and even integrated with traditional information systems. We have already got more and more multimedia functions in ordinary information systems, often web based. These new multimedia information systems will probably

follow the traditional lifecycle of information systems. The web bureaus we have interviewed, confirm this even though they express their guilty about too little efforts put on analysis and design. Even if the lifecycle may look similar, there are far more competences needed for multimedia development compared to traditional development. The method use will probably not be the same as today either. In next chapter, we give a brief overview of the competences needed to develop modern multimedia information systems. The method problem will be discussed in Section 6.2.

4.3 New applications and actors

This section includes a brief presentation of multimedia applications categories that already have had a big impact on and are likely to influence, the development of multimedia issues of future information systems in general. These application categories are computer games and computer-aided learning media. The new generation multimedia applications are various web-based applications offering new services or old services in a new suit on the web. New actors on the market often develop the new applications. Those actors often come from the advertisement business or they are fresh with no former business experience. The later category often consists of young people with limited or no employment experience at all, but with experience from using computer games and with knowledge about the Internet. This, together with visions about how to attract people to use the web has become an important factor for the expansion of Internet companies, such as the Swedish companies Framfab and Icon Medialab. Internet companies are often related to the economic growth of the nineties in the western world, also called the new economy.

4.3.1 Computer games

Computer games have been developed since the early sixties (Laurel, 1993). Even if computer games may not have been seen as part of serious computer science they have contributed to software development in general. Especially the computer game industry has contributed to the development of usable user interfaces and graphics. This is very important as the user interface conceptualises the application and use (Laurel, 1993).

In the middle of the seventies, adventure games became popular (Aarseth, 1997). The adventure games where text-based, but often available for network playing. As the Internet and interactive multimedia have evolved, new types of computer games have seen the light of day. They have gone from single player arcade games, such as Packman and Space Invaders, to networked multiplayer games on Internet. The interaction in those networked multiplayer games is not only depending on predefined rules and profiles, but also on how different players act and react (Crawford, 1998). Violence has been characteristic for computer games (Pearce, 1998), but there are examples of computer games that have been very successful without emphasising violence, but rather social aspects. SimCity, for instance, is a computer game letting its players build a city and populate it with “people”, so called Sims. Like other cities, SimCity suffers from various problems that must be solved. That is the play of the game. There are several graphical multiplayer virtual reality games, similar to SimCity about to be launched on Internet. One example is EVE of CCP (www.eve-online.com), which is a multiplayer online game, where players can create roles and build empires.

The development of computer games is of course interesting from a commercial point of view, but computer games can be used for education as well. There are several examples of applications for computer-aided learning that are made in form of a game. The purpose of the game can be as different as teaching staff in supermarkets and hotels to discover credit card cheating (American Express, 2000), as well as teaching children to sort litter with help from a bird called Ropos (Sundin et.al., 2000). Mixing education and entertainment is often called edutainment (Druin and Solomon, 1996).

As computer games are multidisciplinary, there are several competencies needed in order to develop a computer game. Below we a give brief view of the working organisation of computer game development. If nothing else is stated, the overview is based on Omarsson (2000).

Computer game development differs from the development of traditional business information systems in several aspects. First of all, computer games are not mission critical, and the development is initiated by an idea or a vision instead of an organisational need. Computer games development also requires competencies from

areas that traditionally have lain beside information systems development. Every project has staff taking care of budget, marketing, publishing as well as administration. Those people are not directly involved in the development of the game itself. The development team contains programmers (and other software engineering staff), content (mainly aesthetic content) staff and a producer.

The producer is responsible for the progress of the project and day-to-day problem shooting. It can be everything from buying pizza to assisting the audio technicians to find an actor for a specific voice character.

The programmers can be divided into the following main categories:

- *Core technology*:

  Those programmers are responsible for the game engine. Usually the lead programmer is one of those.

- *Tools programmers:*

  They are responsible for developing the various applications needed in order to put the game into practice. It can be a question of plug-ins or editors for creating levels/paths. About 50% of coding in a game development project is estimated for creating development tools that are used to build the game itself.

- *Logic and AI*:

  Every computer game has rules for the progress of the game and the behaviour of different characters. In some cases, AI is used to control various personalities of the game.

The content producers are those who create the artistic part of the game. It may concern the story telling, the music and the graphic design. The main characteristics of the aesthetic part is that it can exist independently of the game itself, in form of stories, graphics, music, etc. There are several types of artists that can be involved in the creation of the aesthetic content. Below are the most central competencies presented.

- *Graphic artists:*

  Responsible for the creation of still graphics, videos and animations. They can be divided into the following categories:

  - 3 D-specialists
  - 2 D-specialists
  - Animators
  - Photographers (film-photographers as well)

- *Audio technicians:*
  Responsible for identifying different voice characteristics, recording and manipulating audio.
- *Scriptwriters*:
  Creation of a story and dialogues.

The development team is usually located in a single room in order to get as close contact as possible. Every discipline involved uses its own methods and techniques. The software engineering process usually lacks comprehensive methodologies, but it becomes more and more common to use techniques from established methodologies. Especially techniques from RUP (Rational Unified Process), UML (Unified modelling language) and RAD (Rapid Application Development) have been used in the cases Omarsson has experience from. Regardless of specific techniques used, the common way of organising the software engineering process is to define different milestones that must be reached. The goal for each milestone is often in the form of a certain technical feature that should be finished. The progress of the projects is hence driven by the technology.

The main problems in computer game development according to Omarsson are poor or non-existing design documentation (requirements specifications) and difficulties related to the coordination of activities in the software engineering process and content process. These problems together make it difficult to estimate when projects will be finished.

Omarsson’s statement about poor design documentation is well known in the computer game society. The magazine Game Developer has, for instance, a theme called ‘postmortem’ where different game development teams present their experiences. Poor design documentation seems to be the lowest common denominator when it comes to the usual pitfalls of game development. Collections of postmortems

published in Game Developer are found on the web at Gamasutra (2000). Use of design documentation is getting more and more common, but Omarsson claims that documentation is often only created at the beginning and not maintained through the process. This causes problems later in the development process when various tasks are to be coordinated and decisions must be traced. There are examples of game developers that have adopted traditional software development methodologies, including methods for requirement engineering and improved their processes (Walton, 1998).

Coordinating the software engineering process and the content process is, according to Omarsson, a very important issue, because the content producers and the programmers often have problems to understand the nature of each other's problems. The programmers put restrictions on, for example, the graphic designers, because some graphics may be hard or impossible to implement. These restrictions might make the graphic designers unsure and obstruct their creativity. The solution, according to Omarsson, is to employ a technical art director in every project. The technical art director must be well oriented in software engineering and graphical design, as well as in narrative techniques in order to coordinate the processes and find new ways to solve problems.

Omarsson points out component-based development as well as massive entry of academics, as two very important things happening in the computer game industry of today. Component-based development is important because of the advantages of shorter development cycles and standardisation. The entry of academics is necessary because computer games are getting more and more complex and the structural knowledge and skills of the academics are needed.

4.3.2 Computer-Aided Learning

With the exception of computer games, the main interest in multimedia has been directed towards the development of software for educational or entertainment purposes (Phillips, 1997). The absolute borders between these different types of applications are not always clear and, as mentioned earlier, the term edutainment (Druin and Solomon, 1996) is sometimes used for applications that are at the same

time educating and entertaining. Different games are Quite often used to gain both entertainment and educational objectivities.

Educational software is internationally called *computer-aided learning* or *computer-based training* if it is primarily aimed for industrial use (Ulfhake, 2000). We use the term computer-aided learning in this work for educational software in general and we regard educational software as multimedia applications.

The purpose of computer-aided software is according to Ulfhake (2000) to support the process of learning. It can either be a question of supporting traditional educational material or certain forms of teaching.

The strength of using multimedia in education is, according to Phillips (1997), the opportunities to mix media, give the user control over the learning situation, use simulations and visualisation and finally to support different learning styles. The common use of multimedia in education is as instructional aids, interactive tutorials and reference works.

Developing computer-aided learning media is a multidisciplinary problem that requires knowledge about development of computerised information systems as well as an understanding of how humans think and learn (Ulfhake, 2000). In Section 6.4 we give an overview over the competencies needed for developing multimedia information systems in general. We claim that developing computer-aided learning media does not differ from developing multimedia applications in general. It is only a question of bringing in competencies to each project that takes care of special issues that are critical for the project. In projects directed towards the development of computer-aided learning media it is, of course, very important to use pedagogical specialists as well as domain experts of current interest.

We have, as mentioned, until now been used to computer-aided learning media on CD-ROM. As the web has become more and more wide spread and multimedia based, the interest of using the web for educational purposes has increased. The term e-learning (even web-learning) has become a buzzword, even if there is no common definition found for it. As the demand on lifelong learning seems to be increasing, new forums and forms of learning increase. The advantage of the web as a distribution channel are obvious, as it gives people opportunities to access the material from

everywhere at every time. There is also a trend towards more individual oriented needs for education as various demands on new knowledge or skills occur. An example can be the need for knowledge about a new programming language. The usual way of solving the problem has been to send the employees to a five days course given by some education entrepreneur. Experience from Ericsson shows that today this can be solved by a web-course for only a small piece of the costs of the traditional five days course model (Ogelind, 2000).

There seems to be big opportunities in e-learning, but it is obvious that the area is still immature. There are technical problems as well as pedagogic problems to be solved. These are important to evolved because distance-education and web-based courses are becoming more common at universities, and it is not unlikely that it will even be a usual form for education in ordinary schools in the future. Even if e-learning can be used for diverse training, the question is how far e-learning can replace a human tutor?

4.3.3 The web-(r)evolution

The World Wide Web, as a phenomenon, has just entered its second decade. Things have happened fast since the first embryo to the web was born in CERN in Switzerland in the end of the 80's and made available over the Internet. From being text-based, the use of graphics became common as the Mosaic web-browser was introduced in the early 90's. The introduction of Mosaic and its followers, Netscape and MS Explorer, put the web in focus because they offered a user-friendly multimedia interface to the web. The web in its turn made Internet available to people in general. In the years 1994 and 1995, the web started to increase fast, both according to the number of users and to available websites. Other important factors behind the success story of the web are the use of hypermedia, common protocols and free flow of information. Hypermedia allows associative linking and non-linear presentation of information and the protocol commonality has bridged compatibility problems, which has enabled communication between various technical platforms. Due to the lack of central administration and control, Internet has offered almost each and everyone with access to web servers an opportunity to present his/her information without any general restrictions. It is important to bear in mind that general access to Internet and the web is so far a privilege to citizens of the industrialised part of the world.

It is difficult to point out exactly which the success factors of the Internet and the web are, but some of them are listed below:

- *Easy and almost immediate access to information, services and even digitalised products over the Internet.* It can be everything from the weather forecast to music or video films. The development of mobile services will probably strengthen this.
- *Dynamic factors are also very important*. Information, services and products can be updated and distributed very rapidly compared to most medias.
- *Commonality is important.* Internet enables people to get or stay in contact with those who share their interests, regardless of geographic location.
- *New and exciting services make Internet also more interesting.* For example, many newspapers nowadays offer a web version as a complement to the traditional paper version. The web version can be updated continuously and it often contains video and audio files in order to enrich the content of the medium, as well as special webs for various issues.

The impact of Internet has been huge in the last five years. The widespread use of Internet has caused several changes and opened up for new opportunities for information exchange and development of new services and businesses. One of these new services is e-commerce, which is gaining a lot of interest and big investments.

The demand for web applications has been big through the last few years. New types of pure web-companies, such as Amazon.com, have entered the scene. Many traditional companies have at the same time recognised the opportunities offered by the web for informing about the company, exposing its products and even sell them. This demand has been a Klondike for companies specialised on developing web-applications. In Sweden, it has not been the established IT-consultants that have provided the market with web-solutions, but new actors with new ideas and working methods, i.e. the so-called web-bureaus. Young and enthusiastic people with good computer knowledge and experience of the Internet have started most of the web-bureaus. Another category is advertisement bureaus that early saw the potential of Internet and soon, more or less “converted” to the new medium. The web-bureaus have in common that they usually have had knowledge and skills to create good-

looking web sites and sell their services. As the customers have seen the potential of Internet, they have demanded more complex solutions, often coupled to the ordinary business systems. In order to cope with this problem, some web-bureaus have bought or merged with traditional IT-consultants and become complete Internet-consultants. This has been necessary in order to get know-how about the architecture of complex information systems as well as about methods for developing them.

Examples of these companies are given below in order to illustrate the fast growth of Internet related development.

- *Framfab* has gone from five employees' 1995 to 450 employees 1999. In September year 2000 has the number of employees increased to 2570 and the company is represented in both Europe and USA (Karlsén, 2000).
- *Icon Medialab* has increased from 4 employees in 1996 to more than 1900 employees in September year 2000. The company is represented in 18 countries (Karlsén, 2000).
- *Adera* was from the beginning an advertising agency, launched 1983. In 1997 the company integrated its activities in both traditional and new media. At that time did Adera have about 60 employees and now the company expects to count between 800 and 1000 employees at the end of year 2000 (Adera, 2000).

All these companies have increased through takeovers and merging with other companies. Only the fast growth must be a challenge in itself, not to mention how to integrate, organise and maintain methods and models for the daily work.

4.4 The merge of traditional information systems and multimedia systems.

In this section, we discuss briefly the benefits of mixing media in information systems. A quite comprehensive example of an imagined workflow system with active multimedia support is presented and both advantages and problems are discussed. Finally, a brief overview of possible solutions for adding value to products and services by various web-services is given.

4.4.1 The benefits of mixing media in information systems

The trend towards multimedia-based systems is obvious in web-based applications, but the question is how important it is when it comes to more traditional applications? Do we need multimedia in our traditional business administration systems? We claim that the answer is yes, because the mixing of media has obvious strengths that can make these systems even better for supporting the work they are aimed for. Phillips (1997) explains the advantage of mixing media as using the most appropriate medium for different purposes. Text can be used for thoughts while graphics can be used for illustrating spatial relations and animations can be used for dynamic information. The use of multimedia is already common in traditional information systems applications. This document, for instance, is written in MS-Word. MS-Word has a multimedia interface mixing text and graphics in an interactive interface aimed for supporting the user while working on the creation of various documents.

An example of traditional information systems that may become more useful by integrated multimedia interface is various healthcare systems. An ordinary patient record that is fully digitalised may for instance include, besides traditional text reports, both x-rays, audio files and visualised data from different tests. All this information should be integrated and made easily accessible from an integrated interface. This development is likely to become real because of increased use of telemedicine. It is today already quite common that tests are performed at a patient's nearest hospital, and then sent in an electronic form to a specialist somewhere else for interpretation. The interpretation can also be done in cooperation between a doctor at the local hospital and a specialist at some other hospital by simultaneously viewing the result in real-time.

The opportunities are many, and it is only the imagination that puts the limits for which applications that can be created. The problem is that the gap between imagination and reality is quite big. In Kaindl (2000) a case study describing of use of hypermedia in requirements engineering practice is given. In order to trace requirements in a project, audio recording as well as video recording were applied in meetings with key persons. Because of the difficulty to get in contact with these persons it is very important to catch and record their opinion in certain questions. Even pictures and diagrams were photographed and stored, in order to be documented

in an efficient manner. The problem is not to record or store data in various formats, but to organise it and retrieve information from it. Which strategies should, for instance, be used to search for certain terms in streamed data types such as video or audio? One way is to make transcriptions of the video and audio files and applies text searching. It seems quite unrealistic because it demands big personnel labour demand. Another problem is to catch visual information that may be found on the videotapes, such as diagrams and other illustrations. Photographs of pictures and diagrams are also problematic to deal with. These photographs can be semantically very rich and they must be labelled with keywords in order to be searchable. Even the organising of the storage of all these different data types is problematic regarding to fast search and access.

If we, in the future, want information systems to enable as natural human communication as possible and to support us in complex problem solving, we need efficient multimedia systems that can cope with multiple data streams (Cardenas, 2000). In other words, there are big challenges in developing web-based multimedia applications.

4.4.2 Illustration of a workflow system – an example

In this section we give an example of how interactive multimedia can be used to illustrate workflow and to support employees affected by a workflow. Such multimedia support may be of great interest for beginners, but it may also be useful for securing the quality of work carried out by more experienced staff. The example in Figure 4.6 below is a simplified lifecycle of a customer order and it's treatment. To begin with, a workflow can be defined as:

> "…series of carefully orchestrated processes that must occur in order for work to be accomplished." (Doyle, 2000)

A workflow can be illustrated as a model for how certain activities should be carried out in order to explain which actions must be taken and in which order. Figure 4.6 gives an overview of a workflow and Figure 4.7 presents a possible interactive interface for part of the actual workflow. First of all we give a short explanation to Figure 4.6.

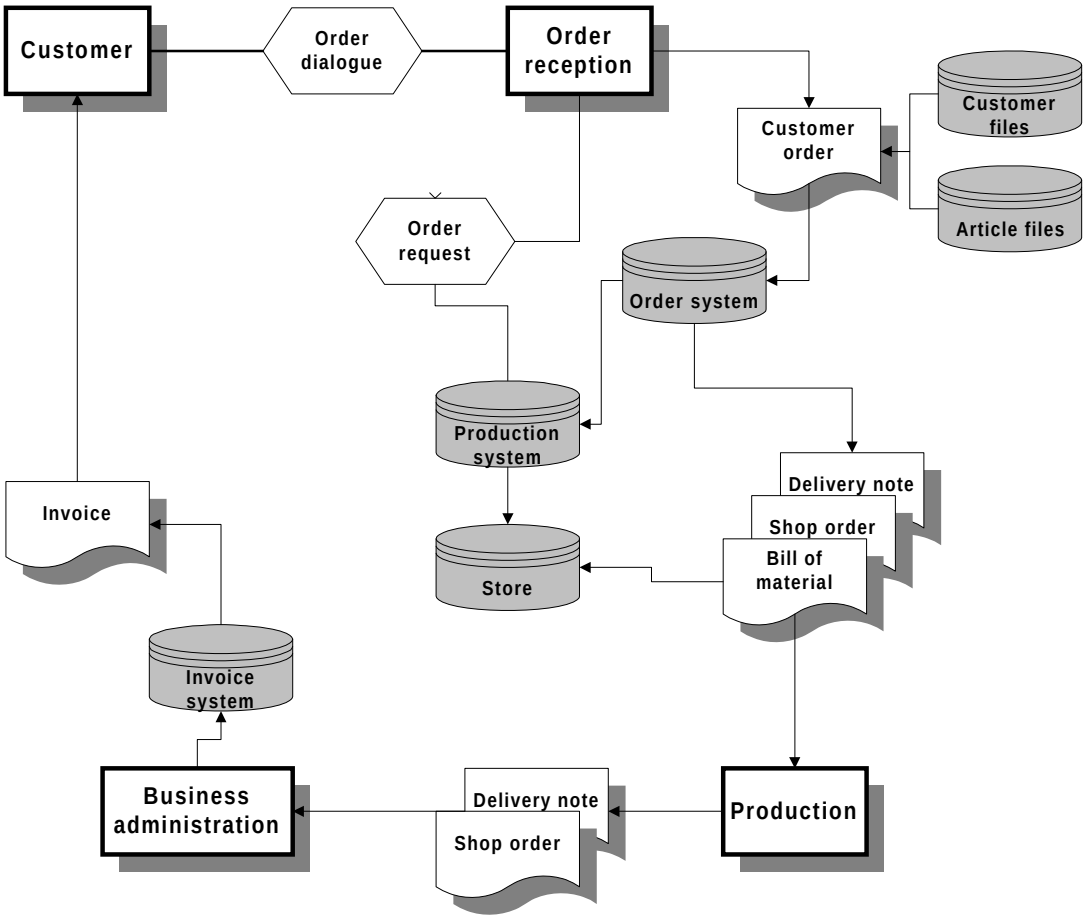

Figure 4.6 Workflow for the lifecycle of a customer order

1. A customer contacts order receiver and ask for the conditions for a suggested order.

2. The order receiver first makes a check against the production system to find out when the order can be delivered. The customer is informed about the result.

3. The next step is to generate a customer order. The order system uses data from customer files and article files as input to the production system as well as for creation of a delivery note, shop order and bill of material.

4. The bill of material is used for picking articles from the store and the shop order is used to start the production of the articles needed for finishing the order.

5. When the order has been shipped, copies of the delivery note and the shop order are sent to the business administration. The delivery note copy is used to signal that the order has been shipped and an invoice can be sent. The shop

order contains information about the production, such as which worker did what and for how long while the order was finished.

6. Finally, the invoice system sends an invoice to the customer.

All documents are of course digital and pop up in the monitors of the affected employees.

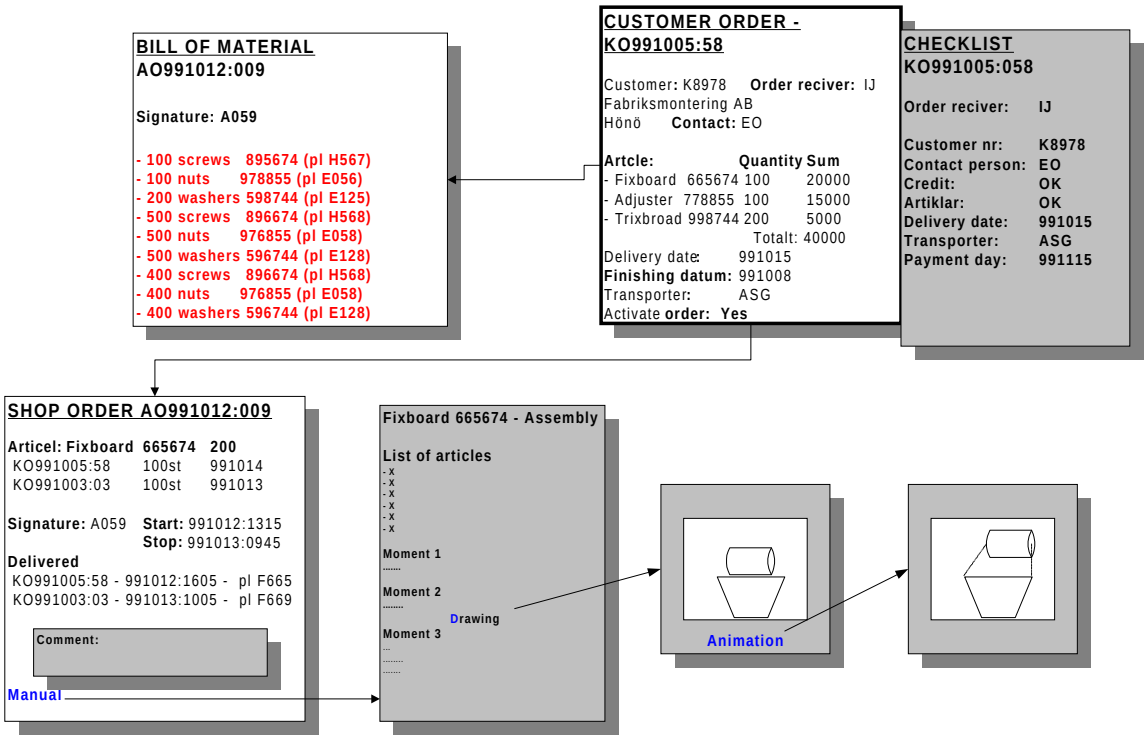

Figure 4.7 Examples of a possible multimedia interface for supporting a workflow.

Figure 4.7 illustrates a possible interface for a system supporting a part of the workflow described in Figure 4.6. While the customer order receiver registers the order, a checklist is activated on the screen beside the order window. This checklist is filled in automatically as various issues are registered. In some cases the order receiver has to confirm some issues in the checklist. The order cannot be registered if the checklist is not complete and correctly filled in. As the order is registered both bill of material and shop order are created. The bill of material is used to pick components needed from the store. The bill of material is then sent to a dedicated worker at the production department. The worker gets the bill of material on the screen in his mobile monitor. The worker uses a carrier to pick the components from the store. As he picks up the components, he registers the components by a barcode scanner. If the worker forgets some component or has not picked the full amount of some

component, the system sends an alert. The shop order is also sent in an electronic manner. It of course contains data about the amount of articles being produced, as well as planning information. As the assembly is started, workers can get full manual support hyper-linked from the shop order. The manual includes text descriptions as well as drawings. If the worker wishes, he/she can go further on from the drawings and get animations that illustrate different assembly operations from various angles.

The application described above is of course a far from complete solution, but it illustrates a possible interactive multimedia support to a workflow. One gain from such a solution could be improved quality assurance as the system checks all critical operations. Another gain would be the illustrative and active help functions for the assembly. This must, of course, be most valuable for less experienced workers, but may also be seen as an important quality assurance issue available for senior workers.

There are many challenges according to the design of a system as the one described above. First of all, a representation of the workflow must be defined. It is important to make this representation as intuitive as possible. A graphical user interface is not enough. All steps that must be taken, must be clearly defined and meaningful, and in case of a multi-choice situation, it must be clear which opportunity to choose and why. The system must also contain a powerful database that can manage all the various data types needed in order to support the employees with instructions, drawings and even animations, explaining different operations. In order to minimise redundancy, it may be desirable to create a 3D-model of every article. Every such model must have a well-defined interface to other article-models, so that these will be assembled in the same way as the real articles. For every real world assembly operation, there should be a corresponding one in the virtual reality explaining from various angles how every operation must be performed. The problem is how to carry out all these animations. It is desirable to have a CAD/CAM system where 3D models of every designed article are generated and the system is used to design and generate assembly operations as well as products. As soon as an order receiver runs an order for a specific article, the system should be able to generate all animations needed. The information needed is the bill-of-material, operation lists and information from the CAD/CAM system. There are, of course, several problems left to solve. First of all, it is difficult to make flexible virtual components representing each article and its

properties. Just the conceptual modelling of multimedia databases is a challenge as well (Axelsson, 2000), so it is not likely that we get support systems, like the one described above in the nearest future.

4.4.3 Connecting information and objects

The web and various mobile services opens up new possibilities to add value to different products and services by connecting the objects of interest to various information services. By connecting the barcodes of a product to a website offering various services related to the product, new and expansive services can be offered to customers. A fundament for these services is about to be established by the ‘Connecting things’ project of Ericsson (Rittsel, 1999) and a number of other large telecom companies (Johansson, 2000).

A situation explaining how this technique can be applied can be as follows: You are tiding up and run out of dust bags to the vacuum cleaner. To save time and effort you pick up your special barcode scanner (Rittsel, 2000), read the barcode of the vacuum cleaner and beam it over to your PC (or the digital TV in the future). You get directly access to the service site for the specific model of your vacuum cleaner, where you can choose from different options. As the dust bag is of central interest, you ask for it. First of all you can get the address of the closest store that sells the right dust bag model and has it in stock. You can either buy it directly on the net (and get it from a delivery firm) or you can drive to the store if you are in hurry. If you choose to go by car, the service site of course gives you information about the way to the shop, the actual traffic situation and estimated driving time. This information can by one click be sent over to the navigation system of your car, so you can get guidance in form of graphical maps and voice instructions. As you have got the dust bag, there is of course an animation found on the service site, demonstrating how to replace a dust bag and filters. This is just a simple example of how objects can be connected to value adding information on the net. This can of course be much more advanced and more complicated, with several items connected in an object/information network. This type of possible services is thoroughly explained in Rehbinder (1999).

5 The challenge of developing future information systems

This chapter contains a brief presentation of how the interviews were conducted, including motivations for the interview form, applied in this work. A presentation of the respondents is given as well as of the interview material.

5.1 The interview study

In order to get a view of the trends and challenges in developing future information systems, we have interviewed people employed in enterprises that develop different web applications. A computer game developer has been interviewed as well.

The total number of interviews is seven. We have tried to interview people representing various competencies in order to get different viewpoints and as broad perspective on the development of multimedia web-solutions as possible. We tried to get in contact with respondents working on developing of computer-aided learning media, but were unfortunately unable to get in contact with any one that were willing to take time for an interview.

As this work is of a survey character, the overall aim of the interviews was to capture trends rather than going into any deep details focusing on specific questions or concepts. The questions were of an open character without any predefined answer alternatives. The questions have been adapted to each respondent, depending on his/her area of knowledge and competence. All interviews except one has been a single person interview. In one case, five persons were interviewed at the same time, as they represent the entire staff at the actual company. Only one of the interviews was a telephone interview, hence all other interviews have been performed by meeting the respondents. All interviews were taped with permit from the respondents. The transcriptions have not been made word by word, but are more of a summarising nature. In some cases, the respondents have used figures to explain their view on certain issues. In these cases we have tried to capture the figures and present them within the interview transcriptions. Central concepts such as ‘lifecycle’ have been presented and discussed as they have occurred.

The main experience while working with the interviews has been the struggle to get in contact with people in the web-business and to find a time for an interview.

Below each respondent is shortly presented.

- Darek Eriksson (Eriksson, 2000), Adera (www.aderagroup.com), Stockholm.
  Adera has been one of the salient Internet consultancy companies in Sweden in the late nineties (see Section 4.2.3). Eriksson is a strategy consultant with e-business as a special area of interest. He has experience from methodology development and that is where the focus of the interview is.

- Hans Willars (Willars, 2000), Adera, Stockholm.
  Willars is a business development specialist. Willars has a long experience from business modelling in traditional IT-consultancy companies. Due to his long experience from business modelling we did focus on the working methods of the modern web-consultancies compared to the more traditional information systems developers.

- Gunnar Dagnå (Dagnå, 2000), Dagnå Grafisk Design, Stockholm.
  Dagnå is a graphical designer with experience from designing books, records albums etc. He has worked on multimedia web-design since 1998. The main focus in the interview is on the working methods of the web-consultancies compared to more traditional graphical designers. The cooperation between different competencies in a web-project is in focus as well.

- Jonas Augustsson (Augustsson, 2000), Framfab (www.framfab.se), Lund.
  Framfab is one of the biggest providers of web-solutions in Europe (see Section 4.2.3). Augustsson is since august 2000 the test leader of a sub-project of the Brikks-project of Framfab, called Brikks-core. We have primarily put focus on the difference of working methods in Framfab compared to more traditional information systems developers.

- Vigfus Omarsson (Omarsson, 2000), Light Speed Games (www.lightspeedgames.com), California.
  Light Speed Games is a company providing components and services to computer games developers. Omarsson is originally a graphical art director but has become more and more technically oriented. Now his main interest lies on the border between the programming and the graphical design in computer game development projects. Omarsson has previously worked for CCP

(www.ccpgames.com/) and OZ.com (www.oz.com). As the computer games industry is commonly agreed to be leading the development of new multimedia solutions, we found it important to interview a person with an insight to that industry.

- Benny Johansson (Johansson, 2000), Morot (www.morot.se), Skövde.
  Morot is a communication consultancy and web-bureau in Skövde, founded in 1994. The number of employees is six. Johansson is a managing director, a project manager and a marketing strategist. This was the first interview we carried out. First of all it was thought of as an orientation in the area and secondly we wanted to get an overview of how a traditional advertisement bureau becomes a web-bureau.

- Ingela Sundin, Inger Wilhelmsson, Patric Jonsson, Torgny Rosengren and Jonas Pettersson (Sundin et.al., 2000), Optimalmedia (www.optimalmedia.se), Skövde. Optimal media was founded 1995 as a multimedia bureau. In the last two years all work has become more and more web-oriented. The focus of the interview is on working methods for developing web-solutions as well as the cooperation between various competencies in a web-project.

In sections 5.1.1 – 5.1.8 we present some central issues from the interviews. We have chosen to focus on questions that mirror the views the respondents have on information systems development in the context of multimedia web-systems and computer games development.

5.1.1 The concept of information systems

In general, respondents defined information systems as systems used for communication or manipulation and storage of information.

Dagnå (2000) primarily relates information systems to databases and other more technical issues. The explanation may be that he is the non-technician among the respondents.

Eriksson (2000) is the respondent that had a longer discussion about the concept of information systems. He claims that the information systems concept will change and that it in organisations will be considered as a business support system aimed for information handling. The alternative is to use a generic definition comparable to the

one in Section 2.3, but then it will be necessary to view it from two main perspectives. These perspectives are a *technical* perspective and a *business* perspective. Eriksson claims that the business perspective is the one that requires the most interest, as it is critical in order to integrate the information systems in the organisations and their business logic.

5.1.2 The lifecycle concept

In order to get an idea about how modern web-productions fits to a traditional lifecycle model, we have presented a lifecycle model similar to the one in Section 3.1. In general, the respondents confirm that the development of the web-solutions they have been involved in fits well to a traditional lifecycle model. Willars (2000) decided not to answer the question because he claims that he does not have full insight in how multimedia web-systems will evolve in the future. Most of the respondents point out that the early phases (prestudy, analysis and design) gain too little interest, which usually causes problems later on in the projects. The explanation given is the demands from the customers that want fast solutions, so there is usually no time for any deep analysis.

Eriksson (2000) puts a question mark on the lifecycle concept because it is a biological metaphor that has its reference point in something that is born, lives and dies. Eriksson claims that it is important to bear in mind that information systems are often social systems and that they can have properties that biological systems do not have. This may according to Ericsson be an explanation to the fact that many information systems development methodologies do not cover political and cultural aspects at all.

5.1.3 Methodology use for developing web-applications

None of the respondents claimed that there is any specific comprehensive methodology applied in the organisations they work in.

The respondents representing Optimalmedia (Sundin et.al., 2000) and Morot (Johansson, 2000) spontaneously answered that there is no methodology used at all in their organisations. As the interviews went on, a picture of a structured way of working appeared anyway. The structured work at Morot is a heritage from the advertisement business, and the way of working at Optimalmedia is similar to the

working phases presented in Lopuck (1996) (see also Section 4.1.1). The people at Optimalmedia formulated the issue as follows: “We do have our special way of working, even if we do not have any rigid framework for it.”

Johansson (2000) claims that as far as he knows, methodology use is not common among web-bureaus in general. Johansson recognises the same Klondike atmosphere in the web-business of to day as in the advertisement business twenty years ago. He talks about how it was back then; “it was just to buy a Mac, rent a basement flat and start”.

Both the employees from Morot and Optimalmedia point out the tight time schedules as the main problem while developing web-solutions. Usually there is no time for any deep analysis.

Dagnå (2000) uses similar working methods as he used to do, while designing printed matters.

Methodology use in the computer games industry is briefly discussed in Section 4.2.1.

Framfab is, according to Augustsson (2000) working on the introduction of a more methodological way of working compared to before. The working culture at Framfab has been very free. Fast results and creativity has been more important than structured ways of working. In a long term, more structured working methods must be introduced, and that is what Augustsson is working on in the Brikks projects. Augustsson has identified many problems related to an unstructured way of working. He also points out that a lot of good work has been done anyway, but there is a risk that the good ideas crash because of a lack of structure, when they are to be fully implemented. Augustsson has noticed two different attitudes to the introduction of structured working methods at Framfab. Some people welcome it as something that will make good work excellent, while some people claim that it will kill the creativity.

Adera seems to be the company among those involved in the interview study that has made most work on methodological development, even though Willars (2000) claims that there is no homogenous methodology used in the company, but that there are common principles of design applied and a common process model has been developed. Below, a presentation of the process model at Adera, is presented. The material is based on Eriksson (2000).

Eriksson choose to discuss in terms of methodologies. A methodology is according to him, logic for creating and form a method for every specific situation. Method is then a more specific description of which activities to perform and how. First of all, he distinguishes between two main information systems development activities, *rational* and *emotional* driven development. Traditionally, information systems development has been based on a requirements specification where all necessary functions are defined. This way of working is a *rational* driven approach according to Eriksson. Eriksson argues that if the systems users are not pleased, it does not matter how well defined and implemented the functions of a system are. This gets especially critical while developing web-applications. If the intended users do not like the application, there is a risk that they will choose some other similar application in stead. It does not matter how well designed the functions are if they do not please the users. This means that rational development must be complemented with what Eriksson calls, an *emotional* development. *Emotional* development is necessary in order to take care of all aspects that makes the user pleased with the system and makes the user feel that the system adds value to the work of the user.

Traditional methodologies for information system development usually include a moment where the customer's requirements are asked for. This activity is based on an assumption that takes for granted that customers know what they want. As a developer, one must together with the customer, get a good understanding of the customers' business. Most information systems development methodologies do not give any good support for such activities and even if they attempt to, they do not take into account the political and cultural structures in organisations. Eriksson has experience from projects in the defence sector where these problems were significant. As soon as some person higher in the hierarchy took a decision, those on the lower levels never questioned it, even if they knew that the decision would not solve the problem it was aimed for. The first step must always be to get to know the organisation of the customer and its opportunities and hinders. Instead of using a single methodology, Eriksson thinks in terms of a toolbox containing several methodology components that can be picked and used where they are needed. There are, for example, methods found for dealing with political and cultural problems as

the one described above. These methods are usually not included as activities in information systems development methodologies.

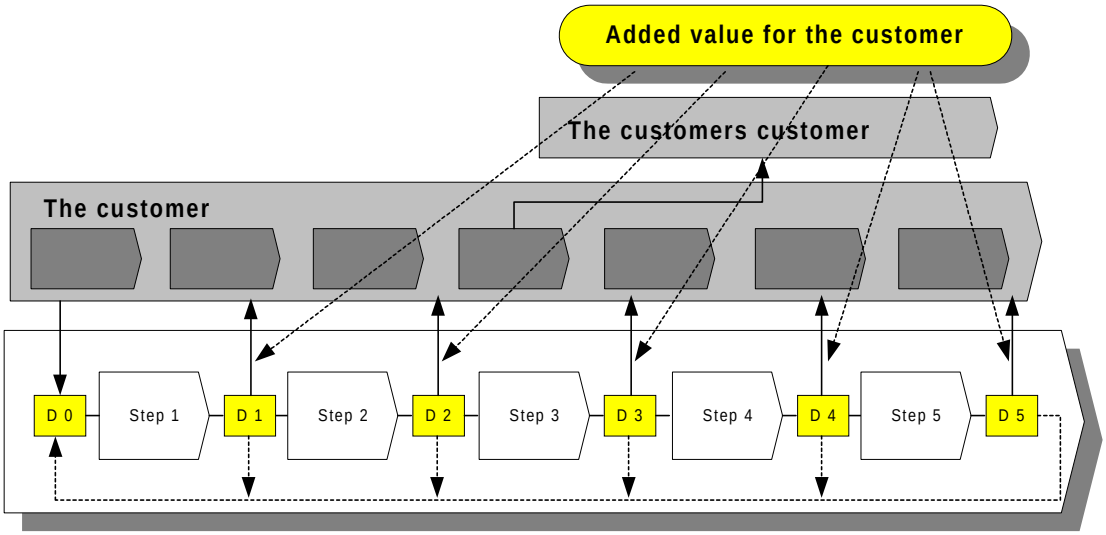

Figure 5.1 ADERAs process model for development of E-business systems. After Eriksson (2000) Copyright ADERA.

Figure 5.1 represents a process model used at Adera. Every process is divided into steps that result in a deliverable that is checked with the customer before the process continues. Iterations are applied as necessary. The first step in a process is to help the customer to make the position of the business clear. Strategies regarding business concepts, trademarks, co-operators, competitors etc. must be developed and stated. Only when this has been done, processes can be identified. As soon as the processes are identified, it can be figured out which IT-support is needed.

Below a short description of process steps and deliverables in figures 5.1 and 5.2 is given.

D 0: Instructions and state of the art.

S 1: Development of e-service strategy.

D 1: E-service strategy.

S 2: Development of desired e-business.

D 2: Description of goals for wished e-business.

S 3: Development of plans for introduction of e-business.

D 3: Plans.

S 4: Roll-out.

D 4: E-business introduced.

S 5: Evaluation and correction.

D 4: Status report.

The leading star of everything performed in the process, is value adding to the business of the primary customers in order to make the primary customers more fit to meet the needs of their customers. Each process phase requires activities that in turn require competencies and tools to be carried out. It is important to keep the process model as simple as possible in order to cope with the complexity. In Adera there are three different main categories of competencies involved in each project. Together, the different competency categories include hundreds of specific competencies to be chosen from. This is important as the projects has e-business development in focus. In Aderas definition of E-business, it comprises all parts of an organisation, where use of IT is natural. Figure 5.2 illustrates the different competencies and their relation to the development process.

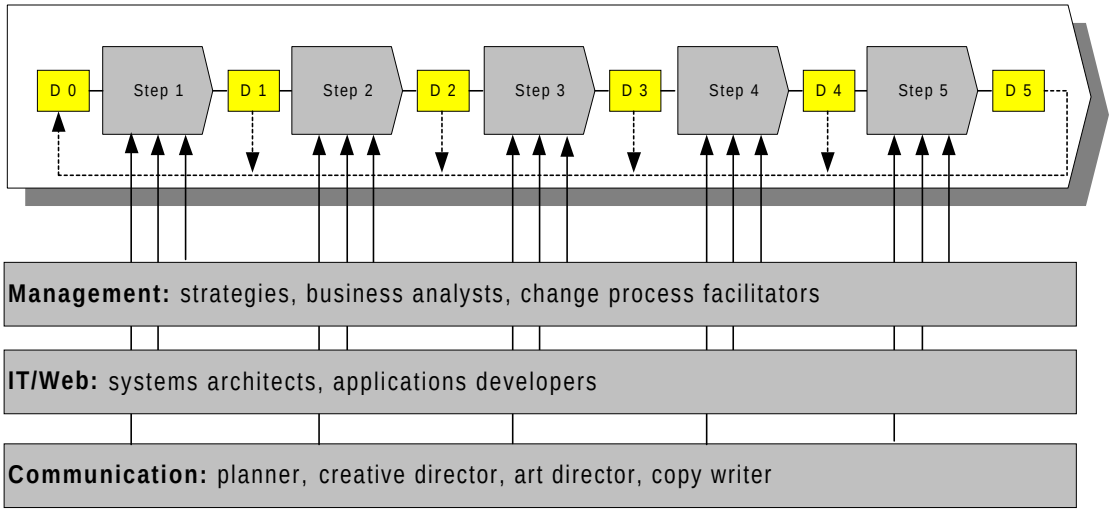

Figure 5.2 A process model for developing E-business systems and required categories of competencies. After Eriksson (2000). Copyright ADERA.

For every new project, a new cocktail of competencies and tools is mixed.

Eriksson emphasise that the role of the project manager becomes very critical in projects based on a process model, such as the one applied at Adera. The project manager must have a comprehensive knowledge to pick the right competencies every time. The availability of competencies is of course critical for the success of each

project. Which modelling techniques to use is therefore not the most important issue. What counts in the end is if the customer is satisfied and has got a useful solution that is compatible with the rest of the customer's information system.

Eriksson summarises the main challenges of developing information systems as follows:

1. It is not question about developing IT-applications, but rather about developing business processes. Developing IT-applications, implementation and validation of these, are only a part of a business process development.
2. It is important to take both *rational* and *emotional* development issues into account.
3. There must be methods and competencies found aimed for dealing with political and cultural structures.

5.1.4 Competencies and inspiration needed for development of web-applications

In this section we present results from the interviews according to competencies needed for web-application development. In Section 6.1 a more comprehensive presentation of needed competencies is given, based on this section as well as the literature study.

According to which competencies are needed, the answers were quite homogeneous. All respondents identified two main processes, a technical process and a content development process that must be administrated and coordinated by a visionary project manager. Both Dagnå (2000) and Johansson (2000) points out the fact that the organisation in web-projects is very similar to what it is used to look like in advertisement bureaus and the competencies are very much the same. Omarsson (2000) gives a thorough walk through of the competencies in computer game development projects. A review is found in Section 4.2.1.

The answer to the question where the respondents got their inspiration from varied. Some of them got inspiration from films, litterateur, theatre and the Internet. Most of them refer to former experience as an important source of inspiration. Willars (2000) mentions even systematic use of patterns as a way to get inspiration.

5.1.5 Coordinating technicians and content staff - what can they learn from each other

There is an agreement among the respondents that the role of a project manager is critical for the success of a project involving multidisciplinary staff. Sundin et.al. (2000) and Johansson (2000) especially points out that it is very important that all involved persons really understand the mission of the project as well as each others working conditions. Omarsson (2000) claims that one of the main problems in computer game development is a fragmented view among the programmers at the end of the projects. They have, often by then, lost the vision of the actual project out of sight and must be supported by a technical art director or a producer.

Dagnå (2000) has experience from html-based projects where the graphical design was a question of compromising from the first beginning to the end. He finds it critical that those who develop content issues must be capable of adapting their ideas to the technical possibilities at any time. The staff at Optimalmedia (Sundin et.al., 2000) has the same experience as Dagnå. They even claim that it is common that programmers put restrictions on the content people. From the first beginning, these restrictions may be necessary because of technical matters, but in some cases these restrictions continue to be current even if the technical problems have been solved. In order to avoid this, the staff at Optimalmedia (Sundin et.al., 2000) have changed approach from a technically oriented approach to a more content-oriented approach. Now, the content-people create and design solutions without reflecting over the technical solution. The technicians then do their best to implement the content as far as possible. Since the staff at Optimalmedia changed their approach, they have made their fastest technical progress ever.

Erikssons (2000) solution to the integration problem between programmers and content staff is to make it clear that the technical architecture only exists in order to make the creation of an application possible. To support this view, Eriksson claims that it is very important to present a clear IT-strategy and business strategy that is made clear for all involved.

Willars, (2000) points out the fact that programmers usually have totally different attitudes to problem solving compared to the content staff. He claims that the experienced technical staff contributes with structure while the content staff has other

insights about problem solving that the technicians lacks. This is mainly about using alternative methods when the ordinary methods do not work. Willars (2000) tells an episode from a project at a newspaper. The mission of the project was to analyse the editorial processes in order to introduce a support tool. As the project team started their usual way of working, modelling in form of flowcharts, the employees at the newspaper expressed very clearly their dissatisfaction. The only thing to do for the team was to return to their office and figure out how to solve the problem. After a while they contacted an art director and presented the problem. The art director painted several aquarelles representing various working situations related to the editorial process. One of these paintings represented for example a chief editor discussing a problem with a journalist over a cup of coffee. This painting was used instead of a flowchart to illustrate coaching. All the aquarelles were organised as a painting exhibition in the lunchroom at the newspaper. This became a second beginning of a success project that from the beginning seemed to fail. Later on, the project team used their usual working methods, modelling with help of formalised flowcharts. Another important contribution from the new actors is, according to Willars, their focus on the communication of the customers with their own customers. This issue has, according to Willars, not been given any big attention in traditional information systems development.

Willars argues that it would be most interesting to make some research on the interaction between the technical staff and the content staff in different projects in order to get an understanding of which facts facilitate or hinders the utilisation of their competencies. The question is how the communication between these two categories can be made more efficient?

5.1.6 Alternative strategies for developing information systems

The traditional way to develop information systems is to run a project in a similar manner as the one described in Section 3.2.2. Usually, this becomes quite static and insensitive to changes. An alternative to this may be to introduce a development process of an editorial character. In such a process, a new release of an information system may be launched on a regular and rather tight time base, e.g. weekly or monthly.

Only few of the respondents answered this question. The staff at Optimalmedia (Sundin et.al., 2000) did not have any clear answer, but they discussed the need for web-systems where the information can be updated by the employees of the organisations that the systems are serving. The design itself should normally be taken care of by a consultancy bureau such as Optimalmedia.

Eriksson (2000), Willars (2000) and Augustsson (2000) claims that some development is already performed in a more or less editorial manner. For that purpose they point out the use of components as a critical issue. Eriksson emphasise the role of the organisation in this context. If there are continuous changes, the organisation must be capable of picking up various signals and react properly to things that are not possible to plan for. Finally, Eriksson stresses the fact that technical know how is not enough to run a development process of an editorial character. The organisation must be mature and capable to deal with a continuously changing environment.

5.1.7 Techniques for speeding up the development lifecycle

All respondents refer to some kind of a reuse of former solutions in order to speed up the development process.

Willars (2000) did not give any straight answer to this question, but pointed out that the development of information systems is maybe not the largest problem, but operation and maintenance are. The most important thing is, according to Willars, sound models and good structure regardless of which techniques are used. Patterns can be useful as a support in this case. Most useful are simple patterns representing basic knowledge such as how to identify different levels in goal structures.

Eriksson (2000) takes ERP-systems as an example of a concept used to speed up de development process and make it more flexible. The ERP-systems can be seen as a fundament with a well-defined interface that makes it possible to plug in various web-components that gives a tailor made solution to different customers with different needs regarding languages, currency etc.

According to Augustsson (2000), a component-based development is a natural way to standardise and facilitate the development process. The Brikks project of Framfab is heavily component-based (Augustsson, 2000) in order to make easy customer adoption possible.

Use of components in the computer game industry is widely spread and well developed (Omarsson, 2000). Component use gives fast development cycles and facilitates prototyping. The aspect of efficient prototyping is according to Omarsson important in order to eliminate misunderstandings between the technical staff and the content staff. The content staff gets an opportunity to see their ideas implemented and tested faster than in a traditional development environment. There are computer games found that are almost 100% based on components. Those are called “mission packs”. The game engines are in these cases reused and only the content is developed or adapted to new demands. Omarsson takes the engine in Quake as an example. It can easily be used as an engine for e.g. a Superman game. Except the graphics and some details, the only thing that must be developed in the Superman case, are levels that enables the characters to fly.

Even content can be reused in form of components (Dagnå, 2000). Dagnå regard various graphical patterns and frameworks as components. The difficulty is to think of all possible scenarios that can emerge and affect the graphical patterns and the use of those. Dagnå sees construction of building bricks for graphical designers as a very exciting issue.

5.1.8 Possible contributions of modern multimedia information systems to the information systems area in general

Both Dagnå (2000) as well as Sundin et.al. (2000) argue that the main contribution of multimedia systems to the information systems area are the possibilities to visualise and simulate in order to make applications easier to understand and more attractive to use. Dagnå points out the role of Internet as important for the further development of multimedia information systems. The combination of Internet and multimedia gives new opportunities to influence people and people’s decisions in various situations. Pedagogic aspects can, for example, be used in order to make things interesting and funny. Internet-based applications open up new possibilities for two-way communication and increased interactivity. This will be especially interesting as the possibilities to suit solutions to specific user or user profiles will increase. Dagnå finally emphasises the importance of Internet because of the easy access and its potential as a common and cheap communication channel.

Methods and techniques for representation of people/characters in virtual reality can according to Omarsson (2000) be an important contribution from the computer game industry to the information systems area in general. Omarsson regards virtual reality solutions as a natural part of the information systems in the future. These can be used for training and guidance purposes. This will be especially important for visualisation of complex systems.

Omarssons vision of future information systems is agent-based systems controlled by voice command. A user of such a system could give direct oral orders to the system. In order to make the system as natural as possible to interact with, the most important agents should have some kind of a human outfit, and they should be represented in a 3D environment. One could, for example, have a secretary that takes care of incoming telephone calls and letters as well as the calendar. For other important activities, there may be personalised agents such as “data miners” and “data warehouse workers”. The success of the use of such personalised agents can depend on details such as synchronisation between the facial expressions of the agents and the message they deliver. Omarsson claims that the computer game industry may have big contributions to make to the creation of natural like characters and environments.

5.2 Summary of the interview study

The respondents had a quite homogeneous opinion about information systems as systems for communication.

The lifecycle model was also commonly agreed to be a relevant reference model. Eriksson (2000) puts a question mark on the biological metaphor of the lifecycle model, as information systems are social constructions.

Comprehensive development methodologies are not used in any of the companies where the respondents work, even if all of the companies have some kind of a structured way of working, usually a heritage from the businesses where the respondents and their companies have their roots. At Adera, a common process model is applied in order to give a common approach to design within the company.

All respondents refer to a division of competencies needed for developing multimedia web-systems, into technical and content staff. The problem is to coordinate these two different categories of competencies. The role of the project manager is very critical

for efficient coordination and cooperation between the two categories of competencies.

Speeding up the development lifecycles were generally pointed out by the respondents as a way of dealing with fast change rate. Reuse and component-based development are techniques mentioned for speeding up the development cycles.

Finally, the respondents were asked to mention how the multimedia domain can contribute to the information systems domain. Visualisation of information systems that makes them easier to understand and more interesting to use, were mentioned as core issues.

6 Synthesis

In this chapter, we synthesise the topics dealt with in this work and make some analytical reflections of the material at hand. First of all, we will discuss the trends towards future information system as well as the trends in methodologies for developing information systems. We will also very briefly discuss the development of some technological issues that affect the development of future information systems. Finally, we present some competencies needed for the development of multimedia information systems.

6.1 Future information systems

The use of computerised information systems has increased and changed dramatically since the first systems were constructed less than 50 years ago. As information systems have went from being only regarded as pure business applications to being integrated parts of public products and services, the view on information systems must be revised as well as the methods for developing them. We find it important to regard information systems as communication means for human communication in general, regardless if it is for professional or private use. This general view has also appeared in the interviews we have performed.

The trend in information systems development seems to be towards increased interactivity, mobility and mixing and integration of media in order to make information systems more expressive and powerful for what they are aimed for – human communication. This requires an understanding of how technology and human communication means relate and can be integrated. One consequence of this trend can be shifting the focus from technical issues to a more usability-oriented perspective (Eriksson, 2000) while developing the information systems. We find it important to stress the need of developing both the technical and human aspects in harmony, as information systems are technical systems for human communication.

There is a general agreement among the interview respondents as well as in much of the literature, which Internet has been, and will be critical for future developments in the information systems area. Internet offers a homogenous platform for information exchange and communication in general. Internet and the web also offer new services

that probably will have great impact on both our way of communicating as well as doing business. A key issue in this development is the use of multimedia in order to make the applications more effective by offering communication means that are better adapted to our natural way of perceiving the world and interacting human-to-human. A video telephone is an example of a communication device that can enrichen the communication between humans compared to a traditional telephone, as visual expressions such as facial and body movements also are part of human communication. Web-based e-commerce systems will in the future probably offer opportunities to demonstrate products from various angles as well as their dynamic properties. It may even be possible in the future to feel and test some aspects of products on-line in a virtual reality. Virtual reality is by some sources (e.g. Tannenbaum, 1998; Omarsson, 2000) regarded as a natural issue in future information systems. The crucial thing is that it is not enough to mix media and make them available on-line or even to create virtual realities, if they do not contribute to a better communication for the users of the information system.

One of the most critical issues for the development of future information systems is, from our point of view, the user interface. Today, the normal interaction with an information system is through screen, keyboard and mouse. In order to make human interaction to information systems more natural and more efficient, it is desirable to enable speech as an interaction means. Research is carried out in this area. Conversational interfaces are for instance the theme of the September volume of the Communications of the ACM (2000). If, in the future, we will get speech-controlled information systems with rich graphical expressions as well, these systems may include human-like agents, which solve the problems, we ask them to solve (Omarsson, 2000). Such development would of course have a great impact on our view on information systems. The division of systems into categories (see Section 2.3.1) may not be necessary. Instead, all the properties that are specific for each system category may be seen as various issues that our intended agents would be capable to deal with. The agents may be regarded more as working mates or servants instead of information systems.

Now back from ‘science fiction’ to ‘real fiction’. In Section 3.2.2 we have presented a view on information systems development where we start with a reality of interest that

we call ‘an object system’ from which a requirements specification is derived. The information system in turn is based on this requirements specification. Normally, the object system is an organisation or some other system, which requires a computerised information system for control or support. As information systems get more and more multimedia-based, they may get even more complex to maintain due to the fact that as the object system changes the information system must be updated and in some cases redesigned. The multimedia aspects means that there are even more issues to be regarded, as an update must be made. In the case of redesign or extension of the system, even more stakeholders (aesthetic developers) will be affected. Another interesting issue is that increased multimedia use in traditional information systems applications or new applications such as e-commerce systems are made in order to make the systems easier or more exciting to use. As storytelling, theatre and other art, influence our communication (Laurel, 1993) we will not only base our information systems on an object system referring to the real world, but on fiction as well. An example of this is the possible use of narratives in order to facilitate understanding of business information systems and how they can be modelled (Furtado and Ciarlini, 2000). This trend will emphasise information systems and their development as a multidisciplinary effort, where well-known communication patterns and metaphors are needed as support in order to understand and manage complex information systems.

6.2 Methodological challenges and trends

For approximately 40 years, there has been work done on evolving methodologies for the development of well-structured and functioning information system. The trends have varied as described in Section 3.1.1. The development of the first methods can be seen as a reaction to unstructured ways of working, where the most important thing was to get the applications up and running. The same tendency can be identified in the web-applications development of today. The difference today, compared to the childhood of information systems development, is the widely spread knowledge of methods, techniques and tools for information systems development.

The main contrast in information systems development of today is Internet as well as the fact that information systems are developed for far more categories of users and

the systems are no longer mainly seen as technical devices, but as a support for certain tasks to be carried out by organisations or public users.

6.2.1 The challenges of developing information systems

In Section 1.3 we presented the six fundamental problems in systems development by Langefors (1995). Below, we relate the findings of this work to these problems.

- *Cognitive limitations*

  The use of various information systems development methodologies is an example of how humans cope with their cognitive limitations. Unfortunately, many of these models and methods do not fit very well to dynamic environments (see Section 3.2). They easily get so complex in them-selves, so they surpass human cognitive limitations. Even aids such as meta-models applied in order to understand the models and the methodologies, easily get difficult to overview and understand as well.

- *Complexity*

  We claim that complexity of information systems tend to increase, as these systems get more dynamic, more multidisciplinary and related to a greater number of other systems through networks. Despite the complexity of information systems, it seems to be quite common among developers of multimedia and web-applications not to use any comprehensive methodologies for analysing, developing and implementing their applications. Component-based development is pointed out by some of the interview respondents as a way of dealing with complexity of information systems development, as it support division of systems into smaller units that are easier to handle than more extensive systems.

- *Multidisciplinarity*

  As information systems get more multimedia and web-based, the number of stakeholders in the development process increases. It is not only a question of technicians and content people, but even management people and communication experts as the systems get integrated with more and more business processes. This is, of course, more critical as organisations get more

virtual, because the identity of such organisations is more or less identical to their information systems.

- *Systems and change*

  The interview respondents referred to reuse of former solutions as an important issue in order to react to changes. Component-based development and the use of patterns were also mentioned as a possible way of making the systems more flexible and easy to adapt to changes and for shortening development cycles. Short development cycles are of interest in order to realise solutions supporting the actual object system and not an object system represented in a requirements specification that is out of date. Eriksson (2000) sees a development towards ERP-systems as a company infrastructure with well-defined interface as a way to cope with changes. Such a system would allow the development of web-based components that can be plugged into the system in order to meet different needs of the users.

- *Infology*

  There seems to be a wide spread consciousness among the interview respondents about the importance of involving users in the information systems development process. It becomes more and more common that users can make their own user profiles in various information systems.

- *Human and social aspects of information systems.*

  Humans create information systems that will carry out various services to them and to their organisations. This means that the development of information systems must mirror the users needs and wishes at any time, which both gives us new opportunities and new problems. Information systems entrance new application areas all the time, and as they become more multimedia intensive, they open up new opportunities as means for communication. The new opportunities affect both individuals and social structures. E-commerce as an example will change our shopping patterns and the use of Internet demands time that must be cut from other activities.

Langefors' (1995) fundamental problems thus seem to be of interest even for the future information systems.

6.2.2 Methodological trends

Multimedia web-systems developers seem to take a reference point in a lifecycle model similar to the one described in Chapter 3.1.

Most of the respondents have described some kind of a structural framework, including various activities resulting in more or less well defined deliverables that are checked with the customer before next activity will start, as illustrated in Figure 7.1. For every activity, suitable competencies, tools and techniques are picked from a 'toolbox'. The different competencies are of both technical and content nature. There is of course a big difference between the big Internet consultancies and the small web-bureaus according to the supply of various competencies needed.

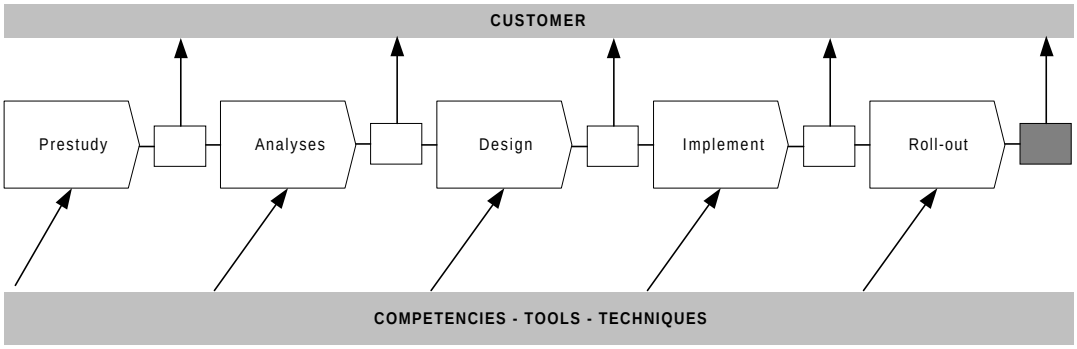

Figure 7.1 A simple process model for developing web-applications. Inspired by Eriksson (2000).

The advantages of using such a process model instead of a formal method are several:

- No two projects are identical, so it is usually necessary to mix a new cocktail for every new project (Eriksson, 2000).
- Developing multimedia web-systems requires competencies from several domains that use domain specific methods and techniques.
- Normally, formal methods do not take care of political and cultural structures, which may affect the development work. Here, specific techniques and competencies can be picked for each issue (Eriksson, 2000).
- The process model gives possibilities to use the techniques and tools that best fit each situation.
- The process model emphasises continuous validations with the customer to be carried out throughout the entire development process.

- The process model gives a good opportunity for shifting between wide and narrow perspectives. The project manager must introduce different hired competencies to the vision of the project so that they can deliver what the customer wants in the following deliverable.

A process model such as the one described in Figure 7.1 gives opportunities for a flexible way of working, but we also see some disadvantages. Everything depends heavily on the project manager and his/her ability to coordinate all the required competencies as well as the tools and techniques used. Some of these tools and techniques may be incompatible. Even if the outcome works well, the question is how well it works if it must be integrated with other systems.

Both Willars (2000) and Augustsson (2000) point out the importance of structured working methods. If a process model such as the one in Figure 7.1 is to work well, it will be important to apply structured modelling and design principles, even if different working methods and techniques will be mixed. How to solve this problem in a proper manner is, however, not included in the scope of this work.

6.3 Technical issues

We have in this work not focused on technical development and technical issues. Even so, we will shortly mention technical development that will probably affect the use and development of multimedia web-systems in the future.

First of all, information systems will be accessible from more appliances in the future. The WAP-protocol makes web-services already available from mobile phones. The Internet will probably also be accessible through digital television in the future and there are examples of more electronic devices that will make Internet access possible, such as digital personal advisors (like Palm Pilots).

In order to make virtual reality (VR) a serious alternative, effect full devices such as VR-helmets and VR-gloves must be available to a modest prise. Today, such devices are not common in public use.

The bandwidth is also a critical issue. Increased use of multimedia requires increased bandwidth due to the increase of data to be transferred. It can just be mentioned that the human bandwidth (all senses together) is about 11 Mbit/s (Zimmerman, 1989),

which means that in case of advanced virtual reality applications, bandwidth of that size is required.

6.4 Competencies needed for the development of multimedia web-systems

As discussed in this work, multimedia development is a multidisciplinary issue. Several competencies are needed from the fields of engineering, fine art and media as well as from management and communication. Comparisons are made to both the film industry and the advertisement business. In these businesses, many competencies are coordinated in order to catch an idea and to present it in a form that affects people in a certain manner. Coordination of all the competencies needed is of importance in order to keep every project on track and within budget and time frames. It is also important to facilitate an understanding among the various competencies. An understanding of each other's working conditions is important in order to avoid sub-optimisation within one domain that may cause problems somewhere else in a project.

Below, some different competencies possibly needed in multimedia production are listed. The list is far from complete, but it gives an idea of the complexity of the area. The below identification of competencies is based on Tannenbaum (1998), AMIT Consortium (1997) and Lopuck (1996) as well as on the interviews performed. In the list, the competencies are associated to either the software engineering process or the content process or to an overall project management level.

The overall management process

- *Marketing*

  A key factor for bringing in money to pay the costs of the project and hopefully bringing the investors some profit.

- *Project management*

  Responsibility for giving a general understanding of the process as a whole, which competencies and tools that are available, how they can be combined and where and when they fit in the process. Daily management of people and other resources as well as customer relationships must be taken care of. Every project must be run on time and within budget.

The software engineering process:

- *Technical art direction*

  Should be taken care of by a person that has good knowledge of software engineering as well as graphical design and narration. This person must be able to judge what is technically possible to implement and act as a broker between the software engineering staff and the content staff.

- *Software design*

  This process can take different directions depending on if the system is designed and coded from scratch or if it is component-based. The content of the system can also affect the design of the technical system. It can for instance be a question of managing various data-types and supporting certain behaviour of objects in the system.

- *Computer programming*

  Implementation (coding) and testing of the design.

- *Network*

  Many multimedia applications are designed for network use, as for example the web.

- *Interface*

  Design of the user interface with respect to usability aspects and navigation.

The content process

- *Art direction and graphical design*

  Creation of the graphical parts of the system. There can be many subcategories found, directed towards for instance; 3D, 2D, still images, animation, stage setting and morphing.

- *Business analyse*

  Identification of the business concept and different strategies necessary for progress.

- *Playwriting*

  Composition of a possible story and a dialog and adapting it to the possibilities of expression that the media offers.

- *Layout*

  Design, formatting and layout of text and its combination with graphics.

- *Communication*

  Design of interaction, navigation and interface issues.

- *Photography*

  Ordinary photographing and video filming are needed as well as editing of those

- *Audio*

  Audio recording as well as editing.

- *Acting*

  Actors are necessary for both acting in video-sequences, as models for photography's and not to forget lending of their voices to different characters or for storytelling.

- *Pedagogy*

  Pedagogy is essential in the development of all computer-aided learning media.

- *Behavioural science*

  Psychologists and anthropologists may be of great value advising how to adopt a product to different customer categories and ethnical groups.

- *Law*

  Lawyers should be involved to deal with both contracts and intellectual property rights.

- *Domain expertise*

  Specialists are required from the business of main interest for the actual project as well as technical writers, light operators etc.

It should be noted that several competencies can be combined in one single person. Hence the above list should be adjusted to every specific situation.

7 Further work and concluding remarks

In this chapter we present some research issues in the area of multimedia web-systems development. The suggested research areas concern the modelling and methodological level, since technical issues are not covered in any detail in this work. Concluding remarks are given as well as a brief discussion in which we value the use of different sources as well as some experience from the work.

7.1 Possible research areas

The possible research issues presented below reflect issues we have identified in this work as of great interest for working methods and organisation of competencies in multimedia development. Primarily we focus on multimedia web-systems.

Coordinating technicians and content producers while developing multimedia web-systems

We have in this work identified problems that concern cooperation and coordination between people working in the software engineering process and the content process of multimedia projects. An interesting research issue would be to identify the factors that facilitate or hinder efficient cooperation between the two categories. It may also be of interest to investigate methods and techniques in other multidisciplinary areas such as movie production. Could such working methods possibly be adapted to multimedia information systems projects?

Conceptual modelling of multimedia web-systems

The development of several web sites and intranets has far too often resulted in a mess that is difficult to navigate (ER2000, 2000). The multimedia aspects and possible linking and integration to other applications seem to be the main difference of multimedia web-systems as compared to traditional information systems. The question is if there are any major differences between conceptual design of traditional information systems and web-systems? Is there any need for various conceptual modelling techniques?

Maintenance of content in multimedia web-systems

Developing multimedia web-systems is a complicated task requiring several competencies. Who is going to maintain these systems? The users at the organisations where the systems are in use will probably update various content *facts* characters. The question is if it is appropriate to let the users do updates that affect *form* and *functionality*? Probably, it would be more secure to let developers maintain *form* and *functionality*, as they should be better aware of the consequences of certain changes. It could be interesting to work further on the concept of content in order to get deeper understanding of its nature and how different categories of content interact. Such work may be interesting in order to facilitate maintenance of multimedia web-systems. (The concept of content is discussed in Section 4.1).

Requirements engineering and management for multimedia web-systems

Requirements engineering and requirements management are important issues in information systems development and information systems maintenance in general. Development of multimedia information systems requires several more competencies compared to traditional information systems development. Some of the requirements may be of an aesthetic or some other character that is difficult to measure and treat with formalised methodologies. Development of web sites may also offer some new challenges (Overmyer, 2000). Do the methods and techniques already found for requirements engineering and requirements management fit for multimedia web-systems and if not, which are the challenges?

Novel information systems development approaches

In order to cope with dynamics, it can be important to speed up the development cycle of information systems (see Section 3.2). This should be especially important in multimedia web-systems development projects as these include more developer's categories compared to information system development projects in general. Component-based development is probably critical in this context, but new ways of running the development processes may also be of interest. One alternative could be applying an editorial view instead of a project form. It may result in a regular launch of new versions of an information system, e.g. monthly. Investigating experiences from such kind of development, if found, would be interesting. It could be interesting

as well to analyse methods and techniques, such as extreme programming (Infoworld, 2000) in order to validate if they could be adapted to more editorial-like development of multimedia web-systems.

7.2 Concluding remarks

This work presents a general overview of development of information systems in dynamic environments, trends in information systems development and possible future trends in the area.

Our conclusions according to the future of the information systems area is that tomorrow information systems will be:

- more multimedia based,
- generally accessible from Internet by various devices, such as digital television and mobile phones,
- used in greater extent for direct (synchronous) communication between people,
- critical as an aid for visualising complex phenomena and adding value to various products and services,
- offering new data-types, such as streamed data.

According to methodological evolution and competencies needed for developing future information systems, our conclusions are:

- The focus in information systems development will move from the technical issues towards the purpose and the content of the systems.
- Far more categories of competencies will be needed for developing the future multimedia systems.
- The development projects will get more multidisciplinary and thereby more complex, which requires new methodologies and techniques for facilitating the coordination and cooperation of the competencies involved, as well as their use of domain specific methodologies.

- In order to cope with change and the complexity of information systems development, component-based development and other techniques facilitating short development cycles are promising.

Finally we have found the six fundamental problems of information systems development in Langefors (1995), (presented in sections 1.3 and 6.2.1) highly relevant to multimedia web-systems development.

7.3 Discussion

The overall aim of this work is to generate a research proposal. Hence it requires identification of possible research areas. As a consequence, it is difficult or perhaps not desirable to make any definite delimitation and focus on a single problem.

The result of this work is the material presented, describing the domain of interest with regard to the aims and objectives stated. It can, of course, be questioned how well we fulfil the aims and objectives as we have only been able to make a general overview of questions comprising a wide scope. We find the result satisfying anyway, as we have got new insights into the problems of future information systems development.

We have presented five possible future research areas, which we find of great interest for the evolution of future multimedia web-systems. There is some work identified according to conceptual modelling of Internet sites, e.g. ER2000 (2000), and requirements engineering for web sites, e.g. Overmyer (2000). Researchers all over the world continuously seek for new approaches for information systems development, but we find it especially exciting to take a look at an editorial perspective. According to methodologies and techniques for coordinating technicians and content people in multimedia development projects, we have not found any particular research work done. Even problems according to maintenance of content in multimedia web-systems context, seem to be an issue that have not got any major attention from the research society.

The literature study we have carried out has been based on various sources. We have sought for material in research articles and books covering the area. These sources have normally not been focused on the future of information systems developing and they do not cover news from this area, either. In order to follow the actual evolution of

the area we have used Internet as well as magazines such as Computer Sweden and Communication of the ACM, to search for information. The Game Developer magazine has also been useful source to get an insight into the computer game development society, as it is not frequently treated in research articles or books.

The interview study was important to get insight to the use of methods practised by people developing multimedia web-solutions. Better-structured questions with sharper follow-up questions would have improved the result of the interviews. The experience from these interviews will make us better prepared for future interviews. The interviews have also increased our knowledge about the area as such, which makes us know better what to ask for in the future. We experienced that it can be very hard to get time for interviews with people working in the multimedia information systems area. The workload seems to be heavy and time secludes tight.

What we have learned from this work is primarily that the domain is big and complex, and in order to make progress with particular research questions, these must be delimitated and clearly focused.

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