Design of Interactive Narratives: Concepts, Methods, and Architectures

by

Mikael B. Skov
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Mikael B. Skov
Department of Computer Science
Aalborg University

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April 11, 2002

Opponents:

Professor Chris Johnson
Department of Computing Science, Glasgow University

Professor Lars Qvortrup
Department for Literature, Culture, and Media, University of Southern Denmark

Associate Professor Peter Axel Nielsen
Department of Computer Science, Aalborg University

Supervisor:

Associate Professor Jan Stage
Department of Computer Science, Aalborg University

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Abstract: This thesis deals with the design of interactive narratives. Interactive narratives are software systems that enable users to create stories when using the system. Interactive narratives are used for many purposes and in many different contexts, e.g. to facilitate children to tell stories in order to cope with their illnesses. Interactive narratives challenge software design processes as an emerging technology. Research indicates that interactive narratives design is difficult, that most design processes are approached in an ad-hoc manner, and that design processes and solutions are based on intuition.

This thesis addresses three themes within interactive narratives design: concepts, methods, and architectures. The themes define three research questions that form the conducted research. Five individual paper contributions try to answer and address different aspects of the three research questions. Due to the vast amount of different kinds of interactive narratives, this thesis presents a space that characterises interactive narratives according to their level of interaction and narration. The five paper contributions are mapped in this space to signify similarities and differences between the five paper contributions.

Three empirical sources contribute to the results. Practice studies address the application and understanding of concepts and identify challenges and architectures in interactive narratives design. The primary sources to the practice studies are interviews. Secondly, experiments provide the evaluation of object-oriented design methods in attempts to evaluate their applicability for interactive narratives design. The focus is on identification of opportunities and limitations of the design methods. An intervention driven study develops an agent-based architecture for new forms of interaction and application of concepts.

The primary results of this thesis are: 1) the concepts of interaction and narration define key properties of interactive narratives. Different understandings of the two concepts are applicable and signify different kinds of interactive narratives. This thesis identifies temporal-oriented and spatial-oriented interactive narratives primarily based on the definition of narration. 2) A key challenge in interactive narratives design is the creation of the narrative. During the creation of the narrative is not obvious how users could be involved in determining functional requirements to the system. This is partly explainable by the lack of definable future use situations. Object-oriented design methods have a number of limitations in interactive narratives design. More key activities in the design methods are of limited value because the focus

on work domain does not necessarily hold for interactive narratives. 3) Two architectures are proposed to support the design of either temporal-oriented or spatial-oriented interactive narratives. The architectures identify two different understandings of narration and addresses interaction at two different levels.

Design af interaktive narrativer: Begreber, metoder og arkitekturer

Mikael B. Skov

Resume: Denne afhandling omhandler design af interaktive narrativer. Interaktive narrativer er software systemer som muliggør fortælling af historier under brugen af systemet, og interaktive narrativer benyttes til mange forskellige formål og i mange sammenhænge f.eks. systemer der hjælper børn til at fortælle historier om de alvorlige sygdomme de lider af. Som en ny teknologi medfører interaktive narrativer store udfordringer under designet. Forskning har vist, at designet af interaktive narrativer er svært, og at de fleste designprocesser bliver tilgået ad-hoc samt at designprocesser og løsninger i høj grad er baseret på intuition.

Denne afhandling adresserer tre temaer indenfor design af interaktive narrativer: begreber, metoder og arkitekturer. Temaerne definerer tre forskningsspørgsmål som har formet udførelsen af nærværende forskning. De tre forskningsspørgsmål bliver besvaret af fem individuelle videnskabelige artikler. På grund af den store mængde af forskellige interaktive narrativer præsenterer denne afhandling en model som karakteriserer interaktive narrativer i forhold til deres grad af interaktion og narrativitet. De fem videnskabelige artikler bliver placeret i denne model for at synliggøre artiklernes ligheder og forskelle.

Tre empiriske kilder bidrager til resultaterne. Studier af design praksis adresserer brugen og forståelsen af begreber, og studierne identificerer ligeledes udfordringer og arkitekturer i forskellige designprocesser. Den primære metode er interviews. For det andet benyttes eksperimenter under laboratorieforhold til evalueringer af objekt-orienterede design metoder i forsøg på at evaluere deres brugbarhed i forhold til modellering af interaktive narrativer. Her er fokus på identifikation af muligheder og begrænsninger i metoderne og på brug af begreberne. Slutteligt foreslår et interventionsdrevet studie nye interaktionsmuligheder og muligheden for fortælling af historier gennem to forskellige arkitekturer.

De primære resultater af denne afhandling er 1) begreberne interaktion and narration definerer centrale egenskaber ved interaktive narrativer. Forskellige forståelser af de to begreber muliggør forskellige typer af interaktive narrativer. Denne afhandling identificerer primært temporal-orienterede og rummelig-orienterede interaktive narrativer baseret på forskellige definitioner af narrativitet. 2) En central udfordring under designet af interaktive narrativer er beskrivelsen af historiefortællingen. Herunder er det uklart hvordan fremtidige brugere kan inddrages i designprocessen blandt andet fordi den kommende brugssituation ikke altid kan defineres. Objektorienterede designmetoder har et antal begrænsninger i

designet af interaktive narrativer. Flere af de centrale aktiviteter i designmetoden har ikke den store nytteværdi, da fokusering på arbejdsomgivelser ikke er relevant. 3) To arkitekturer bliver foreslået for at supportere designet af enten temporal-orienterede og rummelig-orienterede interaktive narrativer. Arkitekturerne benytter forskellige forståelser af begrebet narrativitet og adresserer interaktion på forskellige måder.

Preface and Acknowledgements

This thesis deals with the design of interactive narratives with a particular focus on concepts, methods, and architectures. The thesis comprises this summary and five individual paper contributions. The publication record for these five papers is as follows:

[1] Skov, M. B. and Stage, J. (2001) Using Software Engineering Approaches to Model Dynamics in Interactive Software Systems. *Virtual Interaction: Interaction in Virtual Inhabited 3D Worlds.* Springer-Verlag, London, pp. 404 – 421

[2] Skov, M. B. (2001) Autonomous Agents for Initiating Communication in Internet Community Chat Rooms. *Proceedings of the 3rd International Bi-Conference Workshop on Agent-Oriented Information Systems (AOIS-2001),* iCue Publishing, Berlin, pp. 13 - 21

[3] Skov, M. B and Eriksen, L. B. (2003) Evaluating Software Engineering Modelling Concepts for Interactive Narratives Design. *Behind the Scenes of Multimedia Production: Methodologies of Virtual Inhabited 3D Worlds*. Springer-Verlag, London, pp. 6 - 17

[4] Skov, M. B. and Stage, J. (2002) Designing Interactive Narrative Systems: Is Object-Orientation Useful? *Computers & Graphics*, vol. 26(1), pp. 57 - 66

[5] Skov, M. B. and Andersen, P. B. (2001) Designing Interactive Narratives. *Proceedings of the first International Conference on Computational Semiotics in Games and New Media (COSIGN 2001),* CWI, Amsterdam, pp. 69 – 75.

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Chapter 1

Introduction

Design of software systems is a difficult and challenging task. Software design involves the understanding of details and relations in user organisations, handling new technologies, meeting requirements of prospective users, and operating in turbulent environments that change during the design task (Mathiassen and Stage 1992). In addition, aspects of software complexity, conformity, changeability, and invisibility imply that no simple technique can solve all inherent problems of software design (Brooks 1987). Challenges faced within software systems design increase as new technologies emerge and new types of applications are requested (Mathiassen 1997). Such challenges include increase of task complexity, increase of technology variation, increase of multiplicity in people skills etc. (ibid.).

This thesis deals with the design of software systems that enable users to experience and create stories when using the systems. This emerging class of software systems is often referred to as interactive narratives (or computational narratives), cf. (Brooks 1996; Flanagan and Arble 1998; Galyean 1995; Kolstrup 2001b). The introduction of story telling (or narration) challenges the software design process further, e.g. since aspects of complexity and the group of prospective users changes (Webb 1996).

1.1 Interactive Narratives

Since accepted definitions on interactive narratives are still to emerge and due to the lack of a generally accepted understanding of interactive narratives, I will start by exemplifying the term interactive narrative.

1.1.1 Example: Story Agent Generation Environment

Story Agent Generation Environment (SAGE) is a PC-based storytelling software environment that supports children in the creation of their own wise storytellers to play with (Umaschi et. al. 1998). SAGE was installed at the Boston's Children's Hospital to facilitate personal storytelling for the children as a way of coping with their cardiac illnesses, hospitalisation, and invasive medical procedures. The idea was that through telling stories the children would be able to learn to handle situations that arise from their illnesses. SAGE supports two modes of interaction. Firstly, the children can share stories with the environment and secondly, the children can design new storytellers to interact with. As a part of sharing stories with SAGE, the children can interact with a wise sage and its animated stuffed rabbit. The wise sage listens to the sto-

ries of the children and offers relevant tales in response. The children interact with SAGE through the keyboard for typing in input and listen to outputs through a text-to-speech component and pre-recorded sounds. In a typical conversation between a child and the wise sage, the wise sage would pursue a particular topic for the conversation. E.g. in a conversation the stuffed rabbit is best friend of a virtual figure called Mrs. Needle and the wise sage would make the conversation span around children's fear of needles. The wise sage would typically ask the child a number of questions, e.g. what is your name, have you ever met Mrs. Needle, and are you afraid of Mrs. Needle, and let the children answer these questions in their own words. In this sense, SAGE is letting the children create their own stories by letting them tell and explain their fears and worries related to the particular topic; in this case needles. While the wise sage interacts with the child, the stuffed rabbit would perform nonverbal behaviours that humans normally associate with engagement and which are found in conversational narratives between people. Thus, the children would perceive the rabbit as having a life of its own and attribute the rabbit as being warm and gentle.

1.1.2 Interaction and Narration

SAGE is an example of an interactive narrative and the above description illustrates the use of SAGE. The class of interactive narratives includes a large amount of different interactive systems, cf. (Flanagan and Arble, 1998). It is difficult to delimit and define this emerging genre of interactive systems since different perceptions and perspectives exist. Interactive narratives can be utilised to retell history, educate, or entertain users (ibid.). However, SAGE illustrates two predominant components of an interactive narrative namely aspects of interaction and narration. SAGE integrates interactivity in the sense that children interact continuously with the application on different levels. During conversation the children type in messages and answers through the keyboard and they listen to questions asked and information told through audio speak. In addition, the children can interact with SAGE and construct new storytellers or program new behaviours of the stuffed rabbit. The aspect of narration is also important in SAGE. The wise sage would structure a conversation around a specific topic to control the conversation thus assuring coherence of the conversation, e.g. maintain the focus on the discussion of needles. The children would add to the narration by telling the wise sage their own personal stories related to their situations and their illnesses. Furthermore, the wise sage and the rabbit add to the narration by acting as believable characters that retell stories and initiate interaction.

Interaction and narration are key properties of interactive narratives, cf. (Galyean 1995, Jensen 2001, Kolstrup 2001). Based on the description of SAGE, tentative understandings on interaction and narration could be that interaction relates to the user's

application of the system and narration relates to the telling or creation of a story during the interaction, but further explorations of the two terms seem necessary.

1.2 Design of Interactive Narratives

The above illustrates an interactive narrative and identifies some key characteristics of interactive narratives. This thesis is about the design of interactive narratives thus the question remains how such software systems can be designed? Research studies of interactive narrative design practice indicate that this kind of design is difficult, cf. (Webb 1996), and Pauen et. al. (1998) and Sutcliffe and Faraday (1994, 1997) claim that interactive narrative design processes seem to be intuitive and approached in an ad-hoc manner. One problem is that it is difficult to design the presentation of systems in order to support users' tasks (Sutcliffe and Faraday 1994). Webb (1996) points out that some design practices, e.g. prototyping or modelling, are applicable for interactive narratives design whereas others are less applicable, e.g. the application of the business metaphor for describing work tasks. Furthermore, no methodological support is applied and very unsystematic work practices characterise the projects. It seems as if design projects on interactive narratives completely ignore the body of knowledge that has been established in software engineering and information systems development. A fundamental lesson learned through many studies and experiments in software engineering is that improvements in design processes require systematic work practices that involve well-founded methodologies (Fairley 1985, Pressman 1996, Sommerville 1992).

The above-identified problems in interactive narrative design practice suggest initiatives for improving the design process. The body of knowledge and experience within traditional information systems development is rather substantial, cf. (Booch 1994), and utilising the existing body of knowledge for the design of interactive narratives seems sound. Within information systems development research, the experience-action cycle constitutes a general approach to understand and improve software design practice, cf. (Checkland and Scholes 1990; Mathiassen 1997). In this cycle, researchers try to understand current design practice in order to identify challenges and solutions. Based on this understanding, researchers can yield experience-based knowledge that is both interpretive, helping to understand practice, and normative, providing support for systems design or for improving practices (Mathiassen 1997). Information systems development research has yielded vast amounts of design methods, concepts, notations, architectures, activities, techniques etc. for improving and supporting the software design process. Inspired by the experience-action cycle and the division of the design process into concepts, processes, and product, cf. (Booch 1994), I choose to address the following three themes for bringing support to the design of interactive narratives: concepts, methods, and architectures.

1.2.1 Concepts

Software design is about understanding and construction. During analysis, designers try to understand a problem domain for which they are to model the future system. Rumbaugh claims that a model is an abstraction of something for the purpose of understanding it before building it (Rumbaugh et. al. 1991). Booch (1994) argues that during the modelling of the system, designers apply and utilise concepts for analytical purposes (understanding) and for constructive purposes (designing).

Concepts for understanding and constructing interactive narrative are still understood vaguely. In one hand, contemporary research studies claim that more of the traditional design concepts found in more conventional software design are not applicable for design of interactive narratives, e.g. the concept of work tasks or business metaphors (Webb 1996). During design of more conventional software systems, designers often apply a distinct focus on aspects of current and future work tasks of prospective users (Jacobson et. al. 1999). E.g. use cases offer systematic approaches to capture functional requirements with focus on value for users and use cases drive the design process from analysis through design to implementation (ibid.). However, it is imprecise whether the concept of work tasks is inapplicable for the design of all interactive narrative or whether it may be useful for the design of some types of interactive narratives. Other research studies focus inherently on aspects of interaction and narration and the dependencies between these two concepts in analytical evaluations of interactive narratives cf. (Wibroe et. al. 2001; Benford et. al. 2000; Jensen 2001). From a constructive point of view, it is still vaguely understood how these concepts are applicable and how the different understanding of the terms may form design processes. We need to understand aspects of the two concepts further and understand their mutual relation in interactive narratives.

The above leads to the first research question: *What are the key concepts for understanding design of interactive narratives?*

1.2.2 Methods

Booch (1994) argues that software engineering design methods constitute ways of systematising the design process by illustrating activities and tasks to perform. Hence, a perspective on software design methods is that of process-orientation. For interactive narratives design, new challenges and issues related activities and phases may emerge as a result of the nature of these kinds of systems. E.g. for specification of functional requirements in conventional software design processes, user involvement plays an important role but also a difficult challenge since user may communicate their requirements by a vocabulary different than the one of the designers (Mathiassen et. al. 2000). Software engineering design methods are systematic attempts to support and mature the design practice by establishing notations, concepts, and proc-

esses. The entire software engineering design process encompasses the disciplined approach used to invent a solution for some problem (ibid.) and it is the total set of activities needed to transform a customer's requirements into a consistent set of artefacts representing a software product (Jacobson et. al. 1999).

Software design methods serve important roles in influencing design practices by being means for training beginners in the field by turning the design process into being method driven or facilitate experience and knowledge dissemination between practitioners, cf. (Mathiassen et. al. 2000). Software design methods have evolved in response to the challenges faced by emerging technologies and requests of new applications (Mathiassen 1997). Sommerville (1992) argues that most system design methods can be characterised as either top-down structured, data-driven, or object-oriented. Top-down structured design methods, e.g. (Yourdon and Constantine 1979; Myers 1978), apply algorithmic decomposition of the problem. Top-down structured design methods have shown their usability for many years, but do not address issues of data abstraction or information hiding and have problems when modelling extremely complex systems. Data-driven design methods, e.g. (Jackson 1975; Orr 1971), are characterized by the direct mapping of system inputs and outputs and have been successfully applied in modelling complex domains like information management systems. Object-oriented design methods, e.g. (Booch 1994; Rumbaugh et. al. 1991; Jacobson et. al. 1999), rely on modelling software systems as collections of cooperating objects, treating individual objects as instances of a class within a hierarchy of classes, cf. Booch (1994). During the 1990's object-oriented design methods have become state-of-the-art both within research and industry, cf. (Mathiassen et. al. 2000), and with the invention of the Unified Modeling Language (UML), cf. (Jacobson et. al. 1999; Rumbaugh et. al. 1999), this position has gained even more strength. For this reason, I choose to investigate the applicability of object-oriented design methods in interactive narratives design.

This leads to the second research question of this thesis: *What are the key challenges during the design process of interactive narratives and how can object-oriented methods support the design process?*

1.2.3 Architectures

Software engineering design methods provide support for the design process through specification of design activities and processes. Software architectures are complementary ways of providing support for the design. Architectures are product-oriented by supporting design practice to structure and organise the software system in components (Rumbaugh et. al. 1991). Software architectures serve to understand the future system and organise the design of the system (Jacobson et. al. 1999). Thus, requirements for design architectures are that they are interpretive helping us to un-

derstand the context of the system and normative providing us support for the design of the system. Software architectures direct the organisation of the software system and the structuring of elements of the system and their interfaces (ibid.). Hence, software architectures provide a platform from which designers can model and design future systems.

Even smaller software systems often contain many software components (e.g. objects) and a sound architecture provides designers to structure these components (Mathiassen et. al. 2000). The design method object oriented analysis and design provides a general system architecture containing three layers of software components; the interface layer, the function layer, and the model layer (ibid.). This architecture applies different perspectives on the system. E.g. the function component contains the facilities through which the user updates the model component. During analysis, the architecture guides the developers to identify requirements to the system whereas during design the architecture guides the structuring of the system (ibid.). Architectures address different levels of abstraction on the future system. The above example takes the perspective from a system level, whereas other architectures organise software components (e.g. classes and objects).

Different software architectures suit different kinds of systems. Prototypical architectures save design efforts by the utilisation of similar characteristics between similar systems (Rumbaugh et. al. 1991). As an emerging class of software systems, it is not obvious what kinds of architectures are suited for interactive narratives design and what kind of requirements interactive narratives poses on design architectures. The introduction and integration of narration and interaction may yield new kinds of design architectures. Therefore, we need to address requirements for design architectures for interactive narratives that can support the structuring and organisation of interactive narratives.

This leads to the third research question of this thesis: *What characterises design architectures for interactive narratives?*

1.3 Research Questions Summary and Thesis Structure

The above three illustrated themes and research questions are listed in the following table:

Theme	Research Question
Concepts	*What are the key concepts for understanding design of interactive narratives?*
Methods	*What are the key challenges during the design process of interactive narratives and how can object-oriented methods support the design process?*

Architectures	*What characterises design architectures for interactive narratives?*

Table 1.1: Research themes and questions of this thesis

This thesis consists of this summary and five individual paper contributions as listed in the preface. The papers deal with different aspects of the design of in interactive narratives and origin from a number of empirical studies.

Chapter two of this summary presents a space for interactive narrative experiences. The space presents interactivity and narrative structure and these concepts map a space of different kinds of interactive narrative experiences. Chapter 3 illustrates the research contributions based on results from the five paper contributions, and the five contributions are mapped in the space according to their level of interactivity and narrative structure. Chapter 4 discusses the three above listed research questions by addressing the research results of the five paper contributions and by additional literature. Chapter 5 discusses the research approach taken in this thesis and issues related research methods and data collection and analysis are discussed in relation to the five papers. Chapter 6 concludes the work and outlines limitations of the results and suggests avenues for future research

Chapter 2

Interactive Narratives

The class of interactive narratives is diverse and addresses many different application domains, goals, or user groups, cf. (Brooks 1996; Flanagan and Arble 1998; Galyean 1995). Examples of interactive narratives are computer games cf. (Konzack 1999, Rolling and Morris 2000), interactive training and assessment systems cf. (Rosenstand 2001), and collaborative and therapeutic systems cf. (Mallon and Webb 2000). The SAGE environment as illustrated in the introduction is an example of a therapeutic system for children coping with cardiac illnesses, hospitalisation, and invasive medical procedures. SAGE introduces aspects of interaction, the user can interact with the wise sage in the system e.g. type in text and sentences or listen to audio speak. SAGE also introduces aspects of narration, e.g. the facilitation of telling personal stories to the wise sage and the stuffed rabbit (Umaschi et. al. 1998). Other interactive narratives emphasize other characteristics related to interaction and narration, e.g. frequent and unstructured interaction in the system illustrated in (Benford et. al. 2000).

In this chapter, I will characterise interactive narratives and provide a preliminary conceptual definition of this class of interactive systems. Due to the diversity of interactive narratives and the differences with respect to the characteristics of interaction and narration, I have searched for a broad definition that supports the description and characterisation of the differences between interactive narratives and that relates aspects of interaction and narration. For this reason, I choose a definition by Galyean (1995) on interactivity and narrative structure for interactive narratives. This definition fulfils my requirements as it enables the characterisation of both interaction and narration and relates the two concepts. Furthermore, it provides the service of relating my paper contributions.

The following two sections present his definitions and examples. In chapter 3, I will apply the definition and illustrate its applicability according to the five paper contributions of this thesis, and in chapter 4, I will evaluate the definition upon the experiences of chapter 3.

2.1 Interactive Narratives Taxonomy

Galyean (1995) provides a taxonomy for describing and understanding interactive narratives. Specifically, he stresses that the taxonomy helps to classify and organize the class of interactive narratives and it provides an overall context for his work (ibid,

p. 77). The developed taxonomy consists of three components (ibid, p. 80). First, he introduces a space that defines a map of interactive narratives based on the two variables of interaction and narration. The space is useful for finding different interactive narratives and for explaining differences of interactive narratives based on the degrees of interactivity and narrative structure (ibid, pp. 80-85). The space defines any experience a viewer or a user has with a narrative and it signifies differences between experiences with respect to their level of interactivity and narrative structure. Galyean applies audience, viewer, or user for the person(s) confronted with the experience. Secondly, designers have to connect the interface with the narrative. Interface issues affect both the plot of the narrative and the presentation. Galyean suggests that the plot of the narrative is affected either directly, e.g. letting the user decide from a set of choices to happen in the narrative and thereby deliberately altering the plot, or indirectly, e.g. by letting the user adjust the tension of the narrative (ibid, pp. 85-90). Thirdly, this concerns the viewer's relationship to the narrative and the camera's relationship to the elements of the narrative. Either the viewer is playing a role of one of the characters in the narrative or viewer has a relationship that sets them outside the narrative in a god-like presence. The camera can reside inside the head of one of the characters or hang disembodied observing the narrative (ibid, pp. 90-92).

2.2 Interactive Narratives Space

The first part of Galyean's taxonomy is the space that integrates interaction and narration, and Galyean defines the two concepts in the space. For this reason, the space is further explained in the following.

The two primary distinguishing variables of an interactive narrative are the amount of interactivity the viewer has with the experience, and the amount of narrative structure the experience imposes (ibid, p. 80). The two variables map a space of interactivity and narrative structure that defines different kinds of experiences (as illustrated in figure 2.1). Galyean states that there is no relation between interactivity and narrative structure and the space presents these variables as independent allowing experiences that are both highly interactive and at the same time have a high narrative structure (ibid, p. 81). The spectrum of the two axes ranges from the extreme of unstructured daily life exploration (low narrative structure) to highly structured presentation of a suspenseful film (high narrative structure), and from passive television or film watching (non-interactive) to a highly interactive routine of our daily lives (highly interactive). Galyean defines the two axes and then populates the space with specific examples in order to explain the axes.

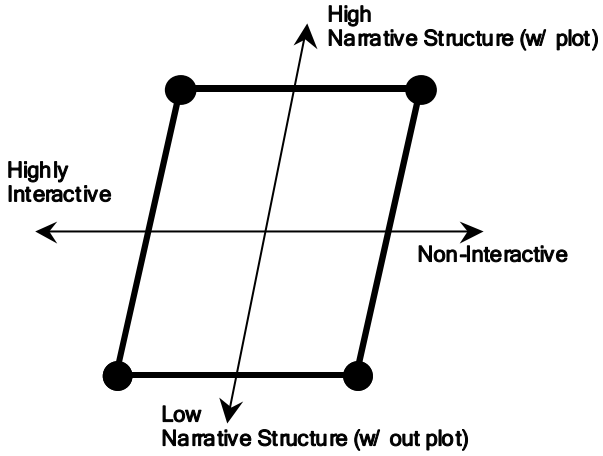

Figure 2.1: Interactive narrative space of experiences–
defined by interactivity and narrative structure (Galyean 1995, p. 81)

Galyean defines interactivity out of characteristics of conversation-like interaction (e.g. as interaction taking place between humans). He adapts a definition of the give and take of conversation from (Anderson 1989), and Galyean claims that the following five properties must be a part of a conversationally based interactive experience (Galyean 1995, p. 82):

- *Interpretability*, each individual in the conversation has to be able to interrupt the other.
- *Granularity*, the size of the smallest element from which the interaction is built.
- *Limited look-ahead*, there must be a limited reliance on any ability to precompute, because the nature of interactivity and conversation is to change and adjust constantly.
- *Graceful degradation*, requests that cannot be addressed should be gracefully deferred.
- *Appearance of infinitude*, the system should provide the illusion that there are an infinite number of alternatives.

Galyean claims that the more the interaction achieves these five properties the richer the interaction with the narrative. He continues by saying that a system is considered more highly interactive if it more fully meets these five properties (ibid, p. 82).

Galyean defines narrative structure from structuralism theory, cf. (Branigan 1992, Chatman 1993). Here narrative is understandable as both the events that make a story

and the process by which these events are presented to the audience (Galyean 1995, p. 19). Narratives are though dividable into two components (ibid, pp. 19-20):

- *Story* of the narrative is the content consisting of events and existents, e.g. the characters and the settings.
- *Discourse* of the narrative is the expression of the story, the means by which the content is communicated to the audience.

The story is the core of the narrative that can be presented to the audience in a number of different ways (ibid, pp. 41-42). This leaves the author to choose the most effective presentation or discourse for the narrative. Galyean defines narrative structure as the temporal relationship of the events presented to the viewer that gives intensity and meaning to the narrative world. This structure (sometimes referred to as the plot) grows over time and it is only because of this temporal quality of the plot that dramatic phenomena as expectation and suspense can be created (ibid, p. 81). The more a narrative adheres to a strict order of presentation (a plot) the higher the narrative structure is.

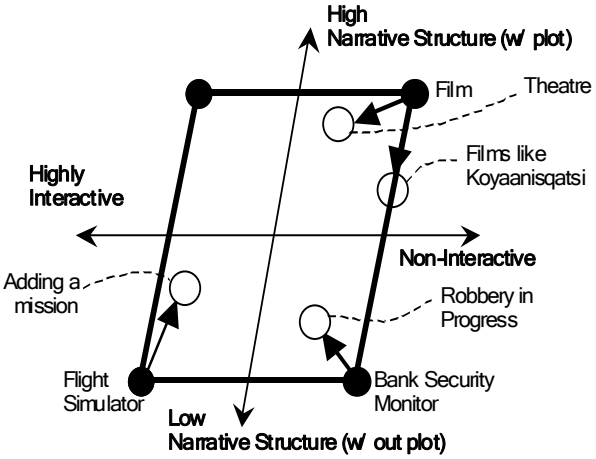

Figure 2.2: Populating the interactive narrative space with different types of experiences (Galyean 1995, pp. 83 – 84)

Galyean populates the space with examples on different daily life experiences in order to illustrate the nature of the two axes. The following figure 2.2 presents his examples of different kinds of experiences.

The right hand side of the space illustrates experiences with little or no interactivity. The upper right hand corner signifies high narrative structures with no interactivity. Classical examples are films where the user (audience) has no interaction opportunities and where the audience watch the film passively, but has a high narrative

structure involving plots. A traditional film is not interactive according to the definition on interactivity, since all of the five properties are lowly met (e.g. granularity is lowly met since the user can only stop, rewind, or fast-forward the film). As another example, the film *Silence of the Lambs* relies very much on the order and method of the presentation of the events (which implies a high narrative structure), e.g. it is important that it is revealed only at the end of the film that the FBI agent finds the kidnapped girl alive. Theatre has similar characteristics as films, but in theatre performances, actors can adjust to audience reactions making the play somewhat interactive and lowering the predefined narrative structure. As an example, interpretability is possible (making interactivity higher) since the audience can interrupt the actors, e.g. by the expressing their attitudes towards the play. Further, the actors may alter the order of the presentation of the events thus lowering the narrative structure. A film like *Koyaanisqatsi,* cf. (Koyaanisqatsi 2001), takes the viewer on a journey presenting various sound and image components. The viewer has no interaction opportunities like any other traditional film but the narrative structure is lower than traditional films since the order of the images and the sounds is less important. The lower right corner illustrates experiences with no interactivity and low narrative structures. A bank security monitor provides no means for interactivity for the viewer and people in front of the camera are not guided by any narrative structures. However, as an example, a robbery in progress can be said to follow a structured plan and the viewer may initiate actions to stop or prevent the robbery, e.g. call the police thereby increasing the level of interactivity and the level of narrative structure.

The left hand side of the space illustrates experiences that are highly interactive. The lower left corner represents experiences with low or no narrative structures but which are highly interactive. Good examples are computer games like flight simulators or racing games. In a flight simulator, users are often able to navigate and explore the controls and the environment with only few restrictions. The user herself forms her missions, goals, or incentives that impose the only narrative structure. But by adding a mission to the game, e.g. seek and destroy enemy aircrafts, overall narrative structure is introduced but still with great freedom in the interaction. In the upper left corner, we find the truly interactive narratives (Galyean 1995, p. 83). The map does not indicate what kinds of systems exist in the upper-left corner, but Galyean points out that the space illustrates the surroundings and the different angles from which the upper left corner can be approached (ibid, p. 85). Galyean claims that the space enables one way of understanding interactive narrative creation as either adding interactivity to some narrative material (origin in the upper right corner) or as adding narrative structures to an already highly interactive environment (origin in the lower left corner) (ibid, pp. 24 –25, 83 – 85).

Chapter 3

Research Contributions

This chapter presents the research contributions of the five individual paper contributions listed in the preface and below. The papers illustrate different aspects of interactive narratives design. The full text of each paper can be found in appendix A. The following shows the publication details for each of the five papers (the order of the listing is arbitrary):

[1] Skov, M. B. and Stage, J. (2001) Using Software Engineering Approaches to Model Dynamics in Interactive Software Systems. *Virtual Interaction: Interaction in Virtual Inhabited 3D Worlds.* Springer-Verlag, London, pp. 404 – 421

[2] Skov, M. B. (2001) Autonomous Agents for Initiating Communication in Internet Community Chat Rooms. *Proceedings of the 3rd International Bi-Conference Workshop on Agent-Oriented Information Systems (AOIS-2001),* iCue Publishing, Berlin, pp. 13 - 21

[3] Skov, M. B and Eriksen, L. B. (2003) Evaluating Software Engineering Modelling Concepts for Interactive Narratives Design. *Behind the Scenes of Multimedia Production: Methodologies of Virtual Inhabited 3D Worlds*. Springer-Verlag, London, pp. 6 - 17

[4] Skov, M. B. and Stage, J. (2002) Designing Interactive Narrative Systems: Is Object-Orientation Useful? *Computers & Graphics*, vol. 26(1), pp. 57 - 66

[5] Skov, M. B. and Andersen, P. B. (2001) Designing Interactive Narratives. *Proceedings of the first International Conference on Computational Semiotics in Games and New Media (COSIGN 2001),* CWI, Amsterdam, pp. 69 – 75.

The following five sections present the five paper contributions individually. Each section describes the paper in three components. First, the background behind the paper is presented and this includes the type of research conducted. Secondly, I map the experience imposed by the system in the paper in the interactive narrative space by assessing the level of interactivity and narrative structure. For practical reason, I choose to assess only whether the level of interactivity and narrative structure is primarily high or low, which places the individual experience in one of four quadrants (implications of this reduction are discussed in section 4.1). Finally, the primary re-

sults of the paper are listed. The last section summarises the mappings of the experiences of the systems in the five paper contributions.

3.1 Using Software Engineering Approaches to Model Dynamics in Interactive Software Systems

Skov, M. B. and Stage, J. (2001) Using Software Engineering Approaches to Model Dynamics in Interactive Software Systems. *Virtual Interaction: Interaction in Virtual Inhabited 3D Worlds*. Springer-Verlag, London, pp. 404 – 421

The paper reports from an empirical study of the design processes of three experienced software designers when designing a highly interactive system (Skov and Stage 2001). One software designer applies an object-oriented method in the design of the dynamics of an interactive system in a laboratory experiment. Two other designers apply respectively a mathematical-logical approach and an operating systems approach for the design of the same system. The object-oriented design process is compared to the two other design processes and difference and similarities are identified and discussed. Two other software designers review the design solutions independently and they mark the three solutions.

The system of focus in this paper is a lift control system for operating elevators in a building between floors. Concerning level of interactivity, interpretability is highly met since users can interrupt each other any time by sending request from either floors or elevators. Granularity is lowly met since users can only interact through selected buttons on the floors or in the elevators. Limited look-ahead is highly met since users cannot precompute events due to the involvement of more users, e.g. it is difficult to exactly determine when the elevator will arrive after it has been requested. Graceful degradation is highly met since the design specification requires that the system will eventually address all requests. Appearance of infinitude is lowly met since definite number of alternatives exists. For these reasons, I choose to assess the combined level of interactivity as high. Concerning narrative structure, no narrative structure exists in the system. This places the experience in the lower-left quadrant of the space.

The paper illustrates that the design of highly interactive systems challenge software designers in different ways. The object-oriented design employs more concepts with the same or similar meaning whereas the two other designs integrate better-defined bases. The multitude number of concepts makes the final solution of the object-oriented designer unclear and fuzzy. This design process is highly controlled by the nature of the problem implying frequent and unsystematic changes between dif-

ferent aspects of the problem. This is in contrast to the two other approaches that were more controlled by the nature of their design specifications where the designers worked for longer periods on the same aspect of the problem. The object-oriented designer faced severe problems in handling synchronisation of events in the system due to the lack of specification mechanisms. However, the object-oriented designer came up with the most sufficient design solution since the two other designers had to reduce their solutions since they suffered from problems of complexity in their solutions.

3.2 Autonomous Agents for Initiating Communication in Internet Community Chat Rooms

Skov, M. B. (2001). Autonomous Agents for Initiating Communication in Internet Community Chat Rooms. *Proceedings of the 3rd International Bi-Conference Workshop on Agent-Oriented Information Systems (AOIS-2001),* iCue Publishing, Berlin, pp. 13 - 21

The paper reports from a research and development collaboration with a local Internet company (Skov 2001). The purpose of the collaboration was to explore autonomous agents as a new way of interacting with web sites and for identifying interesting pieces of information. The collaboration consisted of two major parts and involved participants from the company and a university researcher. First, the concept of an autonomous agent was investigated in a small reading group consisting of the researcher and software designers in the company where key agent literature was identified, read, and discussed in order to create a mutual understanding of the term. Secondly, a design team identified a suitable context for an agent solution and an agent architecture was designed in a collaborative effort. The domain for the agent solution was identified through discussions and through smaller experiments where properties of agents were tested against the task of finding information. Having identified the domain for the agent solution, the design team identified roles for the agents and specified communication between agents and between the user and the agents.

The system of focus in the second paper is an agent-based system for enhancing the usefulness of Internet community chat rooms. Concerning level of interactivity, interpretability is highly met since users can interrupt each other any time either by having the agent suggesting conversations or by having the user selecting or rejecting suggestions. Granularity is highly met even though users can only interact with the agent through rejections or acceptance of suggestions, all actions of user is observable

by the agent. Limited look-ahead is highly met since users cannot precompute suggestions and the agent cannot totally precompute actions of the user. Graceful degradation is probably lowly met since users may not address all suggestions. Appearance of infinitude is low since definite number of interaction exists. For these reasons, I choose to assess the level of interactivity as high. Concerning narrative structure, no narrative structure exists in the system. This places the experience in the lower-left quadrant of the space.

The result of the paper is a description of an architecture for an agent-based design solution for enhancing the usefulness of Internet community chat rooms. The agent solution consists of two types of agents, one type of agents serving users directly and one type of agents monitoring activities in chat rooms. The solution supports users in identifying interesting conversations in these chat rooms by monitoring them and making recommendations to the user, e.g. on specific conversations. The agent solution relies on substantial use of profiles, e.g. a profile of the user and preferences of this user. The solution is discussed and evaluated against literature criteria on software agents. The paper addresses requirements for the division of agent roles and agents are able to interact with users.

3.3 Evaluating Software Engineering Modeling Concepts for Interactive Narratives Design

Skov, M. B and Eriksen, L. B. (2003) Evaluating Software Engineering Modeling Concepts for Interactive Narratives Design. *Behind the Scenes of Multimedia Production: Methodologies of Virtual Inhabited 3D Worlds*. Springer-Verlag, London, pp. 6 -17

The paper reports from an empirical evaluation of an object-oriented analysis and design method for the design of an interactive narrative (Skov and Eriksen 2002). An established object-oriented analysis and design method is selected for evaluation of its usefulness for design of interactive narratives. A case example of an interactive narrative system is identified and the object-oriented analysis and design method is applied for the design of this case. During the evaluation, a primary focus is on the applicability of the design concepts of the method, e.g. how they are able to capture and describe important design decisions related the interactive narrative. The two authors of paper conduct the evaluation, and weaknesses and strengths are written down.

The system of focus in the third paper is a training and assessment system for selecting candidates for open manager positions. Concerning level of interactivity, in-

terpretability is lowly met since users cannot interrupt the system while video sequences are played. Granularity is lowly met since users can only select few predefined options between each video sequence. Limited look-ahead is probably highly met since users cannot precompute all possible selections to choose from. Graceful degradation is lowly met since requests during the playing of video sequences are not possible. Appearance of infinitude is lowly met since definite number of interaction options exists. For these reasons, I choose to assess the level of interactivity as low. Concerning narrative structure, it is high since the experience relies on strict temporal aspects involving a number of plot points. This places the experience in the upper-right quadrant of the space.

The results of the paper point out key weaknesses of the object-oriented method for interactive narratives design. The analysis and design method has a particular focus during early analysis on the situation in which the future system is going to be used. However, for the investigated interactive narrative, the analysis of future use situations does not bring new information on how to design the system. The problem is that the situation does not indicate what kinds of interaction that is going to take place. E.g. what kinds of input users will feed the system and what kinds of output the system will give the user.The concept of a problem domain further challenges the design. In the object-oriented method, the problem domain signifies the part of the real world that is administered, monitored, or controlled by the future system. However, the core of this system lies within simulation of the various situations that the system has to depicture, e.g. the video sequences and their mutual relations. The problem domain analysis becomes too simple to help structure the components of the future system since the system only model the selections made by the user after each video sequence.

3.4 Designing Interactive Narrative Systems: Is Object-Orientation Useful?

Skov, M. B. and Stage, J. (2002) Designing Interactive Narrative Systems: Is Object-Orientation Useful? *Computers & Graphics*, vol. 26(1), pp. 57 - 66

The paper reports from an empirical study of an object-oriented analysis and design method for the design of an interactive narrative system (Skov and Stage 2002). The object-oriented analysis and design method is applied on an interactive narrative case and a design team conducts the analysis, design, and implementation of the system. Experiences from the design process and design document are kept for later evaluation. This design process is compared to the design process of a similar interactive

narrative where the design team employed a different approach to interactive narratives design. This approach is characterised as employment of general narrative knowledge as relies on techniques and ideas from filmmaking. Limitations and opportunities of the two approaches are illustrated and explained.

The systems of focus in the fourth paper are training and assessment systems for selecting and assessing people for respectively umpires for match-races and open manager positions. For the umpire selection and assessment system, interpretability is lowly met since users cannot interrupt the system while video sequences are played. Granularity is lowly met since users can only select few (sometimes only two) predefined options between each video sequence. Limited look-ahead is probably highly met since users cannot precompute all selection options between video sequences. Graceful degradation is lowly met since requests during the playing of video sequences cannot be addressed. Appearance of infinitude is lowly met since definite number of interaction options exists. The manager selection and assessment system in the paper is the same system illustrated in the previous section. The two systems are similar with respect to the properties of interactivity (please refer to section 3.3) and thus for this reason, I choose to assess the level of interactivity as low. Concerning narrative structure for the first system, it is probably still high since the experience relies on temporal structure of presenting the events of the umpiring situations however it may not be as strictly ordered as the second system where suspense is build up during the use. However, the order of presentation of events is still important and I choose to place the experiences in the upper-right quadrant of the space.

The paper identifies six components of a complete design document for an interactive narrative training and assessment system based on a literature survey. The six components point out key areas that have to be analysed and designed for creating a basis for the implementation. The six components define the comparison of the two design approaches. The object-oriented method is able to handle the modelling of the future system and for describing aspects of the functionality of the system. However, it was difficult to specify how and what kinds of media assets that were needed to create an immerse system. The specification of a coherent story was difficult to carry out using the method since it provides no means for handling narratives. On the other hand, the second studied design process applied general narrative knowledge that enabled the designers to specify important aspects of the story, including narrative structure and content of each situation. The process revealed problems with respect to technical quality of the produced solution and changing requirements were difficult to capture and track.

3.5 Designing Interactive Narratives

Skov, M. B. and Andersen, P. B. (2001). Designing Interactive Narratives. *Proceedings of the 1st International Conference on Computational Semiotics in Games and New Media* (COSIGN 2001), CWI, Amsterdam, pp. 69 – 75

The paper explores aspects of interactivity and narrative structure in an empirical study and the problem between the freedom of interactivity and control of narrative structure is exploited (Skov and Andersen 2001). Two empirical studies address the design of interactive narratives through interviews with two interactive narrative authors. The two authors work with the design of different kinds of interactive narratives, and they have both initiated and controlled more interactive narrative design processes. The experiences of this study form a theoretical discussion on the design of interactivity and narrative structure in interactive narratives, and an experimental design architecture is designed upon these experiences and theories from narratology.

The systems of focus in the fifth paper are rather diverse interactive narratives ranging from training and assessment systems to computer games. Some of the involved training and assessment interactive narratives resemble the systems illustrated in section 3.3 and 3.4. For the involved computer games, interpretability is highly met since users can interrupt the system any time and they are free to explore the environment in which they navigate. Granularity is highly met since users can apply different input options. Limited look-ahead is highly met since more events can happen in the world, which are difficult to pre-compute to the user. Graceful degradation is difficult to assess for this system but is probably lowly met since the users may have requests that cannot be served without they knowing the reason. Appearance of infinitude is highly met since the user is free to explore the environment. For this reason, I choose to assess the level of interactivity for the computer games as high. Concerning narrative structure for this interactive narrative, it is high since the user is controlled in the various settings and that events are temporally ordered in order to ensure progress in the game. This places the experiences in the upper-left quadrant of the space.

The paper constructs a design architecture for combining interaction and narration. Aspects of interaction and narration are illustrated through empirical and theoretical evidence. The empirical study presents three different narratives structures, e.g. single selection path, multiple selection paths, and multiple exploration paths, that the two authors apply during the design and creation of the interactive narratives. The narrative structures serve to illustrate the problems of complexity involved

in combining interactivity and narrative structure. The paper concludes that in order to create more free and more interactive kinds of interactive narratives designers need to relinquish the control of time. We claim that this is obtainable through the construction of virtual worlds and a design architecture illustrates how actors, roles, and events in worlds can be addressed.

3.6 Summary

The above five sections outline the five paper contributions of this summary and illustrates different aspects of interactive narratives design.

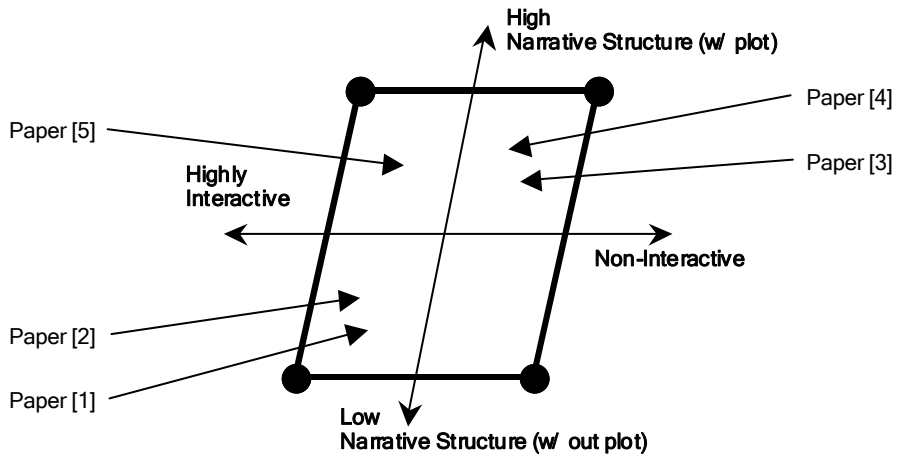

Figure 3.1: Experiences imposed by the systems in the five paper contributions of this thesis

For each paper contribution, I motivate the placement of the experience imposed by the system and assess the level of interactivity and narrative structure for each paper. The above considerations place the experiences of the interactive narratives of the five paper contributions as illustrated in figure 3.1.

Chapter 4

Research Discussion

The previous chapter has presented my five paper contributions individually by summarising the research process and the results of each paper. Furthermore, I argued for the placement of the paper contributions in the interactive narrative space according to the experience imposed by the system in each paper based on the level of interactivity and narrative structure.

In this chapter, I will discuss and give answers to the three research questions raised in the introduction. The purpose of this chapter is to relate the paper contributions to the research questions and additionally complement my research results with selected literature. This is done to further illustrate and understand concepts, methods, and architectures for interactive narratives design. In chapter 6, I will return to the overall theme on design of interactive narratives.

4.1 Concepts

The first research question addresses concepts for the design of interactive narratives and states: *What are the key concepts for understanding design of interactive narratives?*

Galyean (1995) states that interaction and narration are key concepts in interactive narratives design and such aspects of interaction and narration define important issues in interactive narratives use and design. Thus, software designers need to address issues imposed by these two concepts, e.g. what kind of narrative should the user experience and how should the user interact with this narrative. Jensen (2001) stresses that the meaning of interaction depends on the context in which it is used, and Kolstrup (2001) states that narratives imply different understandings depending on media channels and purposes. A variety of different definitions and understandings of the two concepts exists, e.g. definitions of interaction (Dix et. al. 1998; Jensen 2001; Laurel 1993; Norman 1986; Preece et. al. 1994; Shneiderman 1998), or definitions of narration (Branigan 1992, Chatman 1993, Genette 1980).

Jensen (2001) stresses that the diverse understandings of interaction cause considerable disagreements and confusions within academia and practice. He continues by saying that within the field of human-computer interaction the concepts of interaction and interactivity appear to be synonymous although different understandings of the two terms are identifiable and suitable (ibid.). For practical reasons and in line with the traditions within the field of human-computer

the traditions within the field of human-computer interaction, I apply the two concepts synonymously in the following discussion (please refer to (Jensen 1997, 1998) for the differentiation of the two terms). Since aspects of interaction and narration seem to form more interactive narratives, I will discuss these two concepts in the following and illustrate relations between the two. During this discussion, I will address other concepts that seem to form and explain interactive narratives design.

4.1.1 Separating Interaction and Narration

Galyean (1995) argues for the separation of the two concepts and integrates them in a two-dimensional space for finding and identifying interactive narrative experiences. The two axes signify the amount of interactivity the experience imposes and the amount of narrative structure the experience imposes. The two axes are independent allowing experiences that range from low interactive with a low narrative structure to high interactive with a high narrative structure (see figure 4.1). Galyean (1995) defines the axe of interactivity from characteristics on conversation-like interaction (Anderson 1989), and he defines the axe of narrative structure from definitions on structuralism theory, cf. (Branigan 1992; Chatman 1993; Genette 1980). The definitions direct the placement of an experience of an interactive narrative by assessing to what level the definitions are met. This assessment is tried in chapter 3 where I assess the experiences of the systems of the five paper contributions and I place the experiences and the corresponding papers in the space.

The space provides a number of opportunities for interactive narratives design. First, it simplifies the characterisation of interactive narratives and places different interactive narratives according to their amount of interactivity and narrative structure. This may how changes affect the experience when designers increase or decrease the amount of interactivity or narrative structure. E.g. in a flight simulator game, Galyean (1995) claims that designers can increase the amount of narrative structure by adding specific missions for the user to complete. Secondly, the space enables comparison of different experiences on their level of interactivity and narrative structure. From a design perspective, the space is perhaps able to provide a map for characterising a current or future interactive narrative experience as illustrated in chapter 3. The map may also serve to identify challenges and opportunities of designing a specific experience or changing an experience of interactive narrative to a different level of interactivity or narrative structure. In the system illustrated in (Skov and Eriksen 2002) the level of interactivity is low primarily due to the properties of interpretability and granularity. During the design process, the design team is able to identify this level of interactivity and the mapping in the space provides a tool for increasing or decreasing the interactivity by adjusting interpretability, e.g. by allow-

ing users to interrupt or halt the playing of the video sequence. In these ways, the space may direct design decision concerning interactivity and narrative structure.

The space seems to suffer from a number of limitations. First, it is difficult to exactly map the experience imposed by a certain interactive narrative along the two axes. The examples produced in (Galyean 1995) are for most of them not experiences of interactive narratives but of daily life experiences placed along the edges of the space. It seems to be possible to assess whether an experience impose no interactivity or no narrative structure, cf. (ibid, pp. 83-84), but more difficult to assess whether an experience imposes only little or much interactivity or narrative structure. This problem is illustrated in the mapping of experience in chapter three of this thesis. Secondly, it is not obvious how the five properties of the interactivity definition should be prioritised. E.g. is it possible to consider an experience high if only one or two of properties are met? The narrative structure suffers from the same problem where it is difficult to assess the placement of a specific experience, e.g. how many plot points should a narrative contain? This problem is illustrated in figure 4.1 where e.g. it is difficult to exactly map an experience according to the narrative structure. Galyean (1995) provides no answers to this problem.

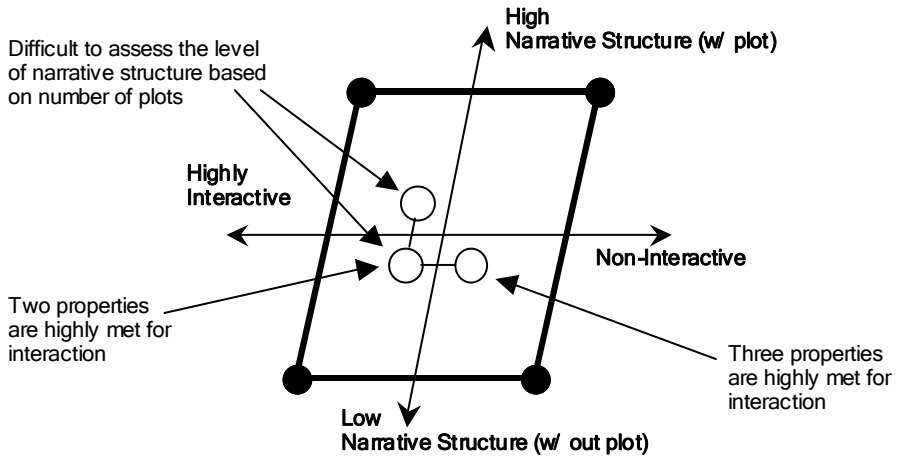

Figure 4.1: Interactive narrative space of experiences:
Difficulties in exactly mapping experiences in the centre of the space

Reducing the axes into discrete values of either high or low interactivity and high or low narrative structure partly solves these problems. This is done in chapter three where I assess whether the experiences imposed by the systems of the paper contributions are mainly high or low for interactivity and narrative structure. However, more of the systems are located approximately at the middle of each axis, e.g. where two properties are found to be lowly met, two other properties are found to be highly met, and one property is difficult to assess. It is not obvious if and how the properties

are to be prioritised (as illustrated in figure 4.1). The reduction of the values on the axes probably oversimplifies the problem of focus and it is questionable whether it is possible to reduce interaction and narration for interactive narrative to an absolute value on one-dimensional axes. Finally, it is not evident when an experience in the space belongs to the class of interactive narratives. I assume that experiences involving no interactivity and no narrative structure are not interactive narratives. For the two systems in (Skov 2001; Skov and Stage 2002), in chapter 3 I choose to assess that they are highly interactive systems and that they do not involve any narrative structures. Are they still interactive narratives? The space seems to signify that only experiences that are highly interactive and have high narrative structures are true interactive narratives, but according to my assessment this would exclude the systems illustrated in (Skov and Eriksen 2002; Skov and Stage 2002) as being true interactive narratives. Based on the above limitations, I will continue the discussion by expanding and illustrating perspectives on interaction and narration, and discuss implications for the design of interactive narratives.

4.1.2 Extending Perspectives on Interaction

One of the properties in conversation-like interaction is interpretability (Anderson 1989) that relates to the dynamics in the interaction between two people or for interactive narratives between the user and the system. Laurel (1986) identifies similar properties of the dynamics in interactive narratives through the term frequency that defines how often user inputs are enabled. Designing and handling aspects of dynamics in interaction seems to challenge software designers. The complexity introduced by synchronising concurrent events and actions cause problems to a number of software designers when designing a system with high dynamics (Skov and Stage 2001). Here, more users access the system at the same time introducing the dynamics. Some of the designers reduce their solutions in order to decrease the overall complexity introduced by aspects of interactivity, and their final designs are oversimplified solutions to the stated problem. The experience of the system in (Skov and Stage 2001) imposes no narrative structure, which may lower the general validity of the results. Aspects of concurrent usage characterise some interactive narratives, e.g. the Klump (Benford et. al. 2000) where children collaborate through graphical faces on the computer screen to create stories. However, for single user interactive narratives, designers may face different or no design problems related dynamics. It is uncertain whether the same potential problems exist for systems with experiences imposing a higher narrative structure.

Action models define a different and well-established perspective on interactivity (Shneiderman 1998). Interactivity defined in terms of actions models seems less successful for interactive narratives design. The basic assumption is that the interactive

system serves as a tool for the user in order to solve some tasks (e.g. work tasks) and action models draw on psychological theory on people performing tasks (Webb 1996). One of the most influential action models is the execution-evaluation cycle, cf. (Norman 1986; Shneiderman 1998; Dix et. al. 1998; Preece et. al. 1994). In the execution-evaluation cycle, a user formulates a plan of action that executes at the computer interface. The user observes the computer interface to evaluate the result of the execution and plan further actions (Norman 1986). We find that it is difficult to identify and describe tasks for certain types of interactive narratives, cf. (Skov and Eriksen 2002). The limited value of the task concept is explainable by the lack of a business metaphor (Webb 1996). Designers identify tasks in applications domains by analysing future use situations in which the system is to be used (Mathiassen et. al. 2000). However, for the interactive training and assessment system in (Skov and Eriksen 2002), the future use situation is undefined and the result is no usable identified work tasks. Qvortrup (1998) characterises some interactive narratives as being media rather than tools and this may explain the lack of dedicated application domains. For interactive narratives demonstrating situations from a virtual world, in (Skov and Eriksen 2002) we outline that situations during design of interactive narratives denote not only the situations of the future use situation but also the situations depictured in the narrative. These situations denote content situations (ibid.). I will continue by discussing aspect of narration.

4.1.3 Extending Perspectives on Narration

The perspective on narration as structuralism theory, cf. (Genette 1980), seems to be applicable for the design of certain interactive narratives. These kinds of interactive narratives often apply digital video to represent or replicate situations from "real life" and they often apply a narrative structure denoted branching structures, cf. (Chatman 1993; Galyean 1995), or also referred to as multiple selection paths (Skov and Andersen 2001). The branching structure is particularly well suited to digital video (Galyean 1995). This is the case in the system illustrated in (Skov and Eriksen 2002) where digital video depicture "real-life" situations from a work environment in which the user has to act as a manager and make decisions. After the showing of one video sequence, the user is required to make input and each decision by the user initiates the playing of a new video sequence.

I denote such systems temporal-oriented interactive narratives. In (Skov and Andersen 2001), we claim that these systems utilise temporal structures and the designer only occasionally relinquish control of time to the user during discrete types of interaction. Creating tension and suspense in the narrative is still manageable for the designer through the partial control of time and through the specification of causal relationships between situations (the discourse) in the narrative. Designers are also able

to verify aspects of the realism in use by traversing the possible paths through the narrative during the design process, cf. (Skov and Stage 2002). The adherence to temporal logic seems to fit some the design processes of such interactive narratives. Tailored flow diagrams enables the visualization of branching structures, cf. (Skov and Stage 2002), and branching structures direct the transitions between scenes and acts in the narrative where transitions represent the interaction between the user and the system (Skov and Eriksen 2002). Branching structures and more simple narrative structures, cf. maze structures (Galyean 1995) also referred to as single selection paths (Skov and Andersen 2001), seems controllable in dedicated tools for decomposition of scenes and acts which helps designers to overcome potential problems of growing complexity (Skov and Stage 2002).

The idea behind branching structures forms an attempt to introduce narratives in object-orientation (Pauen et. al. 1998). The concept of an object in the object-oriented paradigm holds many promising properties in software design, e.g. Stein (1994) argues the concept of objects supports all phases of the development from early analysis to programming diminishing semantic gaps between the phases. The study explores a specialised type of objects/classes called narrative units for modelling narrative structures (Pauen et. al. 1998). These objects handle the flow of what happens in the narrative and organises acts, episodes, scenes, and steps. This approach resembles the basic ideas found in structuralism theory, cf. (Genette 1980). We evaluate concepts from a conventional object-oriented analysis and design method for the design of branching structure interactive narratives (Skov and Stage 2002). Our study indicates that traditional object-oriented approaches face a number of limitations during the design process and that the specific application of the object concept does not address the heart of the modelled system. The experiment in the study reveals that though the concept of an object captures some important aspects of the future interactive narrative, e.g. registration of user actions in umpiring situations, the resulting collection of objects in the object model becomes rather simple including only four classes (ibid.). Furthermore, the objects in the model do not capture aspects related the narrative and the limited amount of objects excludes an evaluation of the object concept for larger number of objects and more complex interactive systems; something Jacobson (1992) claims that object-orientation is useful for.

Branching structures as underlying narrative structure face a number of limitations. Galyean (1995) argues that the discontinuous presentation of the narrative imposed by the discrete type of interaction may destroy the sense of pacing. Traditional films rely on pacing (the rigid control of time) and manipulating pacing may affect the audience of the film. Aspects of pacing support the curve of tension (Skov and Andersen 2001). The relinquish of control of time may destroy this sense of pacing since users have to remove their attention from the video sequence to making inputs

when required (Galyean 1995, pp. 56-57). Timeouts as illustrated in (Skov and Eriksen 2002) partially solve this problem. In case of no user actions within a given frame of time, a timeout makes the narrative continue by playing a new video sequence. This increases pacing in the narrative segregating long periods of no user inputs. As a second limitation, we found that the designer has to precompute all possible paths (or discourses) in the narrative during the design process (Skov and Stage 2002). For the narrative, it is important that all possible discourses make sense to user, e.g. that two scenes relate with respect to the narrative content of the situations. This may lead to reductions in the complexity of the interactive narrative by decreasing the number of different discourses (Skov and Andersen 2001).

The limitations of structuralism theory for interactive narratives design call for further and different perspectives of narratives. We claim that maze or branching structures delimits aspects of interaction and narration since the rigid structure found in e.g. branching structures makes it difficult to change the level and kind of interaction (Skov and Andersen 2001). In this sense, these structures give rise to a basic conflict where the user is controlled through the predetermined paths while at the same time the structures demand active involvement in the course of the experience (Crawford 2001). In (Skov and Andersen 2001), we state that interactive narratives design can be seen as the construction of virtual worlds rather than construction of narrative structures. In this sense, the aspect of narration is understood in terms of worlds inhabited with actors taking on different roles and pursuing different objectives or goals. As an example, Greimas (1966) provides the actant model as a thematic analysis where the narrative is seen as e.g. the relation between a sender of an object and the receiver of the object. Instead, of defining and describing different components of narratives contents and the discourse, narratives define characters and roles that inhabit a world.

The perspective of narratives as virtual worlds seems to form approaches to interactive narratives design in the computer gaming industry (Skov and Andersen 2001). Some computer games, e.g. action, arcade, or adventure (Rollings and Morris 2000), illustrate a virtual world where the user takes on the role of a figure. Jensen (2001) argues that a virtual world is a simulated world that integrates its own "physical" and "biological" laws. Typically, in virtual worlds, the user solves a number of riddles or quests, e.g. find the key to open the door or kill all enemy soldiers in order to advance to the next level.

I denote such systems spatial-oriented interactive narratives. Opposed the temporal-oriented interactive narratives, in (Skov and Andersen 2001) we found that these narratives are more spatial allowing the user to explore locations within the virtual world. This is implies that within a given location, the user will experience great freedom to interact and navigate. As an example, take the computer game *Half-Life*,

which is a typical action game where the user plays a security guard in laboratory facility and the task is to rescue one self after something has gone wrong in the facility. The user can move between the different rooms in the facility, freely collect and use weapons, or talk to other included figures including some scientists and other security guards. We denote this kind of narrative structure as multiple exploration paths (ibid.). The sense of pacing constitutes a potential problem for branching structure interactive narratives, and it may constitute a problem for multiple exploration paths as well. More interactive narratives seems to address (and solve) this problem by integrating different kinds of incentives, for example advancement to new levels that include new kinds of weapons and new enemies, e.g. Half-Life, or making the interactive narrative a competition with some sort of score mechanism, e.g. making money in SimCity.

4.1.4 Combining Interaction and Narration

The perspective of narratives as virtual worlds challenges the separation of interaction and narration as illustrated in section 4.1.2. Jensen (2001) argues that three perspectives of interaction seem applicable for virtual worlds. First, the perspective of sociology where interaction is the mutual relationship between people in the same space and time (ibid, pp. 34-35). Secondly, the perspective of communication and media studies where interaction is the action of an audience in relation to media content (ibid, pp. 35-36). Thirdly, the perspective of informatics where interaction is the process that takes place when a human user operates a computer or machine (ibid, pp. 36-37). The three perspectives on interaction take on different meanings for different kinds of interaction in virtual worlds. He denotes this kind of interaction as virtual interaction.

Jensen (2001) identifies different types of actors in the virtual world and makes an explicit distinction between autonomous agents and avatars. An autonomous agent is a piece of software not directly controllable by humans whereas avatars are representations of human actors (ibid, pp. 28-29). For the computer games illustrated in (Skov and Andersen 2001), we find that this provides a useful distinction where the user controls a figure (an avatar) in the virtual world, e.g. a dog looking for a piece of information, and where this figure occasionally encounter other figures (autonomous agents), cf. other animals. Jensen (2001) explains the different kinds of interaction between different actors. E.g. interaction between an avatar and an autonomous agent is explainable by sociology since it involves relationships between two actors. However, it is also explainable in terms of communication and media studies since it often involves direct communication from the autonomous agent to the avatar. As an example take the computer game *Half-Life* where an autonomous agent (a scientist working in a power plant) will tell the avatar (the user) what to do in certain situations and

where to look for information (communication and media studies), but the user can also address the scientist asking for help (sociology). In this sense, the different perspectives on interaction may provide valuable explanation of interaction issues in virtual worlds and designers may apply these perspectives during the design of the interactive narrative.

Wibroe, Nygaard, and Andersen (2001) define a different perspective on the combination of interaction and narration and identify three levels of interaction: story interaction; plot interaction, and kinetic interaction. Story interaction influences the narrative structure, e.g. outcome of conflicts, plot interaction denotes the user's influence of the order of presentation, and finally kinetic interaction defines body movements of the avatar. Designers of interactive narratives may address how the user is able to alter or influence the narrative, e.g. who gets to buy some property in SimCity. This address story interaction and similar design decisions on plot interaction and kinetic interaction.

The combination of interaction and narration seems to fit certain kinds of interactive narratives, e.g. kinetic interaction that defines body movement in certain spatial-oriented interactive narratives like the computer game Quake. On the other hand, this perspective do not address all kinds of interactive narratives, e.g. in more temporal-oriented interactive narratives, the user controls no actor or avatar in the narrative cf. (Skov and Eriksen 2002).

4.2 Methods

The second research question addresses methods for the design of interactive narratives and states: *What are the key challenges during the design process of interactive narratives and how can object-oriented methods support the design process?*

Studies of interactive narratives design processes indicate that these processes can be regarded software design processes (Rosenstand 2001), but Webb (1996) claims that they also share many similarities with e.g. film making. Eventually, the outcome of an interactive narratives design process is a piece of software capable of executing on some sort of computer. In this thesis, I primarily view interactive narratives design from a software construction perspective, and some of the following identified challenges reside within this perspective.

In section 4.1, I discuss concepts for interactive narratives design and emphasize aspects of interaction and narration. The characteristics of interaction and narration seem to challenge the software design process, and in sections 4.2.1 and 4.2.2, I will illustrate some of these challenges and exemplify how object-oriented design methods can support designers handling these challenges. Furthermore, aspects of interaction and narration suggest that interactive narratives are more media than work task

tools and this challenges the involvement of users in the design process. In 4.2.3 and 4.2.4, I will discuss challenges related user involvement.

4.2.1 Designing the Interaction

Designing the interaction challenge more software design processes. In (Skov and Stage 2001), we illustrate how high interactive systems challenge designers by the introduction of complexity. It seems difficult for designers to handle the design of systems involving concurrent use and synchronising events. Furthermore, it seems that object-orientation provides a suitable level of abstraction for handling dynamics since the object-oriented designer in the study did not have severe problems concerning complexity of the solution (ibid.). In section 4.1.2, I argued that the system in (Skov and Stage 2001) involves no narrative structure and in this sense, it is undecided how this would relate to a system involving narrative structures.

One way of designing interaction is through requirements analysis. During the analysis of requirements, designers strive to understand how the system is going to be used, and then specify functions by which the system can operate and make inputs to the system. More systems development methods support this activity, e.g. Jacobson et. al. (1999) argue that use cases offer a means for capturing functional requirements. Functional requirements seem difficult to integrate in interactive narratives design processes (Skov and Eriksen 2002). This is partly explainable by the difficulties in identifying and describing work tasks. As already discussed in section 4.1.2, the analysis of the application domain was undefined for a certain training and assessment interactive narrative (ibid.). Rosenstand (2001) supports this by stating that interactive narratives functionality mainly support the user's narrative experience opposed more traditional software products where functionality express the actual operation of the system.

Object-oriented design methods typically address functionality of interactive systems. Studies of the underlying model for interactive narratives show that the problem-domain analysis of a specific temporal-oriented interactive narrative results in a quite simple model with only four classes (Skov and Stage 2002). The model comprises classes of the user and calls made by the user but also classes for describing the umpiring situations in which the user has to make calls. However, their presence in the model is perhaps misleading since no user interactions lead to updates in any instances of these classes. Thus, the model of the system becomes rather simple and does not address the heart of the system, the umpiring situations, that are difficult to represent in the model. However, I will not exclude object-orientation for interactive narratives design. For certain spatial-oriented interactive narratives, one would probably find more complex and elaborate models. As an example, in the computer game Half-Life, designers would have to model a range of different properties, e.g.

locations of all figures in the game and status of the user, e.g. score and number of collected weapons.

In (Skov and Eriksen 2002), we claim that the assumption of a strong relationship between real world activities and system representation do not necessarily hold for interactive narratives. The investigated systems represent simulated activities that are not related to tasks in the use context (ibid.). E.g. the user has to make calls in umpiring situations, but this could be done while using the system in a completely different context than umpiring, e.g. while sitting at home or while travelling by air plane. In fact, it would probably not be done while situated in a "real" umpiring situation. Thus, attempts to analyse the use context and use situation is of limited value.

The design of a narration is considered the heart of the system in (Skov and Stage 2002), but it is not evident how the specification of the narrative can constitute a requirements specification and how this is related to aspects of interaction. On the other hand, in (Skov and Andersen 2001) we found that the design of the narration often emphasizes aspects of interaction since it directs when interaction is required or enabled.

4.2.2 Designing the Narration

Designing the narration constitutes a key challenge in interactive narratives design. As argued in section 4.1.3, aspects of narration influence the perspectives on interactive narratives, e.g. temporal-oriented and spatial-oriented narration seem to fit different classes of interactive narratives.

For temporal-oriented interactive narratives, we found in (Skov and Stage 2002) that the description of the narration of a temporal-oriented interactive narrative comprises two components namely descriptions of the individual scenes and the description of the causality between the scenes. This division resembles narrative analysis in structuralism theory, cf. (Genette 1980). The descriptions of the scenes involve specification of the setting, characters, lines of characters etc. and these specifications define the shooting of the scenes as video sequences. Webb (1996) claims that this approach to interactive narratives design more resembles the activities found in a typical film production process rather than the activities found in a typical systems design process. Storyboards were applied in the design process in (Skov and Stage 2002), and these storyboards emphasize temporal aspects in the interactive narrative by specifying the discourse. Cotton and Oliver (1992) argue for a similar approach in their multimedia (and interactive narrative) production process that outlines design activities in the development of multimedia products. One of the first activities in this production process is the detailed design that denotes the creation of a storyboard that e.g. shows the relationship between the components of future system (ibid.). Webb (1996) continues by stating that during story boarding the designer or the author creates the

story behind the interactive narrative. As applied in (Skov and Stage 2002), storyboards define aspects of interaction since they outline the transitions between the scenes, and these transitions signify user inputs.

For spatial-oriented interactive narratives, we identify in (Skov and Andersen 2001) similar but slightly different approaches to the design of the narration. Here we found that the computer game designer in a Danish software house aims at creating explorative interactive narratives with focus on spatial aspects rather than temporal aspects (ibid.). For this reason, the description of the narratives spans around specifications of worlds inhabited by e.g. figures. For such systems, the narrative deals more with conflicts and intentions of figures in the virtual world. We found that in order to control user and thus trying to make the narrative compelling, certain conditions for moving between the different parts of worlds are also specified (ibid.).

Despite the different approaches in temporal-oriented and spatial-oriented interactive narratives design, both approaches involve design of a narration. Based on the experiences in the investigated design processes in the paper contributions, I believe that certain skills within story creation are required of the design team. As illustrated in (Skov and Andersen 2001; Skov and Stage 2002), the people involved in the studied design processes have backgrounds or interests in writing stories, and both interactive narrative authors in (Skov and Andersen 2001) have published written narrative, e.g. poems. Of course, other qualities of design members may prove crucial in interactive narratives design, but story writing skills was identified as decisive in (Skov and Andersen 2001).

The object-oriented design method OOA&D, cf. (Mathiassen et. al. 2000), provides only very limited support for the creation of the narrative (Skov and Eriksen 2002; Skov and Stage 2002). The method provides no direct means for capturing and specifying the temporal aspects of temporal-oriented interactive narratives. In (Skov and Eriksen 2002) we suggest that parts of the method should be revised and that one could distinct between the use situation (the situation where a user applies the system) and the content situation (the situation that is depictured in the system). However, we provide no validation for this suggestion. Attempts to introduce object-orientation into interactive narratives design start to emerge. The object-oriented approach *HyDev* introduces narrative objects for describing narrative structure by ordering events temporally and these objects may be able to handle interactive narratives employing temporal structures (Pauen et. al. 1998).

4.2.3 Involving Users in the Design Process

Design of traditional software systems often suggests active involvement of prospective users during the design process, e.g. through participatory design (Muller and Kuhn 1993) and user involvement may ensure usability and quality in the final soft-

ware product (Nielsen 1993; Rubin 1994). For the design of interactive narratives, the focus on the design of a narration and the potential problems of capturing functional requirements may constitute a challenge in involving users in the design process.

One main reason for involving users in the design process is that designers may not be familiar with the problem domain or application domain. As an example, in the design process of a banking account system, the design team needs understanding of the problem domain, e.g. customers, accounts, and of the application domain, e.g. use situations and work practice. Design teams can involve users in many different ways and during different phases of the design process, e.g. during early analysis for requirements specification or later in the design process for evaluation of a final design solution. Techniques for involving users include among others prototyping (Floyd 1984) and participatory design (Muller and Kuhn 1993). Object-oriented design methods define user involvement through different activities, e.g. by applying uses cases (Jacobson et. al. 1999).

The role of user involvement comprises a challenge in interactive narratives design. One problem resides in the lack of immediate definitions of context in which the system is going to be used. The temporal-oriented interactive narrative in (Skov and Eriksen 2002) defines no immediate use situation or use context since the system can be used in almost any kind of context and it does not support a user in the conduction of a specific work task. In this sense, it is perhaps questionable what kind of information the user can provide on use situations. On the other hand, Skov and Andersen (2001) illustrate that authors in interactive narratives design involve users in order to acquire information about situations that a training and assessment interactive narrative is going to depicture through video sequences. This is done to express the situations as close to real life situations as possible.

I argue that both temporal-oriented interactive narratives and spatial-oriented interactive narratives design processes involve storyboarding and the perspective of interactive narratives as media rather tools challenge user involvement. Webb (1996) claims that interactive narratives are more like theatres than like tools and that user involvement is probably not suitable for writing scripts like storyboards.

4.2.4 Evaluating and Testing the System

The challenges of involving users in the design process of interactive narratives and the lack of explicit functional requirements further introduce potential problems when evaluating or testing the system.

I stress the perspective of interactive narratives as media rather than tools. Designers of such systems may strive at creating interesting and coherent stories in the interactive narrative. I claim that lack of coherence probably destroy the entire experience, e.g. if certain pieces of information are revealed too early or too late during

the discourse. As illustrated in (Skov and Stage 2002), we found that coherence of the narrative is evaluated during the design process by traversing possible paths through the narration as defined by the causality between scenes. In this sense, designers are able to evaluate whether the different scenes are related each other and whether their mutual relations make sense (ibid.). The system's realism in use is assessed upon the situations in the scene descriptions. The specification of situations implies the shooting of the video material in one go. This was of major importance to the design team due to the relative high costs of video production (ibid.). This seems to work for branching structure interactive narratives where all possible paths (or discourses) are predefined during design. For spatial-oriented interactive narratives, coherence and realism in use are more complicated since not all possible discourses can be predefined. No specific solution to this problem is suggested (Skov and Andersen 2001).

Testing the usability of interactive narratives poses a challenge on software design processes. Nielsen (1993) claims that usability testing provides a powerful tool for testing the usefulness and usability of software products. The focus of usability testing is to test to what extend the system supports users in solving tasks, e.g. the time spent on printing a document in a word processing tool (Molich 1997). However, the lack of specific work tasks makes it difficult to conduct usability tests in a traditional sense. Webb (1996) claims that while the quality clarion for traditional interactive systems is usability, the quality clarion for interactive narratives is the critical acclaim, e.g. how much it produces in turnover. The computer game author in (Skov and Andersen 2001) would occasionally conduct sort of discussion groups with primary school children that had been using the game for a couple of weeks. However, no systematic approaches were taken to integrate results from such discussion in future design processes. In (Skov 2001), the design team designed an agent solution, but it was not obvious how users (or even the design team themselves) could test and evaluate the solution. Primarily due to the autonomy of the agents implying that users have no direct control over the individual agent. The aspect of usability needs further clarification and exploration for interactive narratives.

4.3 Architectures

The third research question addresses requirements for design architectures of interactive narratives and states: *What characterises design architectures for interactive narratives?*

Mathiassen et. al. (2000) argue that software architectures guide the designers to identify requirements to the system early in the design process and the architectures guide the structuring of the system later in the design. Software architectures provide thus product-oriented support for the design of interactive systems, cf. (Rumbaugh

et. al. 1991), and software architectures provide organisation of the software system and structuring of components in the system and interfaces of the components.

Software architectures for interactive narratives design start to emerge e.g. objects for structuring designing narrative temporal structures (Pauen et. al. 1998) or for integrating and structuring autonomous agents for story telling (Bradshaw 1997). However, it seems that more work can be done in this respect. Rumbaugh et. al. (1991) claim that different software architectures suit different kinds of systems depending on the characteristics and future use of the system that is to be designed. Given the variety of interactive narratives, this is probably also the case for interactive narrative architectures.

I distinguish between temporal-oriented interactive narratives that apply the timely ordering of events and spatial-oriented interactive narratives that rely on properties of spaces in virtual worlds inhabited by actors. As I argued, the two types of interactive narratives are different in more ways, e.g. the level of control of what is going to happen during use. This influences what designers should specify during the design. For this reason, I will try to illustrate and discuss architectures for temporal interactive narratives and architectures for spatial interactive narratives in the following two sections.

4.3.1 Temporal-Oriented Interactive Narratives

Temporal-oriented interactive narratives involve the construction of narrative structures that defines the showing of timely ordered events. Galyean (1995) argues that temporal-oriented interactive narratives fit certain kinds of narratives and that video is especially well suited for this kind of interactive narratives. As an example, the interactive narrative in (Skov and Eriksen 2002) is an assessment interactive narrative that shows video sequences during the use of the system. Each video sequence depicts a virtual situation in which the user has to operate and make decisions. Between the video sequences, the user is required to make decisions by selecting a number of predefined options and thus influence the narrative (ibid.).

I argued in section 4.1.1-4.1.3, that temporal-oriented interactive narratives concern the timely structuring and ordering of events. It seems that this approach to interactive narratives design expands ideas from structuralism theory e.g. (Chatman 1993). For this reason, I choose to let structuralism theory play an important role in the definition of the following architecture for temporal-oriented interactive narratives. During the design of temporal-oriented interactive narratives, interactive narratives designers may find guidance in the following illustration in figure 4.2. This architecture defines three levels and is inspired by (Cobley 2001), who identifies the story, the plot, and the narrative. I denote these three components as the story, the

discourse, and the narrating. The listings of directions for design and the outcome of design are not exhaustive, but merely examples.

The story level defines all possible events and existents of the narrative. Chatman (1993) defines story as the events of the narrative, e.g. actions and happens, and of the existents of the narrative, e.g. the characters and the setting. These entities may provide useful distinctions for designers when trying to identify the components of the narrative. As an example of story components, let us take the interactive narrative in (Skov and Eriksen 2002) that is a training and assessment system for choosing potential job candidates for open manager positions. Here an action could be the discharging of the secretary, a happen could be the phone ringing during the group meeting, a character could be the secretary, and a setting could be the manager's office in the company. Thus, the possible outcome of the story level is a description of a number of scenes that e.g. found the shooting of video footage.

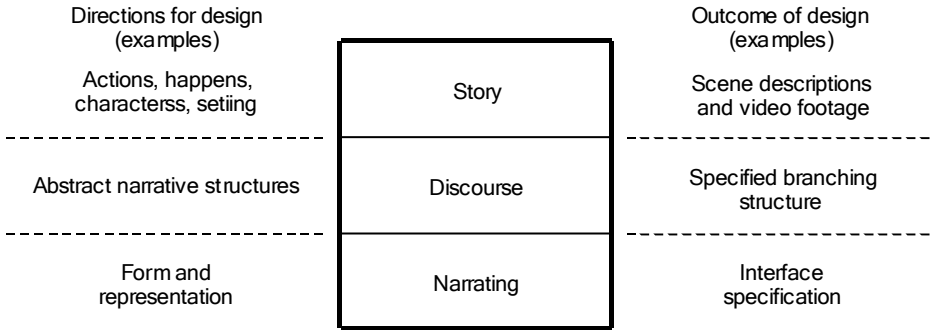

Figure 4.2: Design architecture for temporal-oriented interactive narratives

The discourse level defines the transitions between the story components (or in some cases between the scenes). It furthermore directs the specification of the interaction because the temporal-oriented interactive narrative enables or requests user input between the showings of the scenes. This informs when interaction is possible, but not how interaction is possible. Galyean (1995) identifies two abstract narrative structures that rely on timely ordering namely branching and maze structures. These are abstract in the sense that they define paths leading from the beginning of the narrative to the end of the narrative. For maze structures, only one path will eventually lead to the end, whereas more paths lead to the end for branching structures. In (Skov and Andersen 2001), we identify two similar abstract narrative structures, but more structures may fit this architecture. These structures specify how scenes in the narrative will be connected each other. The possible outcome is a description of the causality between the scenes, e.g. the video footage.

The narrating level defines the form and presentation of the story and discourse. The narrating level addresses the producing act of telling or creating the story. Cobley (2001) defines this component as the telling of the events and the mode selected so that this can take place. For a temporal-oriented interactive narrative, designers need to specify e.g. aspects of the interaction and other interface issues. The discourse level defines when interaction is required or enabled; the narrating level defines how this interaction should take place. E.g. the kinds of input devices or options that should be given to the user. Galyean (1995) argues that for interactive narratives, representation is different and more complicated than for e.g. the written narrative or for films. Information technology provides the opportunity to store the events of the story in different forms, e.g. in simple forms like video footage or written text, but also more advanced forms where scenes may be reproduced through rendering of images (ibid.). Furthermore, designers may integrate different forms of representation in order to create an intriguing interactive narrative, e.g. by adding sound effects to support tension.

4.3.2 Spatial-Oriented Interactive Narratives

Spatial-oriented interactive narratives provide another perspective on storytelling through interactive systems, and as argued in section 4.1.3, this may involve the specification and construction of virtual worlds populated by e.g. actors. Jensen (2001) argues that the construction of virtual worlds populated by actors seems to fit the concept of autonomous agents, and Brooks (1999) continues by stating that autonomous agents serve important roles in virtual world interactive narratives. As an example of autonomous agents in interactive narratives, the wise sage agent in SAGE directs the conversation with the user in order to create an environment for storytelling, e.g. by asking questions concerning a specific topic (Benford et. al. 2000).

What constitutes an autonomous agent in an interactive narrative? Jennings and Wooldridge (1998) claim that this is difficult to answer, and they argue that more perspectives on autonomous agents exist. Nwama and Ndumu (1998) stress the perspective of the role of the agent, e.g. interface agents, collaborative agents, or learning agents. Jennings and Wooldridge (1998) stress another perspective that relates to the context or the setting of the agent, e.g. health care, entertainment, or electronic commerce. Finally, they support the perspective of the properties of the agent, e.g. the agent must be autonomous, proactive, responsive, and adaptive (ibid.). Bradshaw (1997) further claims that even for the properties of agents different interpretations and understandings exist. Jennings and Wooldridge (1998) state that autonomous agents play the part of humans in theatre-style applications and humans players act out roles in a dynamic narrative. I will enter a deeper discussion of the agent concept in this section, but instead adapt an understanding of (Jensen 2001) that states that an

autonomous agent is a piece of software not directly controllable by humans. For the sake of brevity, I will use the term agent for an autonomous agent in the following.

The spatial-oriented interactive narratives provide storytelling through interaction with actors and in (Skov and Andersen 2001), we propose an idea for identifying interaction and narration issues through an architecture for virtual world interactive narratives. This agent architecture defines the combination of interaction and narration through interaction with actors in a virtual world, where these actors can take on certain roles during the discourse of the narrative and trigger predefined events (ibid.). The architecture defines four components: actant, glue, event, and roles (as illustrated in figure 4.3).

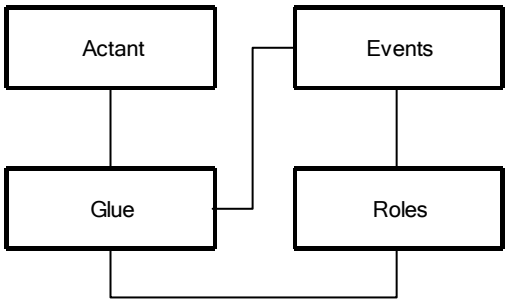

Figure 4.3: Design architecture for spatial-oriented interactive narratives (adapted from Skov and Andersen 2001)

The actant component defines the various actants taking part in the narrative. This component includes actors and objects in the narrative and is supposed to help designers identify e.g. actors in the virtual world. As an example, let us look at the computer game Half-Life where one of the actors could be the security guard played by the user and other actors could be the scientists working in the facility or the commando soldiers. The actants are defined by having certain properties and they emphasize relations to other actants. In Half-Life, the scientists and the commando soldiers are enemies trying to achieve different goals. Furthermore, actants include objects in the narrative, e.g. things that can be utilised. In Half-Life, the user can pick a number of weapons and other objects, which are necessary in solving the task.

The event component defines events of the narrative. Events are defined prior to interaction with the interactive narrative. As an example of an event, in Half-Life an event could be the catastrophe in the beginning of the game where something goes wrong during an experiment and starts the count down for the facility in which the user operates. Additional examples could be security guard kills enemy soldier or scientist opens door to laboratory. An event is associated a value that signifies when the event is executed. Changes of this value must be staged in order to signify such

change to other actants in the narrative. Furthermore, designers must identify events of the narrative that are executed when preconditions are fulfilled.

The role component defines a number of predefined roles in the narrative. In (Skov and Andersen 2001), we propose thematic roles taken from (Jurafsky and Martin 2000), e.g. agent, theme, instrument, and source, is applied to identify roles in relation to events in the narrative. As an example, let us look at the event where the security guard kills a monster with a gun in Half-Life. Here an agent is the volitional cause of an event, e.g. the *security guard* (agent) kills the monster with a gun. Related the same event, a theme is the participant most directly affected by the event, e.g. the security guard kills the *monster* (theme) with a gun. An instrument is an object used in an event, e.g. the security guard kills the monster with a *gun* (instrument). Additionally, a source is the origin of the object of a transfer event, e.g. the scientist moves from the *laboratory* (source) into the hallway.

The glue component defines the probability of an actant filling a particular role and integrates three factors: obligations, desires and capabilities. Obligations range from forbidden through allowed to mandatory, desires range from abhorred through tolerated to desire, and capabilities range from incapable to capable. E.g. an actor may want to fill a certain role (strong desire) but does not have what it takes (incapable). As an example in Half-Life, the security guard may want to kill one of the enemy monsters (desire) but does not have the necessary weapon to kill that particular monster (incapable). Furthermore, the glue component enables the representation of several actors striving to fill the same role.

The architecture allows us to identify actor and objects in the narratives, and it also enables us to identify events in the narrative and how actors relate to these events through roles and probabilities of roles through the glue component. When designing actors and agents in spatial-oriented interactive narratives, we need to identify interaction and modularise the agent components. In section 4.1.4, I outlined different understandings of the combination of interaction and narration where designers may seek inspiration in the properties of interacting with an agent, e.g. the perspectives provided by (Jensen 2001) that resides in sociology, media and communication studies, and informatics. In (Skov 2001), we address agent interaction issues in a design architecture. This architecture provides the distinction of different agents and illustrates the various kinds of interaction and communication between agents and between agents and users. The architecture in (Skov 2001) suggests a simple solution on user interaction where the user interacts with the agent through a dedicated field in the interface. Other strategies for user-agent interaction address different aspects of interaction and integrating graphical characters on the screen for interaction cf. (Smith et. al. 1997). E.g. in the interactive narrative SAGE (Benford et. al. 2000), the agents are represented graphically as a wise sage and an animated rabbit. The ap-

pearance and behaviours of these two characters are deliberately chosen to attribute intelligent behaviour to the characters (ibid.).

The spatial-oriented interactive narratives architecture is a first proposal for identifying components of an interactive narrative. Andersen (2002) expands the idea of this architecture by outlining and specifying the architecture in more detail. However, the two architectures in (Skov 2001; Skov and Andersen 2001) primarily approach issues related identification of agents and roles in the solution. This includes how to combine interaction and narration. Klein (1998) argues that thus the identification of agents is important in agent-based software engineering; more specified design is necessary for implementation. DeLoach (1999) supports this perspective and outlines a multiagent systems engineering methodology that first identifies roles and interaction of agents, and then later addresses agent design, component design, and systems design. These issues have not been of focus in this thesis. However, given the vast significance of these issues and their potential implications on my contributions, I will outline some challenges beyond identification of roles. The following discussion is not meant to be complete in any sense; it serves to illustrate some direct limitations of my contributions.

Jennings and Wooldridge (1998) claim that specification of an agent design bound in formal and mathematical approaches and descriptions tend to be rather complex. As a result, the programming of agent systems is often highly complex and challenging. Jensen (2001) addresses one aspect of this by stating that agents are pieces of software not directly controllable by humans. Thus, human actions do not invoke agents directly, but agents may instead take actions themselves. In the spatial-oriented interactive narratives architecture, it relates when an actor should take on a certain role in relation to a particular event, e.g. when should the security guard in Half-Life fight enemies or should he try to escape. This aspect refers to properties of confidence. Secondly, agents often operate in settings populated by other agents. The agents pursue certain goals and have certain intentions, e.g. to buy a product as cheap as possible or sell a product as expensive as possible. Agents may thus strive to achieve different goals or they may even want to compete for shared resources. This aspect refers to properties of negotiation.

Confidence is an important aspect of agents, cf. (Maes 1994), and relates action taking of an agent. Confidence is not the same challenge in conventional pieces of software that are normally executed when users active functions or when other systems request services (Jacobson et. al. 1999). However, the property of being autonomous requires that agents are able to take action themselves when certain conditions are fulfilled. In (Skov and Andersen 2001), we outline that a number of requirements state provisions for the execution of events, e.g. that the execution is stored together with information on relation to other events, but it is difficult to assess when agents

or actors should take action in certain roles. In (Skov 2001), we identify a solution that defines a dynamic threshold where the level of confidence increases or decreases as the agent suggests either successful or unsuccessful suggestions. This resembles confidence as applied in e.g. (Maes 1994). We stress that no major harm is done if the agent takes action (thus is confident) and suggests a recommendation even though the user does not afterwards accepts and take on the recommendation. The user can either just ignore or reject the suggestion. However, for some interactive narratives, dealing with confidence may be even more challenging. E.g. in SAGE illustrated in section 1.1.1, the stuffed animated rabbit performs nonverbal behaviours during the conversation between the user and the wise sage. However, when is the rabbit confident that the child is afraid of something and thus performs certain behaviours? It is probably difficult for designers to ensure that such emerging behaviours in the narrative make sense to the user.

Negotiation between agents is another important issue for multi-agent systems. Agents may pursue different objectives and have contradictory goals to accomplish, e.g. accessing shared resources. Rosenschein and Zlotkin (1994) identify three types of domains that require different negotiation protocols and strategies. Task oriented domains where the agent is concerned with achieving tasks, state oriented domains where the agent is concerned with moving the world from one state into a set of goal states, and worth oriented domains where the agent assigns worth to potential states that captures the desirability for the agent. Different protocols for communication and different strategies for achieving goals exist for the three domains. I find the role of the three domains unclear for many interactive narratives, e.g. it is difficult to assess the consequences of negotiation for the architecture in (Skov and Andersen 2001). On one hand, some of the agents may have contradictory goals to accomplish, which in line with the approach to negotiation by (Rosenschein and Zlotkin 1994), but on the other hand, the basic assumption for all three domains is that agents should always tell the truth and that hiding or altering information is inappropriate and not worthwhile. This may not be the case for some interactive narratives. In (Skov and Andersen 2001), we claim that the tension in the narration resides within the conflicts between actors and in the anticipation of something to happen. Perhaps negotiation between agents is complex in interactive narratives design; this thesis provides no direct suggestions for this issue.

Chapter 5
Research Methodologies

The research behind this thesis has involved close collaboration with people from such diverse disciplines as computer science, information systems, software engineering, and various disciplines within humanities. This collaboration was organised in a national initiative on multimedia systems use and development called InterMedia. Within this collaboration, I have worked with the software design process. Additionally, disciplines such as human-computer interaction and narratology played significant roles in the planning, conduction, and analysis of the research and they partly formed and structured this summary. Summarised, this research work is inter-disciplinary. In fact, human-computer interaction and interactive systems design are inter-disciplinary themselves; cf. (Burns and Vicente 1995; Johnson 1996; Mackay and Fayard 1997).

The inter-disciplinary nature of research calls for different perspectives on research approaches (Galliers and Land 1987). More than trying to identify the correct research approach, researchers should strive to choose an appropriate one given the situation or combining more approaches to stress variety of perspectives (ibid.). However, Garcia and Quek (1997) stress that this is challenging due to different philosophical assumptions of the methods. In addition, inter-disciplinary research initiatives face potential pitfalls of lacking a clear focus for the contribution, cf. (Johnson 1996). Defining means of assessment for the contribution is needed if the researcher is to avoid some of these pitfalls (ibid.). For the research in this summary and the five paper contributions, I aim at contributing to research within information systems development by addressing concepts, methods, and architectures for interactive narratives design. Thus, I strive to focus on bringing support for the design more than to further analyse the designed systems.

This chapter addresses the research conducted in this thesis and in the five paper contributions. The adoption of different research traditions and assumptions imply different weaknesses and strengths, cf. (Johnson 2001), and the chapter identifies the basic assumptions of the adopted research. Section 4.1 illustrates epistemologies on different assumptions about knowledge and how knowledge is obtainable. Section 4.2 discusses different approaches to conduct empirical research by outlining different research approaches and methods and by presenting the chosen ones.

5.1 Research Epistemologies

Fundamentally, research can be either quantitative or qualitative (Flick 1998). Quantitative research study natural phenomena and makes general statements independent of the studied cases and frequency and distribution normally classify the observed phenomena. Qualitative research study social and cultural phenomena and it attempts to support researchers in understanding people and the social and cultural contexts within they live. Qualitative research comprises the basis for this research.

Qualitative research relies on different epistemologies that characterises assumptions about knowledge and how knowledge is obtainable, cf. (Myers 1997). Some argue that research epistemologies are either positivistic or phenomenological, cf. (Easterby-Smith et. al. 1991), and other argues that epistemology can be positivistic, interpretive, or critical, cf. (Myers 1997; Orlikowski and Baroudi 1991).

Positivist research assumes that the reality is objectively given and that it is describable in terms of measurable data. The researcher is independent of the observed implying that the researcher and her instruments do not affect the observed. Positivist studies attempt to test theory or hypotheses in order to increase the predictive understanding of phenomena (Myers 1997). Positivists often collect data using rigorous measuring equipment (Easterby-Smith et. al. 1991). Furthermore, they typically isolate dependent and independent variables to objectively explain and predict the observed deduced from the empirical generalisations (Dahlbom and Mathiassen 1993).

Interpretive research assumes that access to reality is only possible through social constructions such as languages, consciousness, and shared meanings (Myers 1997). Interpretive research attempts to understand phenomena through assigned meanings of people. Interpretive research does not predefine dependent or independent variables but focuses on the full complexity as situations emerge. In addition, interpretive research seeks to understand phenomenon in depth rather than compare large sample sizes (Travers 2001). Interpretive research relies on phenomenology and hermeneutics (Myers 1997). Phenomenology tends to take people's account at face value whereas hermeneutics seeks to understand phenomena by going beyond texts by addressing meanings and intentions (Dahlbom and Mathiassen 1993).

Critical research assumes that social reality is historically given. People consciously produce and reproduce reality to change their social circumstances but within given constrains of social, cultural, and political dominations (Myers 1997). Critical research seeks to be social critical by addressing restrictive and alienating conditions and by focusing on oppositions, conflicts, and contradictions in society (ibid.).

The overall research epistemology of this thesis is phenomenological. My paper contributions seek to understand sociological phenomenon of software design in interactive narrative design processes. The research is phenomenological and not her-

meneutical since no systematic approaches are taken to question studied texts and accounts of people. This may then lead to inaccurate accounts when people are explaining and describing what they are doing. The phenomenological epistemology is favoured since no deeper understanding of people's opinions and accounts is aimed at.

The research does not apply hypothesis testing in a positivistic research tradition, but tries to understand the richness of the studied design processes. The aim is to try to understand the complexity of the situations in the design processes not to obtain data that necessarily can be compared. In addition, the studies in the five paper contributions rely on small sample sizes which phenomenological research typically applies (Travers 2001) opposed large sample sizes in positivistic research. I acknowledge that larger sample sizes may provide different or more accurate observations, and that larger sample sizes will increase the probability of being able to generalise the findings. Some variations are applied in the answer of the three research questions and the following illustrates the chosen research approach and applied methods.

5.2 Research Approaches and Methods

The three research questions raised in the introduction form the design of the research approach. The questions address understanding and support for design practice, cf. (Checkland and Scholes 1990; Mathiassen 1997), and for this reason practice-related research approaches are favoured, cf. (Nunamaker et. al. 1991).

5.2.1 Practice-Related Research: Background

Practice-related research defines three types of research approaches: Practice studies, experiments, and action research (Mathiassen 1997; Nunamaker et. al. 1991). Each of these approaches is applicable by the use of a number of different research methods. Practice studies, experiments, and action research all contribute to the building of research-based knowledge in form of theories and methods, cf. (Nunamaker et. al. 1991; Mathiassen 1997). Figure 4.1 illustrates the relations between the three research approaches and the building of knowledge.

Practice studies involve research methods where the researcher study practice without active involvement. Some of these research methods are direct by nature, e.g. field studies and case studies, whereas others methods are indirect based on people's opinions and beliefs e.g. surveys and interviews (Mathiassen 1997). The major strengths of practice studies are the explicit focus on design practice and the vast repertoire of techniques to structure the process and the findings (ibid.). The weakness is that practitioners do not take active part in the research process and thereby separat-

ing research from practice. Yin (1994) states that practice studies are limited in the sense that the researcher is not in control in the situation.

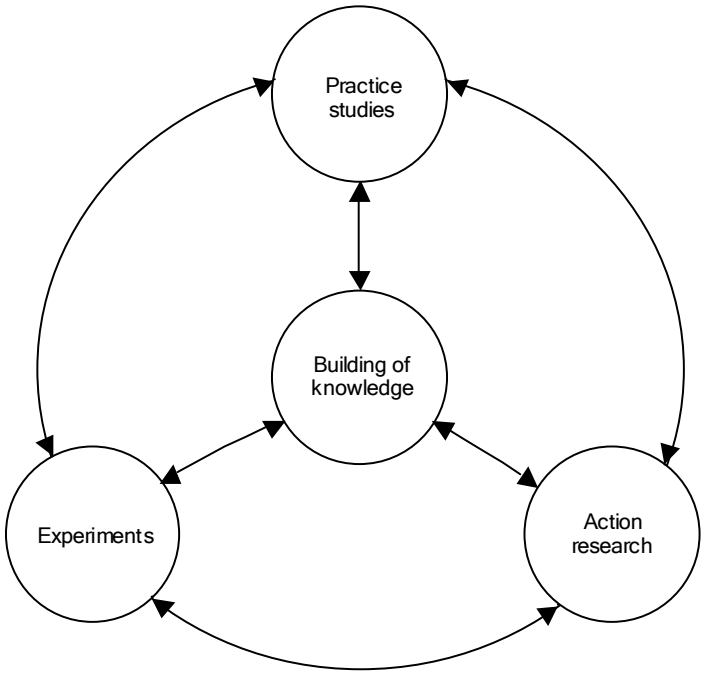

Figure 4.1: Research approaches for practice-related research (from Mathiassen 1997)

Experiments involve research where the researcher is in control of practice. Experiments allow researchers to address and investigate specific research questions (Mathiassen 1997). Basili (1996) argues that experiments take place either in the field under normal conditions (in vivo) or in a laboratory under controlled conditions (in vitro). Experiments in vivo have closer relation to real practice than controlled experiments in vitro; however controlled experiments are able to generate stronger statistical confidence in the conclusions (ibid.).

Action research involves researchers in practice situations closely collaborating with practitioners. The focus is on the design process or alternatively on the system itself. Action research provides strong integration between research and practice, but it is often difficult to structure the research process and findings. The researcher takes active part in practice but is unable to control the entire process. This leaves the researcher vulnerable with respect to external factors. The action research approach compliments practice studies by the providing the researcher to be in control (Mathiassen 1997).

5.2.2 Practice-Related Research: Application

Practice studies, experiments, and action research are used in the research of the five paper contributions. The following explains the use of research approaches and applied research methods.

Practice studies address all three research questions. Practice studies provide basis for identifying key concepts for interactive narratives design and illustrate aspects of interaction and narration. Furthermore, practice studies explore the challenges of interactive narratives design and illustrate design processes. Finally, practice studies provide ideas for requirements to interactive narrative design architectures. Case studies address this research question in paper contributions (Skov and Stage 2002; Skov and Andersen 2001). Multiple case studies are more powerful than single case studies in yielding results that can be generalised Yin (1994). The study in (Skov and Andersen 2001) comprises two case studies that were chosen for their diversity. One case represents design of interactive narratives for training and assessment whereas the other case represents design of interactive narratives in form of computer games. The diversity of the two cases stresses the uniqueness of different approaches of interactive narratives design. The findings of the two cases reveal similarities and differences in the design of interactive narratives. In this sense, the cases are able to contribute to the identification of challenges and solutions in design practice. The case studies are conducted as interviews. The interviews are semi-structured and primarily strive at applying open-ended questions. The interviews are taped-recorded and later transcribed due to their information richness. In addition, it allowed the researcher to discuss details of the interview with the interviewee afterwards. The purpose of these studies is not to establish, evaluate, or compare general aspects of interactive narratives design, but aims at providing illustrative examples of challenges in interactive narratives design and to illustrate the role and use of concepts in the design. The architecture in (Skov and Andersen 2001) is a proposal for the identification and construction or interactive narratives inhabited by actors. The architecture lacks validation in terms of being implemented and in this sense; it tries to serve as a proposal for future research.

Experiments address the first and second research questions. Experiments provide basis for investigating the role of concepts for interactive narratives design and experiments explore the usefulness of object-oriented design methods for interactive narratives design (Skov and Stage 2001; Skov and Eriksen 2002, Skov and Stage 2002). All three papers employ small sample sizes and focus on in-depth analysis of people's accounts and actions. The first paper (Skov and Stage 2001) differs slightly from the two other experiment papers. The paper compares the design approaches of three software designers on a number of variables, e.g. the number of relevant concepts applied during design. Taken the small sample size into account, we deliberately

strive to seek variety of design approaches. Instead of selecting three designers with similar backgrounds, e.g. in object-orientation, we chose to select quite different design paradigms. For this reason, we choose to complement the object-oriented approach with other design approaches. The motivation for the experiment is inspired by (Guindon et. al. 1987) and designed upon ideas from (Basili 1996). In (Skov and Eriksen 2002; Skov and Stage 2002) we investigate the applicability of software engineering design concepts and activities. In these experiments, we chose an object-oriented analysis and design method that we were familiar with. We choose this particular design method since it incorporates experiences from other design methods thereby hopefully signifies the established tradition within software analysis and design. The design method combines three design methods: object-oriented analysis (Coad and Yourdon 1991), the JSD method (Jackson 1983) and the object-oriented design method OMT (Rumbaugh et. al. 1991). In addition, it applies the UML notation as described in (Rumbaugh et. al. 1999).

Action research addresses the first and third research questions. Action research illustrates some of the challenges introduced by application of the agent concept in the design process and action research illustrates the design of an agent solution that signifies requirements to interactive narratives design architectures (Skov 2001). Action research is applied to control the collaboration between a local company and the researcher. In a collaborative effort, we design a solution for a particular problem identified in system portfolio of the company. Regular meetings between the researcher and 4-5 practitioners in the company constituted the main form of collaboration. The meetings are tape-recorded since note taking was impossible due to the conduction of design sessions between the researcher and the practitioners at a whiteboard. The organisation of the action research is inspired by (Lau 1997) that provides guidance on action research conduction. Action research is intervention-driven by nature, cf. (Susman and Evered 1978) and seeks to change or improve practice, cf. (Vidgen et. al. 1997). The action research effort in (Skov 2001) seeks to improve practice by the design of an agent-based software solution. The focus of the project was primarily product-oriented and not process-oriented and some of the tape recordings from the design meetings are transcribed. After each design session, descriptions of design suggestions from that session are transcribed from the whiteboard and these mainly form the work in the research. Tape recordings are consulted when uncertainties emerge.

Chapter 6
Conclusion

This chapter summarises the results of the research conducted in this summary and the five paper contributions. First, I summarise the results of interactive narratives design as discussed in chapter 4. Secondly, limitations of the approach and the results are identified and discussed. Finally, I propose possible avenues for further work.

6.1 Design of Interactive Narratives

Design of interactive narratives involves the construction of interactive systems for storytelling. As an emerging class of interactive systems, I find that interactive narratives pose new requirements and challenges on the design process. Three questions address this issue and they relate to the concepts, methods, and architectures found in interactive narratives design. The five individual paper contributions address and answer these questions of interactive narratives design from different perspectives and the summary attempts to summarise and combine the results of the paper contributions. Furthermore, the summary brings the paper contributions into perspective by surveying additional literature on the interactive narratives design. The primary results of this thesis are summarised in the following three paragraphs.

The key concepts of interactive narratives design are interaction and narration. Different perspectives and perceptions on these concepts influence the design of interactive narratives. Interaction is an important property of interactive systems and also of interactive narratives. Traditional definitions on interaction, e.g. action models, do not apply very well to the characteristics of interactive narratives. One problem resides in the fact that more interactive narratives are not intended for supporting work tasks in a classical sense. This further influences the concept of an application domain, which is found to be indefinable for some interactive narratives. On the other hand, interaction in interactive narratives relates closely to aspects of narration. Narration is understandable in terms of events that are presented to the audience or the user in a timely ordered manner, but narration is also understandable in terms of virtual worlds populated with actors with intentions and roles. For these reasons, I primarily distinguish between two kinds of interactive narratives namely temporal-oriented or spatial-oriented interactive narratives.

The key challenges of interactive narratives design resides in the characteristics of interactive narratives being media rather than tools. The research found that the crea-

tion of a story in interactive narratives is essential and defines a key challenge in the design process. The fact that interactive narratives design integrates creation of stories challenges the potential opportunities of involving users in the requirements specification and in system evaluation. Traditional interactive systems development suggests different kinds of user involvement, e.g. to acquire an understanding of the future use situation or context. However, for more interactive narratives, the future use situation is difficult to define and does not provide much information on how to design the system. This challenges designers in identifying and specifying functional requirements to the future interactive narrative. The role of contemporary object-oriented analysis and design methods is unclear since more activities of these methods are of limited value in interactive narratives design. The inherent focus on problem domains and application domains do not address the heart of many interactive narratives namely the creation of a story. Some extensions to object-oriented approaches start to integrate aspects of designing temporal structures for interactive narratives and agents for spatial-structured interactive narratives, but they still need further validation and examination.

The diversity of interactive narratives seems to characterise architectures for interactive narratives design. Based on the distinction between temporal-oriented and spatial-oriented interactive narratives, I propose two different architectures in this thesis. The first architecture is applicable for designing timely ordered interactive narratives that present events in a temporal ordered manner. The events are causally related through specification of discourses that further directs aspects of interaction by specifying when user inputs are required or enabled. The second architecture addresses spatial-oriented interactive narratives and identifies actors, roles, and events in virtual worlds. The idea is that designers should specify actors in the virtual world and not predefine discourses for the user to follow. The actors can relate to events and roles during the use of the interactive narrative. The telling of a story emerges as a result of the interaction between the user and interactive narratives.

6.2 Limitations

This thesis pursues the three research questions in order to address interactive narratives design. The research is associated a number of limitations with respect to the general validity of the results.

A first limitation originates from the research approach and the point of perspective. The experience-action cycle from information systems development research inspires the selection of the three themes: concepts, methods, and architectures. The experience-action cycle is iterative by nature where improvements gradually are achieved through cycles of understanding and yielding knowledge-based experiences. For practical reasons, the iterative aspect has not been possible to complete for

this research. In this sense, the strength of the experience-action cycle is not addressed. Along this line, I primarily view the construction of interactive narratives as software design. Information systems development research aims to improve design practice by interpreting current design practice and yield knowledge-based experiences of both normative and interpretive kind. Within this tradition, this research seeks to evaluate the applicability of object-oriented design methods and to characterise design architectures. However, the research reveals a considerable focus on aspects of storytelling. Perhaps improvements in interactive narrative design processes should stem from evaluating and exploiting techniques from e.g. film-production or story writing.

A second limitation relates the understanding of narration. I acknowledge that narration and aspects of storytelling is a vast and complex field of research, e.g. narrative analysis. In this thesis, I seek inspiration in some definitions of narration in order to understand key characteristics of the storytelling component in interactive narratives. Cobley (2001) differentiates between three fundamental items in narratives namely the story, that is the events to be depicted, the plot, that is the linking and relation between the events, and the narrative, that is the showing and modes of these events. Genette (1980) supports this distinction and claims that narrative relates to the time of the thing told (time of the signified) and the time of the narrative (time of the signifier). The differences in time of the signified and time of the signifier are only addressed briefly in this thesis. One might pursue this distinction more explicitly in order to provide deeper understandings of storytelling in interactive narratives design.

A third limitation bounds in the lack of implementation. The proposed architecture for spatial-oriented interactive narratives has not been validated in terms of implementation or in-depth design. The architecture in its current form aims at helping designers to identify actors in the narrative. As I argued in section 4.3, agent design and implementation is found to be complex and difficult due to a number of different issues. I presented a number of these issues that might constitute challenges in implementing the architecture, e.g. how to address aspects of negotiation between agents. However, the lack of implementation limits the general validity of the architecture with respect to its completeness and correctness. E.g. it is difficult to assess whether other components should be a part of the architecture.

6.3 Future Research

The findings of the thesis open for future research avenues within the design of interactive narratives. In the following, I suggest three potential avenues for future work. The first two suggestions are motivated directly in terms of the above-illustrated limi-

tations whereas the last suggestion defines future work relating fundamental issues of interactive narratives.

The first suggestion relates differentiating the different kinds of interactive narratives. This research identifies two significant kinds of interactive narratives based on either temporal or spatial characteristics. This variety of interactive narratives leads to further research within characterisation. If we are to design better interactive narratives, we probably need a deeper understanding of the different kinds of interactive narratives. One way to organise this is to identify and classify different genres of interactive narratives. Genres have been used to attribute different systems and phenomena, e.g. within information systems research where Orlikowski and Yates (1994) apply the genre concept to structure communicative practice. The concept of genre could be used to distinguish between different kinds of interactive narratives based on similarities and differences between the systems. The distinction in genres provides the opportunity to develop different design methods and different design architectures.

The second suggestion for future research is to enhance and further develop the architecture for spatial-oriented interactive narratives. The lack of implementation suggests validation of the proposed architecture and thus identification of its limitations and opportunities. This could include specification of the different components of the architecture and further specification of dependencies between the levels. Furthermore, the usefulness of architectures to interactive narratives design should be validated. In this matter, it could be interesting to see how captivating the interactive narratives are and how this would support designers in identifying and specifying relevant components of the future interactive narrative.

The third suggestion for future research addresses the aspects of interaction and narration and the relation between these two concepts. The interactive narrative space does not address the question on how interactive we want narratives to be. I believe that one of the beauties of films is that the audience can sit back and enjoy the film without active involvement. The author of the story has done all the work for you; created a captivating story involving plots and characters, styled settings and basically ensured that the audience will enter an appropriate curve of tension as illustrated in (Skov and Andersen 2001). Why should the user of an interactive system do this job? It is not evident what the opportunities and limitations are in an interactive environment for telling stories. Additional studies may focus on this aspect by varying the degree of interactivity for different kinds of narratives. Galyean (1995) states that the author of an interactive narrative can better reach her audience and more deeply affect them and possibly engage them. But, how interactive do we want narratives to be?

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