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Fly

an organic authoring tool for presentations

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Leonhard Lichtschlag
Aachen, November 9th, 2008

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Abstract

Modern presentation software is still built around interaction metaphors adapted from traditional slide projectors. We provide an analysis of the problems of this application genre, and present Fly, a new presentation authoring tool based on an Organic Interface paradigm that abandons the concept of slide frames. Inspired by the natural human thought processes of information chunking, association, and spatial memory, Fly provides a planar navigation and visualisation technique.

Evaluation of a paper prototype showed that the planar UI is easily grasped by users, and leads to presentations more closely resembling the information structure of the original content, thus providing better authoring support than the traditional slide metaphor. The resulting high-fidelity software prototype confirmed these results, and outperformed PowerPoint in a second study for tasks such as prototyping presentations and generating meaningful overviews. Users reported that this organic interface helped them better to express their concepts, and expressed significant preference for Fly over the traditional slide model.

Überblick

Aktuelle Präsentationssoftware basiert immer noch auf Interaktionsmetaphern, die von traditionellen Dia-Projektoren abgeleitet wurden. Wir stellen eine Analyse der Probleme solcher Software vor und entwickelten Fly, ein neue Autorenumgebung für Präsentationsvisualisierungen. Fly basiert auf dem Paradigma Organischer Interfaces und verwirft die Folienmetapher. Inspiriert durch die menschliche Informationsverarbeitung, -assoziation und räumliches Denken, bietet Fly dem Autor eine planare Navigations- und Darstellungstechnik.

Die Studie mit einem Papier Prototypen zeigte, dass die planare Benutzeroberfläche von Anwendern leicht verstanden wird und zu Präsentationen führt, die in ihrer Struktur dem ursprünglichen Inhalt ähnlicher bleiben. Daher bietet Fly den Autoren eine bessere Unterstützung als die traditionelle Folienmetapher. Die Softwareumsetzung bestätigte diese Ergebnisse, und Fly übertraf PowerPoint in einer darauffolgenden Studie in Aufgabenstellungen wie Präsentationsprototypenbau und der Erstellung aussagekräftiger Übersichten. Die Tester berichteten, dass es ihnen leichter fiel, sich mit diesem Organische Interface auszudrücken, und haben sich signifikant für Fly im Gegensatz zu dem traditionellen Folienmodell ausgesprochen.

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Conventions

The whole thesis is written in British English.

Unidentified third persons are always described in female form. This is only done for purposes of politeness.

Chapter 1

Introduction

"A good traveller has no fixed plans, and is not intent on arriving."

—Lao Tzu

Giving presentations is a ubiquitous task in today's work environment: they are required in business, higher education, and job interviews. The task is demanding: it is frequently a stress situation for the speaker [Moscovich et al., 2004] whose career may hinge on her performance. For example, the proverbial thirty second "elevator speech" can determine funding, employment, or rejection. But giving a presentation is only one aspect: A good presentation often takes many days to research, structure, plan, prototype and rehearse. It may require handouts for the audience, video recordings for online delivery, and all these materials may need to be reused at another date for a different audience.

Presentations are ubiquitous and can have big impact

To support this hard and complex task presenters use slide decks—to such an extend that presenting is almost seen as being synonymous to having a good slide deck [Tufte, 2003, House et al., 2005]. Consequently, Microsoft's *PowerPoint*[1], Apple's *Keynote*[2], OpenOffice *Impress*[3] and similar software, commonly denoted as *slideware*, are among the

Slideware is computer software for the creation and delivery of presentations

[1]http://office.microsoft.com/powerpoint
[2]http://www.apple.com/iwork/keynote/
[3]http://www.openoffice.org/product/impress.html

most frequently used application genres and their use is a common topic in school curricula [Parker, 2001].

Slideware is based on an outdated metaphor

Interestingly, slideware has been criticised repeatedly for degrading the quality of talks [Gopal and Morapakkam, 2002, House et al., 2005, Parker, 2001, Tufte, 2003]. Its conceptual model is based on the notion of rectangular slides shown in a linear, predefined sequence. However, the constraining technical possibilities of traditional slide and overhead projectors that created this model are no longer valid for computer visualisations—yet they still shape our understanding of the nature of presentations.

Fly is based on the Organic User Interface paradigm

The first goal of this thesis is to design a new user interface for the creation and delivery of presentations that does no longer rely on the physical metaphor of slides, but resembles the mental model [Dix et al., 2004] the author and the audience more closely. Secondly, the work is based on the *Organic User Interface* paradigm and serves as an evaluation of this paradigm. *Organic Interfaces* (OIs) are an emerging new paradigm [Holman et al., 2006] for metaphor-free user interfaces [Karrer, 2009]. They are inspired by natural phenomena from the areas of physics, biology, and psychology.

Figure 1.1: The Fly application. The translucent (green) line shows the path the presentation takes through the landscape.

To achieve these goals, we examine slideware based on user studies and previous criticism and the Organic User Interface Paradigm. The analysis shows that current software impedes authoring and delivery of presentations by creating barriers that hinder us or force us to change our mental model [Lovgren, 1994]. Based on these findings we introduce Fly which is by design not slideware. Instead, the presenter places information atomically on a single infinite plane and then creates paths through this plane. During a presentation she can follow one of the paths or move freely depending on audience requests.

We evaluated this design in two user studies, first in a low-fidelity paper prototype and later in a software implementation (Figure 1.1) that covers all fundamental tasks of authoring and presenting. Both studies were restricted to the aspect of authoring presentations. The first user study provided strong evidence that users not only easily understood the new interface but were able to capture the structure of strongly connected topics in their presentations much better than when using the traditional slide interface. We were able to confirm these results in a second user test comparing the authoring process of presentations using a high-fidelity software prototype of Fly against Microsoft PowerPoint.

We conducted two user studies with positive results.

1.1 Chapter Overview

Chapter 1: In this first chapter we give an motivation of our work and an overview of the different parts of this thesis.

Chapter 2: The second chapter covers the background necessary for our work, a short history of presentation visualisations and previous discussions on the quality of slideware. We discuss the task of giving presentations more closely, as well as the organic interface paradigm and the iterative design process, two principles the Fly project builds upon. We also explain the *No Significant Difference* debate and its meaning for our tests.

Chapter 3: Chapter three discusses related work in presentation technologies, what problems they have addressed, and how they improved on slide software. We point out differences between the approaches and how they influenced the design of our work.

Chapter 4: We distil three primary aspects of how slideware limits the author's expressiveness and degrades visualisation quality, and discuss them in detail. These problems arise, because the slide metaphor conflicts with the author's task. We then present our design and the design rationale which is guided by those organic interface design principles.

Chapter 5: Chapter five describes a low-fidelity paper prototype as the first iteration of our design process. We explain the prototype and its user study on the authoring of presentations for a non-linearly structured topic. The results show that the presentations created with the Fly prototype contain more meaningful overviews and often diverge from linear presentations.

Chapter 6: Chapter six describes the second iteration of our design process, the Fly software prototype design, based on the findings of the first study. This prototype was again implemented and tested in a user study comparing it to Microsoft PowerPoint. We could confirm the results of the first study. Users also commented positively on the ability to express their mental models of the material more freely and mostly preferred Fly over PowerPoint.

Chapter 7: In the last chapter we evaluate the progress on the research questions and summarise the findings of this project: the concepts introduced with Fly better support prototyping and re-casting ideas when authoring presentations as well as showcasing the connections and differences between sub-topics in a presentation. We also explain how Organic Interfaces has helped in the design process and the identification of problems of slideware. Chapter seven concludes with directions for further work, as identified by the studies.

Chapter 2

Presenting as a task

"Thus rhetoric, it seems, is a producer of persuasion for belief, not for instruction in the matter of right and wrong ... And so the rhetorician's business is not to instruct a law court or a public meeting in matters of right and wrong, but only to make them believe."

—Plato

This chapter provides the background and explores the problem space for this thesis. It starts with a history of visualisations for presentations and then defines and discusses the different aspects of this task. We also present related work on the task itself and the associated problems here, and related work on possible solutions in the next chapter. Since this thesis follows the design principles of user centred design and organic user interfaces, we introduce them as well.

2.1 History of Presentation Visualisations

Presentations have a long history

To understand a task, it is beneficial to take a look at its history. As explained in the introduction, presenting is an important task today, but is not new—speaking publicly has always been important. Consequently, rhetoric, the art

Figure 2.1: A slide projector, an overhead projector, and a laptop with a beamer

of professional talking and presentation delivery, has been studied extensively. The heritage of visualisations accompanying today's talks, however, is much shorter than that.

Presentation visualisations have a short history

Earnest [2003] illustrates a detailed chronology of presentation visualisations and of presentation literature: Greek (for example [Plato]) and Roman (for example [Cicero, 55 BC]) literature explain how to use body language and clothing to underline the speaker's intent, but are inherently focussed on the spoken word. Similarly, medieval literature is strongly influenced by religious intent and focusses on rhetoric for sermons. It was only after the industrialisation and widespread literacy, that the form of presentation *visualisation* emerged.

Several technical advances form our concepts of today's lectures and talks: Blackboards were introduced in 1801 and became widespread in the middle of the nineteenth century; 35mm slides (Figure 2.4) appeared in 1936 and carousel slide projectors in 1950 (see figure 2.1); overhead projectors were used by the military in 1945; Television was widespread in the United States by 1960. By today, slide and overhead projectors are almost completely replaced by digital projectors and large digital displays.

PowerPoint is the original slideware software

PowerPoint is not only the current market leader of slideware and one of the most used programs, it is also the first program of its kind [Parker, 2001]. It was introduced to the market in 1987 by Forethought for the Apple Macintosh—Microsoft bought Forethought in the same year and in 1990 PowerPoint was released as part of Microsoft Office for Windows. PowerPoint's original intent was to aid the pro-

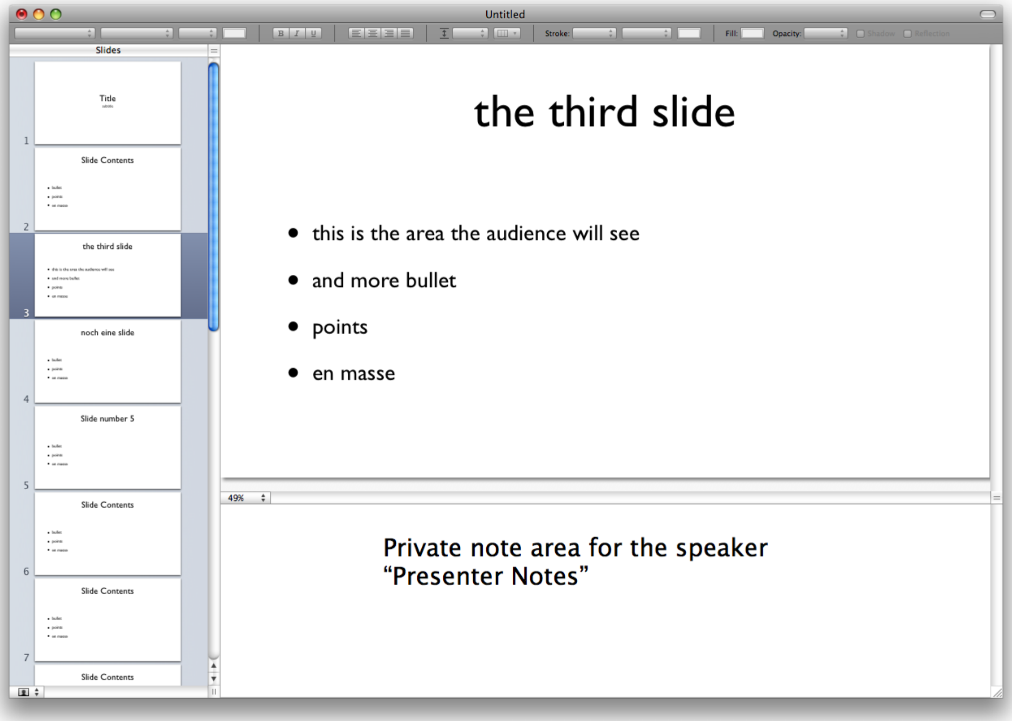


Figure 2.2: Slideware Example

duction of physical slides, today, it is primarily used in conjunction with computer generated projection and large displays. Slideware can be seen as the first generation of computer based visualisations, and is firmly rooted in the model of physical slides.

Slideware mimics physical slides

Presentation literature appears some time after the technological advances. The first textbooks about visual communication were issued in 1952. Interestingly, the problems of slide misuse are already noted and strikingly resemble today's problems [Van Pelt, 1950]:

> *"We have seen overcrowded slides projected by machines that could not be focused. We have watched while speakers in a large room tried to use maps or charts that could not be read beyond arm's length. We have listened in vain as able scholars talked confidentially to a blackboard while writing illegible symbols with invisible chalk. We have fidgeted, mentally*

> *if not physically, as the remarks of a renowned scientist came to a dead stop while he readjusted some ill-arranged piece of apparatus or hunted for a scientific specimen to illustrate his point. The habit of using bad visual aids is rampant among those who 'speak to inform'."*

Slideware has made the creation of visualisations easier than with physical slides, but problems remain the same.

Physical slides had similar problems to slideware

This result is not surprising, as slideware copies the slide metaphor from its ancestry—we explain in chapter 4 how these problems are rooted in the old metaphor.

For a more detailed discussion of presentation history, especially concerning literature, we suggest the study of Earnest's dissertation [2003].

2.2 Tasks for Talks

The task of presenting is not limited to the delivery of presentations, this is only one aspect. This section presents all presentation aspects: research, authoring, delivery and reuse. These do, however, not necessarily have to be done in this order or strictly one after the other—presenting is often an iterative process. Problems of slideware in these aspects is discussed in chapter 4—"Design".

2.2.1 Research and Sensemaking

Before the author can begin composing the presentation document, she has to be aware of what the specific parts of his talk are, and how they are connected. This is often a trivial aspect, for example, if the presenter is an expert in the domain, if previous documents exist, or if the talk is repeated or adapted from previous talks. If not familiar with the topic, she has to perform research, gather information and make sense of it. Often presentations are not prepared by the person who delivers them, in which case the author has to examine the topic domain [Johnson and Nardi, 1996].

The remainder of this thesis assumes that the author and presenter of the talk know the talk domain well and do not have any false understandings.

2.2.2 Authoring

The second major step is to shape the author's knowledge of the task into a talk. This does not have to include preparing a visualisation—talks can be all verbal—but it is very common, and for this thesis we assume that the presenter wants to prepare at least a minimal visualisation document.

The authoring of the presentation document can be very diverse and individual: Although slideware is the dominant software used for the task, Johnson [1996] reports the use of animation software, graphics manipulation software or even text editors. His study also finds that amateurs tend to use few programs, whereas experts use a larger set of tools; especially for important, very polished presentations, slides are designed with general graphic software and only composed with slideware. He identifies three different groups: authors that create slides only peripherally to their main job, professional slide authors that design polished documents and prefer flexibility, and slide "clericals" who have less training and create many "run-off-the-mill" presentations. Consequently presentations feature a diversity of visualisations: text, images, video, animation, charts, etc.

Johnson conducted a study on the creation of slides

Although the author is informed about the topic, the actual selection of content and the form of its visualisation is not determined, but rather evolves through a process of re-casting ideas. Good's [2003] analysis of authoring approaches stated that four parts form the authoring process: generating, organising, composing, and revising. The author performs these stages very loosely in this order and often more than once. Top-Down and Bottom-Up strategies are both frequently employed. Good also stresses the importance of flexibility: "The more difficult it is to explore alternatives, the fewer alternatives the presenter is likely to consider." and "In addition, formal structures can introduce modification costs that reduce the chances that an

Authoring is an iterative process

Ease of exploration is important for authoring environments author will explore alternative organisations.”.

Of course, the early prototyping stages of documents can be done without computer support, for example, on paper with mind maps, storyboards and similar established techniques. The result of this process is not only the visualisation, but the plan for the talk. This extends to notes for the presenter, memorised passages, planned interaction with the audience, backup plans for anticipated changes or even jokes at the right point. It is also very common to rehearse a talk multiple times over, improving rhetoric and visualisations iteratively. The time schedule for slide preparation is commonly limited—finishing in time can become more important than the quality of the visualisation.

The author creates the visualisation and a plan for the presentation delivery

Presentation documents are often created by many authors or the author is not the speaker [Johnson and Nardi, 1996]. Currently slideware does not support collaboration, with the notable exception of Google Documents[1] .

The remainder of the thesis is primarily focused on improving support for the authoring phase of presentations. Our two studies examine the effect of the interaction on the authors’ performance.

2.2.3 Presentation Delivery

Styles of talk vary and styles of visualisations vary accordingly. Talks can be speaker centred, in extreme cases without visualisations at all or very minimalist slide content that underlines the sentence spoken at the moment, often with the exact same words. This method is called *Lessig method*, named after Lawrence Lessig, who invented this form of slides.[2] Lanir et al. [2008] and Slykhuis et al. [2005], on the other hand, examine very content oriented presentations: lectures in a classroom setting. They find that content in such lectures can be divided into *rich content* and *support content*. Rich content gradually built up and referenced throughout the lecture, whereas support content has only

[1] http://docs.google.com

[2] An example presentation with 243 slides: http://randomfoo.net/oscon/2002/lessig/free.html

a short time value. Eye-tracking studies show that students are adept at differentiating the two and spend significantly more time on the rich content [Slykhuis et al., 2005].

The delivery requires constant attention on both sides for the whole period of time, the speaker is observed by the audience, she knows that her performance can have a large impact on her career. All these factors make giving a talk typically a very stressful situation for the presenter and such situations are often feared among inexperienced presenters.

Presentations can be very stressful for the presenter

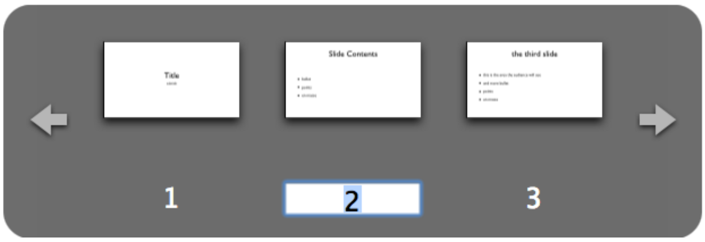


Figure 2.3: Apple Keynote's slide switcher: the presenter can select a slide in private with the arrow buttons or by typing the slide number. She confirms the selection by pressing ENTER.

Handling the controls of the presentation device only adds to the cognitive load and stress of the situation. Any software implementation should prioritise simplicity and error prevention for these reasons during presentation delivery. The speaker can use many tools for the control of computer based presentation: keyboard, remote controls, laser pointer or gestures [Cao et al., 2005]. Slideware commonly allows navigation to the next and previous slide, for example, by using arrow keys, and random access to slides, for example, by typing in the slide number.

Visualisation controls should not add to the presenter's cognitive load

Another common feature of slideware programs are *presenter's notes*: annotations that can be seen on a private screen by the speaker, but are invisible to the audience. This can be helpful for the presenter, if she wants to minimise her memory load, but not distract the audience with too much information. In slideware these presenter notes are typically shown below the current slide on her private screen,

Presenter's notes are cues for the presenter that only he can see

Figure 2.4: Physical slides often carry annotations at their borders that are not shown to the audience.

for example, a laptop. Before computer support, this was often realised with note cards that the presenter held in her hands or annotations upon the sides of physical slides (Figure 2.4).

2.2.4 Reuse

Presentation documents are typically reused

The work spend on the presentation visualisation can be reused in other formats or other talks. Is is very common to give the same or a varied talk about the same subject, maybe in a different time frame or for a different type of audience. In such a case, most parts of the talk can stay the same, while others might be trimmed, recast, or have new materials added. Drucker [2006] implemented a sophisticated prototype for version control and comparison among PowerPoint documents of related talks.

Slides are not suited for handouts

Presenters often want to give handouts to the audience during or after the talk. These handouts can be, for example, a written script or print-outs of the slides. With the development of digital video and increased bandwidths it is also increasingly common to offer recordings of the talk itself instead of paper handouts. He [2000] explored the usefulness of such handouts and found that with highlighted transcripts and video recordings students performed better. In contrast, simple print-out of the slides performed worst and were less accepted by audiences. This has also been observed by Norman [2005].

2.3 Bad Talks

With the growing use of slides and slideware for presentation tasks, their influence on the talks increased as well. Despite the popularity of slideware, anecdotal evidence points out that many people dislike the slideware talks they attend. Several researchers have blamed slides for degrading the talk quality, while others have defended it. We shortly discuss their positions in this paragraph.

Tufte and others argue that the design of PowerPoint degrades presentation quality

The critics of PowerPoint argue that PowerPoint changes the delivery of presentations—for the worse. This criticism almost always only names PowerPoint, but is equally true for all slideware. Tufte [2003] approaches the problem humorously and compares PowerPoint to Stalin, imposing a totalitarian regime on the presentation: all content must fit into the style of bullet points, slide after slide and pretty 'chartjunk'. In his view, "PowerPoint style routinely disrupts, dominates, and trivializes content", and instead of augmenting the talk, it substitutes the talk itself. This might even make talks, that used to employ different styles, look the same after enhanced with slideware [House et al., 2005]. If the presenter talks about the slide, rather than the slide backing her arguments, then the slides implicitly set the pace of the presentation—this can be seen in the disruptions of slide change and the presenter orienting afterwards [Farkas, 2005].

Similarly, Johnson [2005] and Craig [2006] argue that PowerPoint creates a finalised mindset, inhibiting spontaneous discussion or impromptu changes to the talk. Therefore slideware is also seen as unfit for education, because it shows the results rather than the process of obtaining them. [Parker, 2001, Johnson and Sharp, 2005] Also an often voiced concern is the 'perfection fault': instead of thinking about high level decisions, the author is supposedly more inclined to get distracted and beautify low level content [Wright, 1983, Parker, 2001, Tufte, 2003, Good, 2003, Li et al., 2003].

The criticism that PowerPoint diminishes the presenter's ability to prepare a good talk can best be summarised with a quote from Edward Tufte [2003]:

> *"Power Corrupts.*
> *PowerPoint Corrupts Absolutely."*

The responsibility to deliver a good talk is with the presenter, not the software

Those who defend PowerPoint against this criticism argue that PowerPoint is merely a tool—a tool that can be used to create good and bad slides, but the outcome depends of the author's skill. Shwom and Heller respond to Tufte: "Having read hundreds of poorly worded business letters in our consulting practice and teaching, as well as many dense and impossible-to-decipher engineering reports, would we be fair in saying that word processing software is just 'not serious'?". Consequently they ask together with Holmes [2004], Brown [2007], Norman [2005], and Kjeldsen [Kjeldsen, 2006] for proper training of students in presentation visualisations or "Media Rhetoracy". Norman also argues that personal notes, handouts and slides are different documents that should not be mixed, since they have distinct features that make them not interchangeable. Farkas [2005], however, acknowledges that although PowerPoint is basically capable of doing the task he finds it difficult to use it: "I only switched to PowerPoint, which I found very difficult to make do what I wanted,[..]". The view that PowerPoint and other slideware should not be held responsible for the failings of authors [Hardin, 2007] is best summarised by Kjeldsen [2006]:

> *"PowerPoint does not give bad presentations,*
> *People do."*

Fly tries to make it easier for the presenter to fulfil his responsibilities

There will, of course, always be bad talks for very simple reasons: presenters are nervous, untrained, inexperienced or simply lazy. And it will, of course, always be the responsibility of the speaker alone to prepare and give a good talk—this can not be out-sourced to software. In that sense, the advocates of *media rhetoracy* are right: giving presentations is a hard task and requires proper training. On the other hand, it is well known in HCI that the software influences the user in her actions, therefore slideware can potentially make the task harder or easier, slideware can guide the author in the right or the wrong direction. Ideally, it should not be difficult for the author to make the software do what she wants. We explain in chapter 4—"Design" how slideware does indeed hinder the creation of presentation visualisations and it is the goal of this thesis to create a tool that follows the author's mental model more closely.

2.4 Problems to Evaluate Media

There has been significant research on the influence of media on learning since the invention of Radio and Television. Specifically, researchers wanted to find positive effects for teaching with new media. Over a series of articles especially Clark [1983, 1994, 2001] and Kozma [1994, 1991] argue about the general possibility that specific media can influence learning beneficially. The discussion reached a pinnacle in 1994 when Clark and Kozma sharpened their respective views in 'Educational Technology Research and Development'.

Clark [1983] makes the provocative statement, that "[...] media do not influence learning under any conditions." and "[...] media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition." He also states that whenever previous research had found beneficial learning outcomes, these were rather produced by better methods of instruction, rather than different media. Different media may have different economic benefits, but each one can be substituted by others to achieve the same learning outcome. As a result of his theory, he sees no further benefit in media learning research and calls for a hiatus.

It is debatable if technological advances in media research can result in increased learning effects

Based on a review of previous research, Kozma [1994] and others [Reiser, 1994, Brown, 1992] argue that different students perform better or worse depending on the employed media. Kozma acknowledges that no convincing influences have been found, but calls for a tighter coupling of media and method. Several researchers see Clark's distinction between media and method unnecessary and harmful [Ullmer, 1994, Cobb, 1997] as both depend each other—certain teaching methods are more difficult or impossible with certain media: for example, learning about music without auditory media. On the other hand certain media empower methods that were not possible before. Kozma also sees a contrast between traditional passive media (books,...), where the learner is active, and novel engaging multimedia (film, computer,...), where both learner and media are active in a dialogue. With Clark's statements not applicable to those new media, he is confident, that beneficial effects on learning *will* occur.

Significantly better with technology	46
Significantly better in the classroom	3
Mixed results	7
No significant Difference	299

Table 2.1: Distribution of studies with effects on learning as categorised by Thomas Russel [1999].

May studies show that the effects are non-existent or too small to measure

More recent research [Hoyt, 1999, Russell, 1999, Ramage, 2002, Joy II and Garcia, 2000, Clark, 2001] strengthens Clark's line of thought: rigourous testing, especially cancelling the side effects and separating method and media, has found little evidence. Evidence of increased learning are at best unconvincing and insignificant against a vast body of studies that do, in fact, find no influence on learning. Russel summarises in his book *The No Significant Difference Phenomenon* [1999] and website[3] 355 studies, of which the vast majority finds no benefits (see table 2.1). A study comparing varying setups of slideware [Earnest, 2003] came to the same result.

Under these circumstances, how can Fly hope to improve over slideware? Clark's argument that Fly as a different media from slideware will not influence learning seems applicable: Fly can be simulated by other software—general animation software, graphics programming and to a certain extend even with slideware. These substitutions may

[3] www.nosignificantdifference.wcet.info

be clumsy, but will effectively make Fly not more powerful as other media for learning. Consequently, Holman's previous work [2006] on Fly did not produce a significant learning effect.

However, learning measures the impact of the software on the student and not the presenter or author. Previous studies make the assumption that the presenter, if any, is prepared at her best and her materials are as good as possible. The No Significance Claim states that the ceiling of media performance may be the same, and makes no statement about the threshold of using media. Clark and Kozma both agree that different media may be more appropriate for different situations.

Fly does not try to improve audience learning, but authoring usability

In this thesis, we are solely interested in the effects the software has on the speaker during preparation and delivery of presentations. Because the ideally prepared presenter with infinite time at her disposal is far from reality, an impact on the speaker's performance is likely to influence her talks. Fly aims to better support the author at her task and to help her create more meaningful presentations. With the two studies of this thesis we show that the authoring of presentations in Fly outperforms slideware by this measure.

2.5 Organic Interfaces

Organic interfaces are an emerging paradigm

Organic Interfaces (OIs) are an emerging new paradigm for metaphor-free user interfaces [Holman et al., 2006, Karrer, 2009] that serves as a major guideline for the design of Fly. Mackinlay, Rao, and Card [1995] already referred to one of their information visualisation systems as an "organic interface". Holman, Stojadinović, Karrer and Borchers [2006] presented the first definition of OIs in the sense in which it is used here, together with some early ideas for a presentation system such as Fly. More recently, [Holman and Vertegaal, 2008, Schwesig, 2008, Rekimoto, 2008] provided a discussion of physical interaction device qualities that make an interface organic, and highlighted the strong influence of Tangible User Interfaces [Ishii, 2008] on the physical device aspects of Organic Interfaces.

	Organic Computing	Organic Interfaces	Organic Devices
Nature Inspired	PSY Swarm behavior Self-X properties Genetic algorithms BIO	Human thought processes Learning and Adaptation Mental models	PHYS Deformability Adaptable shape & form Motion & kinetics
No Indirection	Direct communication between agents De-centralization of programming	Direct Manipulation Interaction stimulus and system response are co-located in space and time Free of technical metaphors	Input equals Output Function equals Form Form follows Flow
Calmness	Robustness Graceful degradation Controller/observer structures Self-Configuration	Retains user state Observable and plausible links between cause and effect Graceful degradation	Smooth shapes Fluid motion
Continuity	Fuzzy logic Neural networks Convergence of result	Analog data representation Non-discrete system states Relaxation of exactness claim	Analog input & output Gestures vs. series of commands 'Pressure sensors vs. buttons'
Emergence	Emergent behavior of multi-agent systems	Emergent information Bottom-up creation of data/ content Information growth	Emergent shape Multi-device environments Ambient intelligence 'World of blobjects'
Example system	Visual ant-clustering algorithms	Dragon Video Navigation Fly Presentation Software	Twend Reader Gummi PaperWindows SmartSkin

Figure 2.5: The Organic Design Space as defined by Thorsten Karrer [2009].

Organic Interfaces are inspired by nature

Karrer [2009] structured the design space of organic interfaces (Figure 2.5): They are inspired by natural phenomena from the areas of physics, biology, and psychology. In nature, processes are seldom discrete and categorised, but continuous and in fluid motion. An OI therefore aims to accommodate for fuzzy data and state-free relations in its internal representations, and for continuous, physically plausible visual transitions instead of discrete changes in its visual representation. With respect to psychology, OIs aim to adapt to the natural human thought process, allowing information to be arranged associatively, and supporting spatial memory when structuring and reformulating ideas and concepts. Inspired by the performance of natural organisms, OIs respect and plan for gradually emerging struc-

Figure 2.6: Dragon Video Navigation [Karrer et al., 2008] and Twend Reader [Herkenrath et al., 2008]

tures and behaviour. Finally, on the level of physical device design, OIs strive to be as calm and direct as established physical objects: persistent, observable, and predictable. They may also aim to closely represent the physical form and flexibility of natural objects [Holman and Vertegaal, 2008].

Direct manipulation is a successful concept

The concepts of direct manipulation [Shneiderman, 1983], and of physical and tangible user interfaces, have already had a large impact on HCI. They also demonstrate that interaction usually works best when input and output are co-located in space and time, without introducing any intermediary extraneous metaphors that would need to be understood first to relate cause and effect. Organic Interfaces elevate these concepts to a new, even more direct form of interaction.

OIs can thus be considered as a next step following the history of implementation-based, universal-metaphor, and domain-specific-metaphor interfaces: Traditional *implementation-based* interfaces such as early command-line interfaces to databases generally forced the user to adopt to the implementation of the underlying technical system. Later on, we saw the emergence of *universal metaphors*, in particular the desktop metaphor, which during its reign has turned everything into a file, from electronic written documents, to presentations, to movies and music pieces. Finally, recent applications have advocated *domain-specific* *metaphors* where, for example, pieces of music are described and presented as tracks on one of the CDs in the user's collection.

But even domain-specific metaphors are still really modelled after the objects that they are actually replacing (e.g., photo management software groups pictures in analogue photo 'film rolls', and slideware heritage of physical slides).

Organic Interfaces are metaphor free

Organic interfaces break with this tradition. They do not try to communicate a mental model to the user to adopt to, but are modelled in turn after the user's mental model of the objects, data, or task at hand. For example, the Dragon Video Navigation [Karrer et al., 2008] lets the user drag objects to the desired position directly, without controlling them via a timeline slider as an intermediary.

When applying the concepts of OIs to presentations, it becomes clear that presentations are primarily structured talks that discuss a complex topic of which the presenter has (hopefully) built up a comprehensive mental model. To create an Organic Interface for presentations thus suggests to provide the author with a straightforward way to craft and refine a natural and intuitively understandable representation of this mental model, and to make navigation around this model fluid, seamless, effortless, and easy for the audience to follow visually.

2.6 User Centred Design

User centred design explores the needs of the user

User centred design [Nielsen, 1993] is a standard design principle in human computer interaction to improve the usability of the created artefact for the end user. To ensure this, the developer asks users to help at all stages of the development process. The participation of the user uncovers needs and problems that the designer might not have anticipated.

The DIA cycle (Design, Implement, Analyse) [Nielsen, 1993] describes the three stages of iterative user centred design: an initial rough design is built and then evaluated by testers. The next cycle then starts with the design based on

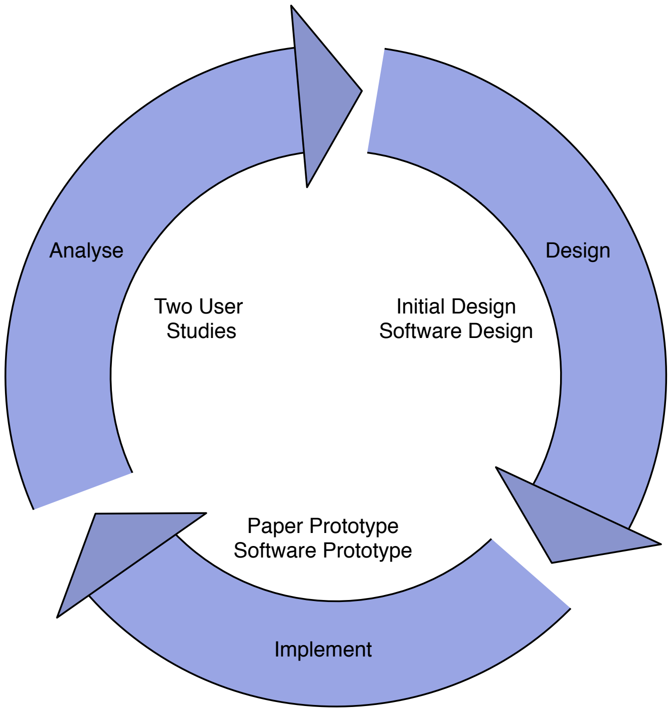


Figure 2.7: The Design/Implement/Analyse cycle with steps in this thesis.

User centred design alternates between design and evaluation phases

the previous evaluation, is built and tested again, and so forth. Artefacts created in this manner evolve from rough initial to sophisticated later designs. Tests of initial designs are more likely to uncover fundamental problems and needs, whereas the evaluation of the later stages is more likely to inform the designer on subtle flaws of the designs or less important user needs.

In this thesis, we conducted two DIA cycles: At first, we tested and evaluated our initial design (Chapter 4) using a low-fidelity paper prototype (Chapter 5). Based on these results we then built and tested the second design using a high-fidelity software implementation (Chapter 6). In the final chapter, we sketch the design of the next phase. To conduct our first study, we used a *paper prototype* [Snyder, 2003]. Paper prototyping is a widely used technique to design, evaluate, and refine user interfaces. The designer creates paper version of the planned interface and simulates algorithms and program behaviour herself. These mock-ups are often enough to test early ideas, to test interaction flows, and to get feedback from users. Paper versions are usually much faster to implement and easier to modify. Therefore, they are very useful for early design studies.

Chapter 3

Related work

"It's the most misused technological innovation since the handgun."

—James Gray on PowerPoint

In this chapter we introduce previous approaches that improved the user interface of slideware systems or designed new user interfaces for presentation tasks. These projects are mainly based on a combination of different technologies and interaction concepts. These range from pen interaction, to physical interaction, to path mechanisms and graph layouts, to zoomable user interfaces:

3.1 Pen Interaction

With the transition from physical slides to digital slides, the presenter has lost flexibility. For example, with overhead slides it was easy to make corrections, gradual buildups, or informal sketches during the presentation delivery. With slideware all content and build-up has to be anticipated. Digital ink technology promises to bring this flexibility back: It becomes easy to add informal content to the slides, for example, a sketch as an explanation to an audience question.

Digital ink brings back usability of overhead slides

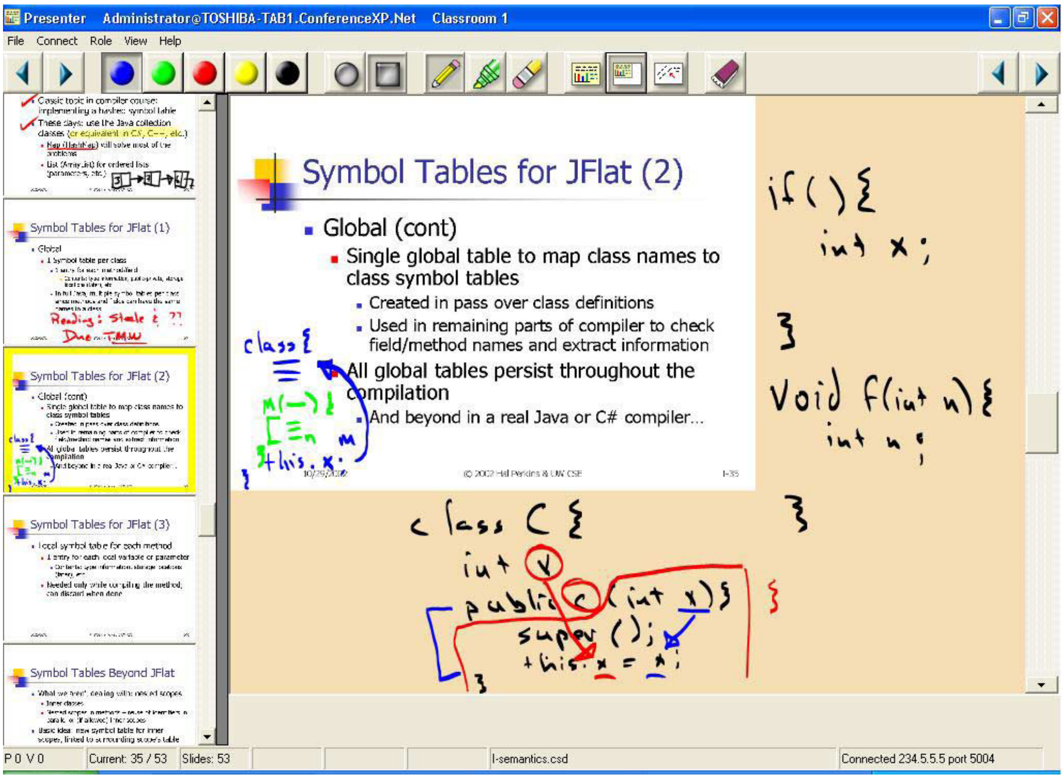


Figure 3.1: Presenter's view of Classroom Presenter during a lecture: the left shows the sequence of slides; the main view shows the current slide and additional space for annotations

3.1.1 Classroom Presenter

Classroom Presenter shares digital ink between presenter and audience

Classroom Presenter[1] [Anderson et al., 2004a] is a tool developed for classroom teaching. It presents PowerPoint presentations, and the speaker can augment them during the lecture with digital ink. She can make slides smaller, so that free space is available for more annotations (Figure 3.1). If the student runs Classroom Presenter on her computer, she can annotate the slides for personal use. Moreover, the presenter can also gather feedback from students and ink annotations from the audience. This is useful for in-class exercises to collect responses, to check learning success, and to display selected submissions to the audience. Student submissions are anonymous.

[1] Available for download and more information at http://classroompresenter.cs.washington.edu

Anderson's [2003, 2004a, 2004b, 2006, 2007] studies from classroom use find that the anonymous feedback does not diminish verbal communication in class. Instead, it seems to increase interaction with students, that are too shy to ask questions publicly. The feedback from the audience easily adds to the cognitive load of the presenter, therefore the feedback was limited to simple statements, like "Please explain" or "Got it!". Anderson also finds that often the lack of support for gesticulation with tablet PCs leads to so-called *attention marks*, which are inkings that only emphasises the current focus. For example, presenters tend to underline the current focus or put check-marks next to discussed bullet-points.

There are many studies for Classroom presenter

3.1.2 SketchPoint

SketchPoint [Li et al., 2003] uses digital ink not only for augmentations during the presentation, but also during the slide authoring. Its main goal is to provide means for a fast and flexible communication of ideas in an informal setting. To do that, the author structures notes and graphics in lists and hierarchies. She then specifies structures to create the slides from. Finally, she draws and writes more items on the created slides. Hyperlinks between slides are created automatically from note structure or explicitly with inking gestures.

SketchPoint uses inking for the creation of informal presentations

Sketchpoint interprets text and charts; the presenter can switch between original and the recognised view. The system does not use slides from the beginning (Figure 3.2, left) of the authoring, but the final presentation (Figure 3.2, right) is in slide format. Feedback from use shows that presenters experience inking as appropriate for an informal setting.

3.1.3 MultiPoint

MultiPoint [Sinha et al., 2001] is an authoring environment for slideware, that uses pen input together with verbal commands. A user draws a freeform shape or word and simul-

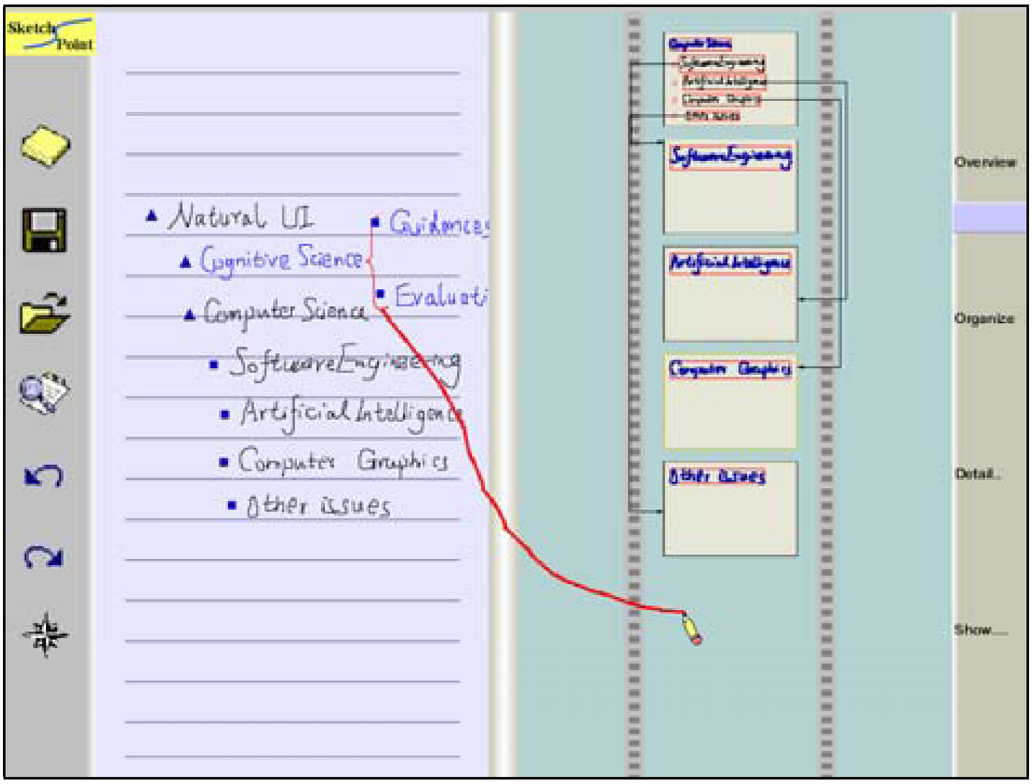


Figure 3.2: SketchPoint during the authoring phase. Left: note structure; right: slide sequence. The gesture creates a new slide from the notes on the left side.

MultiPoint combines pen interaction with with voice interaction

taneously speaks a command, which is then applied to the draw object. The user study shows in a Wizard of Oz prototype, that MultiPoint performs on par with PowerPoint in completion time, number of steps, and number of errors. However, the actual prototype with computer speech recognition performs very dissatisfyingly.

3.2 Physical Interaction

Physical proxies amplify the slide metaphor

The next two systems use physical proxies of the slides during the talk for annotations and presentation control. Advantages of physical interaction are less errors, random access, and easy restructuring of the talk during the delivery. A major disadvantage is the limitation to the physically feasible—slideware works well with physical proxies, because of its physical heritage, but the close coupling of digital and physical slides limits the interaction to the common denominator.

3.2.1 Palette

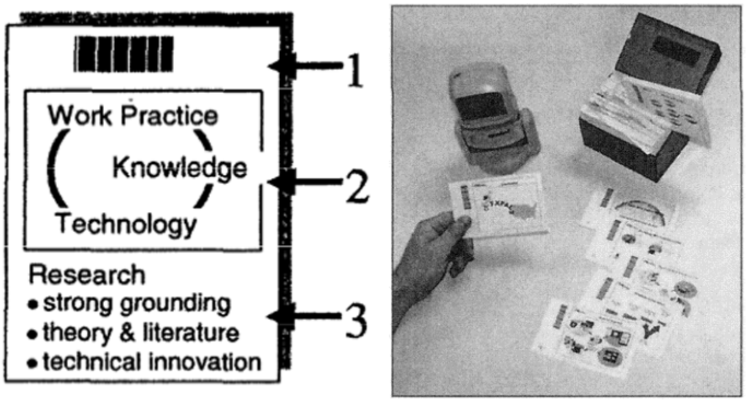
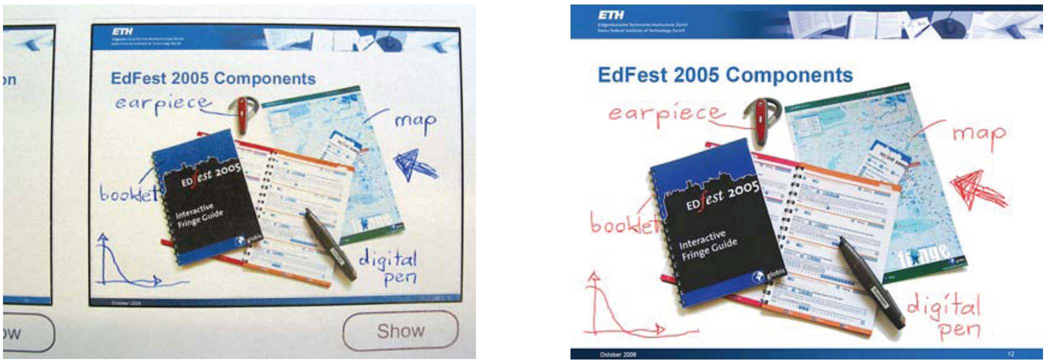


Figure 3.3: a Palette card: 1) the barcode; 2) the slide content; 3) presenter's notes

Palette cards resemble cue cards

Palette [Nelson et al., 1999, Pedersen et al., 2000] uses physical cards with barcodes as proxies to control the presentation flow. The author prints these cards from an existing PowerPoint slide deck; each slide printout (Figure 3.3) has three features: the slide content, private presenter annotations, and a barcode. During the talk the speaker displays a slide by scanning its barcode. The barcode scanner is mounted at a convenient point, for example, on the speaker's podium or the table during a meeting.

Observations of 404 real presentations [Churchill and Nelson, 2002] with Palette shows that presenters like the freedom to walk around in the room, to quickly rearrange presentation structure, and to share slides with audience members or other speakers. Presenters even handed Palette cards to audience members after the talk as business cards. Although the slides are presented in a linear matter, the speaker can spread them out during preparation or presentation to get a big picture and then easily access any slide in the deck. The downside is that only one linear arrangement is preserved. Reusing the cards turned out to be com-



Annotations on paper handouts

Resulting digital slide

Figure 3.4: The strokes of on the PaperPoint prints (left) are displayed on the digital slides (right). The author shows the slide by placing the pen on the show button.

plicated, as any change on the digital files requires a new physical printout to keep the coupling intact.

3.2.2 PaperPoint

PaperPoint presentations are remote controlled through slide print-outs

The physical proxies for the digital slides in PaperPoint [Signer and Norrie, 2007] are printouts on digital paper[2] that are controlled by special pens. With the interactive digital paper technology the presenter can draw on the slides printouts, the software registers the position of the pen, and adds the strokes to the displayed digital slide (Figure 3.4). This way, the PaperPoint prototype combines the benefits of Palette with the flexible inking of Classroom Presenter. The software recognises button areas (Figure 3.4, left) with which the author controls the presentation flow.

With several slides printed on a letter size paper sheet, the presenter has an overview over several slides; it is easy to skip slides or to change the order of presentation during delivery—this allows the presenter to seamlessly respond to unexpected questions or time constraints during presentations. PaperPoint is a great example of a physical interface that expands the interaction without requiring training or new skills: The paper technology is robust enough for an

[2] A technology developed by Anoto. More information at http://www.anoto.com

author to cut and rearrange paper fragments as she sees fit. A speaker is not limited to the podium and free to move in the room, she can invite audience members to write on the slides. They only need a hard surface to write on the paper, for example, a clipboard.

3.3 Graph Layouts

Previous work improved on the linear presentation flow of slideware using connected graphs of slides to display the talk structure to the presenter and possibly the audience. For this thesis we do not further distinguish between mind-maps [Buzan, 1991], concept-maps [Novak, 1990, Carnot et al., 2001, Wiegmann et al., 1992, Chau, 1998], hierarchical maps or other graph layouts. All these graph approaches have in common that they modify the linear slide structure with a connectivity between slides that displays high-level semantics.

Graph layouts of slides display high-level connectivity of talk topics

The author spends time to generate these graphs according to semantic connectivity between the topics presented on the slides. The presenter then profits from the graph, enabling her to respond to audience demands. With some system she can also communicate a "big picture" to the audience. The graph also allows for different paths [Frank M. Shipman et al., 1998] to be planned through this structure for different occasions. Taking different paths is quite common in hypermedia [Zellweger, 1989] and distance learning [Goyal et al., 2006].

3.3.1 Customisable Presentations

Moscovich et al. [2004] developed a prototype of a presenter's private display (Figure 3.5) that structures the slides of a PowerPoint presentation in blocks and different routes. The author anticipates different versions of the talk for different occasions or a contingency plan for a foreseen demand. She then designs a graph with the slides as vertices with these problems in mind. During presentation delivery

A graph of slides for the presenter's private display

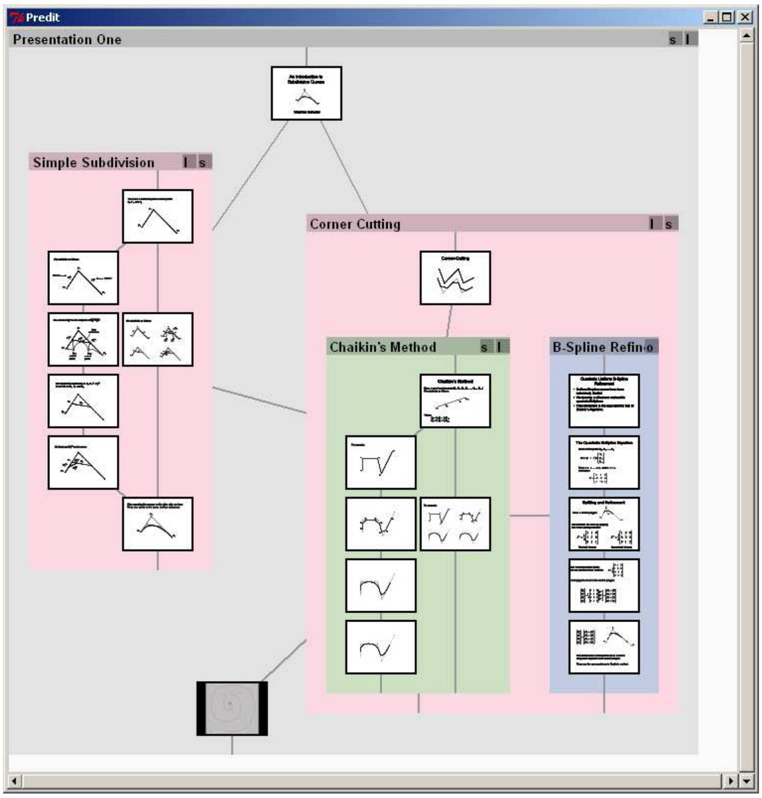


Figure 3.5: The private presenter's view for a presentation that can take many different routes according to audience demands [Moscovich et al., 2004].

she decides at the intersections which route to take. The graph is only visible to the presenter, the audience does not notice the graph or that the presentation was modified on the fly.

A concept-map of slides serves as a skeleton for the talk

Gopal and Morapakkam [2002] designed a similar graph layout of slides by extending PowerPoint slides with Visual Basic macros. In this prototype the author can chose to show a full graph to the audience, only the slides, or a split view (Figure 3.6). Visited slides are shaded in the map, so that the audience gets an idea how far the presentation has progressed and which specific slides have been visited.

Their study finds that 70% of student audiences like the overview and feel that it makes learning easier. However, presenters need to spend more time to prepare the presen-

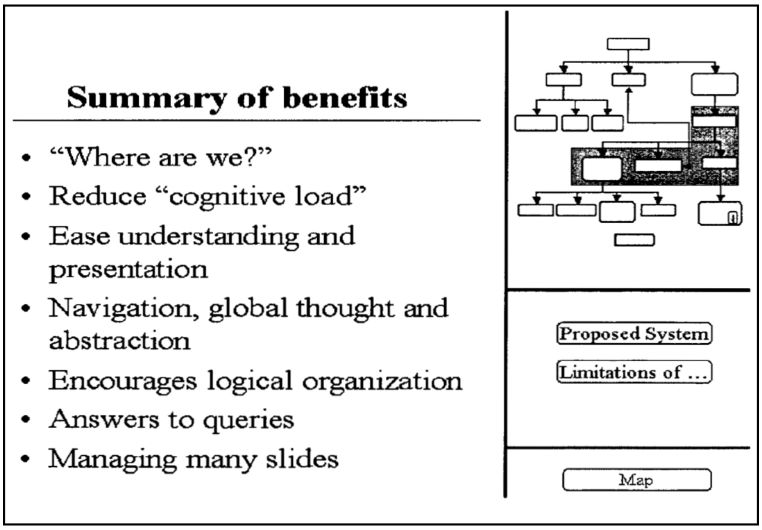


Figure 3.6: A split view of slide and the graph layout of the presentation. The buttons link to adjacent slides in the graph [Gopal and Morapakkam, 2002].

tation and need experience to deliver such presentations, due to the added complexity of presentation choices. They also observe that it is very easy to refer to specific slides during answers thanks to the overview map. Unexpected abrupt switches between slide and map view can be irritating for the audience.

3.3.2 Fly

Our work originated from a mind-map based approach by Holman et al. [2006]. In this prototype the author arranged PowerPoint slides in a hierarchical structure by drag-and-drop (Figure 3.7). Fly then automatically arranged the slides spatially and planned a single path—the depth-first traversal of the slide hierarchy. Subgroups of slides could be coloured and labelled to increase visual clarity.

A previous prototype for Fly was based on a mind-map design

During presentations the camera pans and zooms continuously between slide views according to the organic interface paradigm (2.5—"Organic Interfaces"), rather than instantaneous changes. An initial study of learning effects

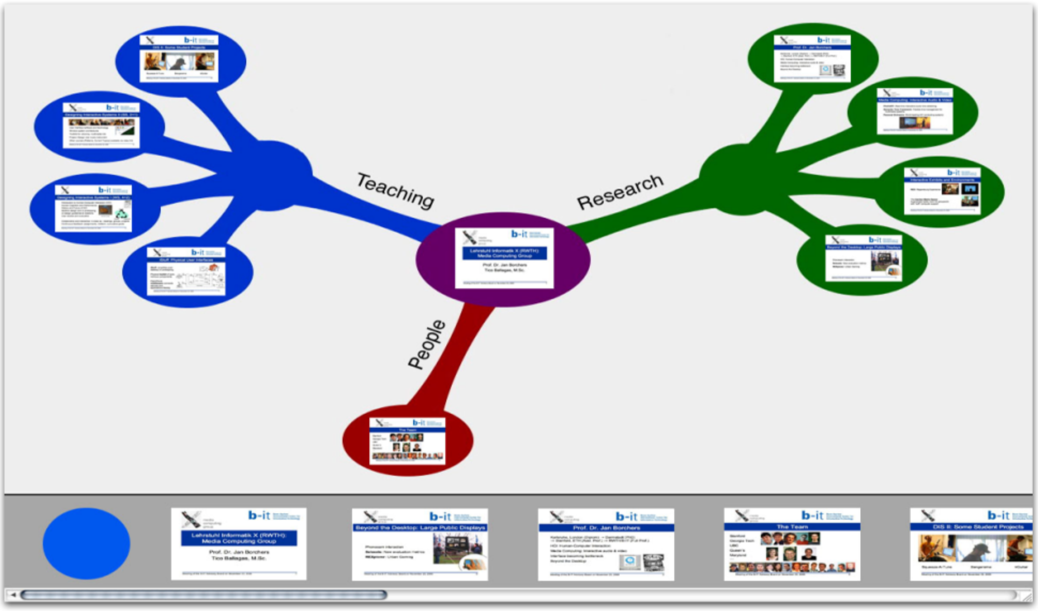


Figure 3.7: Holman's prototype of Fly. The author drags slides from the bottom onto the nodes to create a hierarchical structure.

showed no significant difference in learning outcomes compared to presentations with PowerPoint (compare 2.4—"Problems to Evaluate Media"). In the next chapter we explain the differences between our current design and this mind-map approach and their reasons.

3.3.3 Visual Understanding Environment

VUE generates slides from the concept-map contents the path travels trough

The Visual Understanding Environment (VUE)[3] is primarily a rich concept-map tool with an innovative presentation feature: the nodes automatically function as slides. For presentation purposes each node generates a slide layout of its contents similar to SketchPoint (3.1.2—"SketchPoint"). The author can keep this layout or refine it similar to typical slideware. She then can then plan one or many paths through the concept-map, each path serves as a linear presentation similar to a slideware presentation. During presentation delivery, a presenter can follow these predefined routes through the net, hop to other routes crossing the cur-

[3] Available for download at http://vue.tufts.edu.

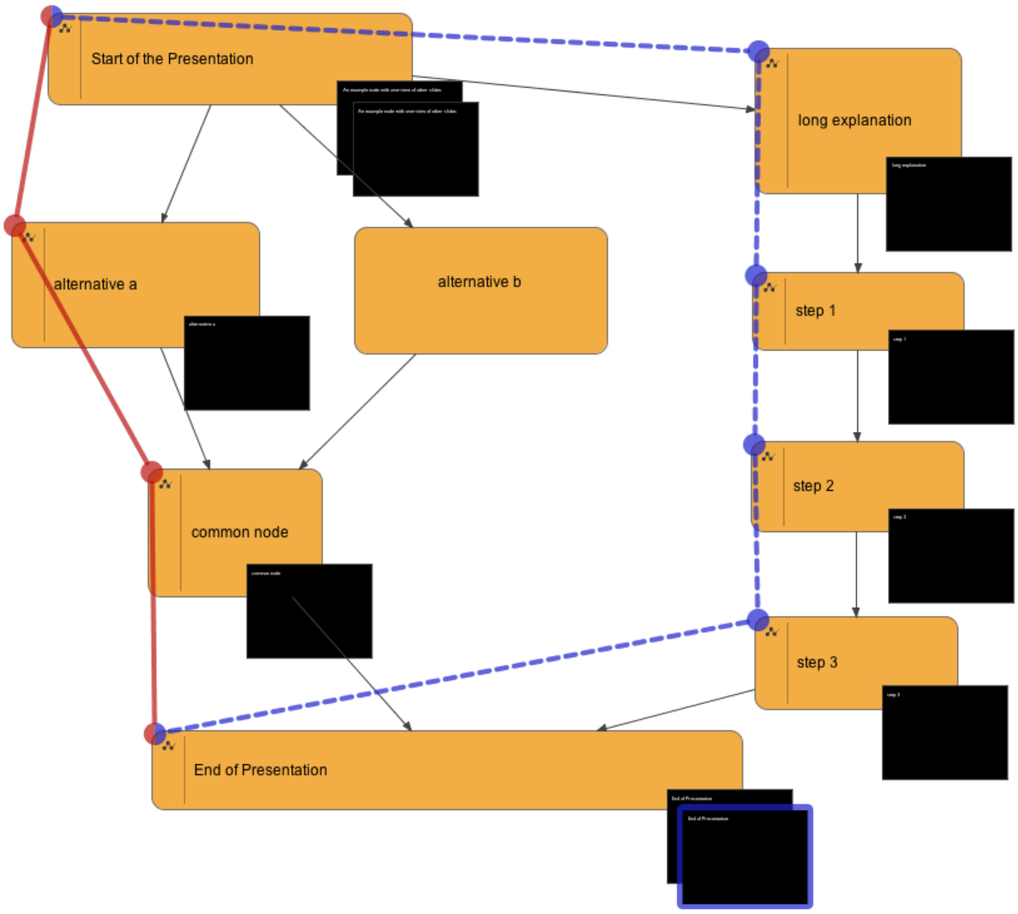


Figure 3.8: A VUE concept-map. Two alternative paths, red and blue, are planned through the graph. Each node has a slide attached for each path it is in, slide contents are generated from node contents.

rent one, or show the whole concept-map to the audience.

3.4 Zoomable User Interfaces

An alternative to graph layouts are *zoomable user interfaces* (ZUIs) [Perlin and Fox, 1993, Bederson and Hollan, 1994] that allow the author to arrange content in a spatial layout at varying distances from the virtual camera view point in the scene. ZUIs have similar advantages as graphs, but differ from them because they rely on depth and size instead

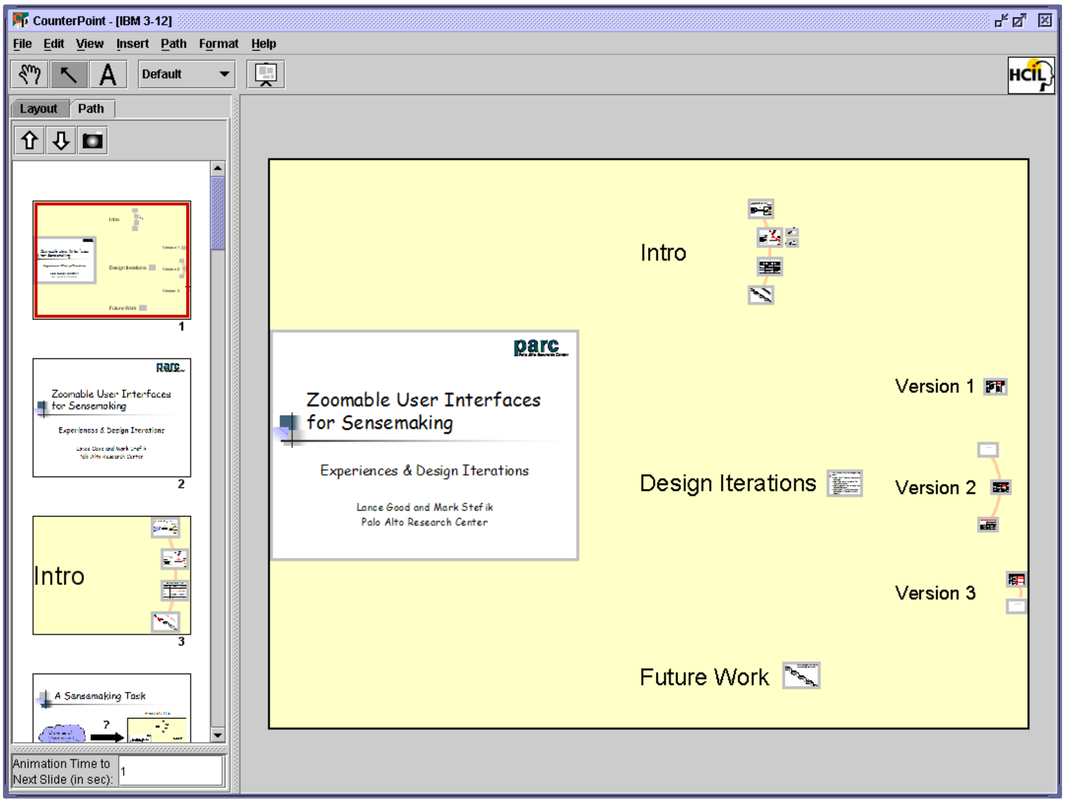


Figure 3.9: Authoring view of CounterPoint. Left: sequence of camera stops in the current path; right: current camera position.

of visible connections to convey context and detail. All the ZUI interfaces presented here animate smoothly between camera positions.

3.4.1 CounterPoint

CounterPoint arranges slides on an infinite canvas

CounterPoint [Good and Bederson, 2001, 2002, Good, 2003] is an extension to PowerPoint that adds a second authoring environment after editing the slides. In this second step, the author arranges slides in a spatial layout in a scene at arbitrary distances. CounterPoint can help with automatically generated layouts based on a hierarchy, similar to the Holman's Fly prototype (3.3.2—"Fly"). The camera can take any position, for example, showing a single slide completely, many slides in an overview (Figure 3.9), or parts of multiple adjacent slides. A sequence of such camera positions forms a path, the author can define as many paths as she likes. These paths are not rendered in the spatial layout, but in a list view (Figure 3.9, left). During presentations the software animates smoothly between the camera positions, so that the audience can estimate their relations based on the visual arrangement.

Feedback from 73 presentations showed that presenters appreciate the ability to show overviews and varying degrees of detail. They also often mentioned that the smooth animations helped their audience's orientation, especially during unforeseen excursions. Presentation documents can become very big with many slides, and the presenter composes a specific presentation sequence on the fly.

3.4.2 pptPlex

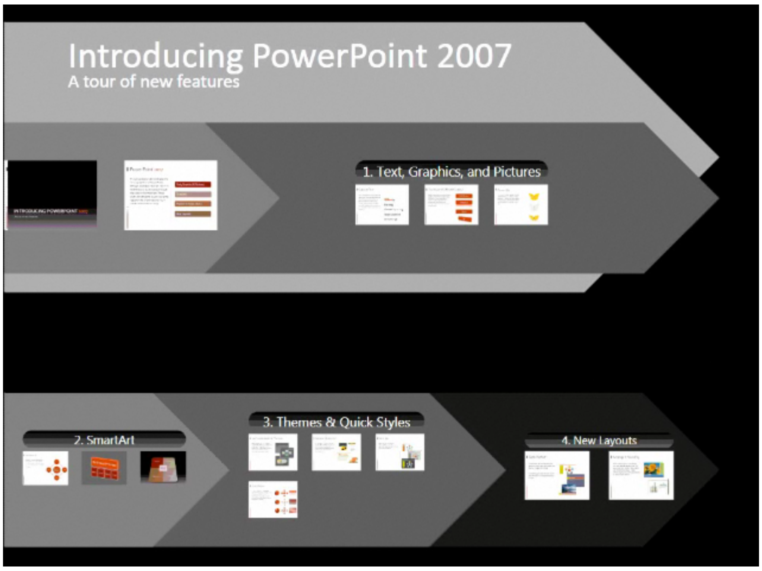


Figure 3.10: A pptPlex background slide during presentation. The other slides are positioned upon it.

The pptPlex[4] plug-in by Microsoft is a tool that enhances PowerPoint with ZUI functionality similar to CounterPoint, but with less flexibility: This plug-in adds a special

[4] Available for download at http://www.officelabs.com/projects/pptPlex/

background slide on which the other slides are placed. pptPlex is firmly rooted in the concept of slides: This background slide is limited in dimensions as all the other slides. Intermediate positions between slides are only possible where they are anticipated and slides are grouped explicitly. It defines both the visual background and the positions of the content slides through placeholders. pptPlex comes with with a set of background templates, the author can choose one of them or add their own. During presentation, the speaker follows the normal linear order of slides, in this case the animations are camera zooming and panning between the adjacent slides. She can also access any slide directly by zooming out and clicking on one.

pptPlex arranges foreground slides on a background canvas

3.4.3 Slithy

Zongker and Salesin [2003] designed a scripting language for flexible animation in presentations. Of course, as a scripting language, Slithy[5] is a tool for technical users and difficult to use without prior knowledge in programming. Its capabilities are more powerful than the other systems, but it lacks a graphical user interfaces and the low-level graphical building blocks need to be composed to a presentation visualisation.

More interesting than the interaction with Slithy, Zongker and Salesin created many presentations with this flexible tool and gathered nine *animation principles*—rationales for presentations based on their experiences with animations. Slithy was refined in an iterative design process to make these principles possible. These principles make a strong case for continuous meaningful animations in a ZUI context, they also resemble a lot of the underlying principles of Organic Interfaces (2.5—"Organic Interfaces"):

They presented design rationales of proper animation use

1. Make all movement meaningful.
2. Avoid instantaneous changes.
3. Do one thing at a time.

[5]http://grail.cs.washington.edu/projects/slithy/

As a powerful tool, Slithy can create "wild" presentations, but the author should take care to limit them to what the human mind can process and what is meaningful in the context of the talk. Overlapping animations cannot easily be followed and convey less then sequential animations that follow the pace of the speaker. The concepts continuity and calmness work well with animations, as feedback from other prototypes has shown, too [Good, 2003, Holman et al., 2006].

The rationales favor organic ZUI animations

4. Create a large virtual canvas

5. Smoothly expand and compress detail.

6. Reinforce structure with transitions.

7. Manage complexity through overlays.

These four points support the use of ZUI semantics for presentations. In their experience, a large canvas is effective to help the audience orientate and keep off-screen items in relation.

8. Distinguish dynamics from transitions.

9. Reinforce animation with narration.

Dynamics are the animations that are content themselves or display changes in the content, for example, the movements of a mechanism. *Transitions* are animations that guide the audience from one topic to the next. To avoid confusion, audiences should distinguish them easily (compare [Slykhuis et al., 2005]). Audiences have problems following the speaker's voice and visual changes at the same time, if they are not illustrating each other. Zongker et al. also observed the presenter's tendency to rush ahead, while the computer is busy explaining the previous point.

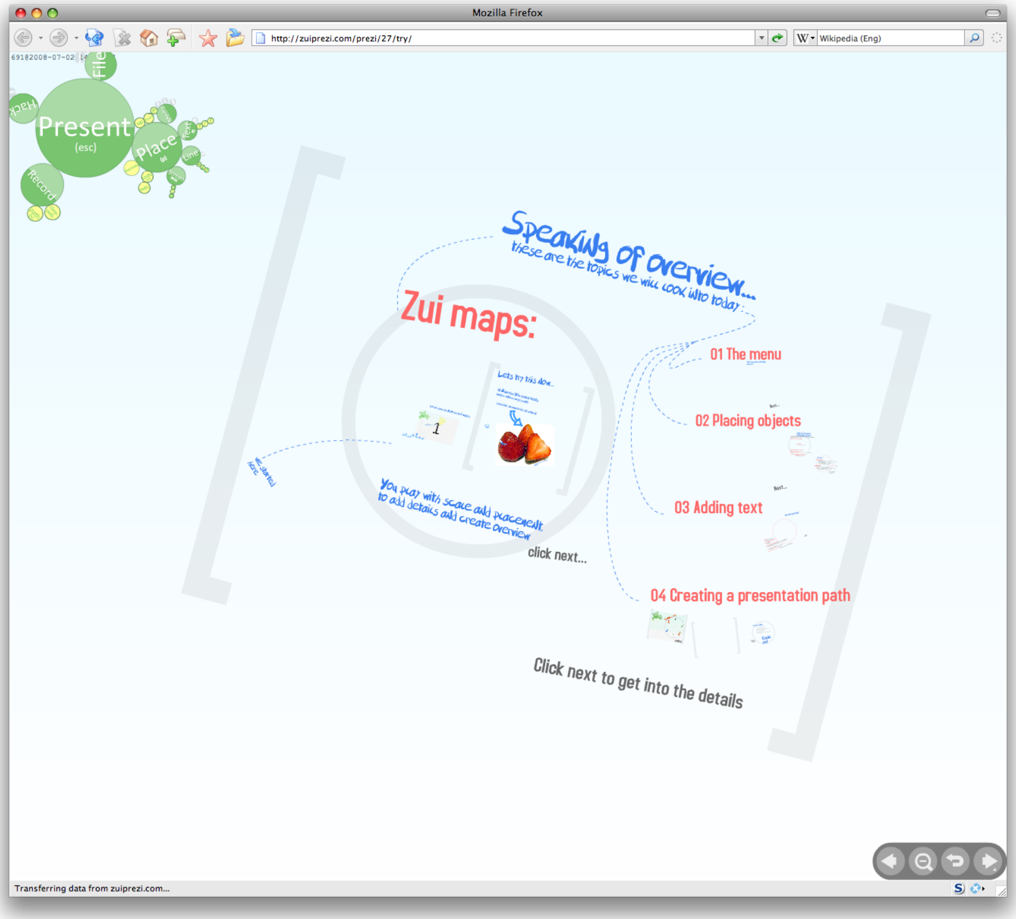


Figure 3.11: The ZuiPrezi presentation web application. The translucent brackets display the position of viewports. Presentation controls are to the lower right, authoring controls in the top left.

3.4.4 ZuiPrezi

ZuiPrezi has no slide metaphor

A recently developed flash[6] web application, ZuiPrezi[7] , is similar to pptPlex and CounterPoint, as it arranges its content on an infinite zoomable plane. In contrast, however, it does not rely on the slide metaphor. The author places any content she loads onto the webpage directly on the plane, without intermediate arrangement on slides. Content items can be moved, rotated, and scaled. All authoring takes

[6]http://www.adobe.com/products/flash/
[7]http://www.zuiprezi.com/

place in an unified environment, whereas the extensions of slideware design inter-slide and sub-slide content separately. Additionally, the author defines viewports or camera positions (Figure 3.11) to use during presentation. She also can also define a sequence of content objects or viewpoints as a path. During presentation delivery, this path can be traversed forward and backward similar to slideware and the camera can bring any object or viewport into focus by double clicking it.

3.5 Comparison

System	slide-free	overviews	encourages non-linear talk	unified authoring
Classroom Presenter				
SketchPoint		author	(links)	yes
MultiPoint				yes
Palette			(yes)	
PaperPoint			(yes)	
Holman's Fly		yes		
VUE		yes	yes	yes
Moscovisc's graph		presenter	yes	
Gopal's graph		yes	yes	yes
CounterPoint		yes	yes	
pptPlex		yes	yes	yes
Slithy	yes	yes		yes
ZuiPrezi	yes	yes	yes	yes

Table 3.1: Comparison of related work

The presentation systems presented here range from simple prototypes to released software packages, yet they share common features. We already filed them in pen interaction, physical interfaces, graph approaches, and zoomable interfaces. Some of these traits overlap: SketchPoint features an authoring view with ZUI traits, PaperPoint allows inking the slides, and Holman's Fly animates smoothly like a Zoomable User Interface. In table 3.1 we compare some high-level traits of these systems.

Almost all related work is based on slides

As introduced in chapter 2.1—"History of Presentation Visualisations" the slideware is firmly rooted in metaphor of physical slides—hence its name. With the exception of ZuiPrezi and Slithy, all prototypes share this trait and build their interaction around that. Roughly half of the systems extend PowerPoint files and then work on these as their smallest units of interaction. This requires switching between applications for the author and makes changes tedious, especially for the physical interfaces. In the next chapter, we argue that the side metaphor is doing harm and should be abandoned; for Fly we envision an atomic placement of content items similar to ZuiPrezi.

The graph and ZUI approaches share as their main goal the possibility to show high-level semantic connectivity of the topics. Graphs accomplish this through a formal structure, ZUIs rely on visual distance. The feedback from use has indicated that both approaches work and are accepted by presenters and audience.

With a visual structure of the topic, the next step for many systems is the ability to encourage non-linear talks. Many researchers have found that the ability to keep the talk structure flexible to audience demands is a valuable addition to the linear flow of slide presentations. An interaction that changes the talk flow has to be both quick and simple, because the audience will not accept long interruptions. This can be accomplished through anticipated alternatives to the talk in the form of paths, of which the presenter chooses the one applicable for the occasion. Similarly, the connections between graph elements and short distances between ZUI elements keep backup material at the presenter's disposal.

In table 3.2 we take a closer look at the ZUI systems and compare them to the design of Fly, which we introduce in the next chapter. Counterpoint is the only presentation ZUI that can store more than a single path, and pptPlex uses the normal order of all slides of the PowerPoint presentation. While Slithy and pptPlex do not display paths at all, CounterPoint displays the camera positions in a list for the author, ZuiPrezi shows line segments during the path authoring, but hides them in the normal view and especially during presentation delivery. With Fly we designed the paths

System	slide-free	rotations	depth	#paths	path visibility
CounterPoint			infinite	n	list
pptPlex			infinite	1	
Slithy	yes	yes	infinite	1	
ZuiPrezi	yes	yes	infinite	1	author
Fly in this thesis	yes	no	limited	n	author, presenter and audience

Table 3.2: Comparison of ZUI presentation prototypes

to be visible not only during editing, but the presenter can choose to display them to the audience. They are reified in the main view because the organic interface paradigm encourages direct manipulation.

All of the above ZUI systems create *infinite* zoomable spaces with nested information. For example, a slide in Counterpoint or a text in Zuiprezi can be scaled up and down (see figures 3.9 and 3.11). This gives the impression that the object moves further away from the camera or closer to it. The downside of this is that content items sometimes lose their proportions to each other. For example, in a case with text on two adjacent slides with different scales, one of the texts will be to big or to small to be comfortably read. The slide-free systems allow the content items and camera to be rotated arbitrarily, but sadly do not report any findings of presenter feedback from this design choice. In the current implementation of Fly this is not possible. Furthermore, we decided to explore a planar interface that restricts the depth of the content arrangement. We further discuss the design of Fly in the next chapter.

The ZUI presentation systems can place objects at arbitrary scale

Although in many studies audiences have voiced positive remarks to novel visualisations for presentations, we have seen in 2.4—"Problems to Evaluate Media" that the pursuit of increased learning effects can be a difficult [Holman et al., 2006]. While Good [2003] collected feedback from presenters and the authors of Slithy collected design rationales [Zongker and Salesin, 2003], the effect of zoomable spaces on authoring of presentations otherwise remains unexplored. In this thesis, we present two studies with both qualitative and quantitative aspects: We explore the work-flow and results of presentation authoring with the Fly interface two times—in a paper prototype and a software prototype.

Chapter 4

Design

One military advisor from Duke University said that the U.S. military, instead of getting our allies to use PowerPoint, should give it to the Iraqis. "We'd never have to worry about them again."

—Wall Street Journal, April 26, 2000

4.1 Problems of Slideware

We have examined the concept of organic interfaces, our study results, and previous criticism of the slideware model to classify the limitations of slideware. We believe that the following three major issues may force the author to change her mental model to the slideware model [Parker, 2001, Lovgren, 1994], making the task harder:

4.1.1 Content Cutting

Slides separate content into discrete chunks of equal size, determined effectively by the target resolution of the presentation display. Conceptually each slide acts like a folder into which the author has to sort her contents [Good, 2003]. Apart from screen dimensions, the size of these chunks is

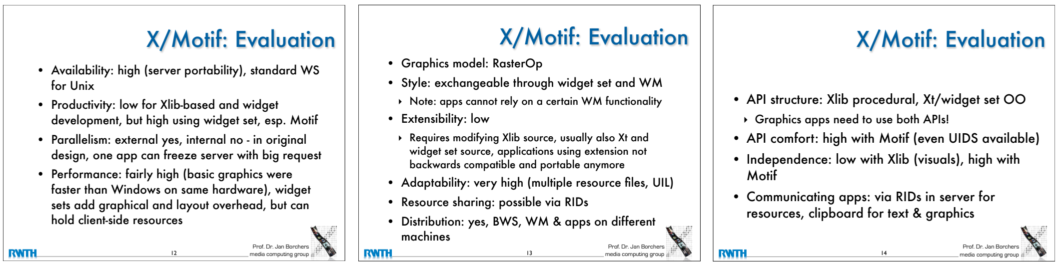


Figure 4.1: Content is stretched over three slides. The author repeats the title on each slide to connect them.

arbitrary. In particular, it is not correlated to the size of chunks in the content. This leads to common problems in slide preparation when sizes do not match:

The concept of slides cuts the content into pieces.

Content cannot span boundaries of slides, and has to be repeated when it is needed again. Content can also overspill a slide, a problem too often battled with tiny font sizes or by simply leaving out content. There is no "half" slide for less content, or a good way to compare two slides next to each other. If content does not fit, it is likely to be dropped from the talk [Parker, 2001]. When a consistent topic stretches over many slides, it is an additional burden on the audience to reassemble the whole from the fragments (Figure 4.1), and the presenter's burden to help them [Good, 2003]. During presentations, slide transitions are often neither calm nor predictable, but instantaneous and abrupt. The author has to take great care to make the animated transitions meaningful instead of annoying [Zongker and Salesin, 2003].

The size of the screen is a matter of fact, but the example of the overhead projector shows that this does not necessarily limit the interaction: in schools the projectors are typically equipped with a transparent roll, so that the canvas is unlimited in one direction. A fellow researcher at our chair complained recently because he had to convert all his slides from 4:3 to landscape format. It should not be necessary to subordinate his content to technical limitations.

4.1.2 Time Dominance

In slideware, the timeline of the talk is hard-coded into the document at the moment of creation. Any non-linear content has to be projected onto the timeline, losing its original shape unless reconstructed via clever overviews by the presenter. Again this leads to common problems:

Connections other than to the adjacent slides are lost, except for invisible hyperlinks. Individual items are either included in the talk or left out, creating a "finalised mindset" that hinders prototyping and exploration of alternatives [Good, 2003, Gopal and Morapakkam, 2002]. Optional material has to be put at the end, rather than close to the topic which it refers to. Since all slides have exactly one position in time, duplicates are needed to revisit ideas. Random access to slides is hard, and jumping to the other end of a talk is usually accomplished by the visually rather jarring experience of rapidly flipping through all slides in between [Moscovich et al., 2004].

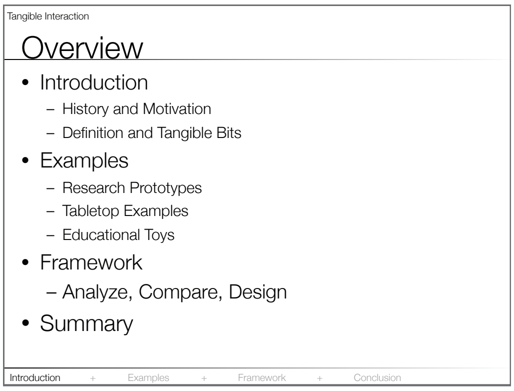
The focus on one single timeline forces the talk into a sequential format.

The resulting document is only valid for its original timeframe: content that is not anticipated cannot be presented [Anderson et al., 2004a]. Reusing of the document for a different talk will most likely require projecting the contents onto a new timeline all over again—even if both share most of their content. It is the author's burden to implement a system of version control among talks [Drucker et al., 2006, Moscovich et al., 2004].

4.1.3 Detail Trap

While slides are limited in absolute size dimension, the presenter is also implicitly limited in scope to editing on a detail level. She cannot "step back" meaningfully, as there is no more context on the current slide [Gopal and Morapakkam, 2002]. Instead she is more likely to beautify the individual slide than to think about its place in the overall shape of the talk [Good, 2003, Li et al., 2003, Parker, 2001, Tufte, 2003]. Current software limits authoring to the smallest level—there is no support for designing a "big picture"

Slides provide no context visualisation.



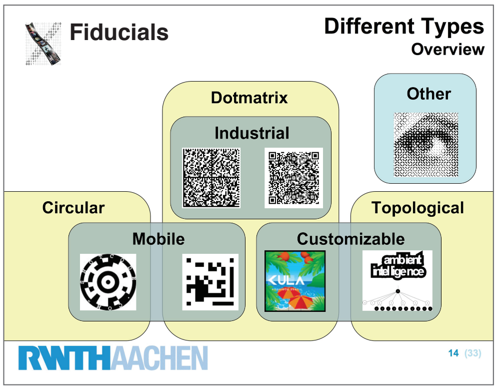


Figure 4.2: Left: a hierarchical talk overview. **Right:** a overview that clusters the topics in multiple ways.

Slides do not afford context visualisation.

of the topic other than manually drawing it on a special slide that resides in between the rest. The only remaining inter-slide connection is the sequence with its transition; anything else is suppressed by the format. The author of a slide deck is required to generate separate overviews or to explicitly name interconnections of subtopics (Figure 4.2). It takes experience to know that this is considered good practice and of great help to the audience [Good, 2003].

Slideware is based on the technical possibilities of slides and overhead transparencies. As we have shown, this metaphor does not possess the traits of organic interfaces because *content cutting* and *time dominance* actively separate where the human associates. Previous work has mainly improved on the last two problem areas, using paths and context visualisations. However, the rigid structure of slide frames is still ill-suited to the natural flow of ideas: their hard boundaries cannot display fuzzy ties and hinder emerging ideas.

4.2 Design of Fly

With the exception of Slithy [Zongker and Salesin, 2003] and ZuiPrezi all previous zoomable approaches are firmly rooted in the model of *slide frames* as discrete rectangular areas, separating interaction for both authoring and presenting into sub-slide and inter-slide steps. Fly unifies context and detail authoring without introducing modes. Following the Organic Interface paradigm, information is placed without the artificial constraint of slides frames. Instead, the visualisation's gestalt can resemble the gestalt of the presentation topic.

Fly does not create slides, but arranges content items individually.

Our design aims at a more atomic and continuous arrangement of information, avoiding categorisation and borders unless they are conscious design decisions by the author. The graph layouts and slides and other formalisms are problematic, because they afford the author to decide early on where she puts content parts. As a consequence, we abandoned our earlier mind-map based design [Holman et al., 2006]: Fly now does not differentiate between subnode and inter-node content anymore; visual connections between items are now optional, rather than required by formalism. This way the author can leave items in an undefined or fuzzy state until she makes up her mind. In Fly, information parts and graphical elements are directly positioned on an infinite plane like a collage, rather than positioning slides containing this information.

Fly does not rely on formalism to visualise context.

As more and more parts are put together, visual structures and a big picture evolve naturally. The form of the visualisation becomes a function of its content. Grouped information atoms form meaningful units that do not have to adhere to boundaries of the screen or the slides. We show in our tests that this emergent behaviour can benefit the author.

The map-based design in Fly is similar to the ZUI used by previous approaches, but is *planar*. The author draws a two-dimensional map of the talk showing the relations of the subtopics. At this stage, she is not concerned about putting information in a presentation order—for some open presentation formats, she may in fact never give it such an order. She is invited to experiment and consider variations. Layout should not be standardised or automated, because the more individual the implemented structure, the better the orientation for the author and the memorisation for listeners [Buzan, 1991]. We aim to avoid putting objects on top of each other, but encourage different representations of the same information: a high level view shows a seman-

Fly uses a modified ZUI design with depth restrictions.

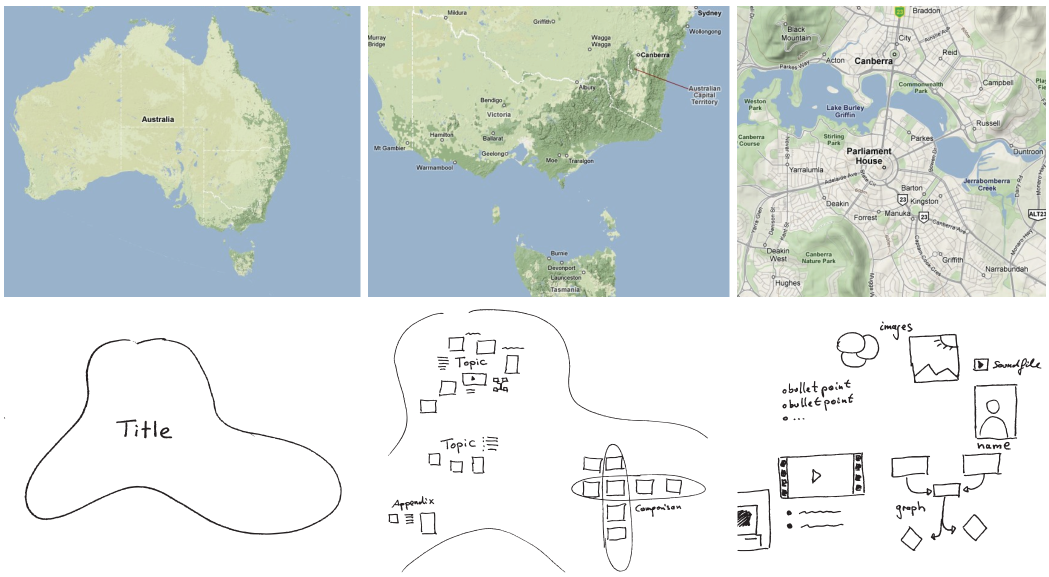


Figure 4.3: Top: map of Australia at different semantic levels. **Bottom:** An early design sketch for the Fly landscape at different semantic levels.

tic abstraction and its context, whereas a near view goes into more detail, similar to the difference between a country and city map (Figure 4.3). We discuss later how this was reflected in our software implementation.

Fly adopts the path mechanism.

If the author wishes to provide a path through the presentation, Fly again chooses an interface design that matches the straightforward mental model of the author as closely as possible: The author simply sets up a certain view of the plane and presses a *snapshot* button. The sequence of snapshots defines the path through the material.

During presentation, transitions from one section of the plane to another are always *continuous*, and they are always *meaningful* due to the layout of the plane itself—whether the author planned for the transition by providing and using snapshots, or whether she does it spontaneously, e.g., in response to a question. The author does not have to define the actual transition animation: the Fly presentation engine does all the work, providing a smooth, cinematographically pleasing "flight" transition between the two locations using camera zooming and panning.

Screen dimensions and timing become important when the author presents or plans the presentation. It is our design to put the time layout after the spatial layout, because the time layout is more likely to change: The author might give a second talk about the same topic under different conditions, or at the beginning of the composition she is not completely sure how to present her material, but she is sure how things are interconnected. In our system, the visualisation should truthfully exhibit information rather than present snippets attractively. Putting content arrangement first ensures that it can retain its form. Rather than projecting content onto a timeline, we want to project the time on the content. Prior work introduced paths for this projection [Good, 2003, Moscovich et al., 2004]. The visualisation of paths in Fly, however, is not limited to the presenters space but can also be shown to the audience rendered in the zoomable view. Also if content is put first, it can be shared by timelines. This way, the presentation document stays more flexible, fluid, and organic. A lecturer might design a unified information landscape about all her courses instead of individual slide sets. This document can also be shared among co-workers: for example, a group of teachers might put their related curricula together, so that one teacher can easily reference other lectures.

If the speaker wants, paths can be visible during presentation delivery.

Our design builds on the ideas of paths and zoomable interfaces to escape *time dominance* and the *detail trap*, but modifies them to better suit the presentation task. Previously it was easier to work bottom-up: first design slides, then put together a bigger shape. In Fly, an author can also work top-down, brainstorming the shape in higher zoom levels and filling in the details later, or mixture of both strategies.

Additionally, we solve the problem of *content cutting* by placing information atomically in the landscape. We examine the effect that such an environment has on the authoring process and resulting documents in 5—"Paper Prototype" and 6—"Software Prototype".

Chapter 5

Paper Prototype

"The world is complex, dynamic, multidimensional; the paper is static, flat. How are we to represent the rich visual world of experience and measurement on mere flatland?"

—Edward R. Tufte

5.1 Design of the Study

We tested our planar concept first by using a low-fidelity paper prototype [Snyder, 2003] to verify that it benefits the authoring process. We found that user workflows changed, and so did the resulting documents. At this point, we limited the evaluation to authoring instead of presenting, as it is heavily debated if and how the learning effects of different presentation styles can in fact be measured and compared rigourously enough to serve as scientific validation (2.4—"Problems to Evaluate Media").

We created paper versions of an imaginary typical slideware application and Fly respectively. The slides were simulated by 5.8 in×8.3 in (A5) sheets of paper (Figure 5.1, left) with a logo and the presenter's name. Fly was simulated by a 33.1 in×46.8 in (A0) sheet for the plane and a cardboard frame (Figure 5.2) for the viewport. The frame sim-

We created paper versions of slideware and Fly.

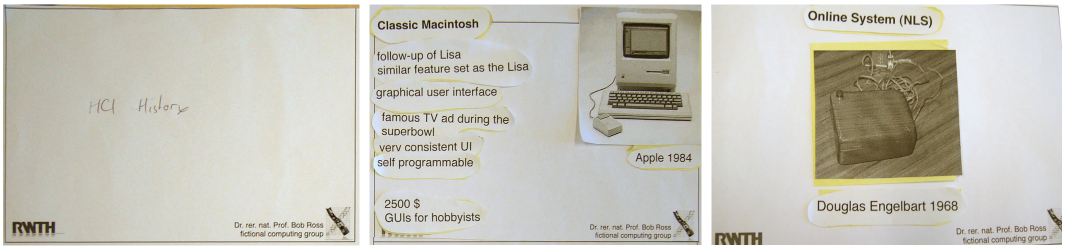


Figure 5.1: Slideware paper prototype. **Left:** An empty slide with custom text. **Right:** The two typical slide compositions

ulated a fully zoomed-in view when laid upon the sheet, and zoomed-out views when held at a distance. The supplied material was presented on snippets of Post-It notes. The font size of supplied notes was 20 points, following the standard practice of a minimal font size in slideshow presentations that ensures all text remains clearly readable from a distance.

Testers prepared one talk with slideware and one talk with Fly

The testers' task was to prepare two talks on the *History of HCI* from two sets of predefined material, which we supplied, as well as from any material they wished to add. The scope of the two sets was designed similar in volume, difficulty of the subject, and interconnections of the six presented computer systems. One of the talks was prepared with traditional slide semantics and the other with Fly's semantics. Sequence of authoring semantics and scope of the talk were counterbalanced.

We instructed the testers to "prepare visual aids for an upcoming talk to the best of their ability", and explained that the resulting document would not be used as handouts or in any other way except for the talk itself. We did not ask the testers to give the actual talk, but to shortly outline how they would use their document. This way, the test remained focused on the authoring process itself, while still making it clear that the document was not required to be meaningful without the presenter's voice. During the test, we were taking notes, the interaction was video taped, and resulting documents photographed.

Afterwards, testers answered six questions (Table 5.3) about their impressions of the interaction. The post-experiment questions about the users' experiences during

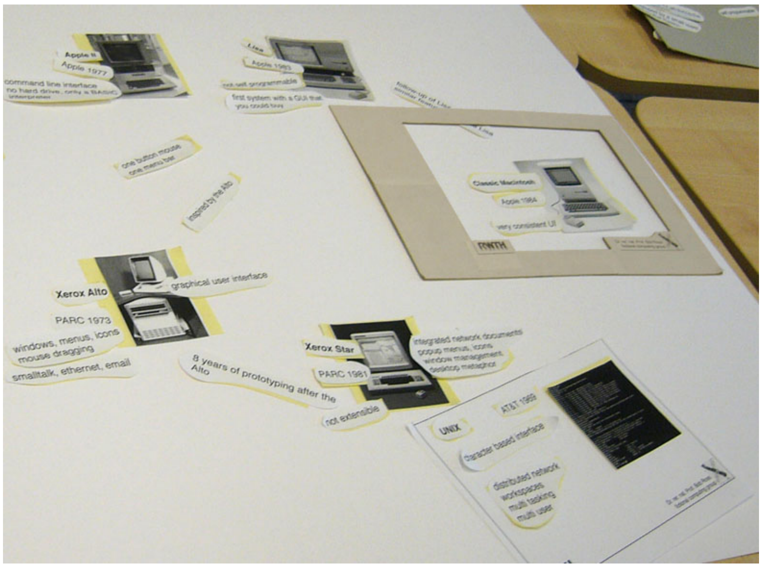


Figure 5.2: Fly paper prototype. A plane presentation with the cardboard frame.

the interaction are listed in Table 5.3. Q1–Q4 were answered on a 1–5 Likert scale, Q5+6 had possible answers *slides*, *no preference*, or *plane*.

Testers were given one set of materials for each talk. They were at liberty to include any or all of that material as well as additional contents they deemed necessary. This way, the testers could start right away without prior research, but were still free to shape their talk the way they considered best with any visual techniques they preferred.

We supplied materials for two similar talks on the History of HCI.

The topic *History of HCI* is quite diverse: systems can be arranged by date, innovations, institutions, success, or heritage and inspiration. The subject is problematic to convey in traditional linear slide presentations, so it is a good candidate to test if the map-based approach improved on this problem. All 13 testers were HCI professionals or students of HCI, and familiar with the subject. In fact, four participants had held lectures on this particular topic before. Additionally, we offered aid on anything unclear, so that the focus of the test remained on authoring and not on testing their knowledge.

old set	new set	
Content ordered by time when possible without conflicts		1
Perfectly time ordered content		1
Alto/Lisa relationship	NEXTSTEP, Macintosh and Mac Os X	1
Lisa/Classic Macintosh relationship	UNIX and NEXTSTEP relationship	0.5
Alto/Star relationship	Windows 1.0 and Mac relationship	0.5
Systems from Apple together	Systems from Apple together	1
Systems from PARC together	Open Source systems together	1
Systems ordered by success	Systems ordered by success	1

Table 5.1: Scoring points for the paper prototypes. Points for relationships were awarded when a visual connection between the items was clear, for example, by proximity, by a drawn line, or by grouping.

Resulting documents were scored and users answered a questionnaire.

We assigned a score to each tester's finished documents to evaluate the visualisation of the talk. Scores ranged from zero to seven, a higher score meaning that the document showed more connections of the topic visually. Two points were awarded per ordering criteria (time, heritage, commercial) and one point for success (See table 5.1 for detailed scoring). We expected plane visualisations to score higher but take more time to author, due to the higher expressiveness of the plane compositions.

- H1: The plane visualisations score higher.
- H2: The plane authoring takes longer.

Due to testing both semantics within groups, learning effects were likely to occur and so we formed additional two hypotheses:

- H3: The second test is accomplished faster.
- H4: The second visualisation gets a higher score.

Finally, to evaluate that no side effects from the choice of subtopics had occurred, we formulated a final hypothesis:

- H5: Both subtopics score about equal.

5.2 Study Results

5.2.1 Scores

The resulting scores (Table 5.2) ranged from 2 to 5 for slides with a mean of 2.85, and 3 to 6 for planes with a mean of 4.62. The mean difference between slide and plane scores is 1.77 points with a variance of 1.026, thus significant to the 0.0001 level. Plane authoring took slightly longer per tester than slide authoring, however the difference is not significant—in fact, 6 of our 13 testers finished the plane editing faster. The results also indicate that the test was not biased by our chosen subtopics or learning effects.

Plane documents scored higher but authoring did not take longer.

	mean	variance	p-value
difference between plane score and slide score	1.77	1.026	0.00004
difference between second score and first score	0.31	4.32	0.603
difference of sets	0.31	4.73	0.619
plane time / slide time	6.37%	11.93%	0.519
second time / first time	12.62%	5.72%	0.081

Table 5.2: Presentation scores from the paper prototype study. Planar presentations scored higher in visualising the topic structure, without taking significantly longer to prepare. Paired t-test, n=13.

Against our expectations, we did not find that plane authoring takes significantly longer, which is encouraging since it indicates that the tradeoff between media quality in the sense of topic visualisation and preparation time is either nonexistent or small when using the Fly approach. In summary, the hypotheses H1, H3 and H5 were strongly supported by the study.

5.2.2 Questionnaire and Observations

Answers to the slide-related questions Q1 and Q2 were widespread, with a tendency towards the positive aspects of slides. The diversity of answers and their statistical variance indicate that this is an issue of personal opinion. We

Question	mean	σ
Q1: Did you feel that the size of the slides negatively limited the way you wanted to do your presentation?	2,54	1,20
Q2: Did you feel positively guided by the slide size?	3,23	1,17
Q3: Before putting information on the plane, did you feel lost in the big free space?	2,23	1,30
Q4: Do you feel that your final result of your plane looks messy?	2,62	1,45

	Slides	None	Plane
Q5: Was it easier for you to express your ideas on the unlimited plane or the slides?	2	1	10
Q6: As a presenter, what would you prefer for your real presentations?	3	6	4

Table 5.3: Results for the paper prototype questionnaire. Q1–Q4 were answered on a 1–5 Likert scale.

observed six users changing their layouts or leaving material out due to limitations of the slide format. All users intentionally implemented a common slide layout and oriented on the slide bounds.

Testers preferred the expressiveness of Fly but are undecided about general preference.

Testers clearly agreed on Q5 that it is easier to convey ideas with a planar visualisation. We discuss the visual diversity of their documents shortly. When asked for their preference, some authors claimed they would decide depending on task: slide visualisations whenever a quick and one dimensional solution is sufficient, planar when they had to present an interconnected subject. Plane visualisation was also perceived to take longer, as indicated in the previous section.

Typical slide authoring started by picking the oldest system and designing a slide for it; in seven cases editing followed a "fire and forget" style: once a slide was finished, it was cast away and not looked at until the very end, in extreme cases even flipped over and made completely invisible. The authors were effectively getting locked into the detail trap (see 4.1.3—"Detail Trap").

Typical plane editing, on the other hand, started by plan-

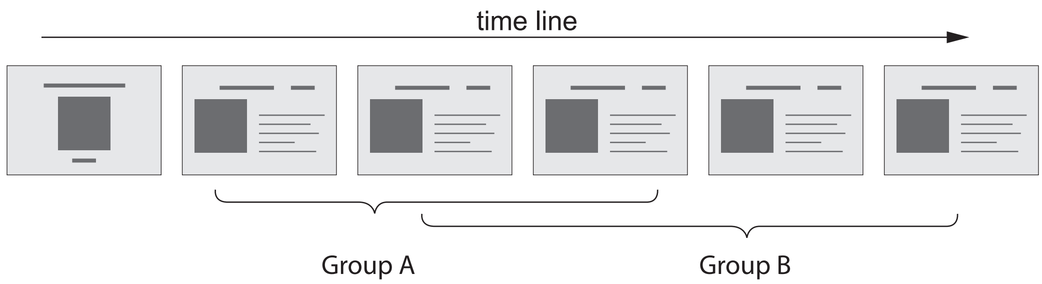


Figure 5.3: Time and group ordering conflict in the linear case.

ning the overall layout of all content on a higher semantic level, i.e., sorting before placement. Images representing subtopics were placed in relation to each other, but could still be rearranged easily. Afterwards, other material was grouped around them. Some users were less familiar with conceptual planning at the beginning, and spent up to two minutes preparing before placing the first material. Q3 and Q4 show that the novelty of plane editing and the different looks can be confusing. Further research is needed to reveal whether this is a permanent issue or due to the unfamiliar interface. However, no testers fully agreed to Q3 or Q4, indicating that plane editing was never entirely rejected.

Testers have the whole composition in mind during plane editing.

5.2.3 Visual Diversity

Figure 5.2 (right) shows the two designs for the slide visualisations: The only variations in this theme were the position of the picture and the date with practically identical results otherwise. If one subject spanned two slides, the image was often repeated (Compare to figure 4.1).

Taking a look at the inter-slide arrangement, we detect two conflicting forces (Figure 5.3): the author has to decide whether she wants to present the computer systems in historical order or grouped by some criteria (company, innovation,...). If she lines them up in precise time order, she will not be able to group correctly, and if she decides to cluster by groups, time will be presented non-linearly. Our testers were very aware of this problem and often commented accordingly: "It is hard to get a good order", and "I

Slide presentations were very much alike.

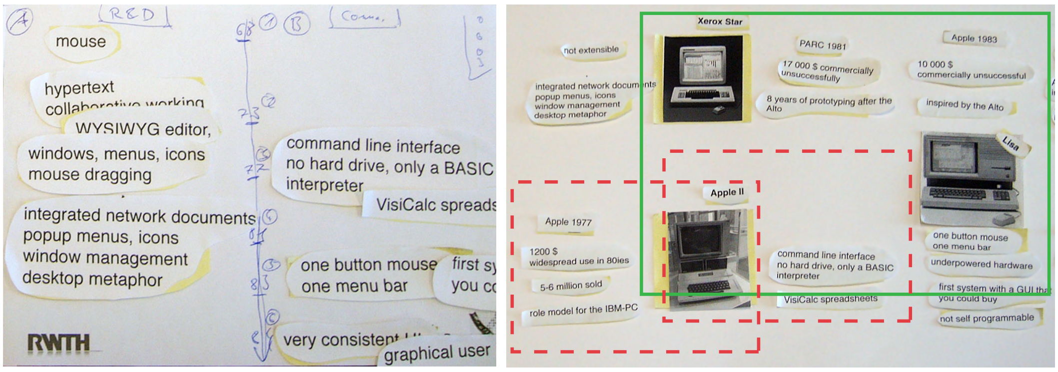


Figure 5.4: Left: A manual timeline slide at the end of a talk. **Right:** Planar compositing. Dashed (red) rectangles show an image being shared between two views. The solid (green) rectangle shows a local overview.

will present non-profits first, and then make a jump back in time and start with Apple's systems." The possible disorientation of the audience was also a concern. Therefore, six authors manually added a timeline slide at the beginning or end of the slide deck (For example, figure 5.4, left.), and four mentioned that they would take special care to make breaks in the time ordering clear verbally during their talk. The mean score of 2.85 also shows the limitations of the slide authoring: authors often scored fully in one ordering criteria and only half in another, because it was not easy to show both in a linear model (compare to 4.1.2—"Time Dominance").

The plane visualisations exhibited more variation on the detail level.

The plane visualisations exhibited more variation on the detail level. Often the whole material for one subject was not visible simultaneously. For example, testers positioned text to the different sides of the image at the same time, thereby sharing the image between two viewports and strengthening the context (see dashed red rectangles in figure 5.4). The more flexible layout facilitated dynamic local comparisons with and without zooming (see solid green rectangle in figure 5.4). Nearly all testers saw this possibility, and planned their layout accordingly.

With one exception, all plane documents were more verbose and left out less material than the slide ones—it is unlikely to run out of space. In contrast, most slide authors started a new slide only when they had enough material,

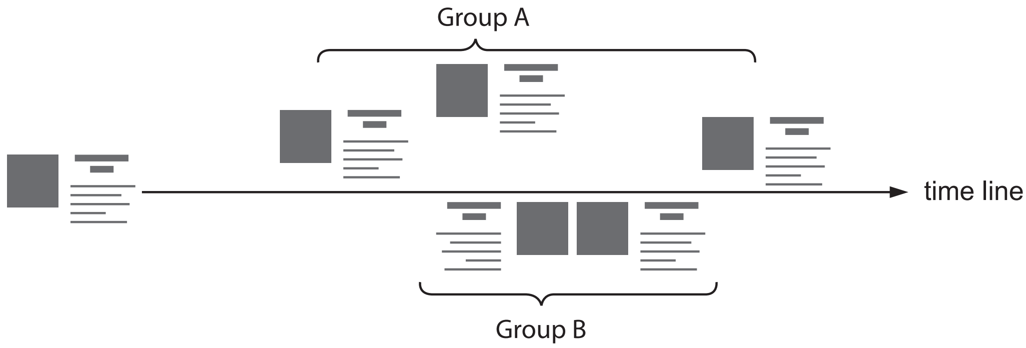


Figure 5.5: Timeline layout. The problem of conflicting ordering is solved in a planar layout.

and left it out otherwise (compare to 4.1.1—"Content Cutting").

Figure 5.5 shows how the problem of conflicting order criteria has been addressed elegantly: the vertical dimension makes it trivial to group subjects without breaking the timeline into segments, or, as one tester put it: "The Apple II should go here chronologically, but it does not fit—I see, that's why we have the plane." Most plane visualisations include the inspirations and heritage as a new dimension, which was uncommon on any slide layouts. This result is coherent with the answers to our question concerning the users' preferences for expressing their ideas.

Since the plane documents were diverse in shape and structure, we asked our testers what the main idea of their visualisation is, and found that the design depends on the dominant variable from the author's point of view: They structured their talk along this dimension, and then tried to include other dimensions. For example, the design in Fig. 5.5 is rooted in the idea of time, and first orders all items chronologically from left to right, then adds clustering in the vertical dimension according to another criterion. A second design (Figure 5.6) starts by constructing "pillars" of a common idea and then spreads them out horizontally. A third design (Figure 5.7) revolves around a central idea of the talk, in this case an important computer system perceived as the origin of the remainder. Designs one to three were observed 5, 4, and 3 times respectively during our study and seem equally capable of communicating the

The plane visualisations exhibited more variation on the topic level.

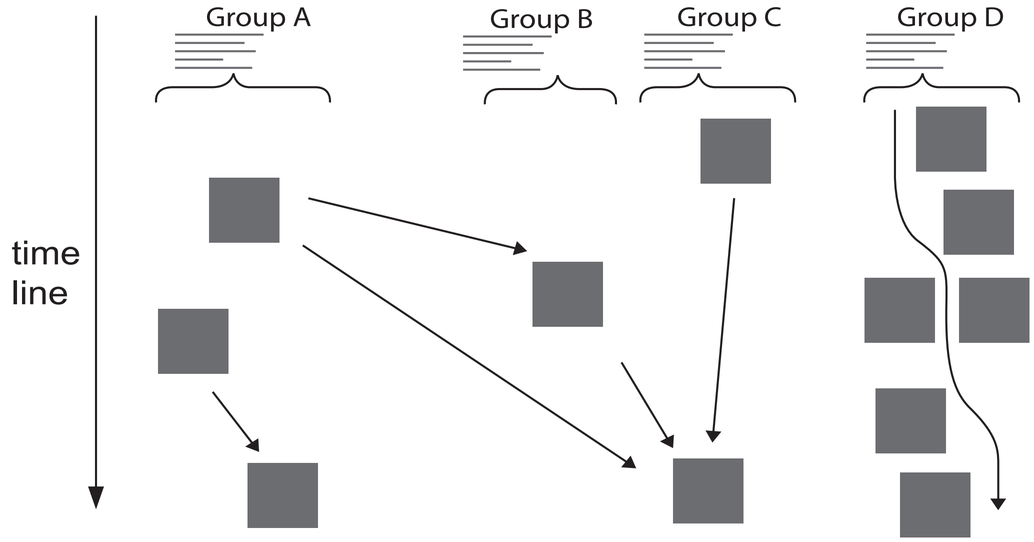


Figure 5.6: A planar layout with groups along the horizontal, and time along the vertical axis.

topic's features.

5.2.4 Feedback and Suggestions

Our testers asked for features which we had not implemented in the paper prototype or had not thought of: Colouring or texturing the background of a subtopic can easily be included in the design and might prove an elegant method to define "regions". Labelled or unlabelled arrows as links between items were simulated with Post-It notes.

Testers asked for semantic scaling.

Many testers noted that simple geometric scaling for higher zoom levels would make little sense to them. Instead, they suggested a variety of solutions for semantic zooming emphasising context and connectivity. Thus, the visualisation should have at least two states: the normal *detail* view in which all material is proportional to each other, and the *context* view in which a subtopic is represented by a short placeholder and shape remains visually intact. Another suggestion was to make the remainder of the material indicate its presence to the viewer, without grabbing attention

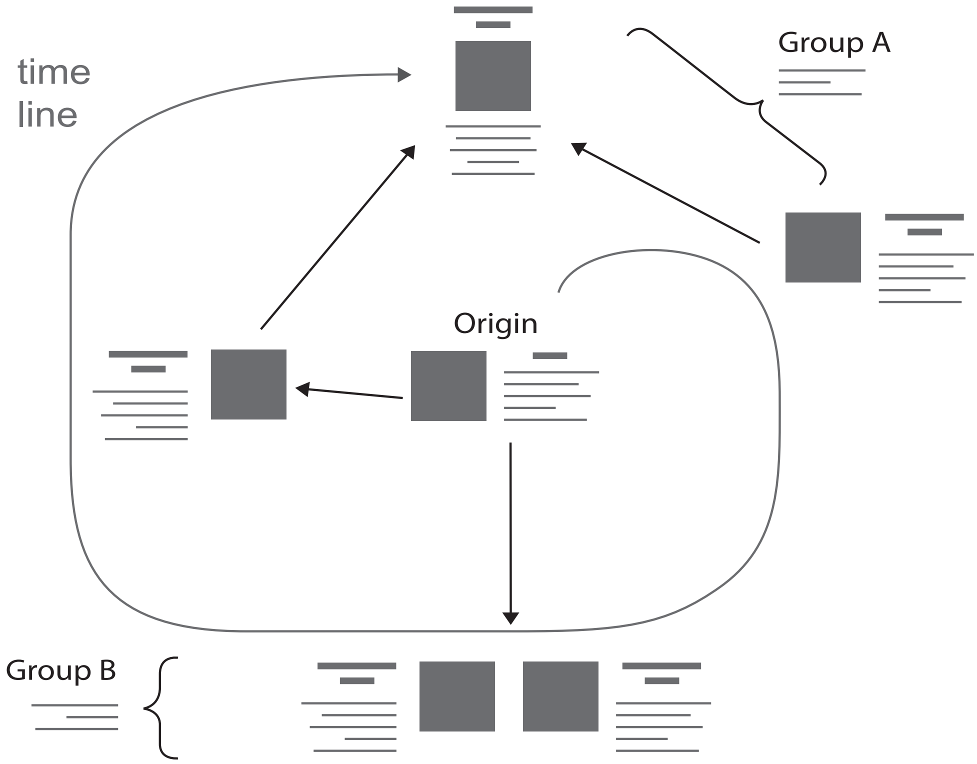


Figure 5.7: A planar layout where the central topic serves as an origin for the talk.

or suggesting that it should be read. Several users stated that they would rather start at this overview level, and fill in the details later.

When testers used the frame to indicate which path they wanted to take, often snippets were half visible or information of a subject not currently in focus could be seen. This is very uncommon in slide presentations where only immediately relevant information is shown. Authors, however, stated that they did not consider this a problem, as long as the information did not disorient the audience or was introduced beforehand.

Revealing of context information should be examined.

Chapter 6

Software Prototype

"The primary duty of an exception handler is to get the error out of the lap of the programmer and into the surprised face of the user."

—Verity Stob

6.1 Design of the Implementation

After completing the evaluation and analysis of our paper prototype, the goal of the software prototype was to find out if the concepts that worked in the paper domain would carry over to an interactive application, and to explore the impact of high-quality visual animations on the perceived fluidity of presentations. Two major problems make it hard to transport the easy paper handling to the computer: limited screen space, and the indirect manipulation through mouse and keyboard.

Our Fly implementation runs on Mac OS X 10.5[1] and uses Apple's included Core Animation[2] library for fluid interaction and animation. Our findings indicated that zooming is an obvious and natural metaphor for revealing more detail about a topic. At the same time, however, unlimited ZUIs

[1] http://www.apple.com/macosx/

[2] http://www.apple.com/macosx/technology/coreanimation.html

Items can be placed at two heights

show that arbitrary geometric zooming is hard to control and leads to much extraneous interaction. Consequently, we introduced a *layer constraint* to the planar interface: Information items can be placed in two layers, *topic* and *detail*. Text size for topics is five times larger than details, and topics are rendered on top of the remaining content.

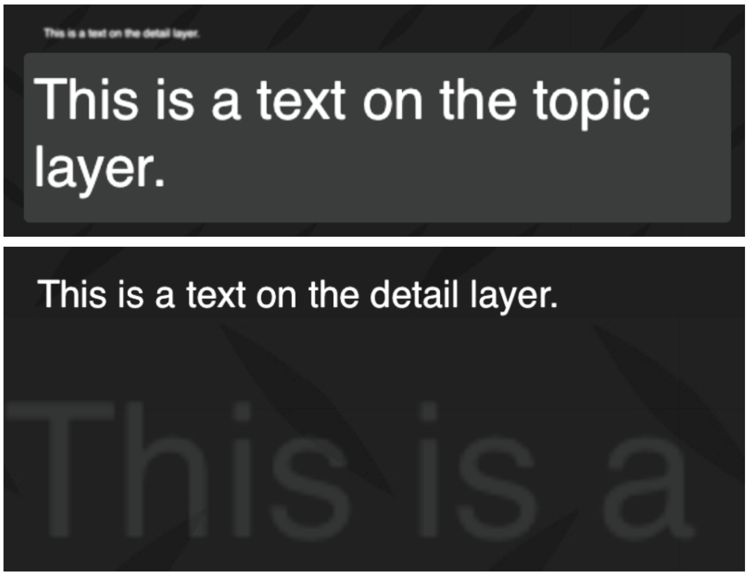


Figure 6.1: The same two texts at different distance levels. **Top:** Camera zoomed in. **Bottom:** Camera zoomed out

All changes are animated and fluid

When zoomed out, details are blurred; when zoomed in, topics are semi-transparent. This ensures that at any zoom level one of the two is always clearly readable, but the other is still visually present, ensuring an organic, i.e., fluid and physically plausible, visual experience (Figure 6.1). Topics are a different representation of the underlying details. This design also ensures that text items on the same semantic level always have the same size, and are clearly readable to the audience. To keep the landscape planar, the interaction is limited to a maximum zoom that corresponds to the details and is visualised with a background texture. This way, content arrangement does not get confusing with arbitrarily small nested and possibly new information, but stands on a firm “ground” that helps to give a clear impression of zoom “height” at all times. During implementation, we found that a background texture is essential for the orientation. Similar to complex written texts and their subheadings, very complex documents may require a third or even fourth level, which is something we intend to study in future experiments.

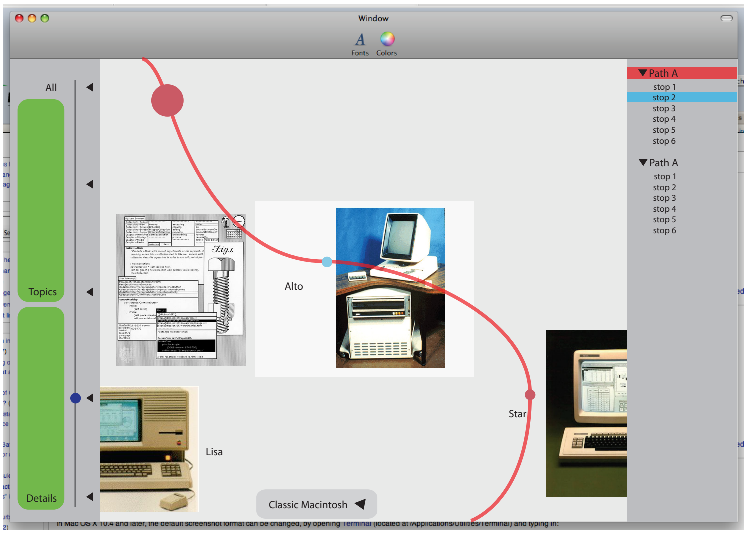


Figure 6.2: An high-fidelity sketch of the Fly main screen before the implementation.

The Fly screen (Figures 6.2 and 1.1) is divided into three parts: the main centre view shows the planar interface in which the user can arrange images and text as in the physical world of paper. The user interacts with objects using the left mouse button. Objects can be moved and their bounds can be changed, when text bounds are changed this causes the text to wrap, rather than scale. The right mouse button grabs the landscape and moves it around. Additionally, we implemented mouse-centred zooming using the scroll wheel. To the left are zoom controls, displaying the current zoom height and button shortcuts to important layers. To the right is a list showing all paths that are defined in the landscape and individual stops (snapshots). The paths may also be displayed in the main view so that the author can see the flow of the presentation. The possible reification of time for the audience was not present in any of the related work we found (3.5—"Comparison"). Upon pressing the *Start Route* button, the main view scales to fullscreen for presentation delivery. During presentation the author can follow the path by pressing the *next* and *previous* buttons on

Fly can store many paths for different occasions the keyboard or a remote, or she can pan an zoom as during authoring using the mouse. A new path stop is defined by moving the view to the desired position, zooming and then creating a snapshot. Stops can be reordered, deleted, named, and directly accessed in the path list to the left. A path stop is the equivalent of a position of the slide frame in the paper prototype test. Direct manipulation of the stops was planned, but not implemented for this study due to time constraints.

A well-known problem of ZUIs is the visualisation of context [Pook, 2001, Baudisch et al., 2002, Baudisch and Rosenholtz, 2003, Zellweger et al., 2003]. We settled with displaying arrows and miniature versions of topics at the screen border. The indications are less transparent if the object is closer, and seamlessly change into the topic's real representation. This visualisation does not show a precise distance measure, but gives an overall feel of the position in the document. The user can toggle the visibility of paths and arrows via the main menu.

6.2 Evaluation

The evaluation was conducted in a similar manner to the paper prototype study

Since we wanted to check the results of the paper prototype in a software setting, we conducted our second study in a similar manner. Yet, we modified several aspects of the earlier user test design: The Fly software was compared to Microsoft PowerPoint 2004[3] . The test was an uneven match, since PowerPoint had more features, better responsiveness, a more refined UI, and is familiar. Fly, however, had the advantage of simplicity and novelty. Users were unfamiliar with Fly and had varying degrees of slideware experience.

Two new topics, "The Characters of Star Wars" and "The Characters of Harry Potter" were tested with 18 users. The topics were chosen to be similar in shape and familiar to most testers. We also supplied images and text snippets to speed up authoring. Testers were 10 students, 5 regular lecturers, one engineer, one architect, and one quality con-

[3]http://www.microsoft.com/uk/education/products/office/office-mac.mspx

troller. Five testers were computer scientists, and none of them had participated in the first study.

We once again assigned scores from 0 to 7 to measure the connectivity and visual clarity of the resulting documents with respect to the topic's inherent structure. Testers answered a questionnaire and we observed the majority of the tests. We also gathered informal feedback from two real-world situations in which presenters used Fly to present their own work to the rest of our research group.

Sequence of authoring semantics and scope of the talk were counterbalanced and assignments handed out randomly. We did not measure completion times, because some of the tests were done without our supervision. Hence, we repeated only three of the hypotheses from the first study:

- H6: The Fly documents score higher.
- H7: The second document gets a higher score.
- H8: The two sets score about equal.

6.2.1 Study Results

	mean	variance	p-value
Difference of Fly score and PowerPoint score	1.97	1.96	0.009
Difference of first score and second score	0.36	2.82	0.3755
Difference of sets	0.25	2.89	0.5435

Table 6.1: Scores of PowerPoint vs. Fly presentations. The Fly software prototype is able to confirm the results of the paper prototype. Paired t-test, n=18.

Score results (Table 6.1) ranged from 2 to 4 for PowerPoint with a mean of 2.78, and from 1 to 7 for planes with a mean of 3.75. The scores are significantly higher in Fly, however not as clearly as in the paper prototype. H7 and H8 are supported, so learning effects between the first and second topic did occur. But since the order was counterbalanced and there was no significant difference between the sets, we can assume the test was not biased by learning effects.

Fly documents scored higher as expected

Question		mean	σ
Q7: I am satisfied with the resulting PowerPoint document.		3.67	0.91
Q8: I am satisfied with the resulting Fly document.		4.22	0.81
Fly - PowerPoint satisfaction		0.56	0.78
	PowerPoint	None	Fly
Q9: It was easier for me to express myself with...	4	4	10
Q10: Overall, for my real presentations I would prefer...	3	5	10

Table 6.2: Results for the software questionnaire. Q7–Q8 were answered on a 1–5 Likert scale, n=18.

Testers preferred Fly

When asked whether they were satisfied with their results(Table 6.2), testers gave generally positive answers for both PowerPoint and Fly. Satisfaction was significantly higher for Fly (p= 0.008). When asked which software it was easier to express themselves in, and which they preferred for real talks, most testers chose Fly. Compared to the paper prototype, the expressiveness advantage was less clear, but more preferred Fly.

6.2.2 Qualitative Results

Each questionnaire (see A—"Summary Forms") had four free text sections asking what the testers liked or disliked about Fly and PowerPoint. Learning a new interface paradigm is a burden, and Fly is no exception; yet five testers stated that after a difficult start, they found Fly easy to use. As expected, PowerPoint was liked by many users because of familiarity (11) and rich formatting options (7); at the same time, it was criticised as to complex or overloaded (6).

The testers comments underline our slideware evaluation

We gathered strong feedback considering the three problems of slideware: Seven testers each stated that they see a benefit in the creation of overviews over PowerPoint, or, as one tester put it: "[It] creates overviews by itself." Two editing layers turned out to be enough for the scope of the test materials. Seven testers see an improvement upon PowerPoint in creativity, and six liked the ability to place elements without restricting slide frames, underlining the *content cutting* problem. Two stated slideware makes "run-of-the-mill" presentations whereas Fly was considered more flexible. Three considered the slide framework harmful, one said it helped her. The possibility to define paths by demonstration was consistently considered positive.

6.2.3 Visual Diversity

Figure 6.3: An example document from the user study with three groups.

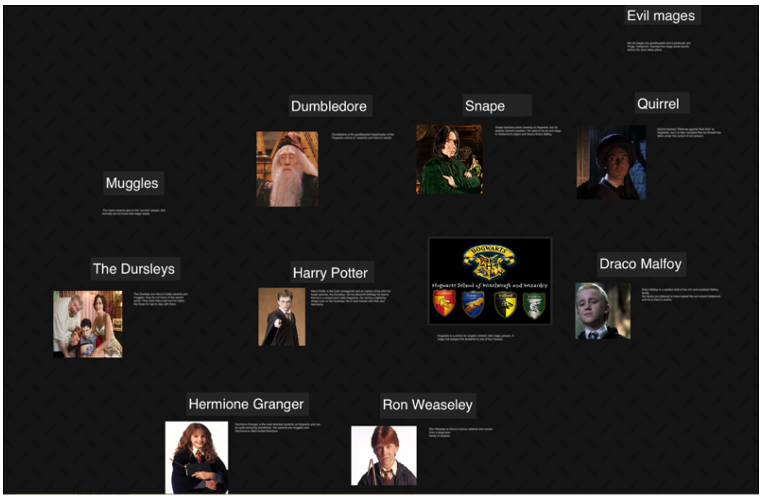


Figure 6.4: A Fly document from the user study, that we classified as a collage.

	slides	plane	PowerPoint	Fly
linear talk	7		14	3
overview followed by individual items	3		1	
timeline overview	3	5		
grouped/clustered			3	3
pillars		3		2
collage				2
circular		4		2

Table 6.3: Distribution of the visual styles of the created documents. One of the plane documents could not be classified.

Most PowerPoint documents were strictly linear

We looked at the resulting documents similarly to the paper documents (See table 6.3 for a comparison between both studies.) Of the 18 PowerPoint documents, 14 were strictly linear. Three clustered all content on less than three slides, and only one created a manual overview slide before sequentially discussing each person in detail.

Fly documents featured a variety of designs

In contrast to that, only three Fly presentation documents were linear, nine divided the topic into two or three clusters (i.e., good vs. evil, Figure 6.3), and two structured the characters in two pillars (Figure 5.6). Two layouts were circular (Figure 5.6), discussing the connection of all characters to the main character in the centre. The last two arranged information like a collage (Figure 6.4), but without hierarchies, relying on proximity alone. All fifteen non-linear talks had meaningful overviews, and fourteen presentation documents used zooming as visual feature in their paths. Only one user overlaid information in z-axis, all other kept it planar. Although part of this roots in the novelty of the interface metaphor, we deduce that users prefer planar over three-dimensional layouts.

6.2.4 Implementation Problems

Mouse-centred zooming seemed to be new to almost all testers, and five did not understand it until it was explained to them. Restricting object placement to the two topic and detail views worked well for our users. They did encounter a problem with our implementation, as the level at which a new content was created depended on the current zoom level. Most testers accidently created objects at the topic level. Creating path segments turned out to be difficult: four testers assumed that, when pressing the "new landmark", the created position would be centred around the current selection. The icon of the button (a flag) could be misleading, because we did not observe this during informal tests, when the icon still showed a photo frame. The next version of Fly should contain better clues for mouse-centred zooming, and remove the side effect of the zoom slider (see 7.2—"Future work").

The implementation should be improved

6.2.5 Revealing Problem

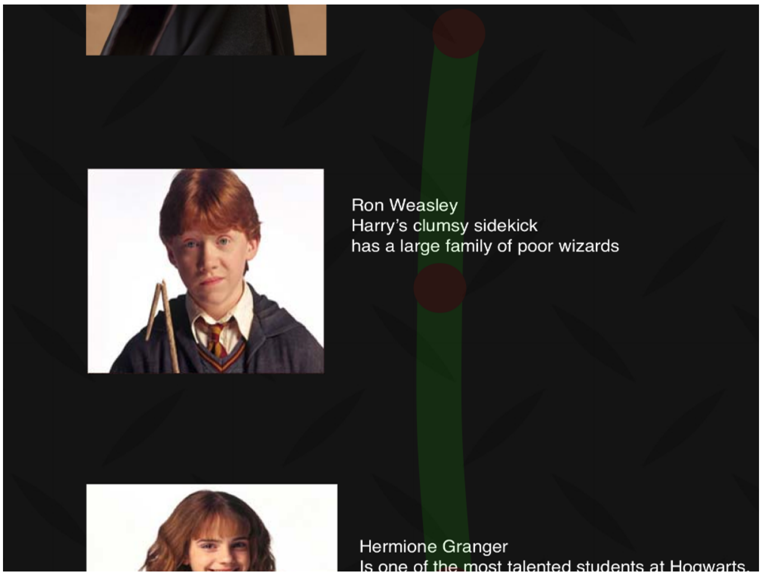


Figure 6.5: An example of the revealing problem in Fly where the heroes are presented after another. The path begins at Harry Potter, and leads via Ron to Hermione. Authors often found the half-revealing of upcoming content (Hermione, bottom) troublesome, but not of already presented information (Harry Potter, top).

When laying out their path, four users were concerned with the visibility of the next topic (Figure 6.5): They tried to hide the upcoming parts, but since Fly has no mechanisms for revealing, they had to place them at greater distance to

The revealing of upcoming content should be studied further

achieve this. For previously discussed topics this was not perceived as a problem (This is consistent with the remarks in the previous study. 5.2.4—"Feedback and Suggestions"). While some content, such as answers to questions for discussion, will always require hiding, in many cases the preview of upcoming content might actually be helpful to the audience. This is clearly an issue that future research on Fly will have to address.

Chapter 7

Summary and future work

"An object in possession seldom retains the same charm that it had in pursuit."

—Pliny the Younger

7.1 Summary and contributions

Presentations are complex tasks, and in this thesis we conducted a literature review of related work on presentation interfaces. Comparing these with the organic interface paradigm and our own study results, we were able to identify at least three major aspects in which current presentation software hinders the authoring and presentation process.

In this thesis we presented Fly, an organic interface for authoring presentations, which is not based on the slide metaphor but allows authors to freely lay out information on a plane in a map-like fashion. Our studies provide a quantitative evaluation for Zoomable User Interfaces in an authoring setting. This concept was first evaluated in a low-fidelity prototype user test which provided strong evidence that users not only easily understood the

The resulting documents are more connected and have more overviews

Authors preferred Fly

new interface but were able to capture the structure of strongly connected topics in their presentations much better than when using the traditional slide interface. We were able to confirm these results in a second user test comparing the authoring process of presentations using a high-fidelity software prototype of Fly against Microsoft PowerPoint. The resulting presentations contained more meaningful overviews and more often diverged from a strictly linear presentation of the non-linearly structured topics. Likewise, users commented positively on the ability to express their mental models of the material more freely and in the second study preferred Fly over interfaces based on the slide metaphor.

Fly improves over slideware in the three problem areas

While these findings support our hypothesis that the Fly interface, allowing planar arrangement of information, smooth and fluid navigation over the plane, and a continuously controllable level of semantic abstraction, is better suited for the task of authoring illustrations for non-trivial topics than slideware, we could also successfully show the applicability of the organic interface paradigm. In particular, it helped us identify the conflicts between the human thought process and the affordances of slideware (4.1—"Problems of Slideware"). We changed our design of Fly to atomic placement of information items, because it provided a rationale against categorisations and structures. When deciding on the planer model of the information landscape, we ran into a conflict between two organic principles. On the one hand, the design should be continuous and allow for a wide range of content scales; on the other hand, this would have broken the principle of physical plausibility, because in nature objects do not scale arbitrarily. We decided to follow the later argument.

Better visuals do not necessarily lead to a better talk, as speaker performance will remain the dominating factor of presentation quality. Yet, fewer barriers in editing will help authors to express their ideas freely, to create richer, more diverse, and more memorable presentations. We hope that Fly, and the concept of Organic Interfaces in general, will help to move research towards this goal.

7.2 Future work

7.2.1 Implementation

The second study has uncovered areas the implementation of the current prototype should be changed. These are not changes in the overall design, merely improvements on its realisation.

First, the mouse centred zooming was difficult to understand if authors were not familiar with it before. We suggest a small animation centred around the current mouse position to make this more clear.

Secondly, the two buttons *new text* and *new media* created content on the currently visible layer. Not all authors detected this and this lead to errors, so we suggest to create content always on the lower level, and maybe include a new set of controls for the second layer.

The interaction with the paths should be realised with more direct manipulation. For example, path stops could indicate their visual region after creation, and path stop should be dragable. Some testers and related work [Moscovich et al., 2004] also suggested a feature to change paths during presentations depending on available time. Further testing should clarify these needs of authors in more detail.

7.2.2 Authoring

We concluded that time difference in paper authoring was minimal, but authors felt that it took longer. We did not measure time in the software test, but no tester voiced concerns, indicating the need for further studies.

The documents created in the studies were all for short talks, documents for real talks are likely bigger and with more appendix material. Related work [Good, 2003] already indicated that this is an area that can benefit from the ZUI approaches. Our tests compared Fly with slideware, a next step could be to compare Fly with slide-based ZUI approaches. Also, we would like to find out how collaborative authoring of presentations works best with Fly.

7.2.3 Presentation Delivery

Future experiments will extend from authoring talks to the task of presenting them. The new dimensions of the document area might need better presentation remotes for spontaneous repositioning of the screen or zooming. For example, a large screen mobile device can use touch interaction or the zooming and panning of the view. Since such a mobile device can display presenter-only information, tests could compare two modes of remote control: The mobile and presentation camera view can be synchronised, or the presenter navigates to a point of interest and then shows this view to the audience.

Our testing showed that authors desire a method to hide upcoming content. One could generalise this concept towards a state machine engine that allows any part of the presentation to change along the path, allowing animations.

7.2.4 Reuse

Many presentations today are recorded for later reuse, for example, as online videos. Fly could record the path the presenter has taken, store an audio recording of the talk, and combine them into an interactive lecture handout. The user then sees which topics were discussed in which order, clicks on the path at the point of interest, and Fly advances the talk and audio recording to this section. This could be an interesting alternative to slide handouts or simple video recordings.

Appendix A

Summary Forms

The following forms were used for the first and second user study respectively. The order of instructions for the software evaluation was counterbalanced.

regarding the slides	absolutely not		unsure		very much
Did you feel that the size of the slides negatively limited the way you wanted to do your presentation?	☐	☐	☐	☐	☐
Did you feel positively guided by the slide size?	☐	☐	☐	☐	☐
regarding the plane					
Before putting information on the plane, did you feel lost in the big free space?	☐	☐	☐	☐	☐
Do you feel that your final result looks messy?	☐	☐	☐	☐	☐
comparison	**slides**		**no preference**		**plane**
Was it easier for you to express your ideas on the unlimited plane or the slides?	☐		☐		☐
As a presenter, what would you prefer for your real presentations?	☐		☐		☐

Notes:

Figure A.1: Questionnaire for the paper prototype

Consent Form for Presentation Authoring Experiment

Please read the following agreement and complete the participant profile:

This study is being conducted by researchers at RWTH Aachen University. We would ask you to create presentation documents using different software. We will measure the impact of the software on the resulting documents, not your proficiency. The two tests should take 40 minutes in total and you can stop and change your mind at any time. We have prepared a few questions for you to answer afterwards. The questions should take about 5 minutes and responses are all voluntary; you may answer as many or as few as you would like. If we use any quotes from your questionnaire in reports or presentations, your real name will not be used, and any personally identifying data will be changed or omitted. If you would like to help us please sign up and fill in the participants profile.
Thank you!

____
signature of participant

Gender	☐ male	☐ female	
Age	____________		
I use a computer...	☐ less often than once a week	☐ more often than once a week	☐ every day
I prepare presentations...	☐ once per year or less	☐ once per month or less	☐ more often than once per month
I currently work as	____________		

1/4 F/HP

Figure A.2: Software Prototype Questionnaire Page 1

Test part A:

We now will ask you now to create a presentation document using the *Fly Software*.

Please follow the following instructions in this order:

1. The topic of the presentation will be the characters of the story *Harry Potter*. It is no problem if you have not read the book, seen the movie or do not remember it. A short summary and pictures are available in the folder "Harry Potter" and more knowledge is not needed. Please open the PDF document.
2. Please start the Fly software. If you are not familiar with the software play around until you feel comfortable. Open the Fly Document in the folder "Harry Potter".
3. Please try to sketch a visual landscape for a talk to the best of your ability, we will however not ask you to give the talk in question. Please focus on the structure of the talk and don't concern yourself too much with the graphical details, typos and the like - they are all irrelevant to the test. We suggest you copy text parts from the PDF document using copy & paste to save you some typing and use any of the pictures in the folder. And remember: the test is still about the software and not about you, it is OK if things do not line up perfectly. This should not take more than 20 minutes and you can do this as quickly as you like.
4. Plan a route through the landscape to describe how you would show things during a presentation.
5. Save the document to the folder "Harry Potter". Close Fly and any other open files.

Test part B:

We will now ask you now to create a presentation document using *PowerPoint*.

Please follow the following instructions in this order:

1. The topic of the presentation will be the characters of the movie *Star Wars*. It is no problem if you have not seen the movie or do not remember it. A short summary and pictures are available in the folder "Star Wars" and more knowledge is not needed. Please open the PDF document.
2. Please start the PowerPoint software. If you are not familiar with the software play around until you feel comfortable. Open the PowerPoint document in the folder "Star Wars".
3. Please try to sketch visual aids for a talk to the best of your ability, we will however not ask you to give the talk in question. Please focus on the structure of the talk and don't concern yourself too much with the graphical details, typos, text color, fonts, etc. - they are all irrelevant to the test. You can copy text parts from the PDF document using copy & paste and use any of the pictures in the folder. And relax: the test is about the software and not about you, it is OK if it is not perfect. We estimate 20 minutes or less for this, but that is not a fixed time, you can finish earlier if you like.
4. If you want, reorder the slides.
5. Save the document to the folder "Star Wars". Close PowerPoint and the PDF file, they will no longer be needed.

2/4 F/HP

Figure A.3: Software Prototype Questionnaire Page 2

Please fill out the following questions according to your experience with the presentation tools you just met.

Statement	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am satisfied with the resulting PowerPoint document.					
I am satisfied with the resulting Fly document.					

Statement	PowerPoint	Neither	Fly
It was easier for me to express myself with...			
Overall for my real presentations I would prefer...			

3/4 F/HP

Figure A.4: Software Prototype Questionnaire Page 3

Please state what you **liked** about the interaction with **PowerPoint**:

Please state what you **disliked** about the interaction with **PowerPoint**:

Please state what you **liked** about the interaction with **Fly**:

Please state what you **disliked** about the interaction with **Fly**:

Thank you for participating!

4/4 F/HP

Figure A.5: Software Prototype Questionnaire Page 4

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