

PRESENTATION IN FREE-FORM SPACE: MANAGING AMBIGUITY WITH  
HYPERMEDIA PATHWAYS WHILE SUPPORTING IDEATION

A Thesis

by

FEIYU YU

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Chair of Committee,	Andruid Kerne
Committee Members,	Francis Quek Sharon Lynn Chu
Head of Department,	Dilma Da Silva

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## ABSTRACT

Traditional Slideware presentation tools (e.g. PowerPoint) suffer from the problem of premature formalism, which interferes with how authors develop new knowledge. Free-form spatial content organization can overcome this problem, by allowing users to express multiple, emerging relationships among content elements. Although its ambiguity fosters interpretation of relationships for both authors and audiences, the ambiguity will make presentation more challenging to perform. Therefore, we integrated hypermedia pathways with a free-form space to support presentations. We conducted a field study, addressing 158 users to understand authors' experiences of creating content in free-form space, integrated with hypermedia pathways for presentation. Our findings show that this integration supports users in not only developing new ideas, but also in performing the presentations.

## DEDICATION

To my parents. And all of my friends, without whom none of my success would be possible.

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All work for the thesis was completed by the student, under the advisement of Dr. Andruid Kerne of the Department of Computer Science and Engineering and in collaboration with Nic Lupfer of the Department of Computer Science and Engineering. The implementation of this work is based on the *IdeaMâché* system, designed and developed by Interface Ecology Lab of Department of Computer Science and Engineering.

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## 1. INTRODUCTION

We built and evaluated a system that supports users' iterative ideation through organizing content in free-form spaces, while providing hypermedia pathways to manage ambiguity through performance of well-organized presentations in those spaces. Hypertext supports non-sequential writing and reading [1, 2] Basically, *hypertext* consists of nodes, connected by links, to form *pathways* [3]. *Hypermedia* simply extends the types of nodes to multimedia. We introduce hypermedia pathways, which enable non-sequential access to multimedia nodes that are organized in a free-form space.

*Slideware*, the prior medium of presentation, typified by PowerPoint, forces users, from the beginning, to slice and dice content into slide units connected into a sequence for presentation [4]. This constitutes premature formalism [5], which has been shown to interfere with how people develop new knowledge.

Spatial hypertext enables users to overcome premature formalism by manipulating relationships among content elements [6]. *Free-form web curation* extends spatial hypertext with support for visual thinking to help users conceptualize and create new contexts—in which they discover, interpret, and represent relationships —by composing content elements into a connected whole [7]. The ambiguity in a free-form space, which enables multiple interpretations of the relationships among content elements, can serve as a resource for design creativity [8]. Authors take advantage of this ambiguity to create new ideas, i.e., to engage in *ideation* [9].

Slideware's premature formalism problem is rooted in an underlying assumptions, such as a separation between emergent creative ideation processes and more focused processes of creating and performing a presentation, based on ideas that are already understood. Slideware does address the need to overcome apprehension associated with performing

presentations [10], by providing creators with structure for a ‘well-organized pitch’ [11]. However, it does not focus authors on the task of articulating relationships connecting assertions with visual evidence; presentations with this structure have been found to support higher comprehension of complex concepts [12]. Our contribution is rooted in enabling the creation and navigation of well-organized presentations while continuously supporting ideation through the articulation of relationships.

In order to support ideation and well-organized presentation experiences, we draw from hypertext. We develop a new, integrated form of hypermedia, which fuses node-link pathways with space. We provide hypermedia pathways to help presenters navigate through free-form spaces. The nodes are built with *presentation frames*, which unitize the content of a space into separate views, like slides. Frames are *linked* into hypermedia pathways, which generalize the form of slide sequences (See Figure 1.1). Our research question is, *How do hypermedia pathways, in conjunction with organizing content in a free-form space, simultaneously support users in using ambiguity as a resource for ideation and then to manage the ambiguity, to support creating and performing well-organized presentation experiences?*

We conducted a field study, addressing 158 users and interviewed 29 authors of presentations. We generated four categories of findings: *free-form multi-scale spaces*, *hypermedia pathways navigation*, *improvisational performance*, and *Ideation*. Our findings show how people use hypermedia pathways in conjunction with free-form space content organization to make well-organized presentations. In the end, we discuss how hypermedia pathways help authors manage ambiguity in free-form spaces, while supporting ideation.

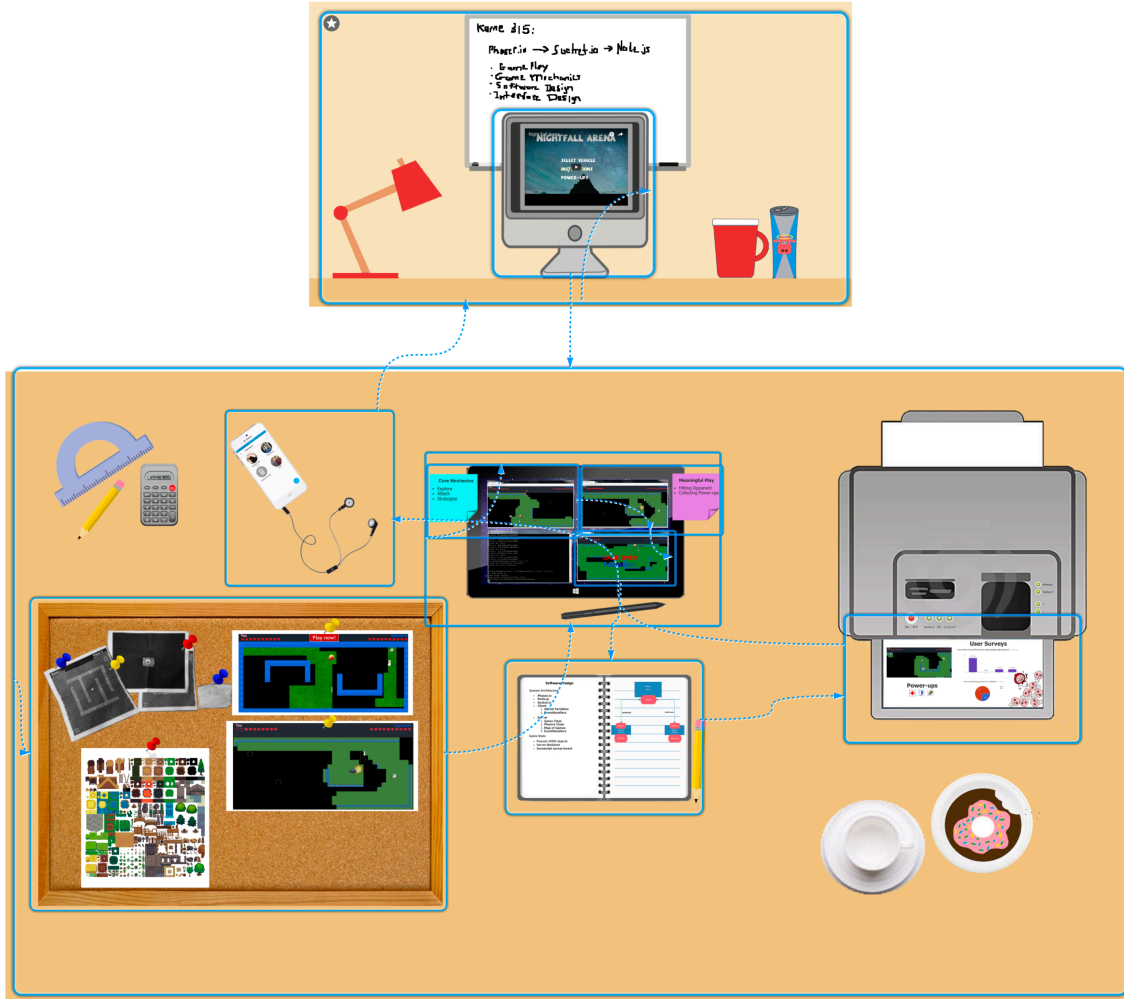


Figure 1.1: *Night Fall Arena*, P21's final presentation for multi-play game design course project (<http://ideamache.ecologylab.net/v/bUfWFcpDUd/>). P21 spatially arranged presentation content in free-form space into a recognizable form which mimics a working desk, for example, put their game structure content on a notebook putting on the desk. Content elements are unitized by presentation frames (light blue boxes). The blue connection lines in conjunction with presentation frames constitute hypermedia pathways, which provide navigation through content for performing presentations.

## 2. BACKGROUND

We situate our work in literature on the drawbacks of traditional slideware, ZUI presentation tools, other presentation tools, hypertext, free-form web curation and performance.

### 2.1 Slideware

Slideware, such as PowerPoint and Keynote provide visual presentation support. A slide is a single view of a set of information [13]. Slides are equally-sized chunks in a linear sequence.

Tufte criticizes slideware's rigid slide-by-slide hierarchies, which slice and dice evidence into arbitrary compartments, producing an anti-narrative with choppy continuity. Slideware forces users to prematurely use the structure of slide sequence and bullet points for presentation content. Shipman and Marshall found that premature formalism interferes with how people develop knowledge [5]. It can produce a gap between the user's goals and the system's representation. Therefore, Tufte suggests to use multiple slides, several images at once within the common view. By doing this, the audiences could select, sort, edit, reconnoiter and review by direct spatial adjacency of evidence.

There is also a time dominance issue with slideware [14]. The slideware tools only provide a hard-coded timeline for the talk. It is hard to get random access to slides. As a consequence, if the presenters do not have enough time to finish talking or anything unexpected occurs, the presenter has no way to directly jump to a desired slide instead of the previously assigned one [15].

Reusing content is also hard in slideware. The only way to reuse a slide is to copy and paste that slide again. If the users want to reuse the contents for different talks, they need to project the contents onto a new timeline again [14]. In our work, we definitely want to get rid of those issues of slideware but maintain its advantages.

## 2.2 Zoomable User Interfaces (ZUIs) Presentation Tools

Zoomable user interfaces enable viewing information at different scales, drawing on spatial cognition [16]. Continuous changes in scale are a fundamental interaction technique. Human memory encodes spatial information distinctly from verbal information as the psychological hypotheses suggest. The spatial layout will provide audiences with an additional attribute or memory pathway with which to recall the presentation content. Prior ZUI presentation tools include CounterPoint, Prezi, and Fly.

*CounterPoint* simplified creation and delivery of zoomable presentations [17], enabling spatial content organization, paths, and levels of detail. However, CounterPoint was implemented as a plug-in of PowerPoint; therefore, users have to start authoring content by creating slides and manipulate content at the slide level. Their study only had 7 presenters who were not involved in CounterPoint's development.

*Prezi* is a popular commercial ZUI-based presentation tool on the web [18]. Prezi allows users to insert multimedia elements to a virtual canvas. When performing presentation, Prezi allows users follow the predefined sequence and zoom in and out to show each slide. A key difference the user model of Prezi, and ours, is that in Prezi authoring of content is performed in terms of a sequence of slide units, while in our work, authoring of content in a free-form space is separated from unitization into presentation frames and linking into hypermedia pathways. Prezi only enables a linear sequence for performing slides.

Lichtsschlag et al. developed *Fly*, a ZUI interface for authoring presentations [14, 19, 20]. Fly allows authors to freely lay out information on a plane, in a map-like fashion, rather than using the slide metaphor. Fly's planar design limits interaction to a finite number (just two) of levels of depth, to avoid the inconveniences of locating a specific item and losing objects' relative proportions. When the users finishes their organization of con-

tent, they need to zoom in or zoom out to choose the exact view the audience will see at one time, and then click the ‘snapshot’ button to make a node on the path. Fly does not support integrated content element editing content elements, beyond copy and paste. Fly also lacks support for branching pathways. A study of Fly showed that it better supported prototyping and re-casting ideas both during the time of authoring a presentation and while performing it.

### **2.3 Other Presentation Support Software**

In addition to Slideware and ZUIs media, prior researchers developed a variety of tools to support presentations.

Spicer et al. addressed PowerPoint’s problem, that it is hard to fluidly navigate linear structure when delivering a presentation to different audiences. They made *NextSlidePlease*, which uses a hyperlink-inspired graph-structure approach for authoring and delivering multimedia presentations to enable users navigate dynamically to respond audiences’ needs [21]. NextSlidePlease automatically searches and analyzes presentation datasets to provide a meaningfully structured presentations. However, since NextSlidePlease only manipulates presentation content on the slide level, there is no ZUI and no capability for overlapping content units.

Drucker et al. developed a technique for comparing and managing multiple slide presentations [22]. They addressed that users commonly create multiple versions of a presentation for adapting it as necessary to the audience or to other presentation constraints. For example, a user may design a short version of a presentation for a conference, while another version might be an hour long presentation for teaching undergraduate students in class. The researchers developed a framework for comparing presentations to identify the subsets of slides that are similar across each version. They then provided an interactive tool for viewing multiple versions of a presentation, which facilitates assembly of



new presentations from prior versions. Our approach to hypermedia pathways provides the support for authoring multiple presentations of the same content as well.

Lanir et al. developed a presentation system which is designed for working on very large display spaces. Their system, *MultiPresenter*, takes the benefits of multiple displays and physically large high-resolution displays. The presenter can author their presentation content in the external slideware tool, an PowerPoint, and then author the flow of a two projector presentation in MultiPresenter [23]. Both static and dynamic presentations are supported in MultiPresenter. The presenters are able to use multiple screens to provide more context, regrading previous information or emphasize the important items, by putting them on the second screen to make them visually available for a longer time. During presentation delivery, the presenter can decide to select and display any slide at any time on the second projector. Further more, there is also a support for multiple versions control. Their system needs multiple displays to achieve dynamic presentation; however, our system only needs one. By arranging the presentation content in a continuous space, we can show the spacial relationships among content units inherently rather than relying on more displays.

Linder et al. proposed a free-form medium of presentation, in which the content is not separated into rigid slide compartments but visually arranged and transformed in a continuous space [13]. They did research on how free-form presentation stimulates free-form thinking and discussion in the classroom. Free-form thinking involves: “1) improvisational exploration of associations; 2) the emergence of new ideas, generated through building on previously known associations; 3) divergent wanderings to unexpected places; and 4) spontaneous synthesis of new understandings, relationships, and ideas.”

From their study, they show that the free-form medium enabled users to experiment with relationships among elements. The free-form assembly of clippings will help users to make connections among elements and, therefore, stimulate thinking and talking. For

this reason, our system provides functions for supporting free-form presentation to help users to articulate complex relationships, and thus stimulate free-form thinking as well.

## **2.4 Hypertext / Hypermedia and Spatial Hypertext**

Hypertext enables non-sequential writing and reading [1, 2]. Hypermedia generalizes hypertext to include multimedia, such as image, audio and video [3]. Since our thinking processes are not sequential, hypertext is expected to provide better support for thinking and representation of ideas [1]. We applied the idea of hypermedia to our presentation content navigation design. Individual chunks of information are usually referred to as nodes. Nodes are content holders [6]. In our context, we called the nodes ‘frames’.

Spatial hypertext enables nodes to be created and moved to express relationships through spatial proximity. It flexibly supports iterative change in design processes [6]. Information composition extended spatial hypermedia—with an emphasis on the visual and a sense of the whole—in order to promote the creative cognition of relationships among elements [24].

## **2.5 Free-form Web Curation**

*IdeaMâché* enables performing strategies of web curation: Collect, Assemble, Shift Perspective, Sketch, Write, and Exhibit [7]. Elements—including images, text clippings, videos, and embedded web documents—can be gathered from web pages by drag and drop. They can be assembled in free-form space by moving, scaling, clipping, and rotating. Collected elements support re-finding to source web pages. A ZUI enables Shift Perspective operations of pan and zoom. The space can be annotated using text and sketching. A cloud service enables Exhibiting curations with permalinks.

While prior versions of *IdeaMâché* enabled free-form web curation, there was no support for presenting content within these spaces, using hypermedia pathways, for presentation. A prior study showed that while free-form curation was valuable for informal pre-

sentations in seminars, where it was shown to stimulate free-form discussion, users were reluctant to use it for formal presentations, because it felt too difficult [13].

## **2.6 Performance**

The performance of presentations is an important aspect of how people engage in and with them. The field of performance studies connects perspectives on “performance” across diverse aspects of human experience. Goffman defines *performance* as, “All the activity of an individual which occurs during a period marked by his continuous presence before a particular set of observers and which has some influence on the observers [25].” From this definition, it is clear “performance” has the potential to provide a useful framing for the investigation of presentation, in contexts such as research, education, and business.

### **2.6.1 Improvisation in Presentation Performance**

Berliner gives a definition of improvisation [26]:

Improvisation involves reworking precomposed material and designs in relation to unanticipated ideas conceived, shaped, and transformed under the special conditions of performance, thereby adding unique features to every creation.

From this definition, we can see improvisation happens in presentation performances. For example, some presenters append extra slides at the end of presentations as a way to prepare to answer questions. For business presentations, the presenter may have back up slides to present based on the reactions of their clients. They can not decide which slides to present until the time they start the presentation and see the reactions of their clients. Time constraint is an another important reason for the presenters to perform improvisationally. When running out of time, the presenters will skip some slides until they find one to resume presentation in order to end the presentation on time. A teacher may change topics during

the class presentation to best respond to her students.

Yates et al. found that “the strong sequentiality of [PowerPoint presentation] constrains the presenter’s ability to respond flexibly to the local audience’s interests and issues” [27]. The limitation of the sequentiality of PowerPoint is shown in this experience of a university student:

“In my class yesterday, I asked a question and the professor said that she would be covering that a few slides ahead. But then several slides later I remember thinking, hey, she’s forgotten my question. I felt annoyed and wanted to say something, but then I could not remember exactly what I was wondering about. The moment had passed” [28].

Because of the multiple usages of improvisation in presentation performance, we designed the functions in our system that support improvisation in presentation performance.

### **2.6.2 Performance Anxiety and Skill**

In 1975, Csikszentmihaly defined *Flow* as “the holistic sensation that people feel when they act with total involvement” [29]. Players in flow may be aware of their actions but not of the awareness itself [30]. The performed activity and interior psychological self’s boundary dissolves.

For presentation performance, if a presenter is in flow, she could maximize her creativity and impact on audiences [31]. Presentations will be believable not only because the presenters are prepared and logical, but also because the presenters are moved by the topic as well. A presenter must fully believe in her story and be ‘lost in the moment’ of engaging their audience.

However, the flow experience can only begin at the time when challenges and skills are above a certain level, and are in balance [32]. This means that when people participate in a highly challenging activity (such as a presentation performance), if they are highly skilled,

they are more likely to be in flow. On the contrary, if they do not have enough skills, they are more likely to feel anxious. For example, a dancer is less likely to experience anxiety if she is feeling more capable of performing a role than one whose skills are deficient [33]. Public Speaking Anxiety (PSA) is a common issue for presentation performers. One study shows that approximately 70% of university students involved in the study indicated at least a moderate level of anxiety in oral presentations [34]. Bishop et al. also conducted a survey which shows that among 803 college students, 35% of them suffered from PSA. Speaking anxiety can lead to low quality presentation performances [35].

Since the cognitive workload of performing presentations is very high [36], performing presentations is normally challenging. Helping people improve their skills has the potential to reduce anxiety. In this research, we provided capabilities to help users respond to the challenges they meet in presentation performance.

### 3. SYSTEM DESIGN

To investigate how people use hypermedia pathways along with free-form spaces to create and perform well-organized presentations, we designed a system that integrates hypermedia pathways with free-form web curation. Hypermedia pathways consist of presentation frames, connections among frames, and visual support for navigation through pathways. The system runs in the Chrome browser. Presentations are stored in the cloud, facilitating access across computers and networks.

#### **3.1 Authoring: Unitizing the Space into Presentation Frames**

While free-form spaces are valuable for showing relationships among content elements, limitations in screen resolution and human cognition dictate breaking content down into units. People learn better when information is presented in bite-size segments [37]. We enable users to create a content unit, i.e., a *presentation frame* node, by drawing a rectangle around a target area or capturing the bounding box of the current view. Frames are editable—e.g., by resize, move and delete—to fit users’ evolving ideas. We use light blue lines, with white highlights, to delimit presentation frames in free-form space (See Figures 3.1 and 3.2). By default, the first created frame is the presentation start node. The author can specify any other frame as the first node.

#### **3.2 Authoring: Linking Frames into Hypermedia Pathways**

Hypermedia pathways link presentation frames. During presentation, each frame is shown one at a time, as the presenter advances and chooses from one or multiple paths from that frame. The link between two frames indicates the potential sequence of those frames in the performance of a presentation. This link is always directed link, either unidirectional or bidirectional. In a linear pathway, each presentation frame has one link

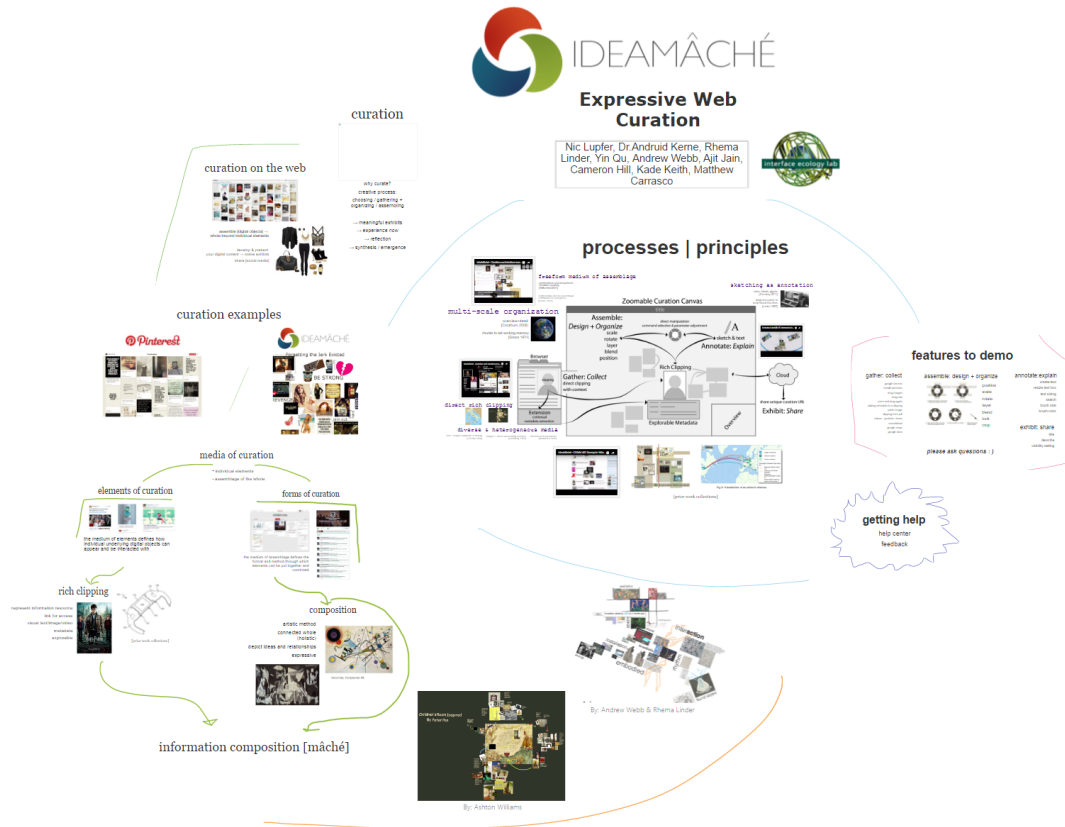


Figure 3.1: Free-form curation example without hypermedia pathways.

which points to the other. Whereas in branching pathways, at least one frame has more than one outgoing link.

The link between two frames is represented by a light blue line, with white highlight; arrowheads show direction(s) (see Figure 3.2). The link points to the frames that potentially will display next. A bidirectional link between two frames indicates that they can be both next or previous. Users create a link by selecting a start frame and then dragging the mouse on the top of desired end frame of this link. The algorithm calculates the exact positions of start and end points of the link, based on the intersection of frame borders and connection lines of two frames' centers. It then draws the links as Bézier curves.

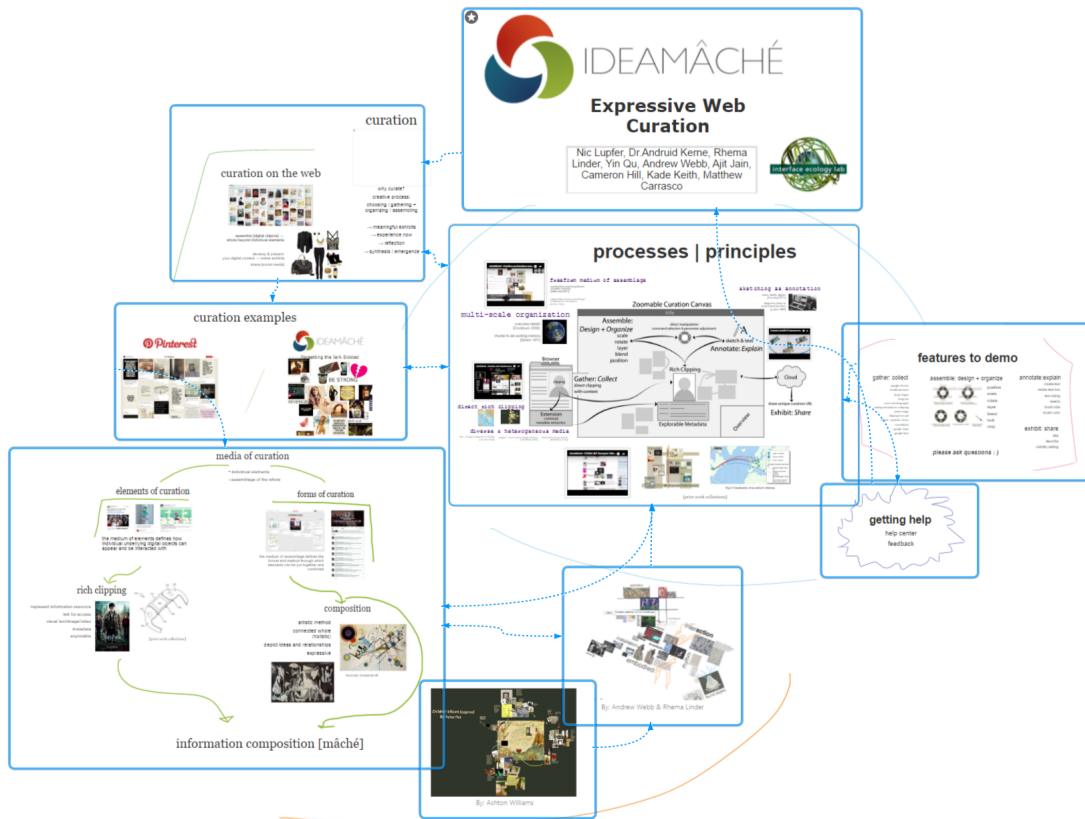


Figure 3.2: Free-form curation example with presentation frames and links, which compose hypermedia pathways.

Moving or scaling a frame will cause redrawing links, without any changes in the links' relationships. When a frame is deleted, all links to it are automatically deleted.

### 3.3 Presenting: Hypermedia Pathway Navigation

After authoring pathways in free-form space, by unitizing content and linking frame units, users are able to start presenting by using hypermedia pathways navigation. Hypermedia pathways include simple linear pathways, which resemble those supported by prior tools, and branching pathways, which add versatility and complexity to content structure.

When the user begins presenting, the viewport is automatically centered and scaled on the current frame to make it fit the window. Frame borders and links are hidden. When



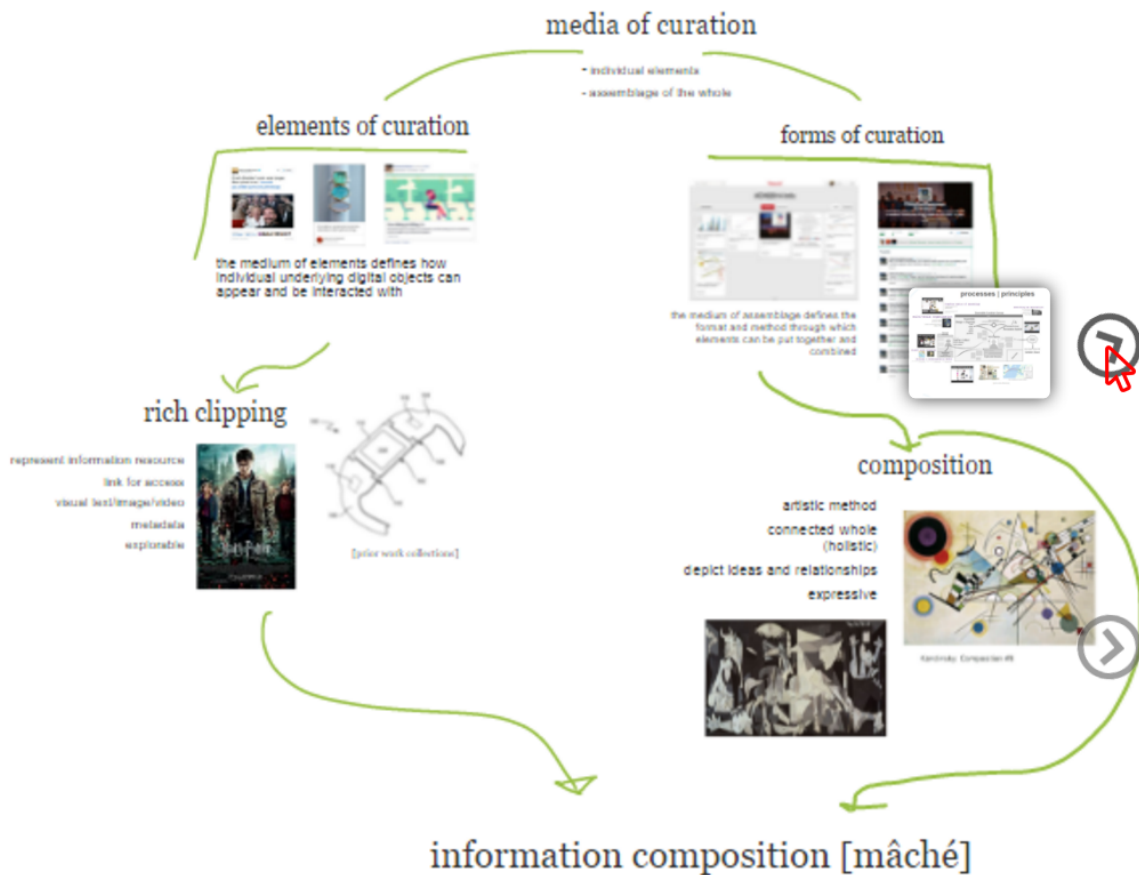


Figure 3.3: Visual Cues in Hypermedia Pathways Navigation. Arrow icons show the direction of connected frames. Thumbnail of connected frames will show up when users hover on the icon.

users set up linear hypermedia pathways, presenting operation is similar to PowerPoint. A single click or keystroke moves the viewport to the next frame or previous one.

With branching pathways, in order to help the presenter choose next frame when there are multiple choices, we provide visual cues, as arrow icons and thumbnails for outgoing connections (See Figure 3.3). The arrow icons are placed around the edges of current frames, indicating the relative position between each linked frame and the current one. The presenters selects one of the frames and then presses 'Enter' or clicks to go to it. For supporting improvisational performance, the system also enables manual pan and zoom of

the viewport during presentation performance.

### **3.4 Presenting: Animating Changes in Scale and Position**

Bederson and Boltman show that animation helps people build mental maps of spatial information [38]. Thus, to facilitate audiences understanding of relationships among content frames, in presentation, transitions between frames are animated. A transition animation algorithm pans and zooms the viewport to show relationships. If the bounding box of a smaller view is contained by the bounding box of a larger one—a transition between an overview and details—zoom and pan will be performed together. Otherwise, we calculate the Euclidean distance between the frames, in 3-D space. If that distance is below a threshold, meaning that the views are nearby, the viewport will again directly pan and zoom. Else, if the distance exceeds the threshold, if there is zoom-in, increasing detail, the viewport will pan first, to illustrate the context of that detail. Otherwise, again to illustrate context, the viewport will zoom-out first and then pan. In comparison to Prezi, which always animates transitions by zooming out and then in, the present approach works to make transitions meaningful. Animation time is based on the Euclidean distance.

## 4. SCENARIO

The scenario is based on our study, which addresses how students use free-form spaces with hypermedia pathways to make presentations for their multiplayer game design project in a computer science course. We take P17 as an example (See Figure 4.1).

Neal is an undergraduate in computer science, taking the Programming Studio class. He and his team member, Matt, Peter and Amy are working together on a multi-player game design project. They already worked on this project for almost the whole semester. Now it is time for them to do a 5 minute final presentation of their game design project, which includes a 2 minute video about their game. The final presentation needs to address aspects of their design process, including user experiences, game mechanics, software design, interface design and evolution of ideas.

Concerning team work, they discussed the whole presentation together. Next, they assigned parts to teammates. They segment the presentation into 4 parts. Neal takes the evolution of visuals part. Matt takes the software design part. Peter takes the game mechanics part. Amy takes the last part, which is about what she learned from the project. They decide they will individually create their segments and then copy and paste them together into Neal's presentation, to make the.

When Neal starts working, he doesn't know what exact structure he needs to use for the content. Therefore, he decides to start by putting everything in the corner. He first inserts the logo picture into his presentation. He decides that this logo should be in a single frame. Therefore, he opens the presentation authoring tool and creates a presentation frame, which covers the logo picture and sets this frame as the start frame (represented by the small star icon shown on the left corner of the frame). (See Figure 4.2)

Next, he decides to put some of their design drafts into the presentation, to show initial

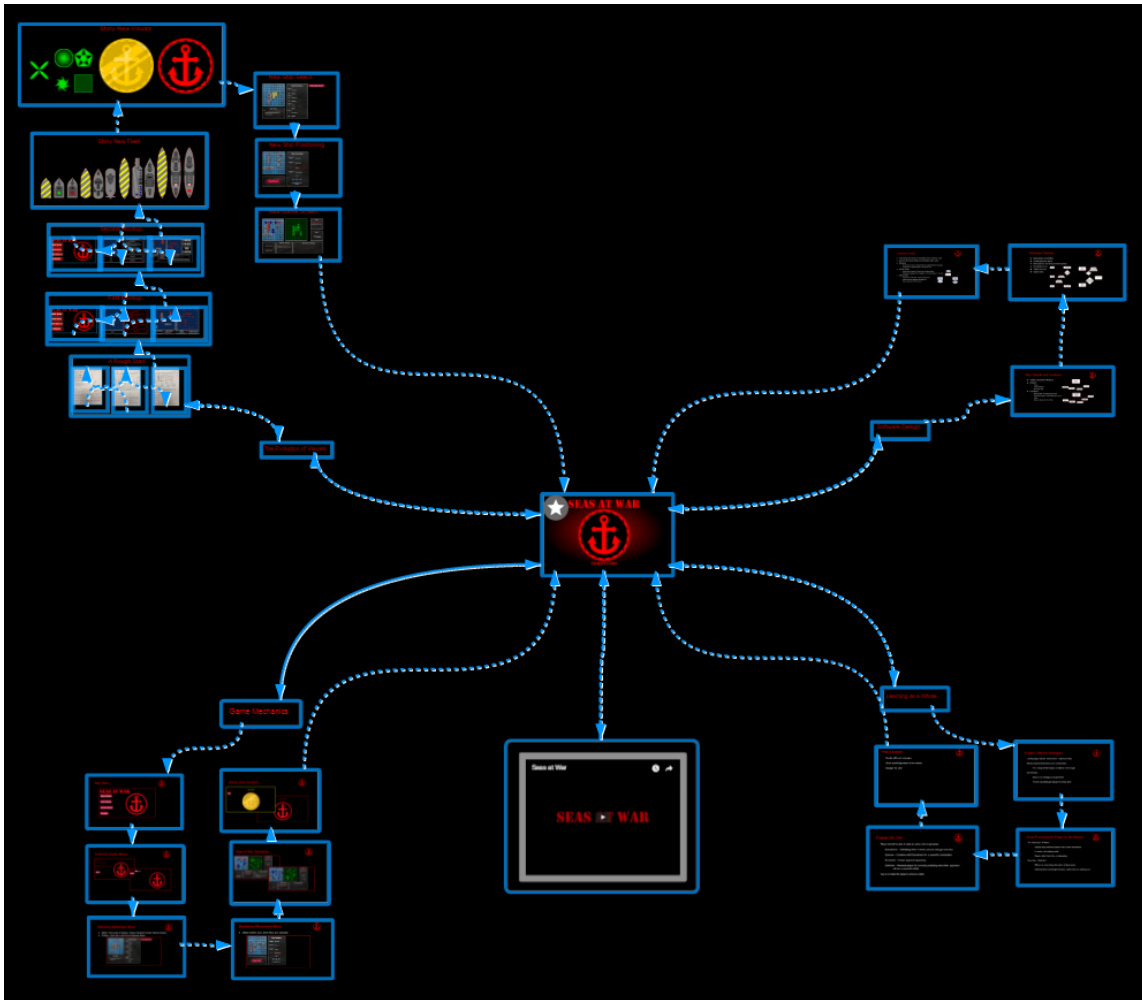


Figure 4.1: P17's final presentation for a multi-player game design course project.

ideas and brainstorm in their heads. He chooses to create an overview frame and detail frames, within the area of the overview frame, to show relationships. After creating these frames, he uses connection lines to link them together in a sequence (See Figure 4.3).

Then, he inserts their first and second game interface mockups. For each interface mockup, he makes a frame to unitize it. He also creates overview frames. He inserts images of game component design, just as one frame, and a bunch of design images for the new visual design of some icons (See Figure 4.4).



Figure 4.2: The start of evolution of visuals part in P17's presentation.

However, he finds the icons are too large compared to other content. He multi-selects the icon images and resizes them into a suitable size. He makes a frame to unitize them as a group. He adds a title to this frame. Then, he inserts the new design for ship selection, ship positing interfaces and new game screens. Initially, he decides to insert those parts on the top of previous content. However, when he tries to do that, he realizes that it is not in a good looking. Since the new design for ship selection is related to the content which shows the new design of the ships, he thinks it might be better for him to move the new content on the right side instead of on the top. He resizes the ship selection interface image and moves it on the right side. Next, he maks each content unit a frame and linking them together (See Figure 4.5).

After Neal finishes his own part, Matt sends his parts to Neal. Neal directly opens Matt's presentation. He copies and pasts the content to his own. Then, he creates frames and connects them to the central start frame (See Figure 4.6).

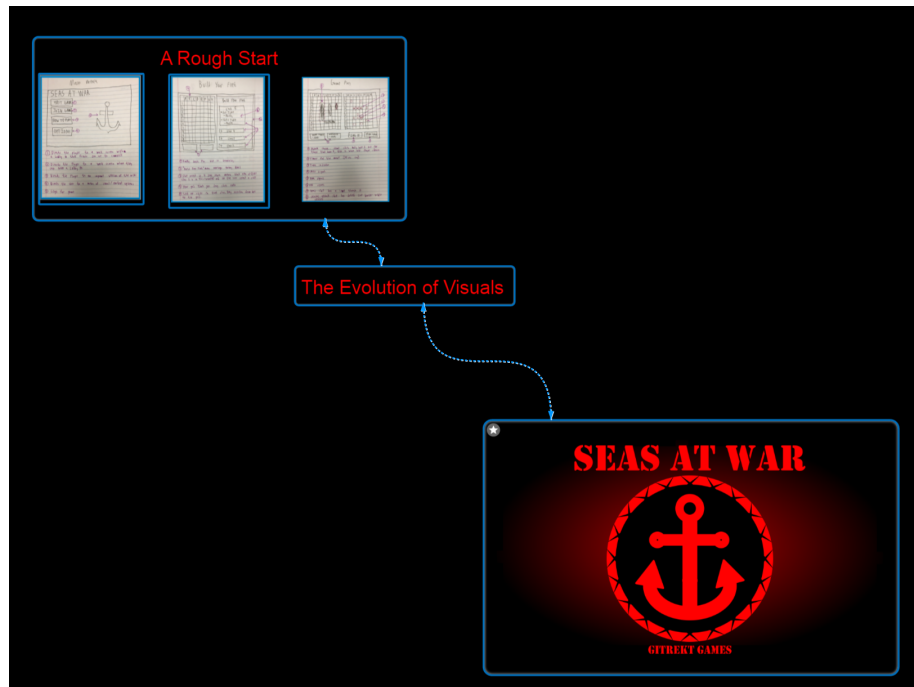


Figure 4.3: Adding rough start frame.

Next, Neal does the same thing to Amy and Peter's segments. He finally makes a butterfly structure of the presentation. Neal thinks he is almost done, but then he suddenly realizes that he missed the video which is required in the presentation! He goes to their video on YouTube. He drags the video webpage directly into his presentation, creating a video clipping. He makes a frame to unitize the video, within the space. He links this video frame to the start frame in the center.

Neal views the whole presentation several times for rehearsal. As he views the presentation, he gets new ideas about revising content and frames. He finds it is good to have a butterfly shape for the whole structure (See Figure 4.1). This butterfly shape of content organization makes it easier to present without deciding the exact presentation sequence. Besides, this organization also shows the relationships among those 4 main parts of this presentation. Finally, he is satisfied with his presentation.

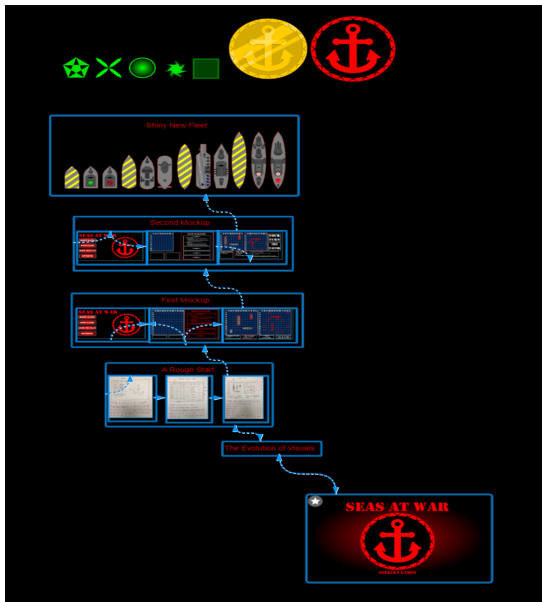


Figure 4.4: Adding more mock ups.

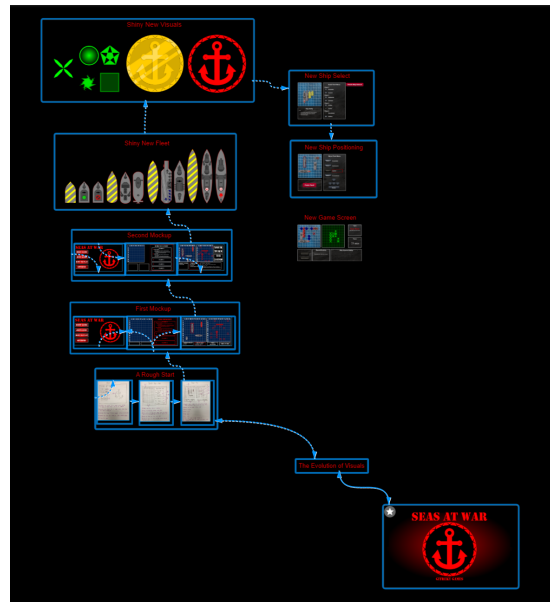


Figure 4.5: Adding more visual designs.

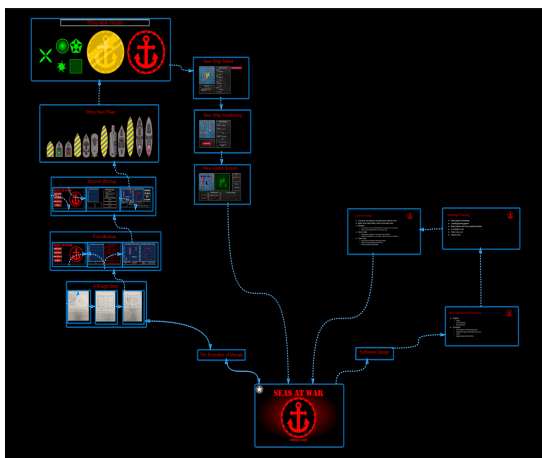


Figure 4.6: Adding *software design* part.

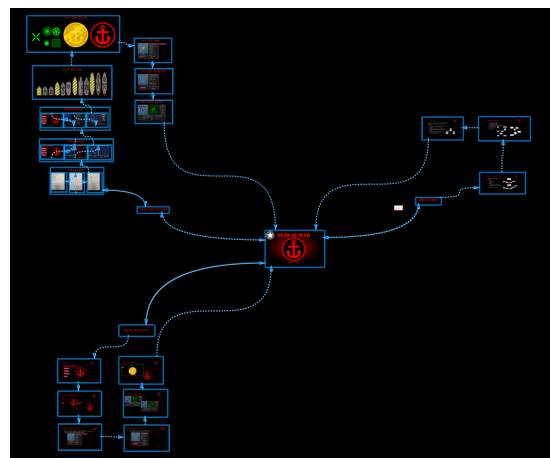


Figure 4.7: Adding *game mechanics* part.

On the day of his presentation, Neal goes to the *IdeaMâché* website, where his presentation is online, to start presenting. When he presents his interaction design of the game, he is interrupted by one of the audience's members. Someone asks for a detailed explanation of the implementation of his interface interaction. He waves the mouse on the current

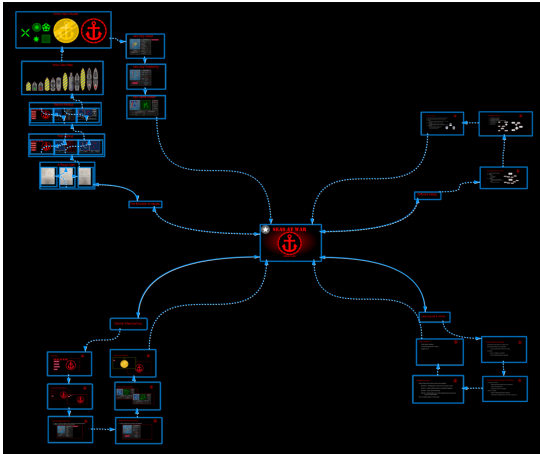


Figure 4.8: Adding *learning as a whole* part.

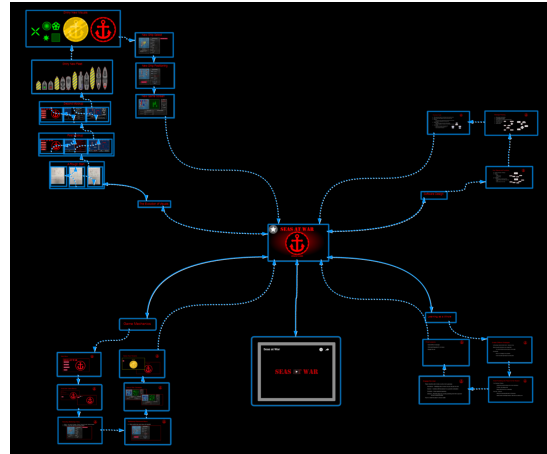


Figure 4.9: Adding a video.

frame. Several navigation arrows appear on the edges of the screen. He puts the mouse on one of the arrow icons. A small preview shows him which frame this arrow icon will lead to. He clicks the arrow icon to jump back to the previously displayed, frame of the video, which shows how exactly users interact with the interface. Next, he clicks the ‘backspace’ key to jump back to where he was in the presentation, to the frame that explains details of interaction design in their game. Then, he continues to the next section.

When Neal reaches the second section from the end, the course’s teaching assistant informs him that he only has one minute left. What to do? He needs to save some time on the current section. Neal adapts his presentation. He starts talking about the conclusion of their game design project. He clicks the appropriate navigation arrow icon. He directly jumps to the conclusion frame. He starts talking about the conclusion instead of talking more about details of the previous section.



## 5. FIELD STUDY METHODOLOGY

The naturalistic setting [39] of our study situated users in a real context of cognition, learning and knowing. Therefore, participants performed presentation tasks for academic purposes where they would normally use slideware; e.g., dissertation proposal defenses and course project presentation. This study methodology matches our research goals, because learning, cognition and knowing are irreducibly co-constituted and cannot be treated as isolated entities or processes [40].

We let participants naturalistically choose if they would use hypermedia pathways in free-form space for authoring and delivering presentations at all, as well as their own presentation topics and goals. Users who have stake in performing tasks, academic performance in this study will be more engaged than users who perform artificial study tasks.

### 5.1 Participants and Dataset

We conducted a field study, broadly involving 582 people who used our augmented version of the free-form web curation environment, *IdeaMâché*, from April to December 2016. Study participants included 420 students in four courses, which span three university departments: Environmental Design (The Design Process: Creativity and Entrepreneurship, 165 students), Communication (Feminism and Technology, 20 students) and Computer Science (Programming Studio, 192 students; Human-Centered Computing, 43 students). In these courses, use of free-form curation was mandated for some assignments, but not for presentations. The instructor in the computer science courses is among authors of this paper. Study participants free access to hypermedia pathways navigation, but were not told to use it. We identified a subset of 158 participants (27%) who used hypermedia pathways, in conjunction with free-form space. We gathered quantitative data via interaction logging.

Within the subset of participants who used pathways, we gathered qualitative data through observation of presentations and semi-structured interviews. We interviewed 29 participants (both individuals and groups) about their experiences of authoring free-form content spaces, conjoined with hypermedia pathways, and using these to perform presentations (Table 5.1). We recruited apparently engaged users, who created visually attractive work and frequently used hypermedia pathways. Several interviewees came from outside the four courses.

We analyzed data according to Charmaz's qualitative methodology for constructing grounded theory, that is, by gathering rich data, initial coding, theoretical sampling, focused coding, categorization, the incorporation of sensitizing concepts, and conceptual refinement [41]. We took transcriptions of interviews as a primary form of rich data. We began by forming 30 initial codes through analysis of all the interview transcripts. Then, we performed focused coding, by combining similar codes together resulting in 10 codes. As we did this, relationships among codes were revealed. Through this process, we organized the codes into 4 categories that we present below.

<i>Participant</i>	<i>Gender</i>	<i>Background</i>	<i>Presentation Context</i>	<i>Presentation Title</i>
P1	M	Grad in CS (same lab).	dissertation proposal defense	Investigating Creative Processes: A Workbench for Exploring and Analyzing User Actions
P2	M	Ugrad in CS.	Multiplayer Game: Final Presentation	Super Aggie Party
P3	M	Grad in CS.	Human-Centered: Final Presentation	Free exploration workflow of Experts
P4 (Team)	M, M	Grad in CS.	Human-Centered: Final Presentation	NACHO
P5	M	Ugrad in CS (same lab).	research presentation	New Extraction Methods, and a Cache
P6	M	Grad in CS (same lab).	research presentation	Collaborative design ideation: pen + touch
P7	M	Prof in CS (same lab).	research presentation	Collaborative design ideation: pen + touch
P8	M	Grad in EE.	research literature presentation	Literature review of intermodulation
P9	M	Ugrad in CS.	Multiplayer Game: Formative User Study	Factions Collide
P10	M	Ugrad in CS.	Multiplayer Game: Functional Specification	Tank Party
P11 (Team)	M, M	Ugrad in CS.	Multiplayer Game: Functional Prototype I	Seas at War
P12	M	Ugrad in CS.	Multiplayer Game: Formative User Study	QuantumSplit
P13	M	Ugrad in Architecture.	Imagine a Perfect Solution Curation	Building a gaming P.C.
P14	M	Ugrad in CS.	Multiplayer Game: Lightweight Prototypes	Sattle Rift
P15	M	Ugrad in Architecture.	Imagine a Perfect Solution Curation	How to improve the Memorial Student Center
P16	F	Ugrad in Architecture.	Imagine a Perfect Solution Curation	My Dream Wedding
P17	M	Ugrad in CS.	Multiplayer Game: Final Presentation	Seas at War
P18	F	Ugrad in Biology.	Imagine a Perfect Solution Curation	Effects of Caffeine on Human Health
P19	M	Ugrad in CS.	Multiplayer Game: Final Presentation	Malware Menace
P20	F	Ugrad in Architecture.	Imagine a Perfect Solution Curation	A Guide to My Etsy Store: ReedCreate
P21 (Team)	M, M	Ugrad in CS.	Multiplayer Game: Final Presentation	Night Fall Arena
P22 (Team)	F, M, M, M	Grad in CS.	Human-Centered: Final Presentation	Visualizing sketch data to support learning sketching
P23	M	Ugrad in Engineering.	Personal Branding Profile	Hello my name is Diego

Table 5.1: Interview Participants.

## 6. FINDINGS

We briefly present quantitative findings, providing an overview of how hypermedia pathways were used. We provide extensive qualitative findings, which we organize into 4 categories: *free-form multi-scale spaces*, *hypermedia pathway navigation*, *improvisational performance* and *ideation*.

### 6.1 Quantitative

We collected 2175 valid (having more than 3 content elements) free-form curation works created in *IdeaMâché* environment from May 2016 to December 2016. In the dataset of 2175 free-form curations, 461 (21%) of these used hypermedia pathways navigation. Among those with hypermedia pathways, 161 (35%) curation works include at least one branching pathway. We included curations with at least 2 frames and 1 connection.

Figure 6.1 shows the relationship between the number of frames and connections in each presentations. Most of the presentations have less than 20 frames which means the users normally unitized their presentation into less than 20 units. We can also see that, the majority of presentations have a linear pathway which consisted a clear trend line in the graph. However, the dots which are on the top of the trend line show the usage of branching pathways.

### 6.2 Free-form Multi-Scale Spaces

#### 6.2.1 Free-form Spaces in Presentation

Free-form spaces provide freedom for users to arrange content elements, without dic- ing content into arbitrary parts. Users said that it becomes easier to articulate relationships among content elements in free-form spaces than it would be in slideware. They use

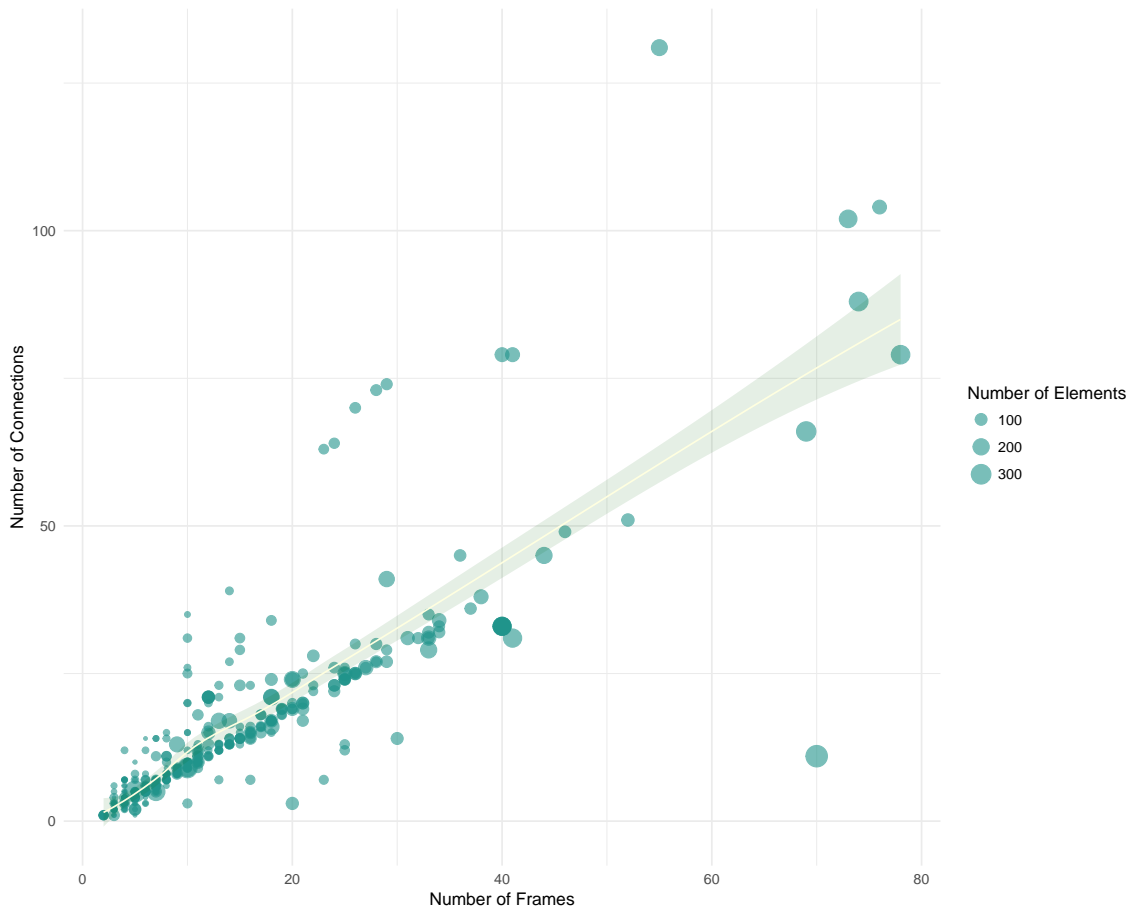


Figure 6.1: The relationship between numbers of frames, connection and content elements in each presentation

overview frames as a means of organizing content in free-form space. Overlap is sometimes used to convey connection among ideas. They sometimes include supplemental content in a space, but exclude it from pathways.

Q1 P4: That's one thing [the presentation class] really stressed. You have to provide signposts of where you are in your presentation. I would have had to add those in, but we didn't really have to do that here. I thought the structure was more obvious.

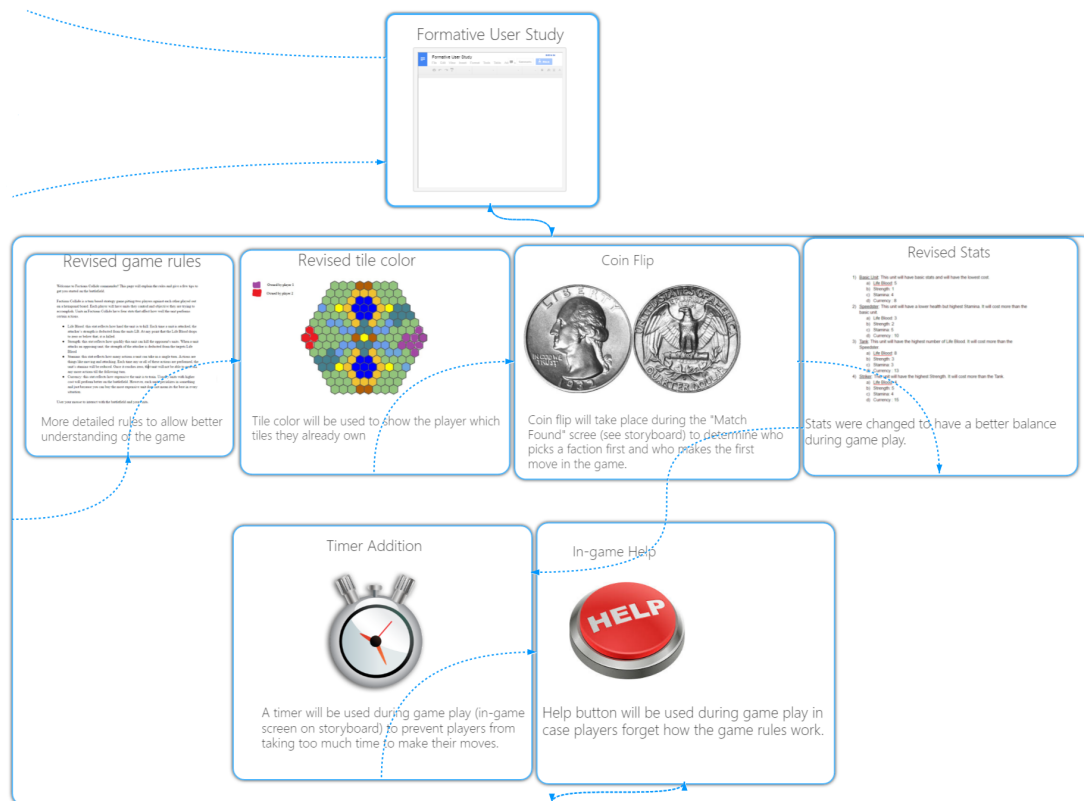


Figure 6.2: Typical overview frame

Q2 P5: On Google slides, it wouldn't have done me much good to show the whole thing. Because when I transitioned, it wouldn't be clear that I was going to a different part of it . . . . I probably would've made a different diagram that was just the names of these things, like Big Semantics and iframe extractor, and have that be my first slide, and then go into the detailed ones.

Participants described strategies for providing overviews, zoomed to cover multiple presentation frames, that helped them present ideas as a whole to audiences. Rather than focusing on the details, the overview frames show the whole structure, which helps users explain how detailed content parts are related to each other (See Figure 6.2).

Q3 P3: At the beginning you need to understand the work flow. Then my idea is that first give an overview, so it's a whole picture. Then I want to introduce several major components.

Q4 P2: You put additional frames inside, starting with the overview frame, which is general information about the game.

Based on the nature of free-form spaces, users can overlap content elements and presentation frames. P6, for example, used overlapping presentation frames to connect two ideas. The overlapped parts are related to the main ideas in two different presentation frames (See Figure 6.3).

Q5 P6: I had a little overlap here where it had a joining thing that was connected to these two ideas, so I joined them together here. ... This middle section is related to both contents so [I] keep it in both frames.

The near infinite space provides the possibility for users to have content which may not be included in any presentation frames. However, that content may still be shown in the overview or in the transition during the performance of presentation. These elements can act as backup or reference, or even for entertainment (See Figure 6.4).

Q6 P5: I didn't actually plan on showing [the implementation detail documents]. I just wanted it to be there as a reference. [It is more] more detailed, cause it's long and text heavy. I thought it should be part of the *mâché* but not necessarily the presentation.

Q7 P4: We had those pictures there. They're never actually really in the presentation. ... It had some empty spaces. I just put them in. I thought it'd be funny. No one would really see them. They wouldn't detract from anything, but we'd know they were there. It's entertaining.

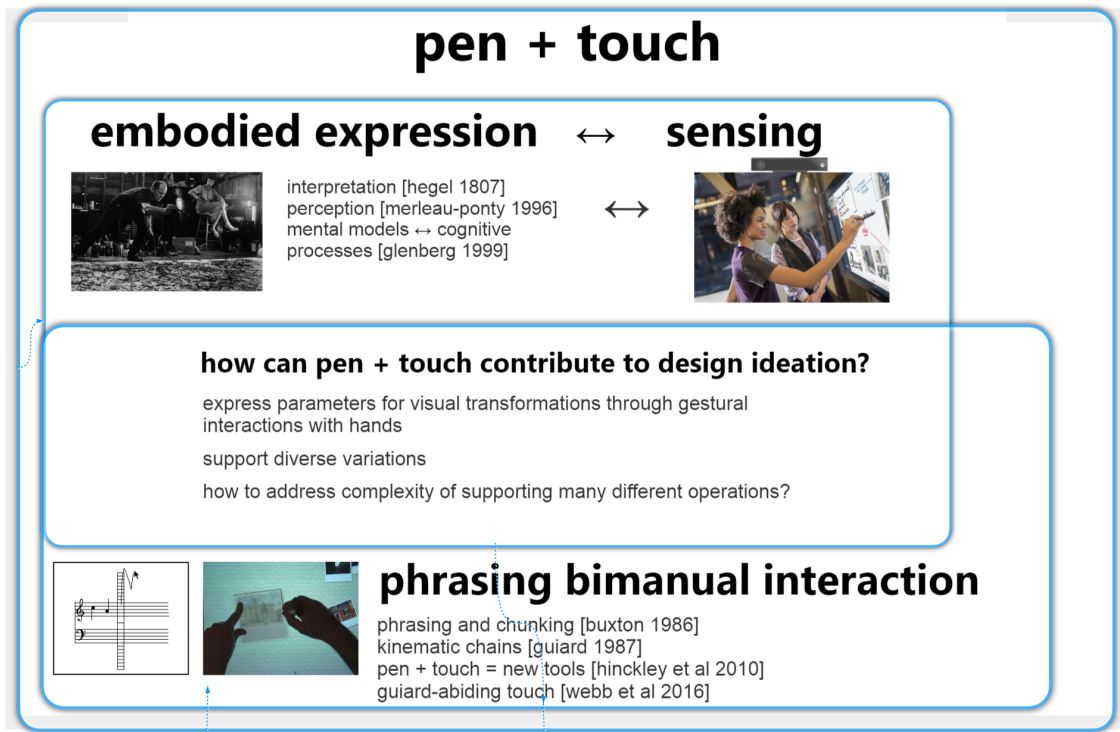


Figure 6.3: Overlapping frames in P6’s presentation.

### 6.2.2 Multi-Scale Presentation Organization

Participants use multi-scale structure to represent the difference in the importance among content parts. For example, P23 authored a presentation about his personal history. Content related to his childhood is shown smaller, compared to content that introduces his teenage years. He created this multi-scale structure because he thinks how he looks now is more relevant than how he was as a baby (See Figure 6.5).

**Q8** P23: It’s just visual effect, and the pictures just get bigger. Because as you get older, you have more responsibility. That’s when you’re going to have to start doing stuff by yourself. So, I believe that these are the most important parts when it comes to goals.



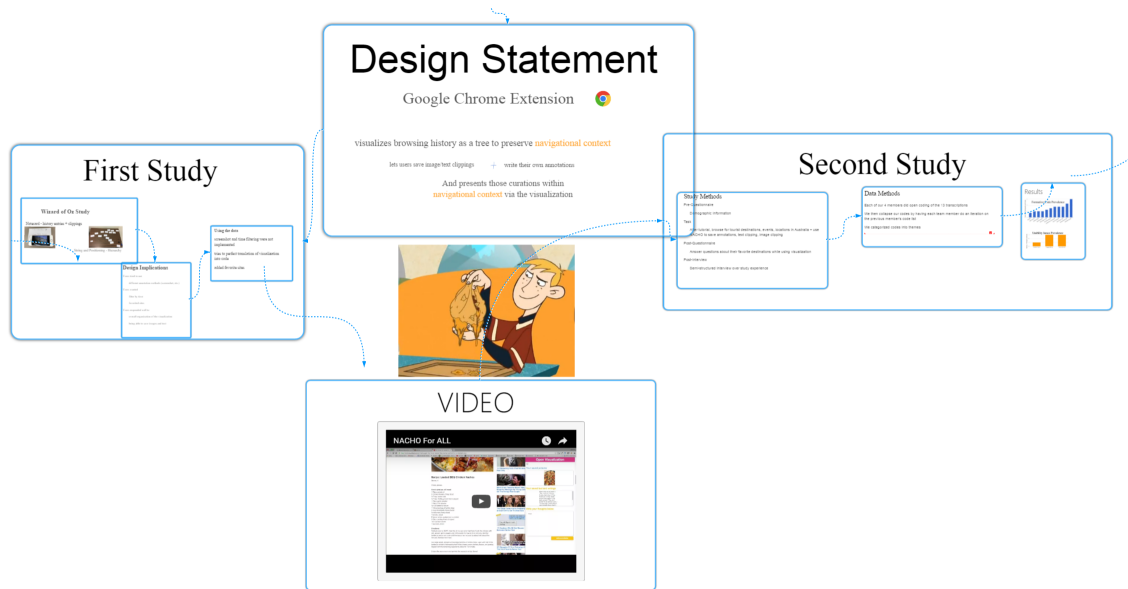


Figure 6.4: A supplemental image, in the middle in P4’s free-form space, is excluded from their presentation.

Q9 P12: If we put [these frames] at the same level, then it would show the same importance for them, but they don’t have that same importance anymore.

### 6.2.3 Sketching

Participants used sketching in our study for variety of reasons, for example, drawing arrows to show the link between elements, drawing frames to group the content or to annotate.

Q10 P10: Before we implemented hypermedia pathways I had those [sketching] arrows to show the relationships.

Q11 P5: I sketched over [the space]. And then at that point I added the presentation part. So I added the frames.

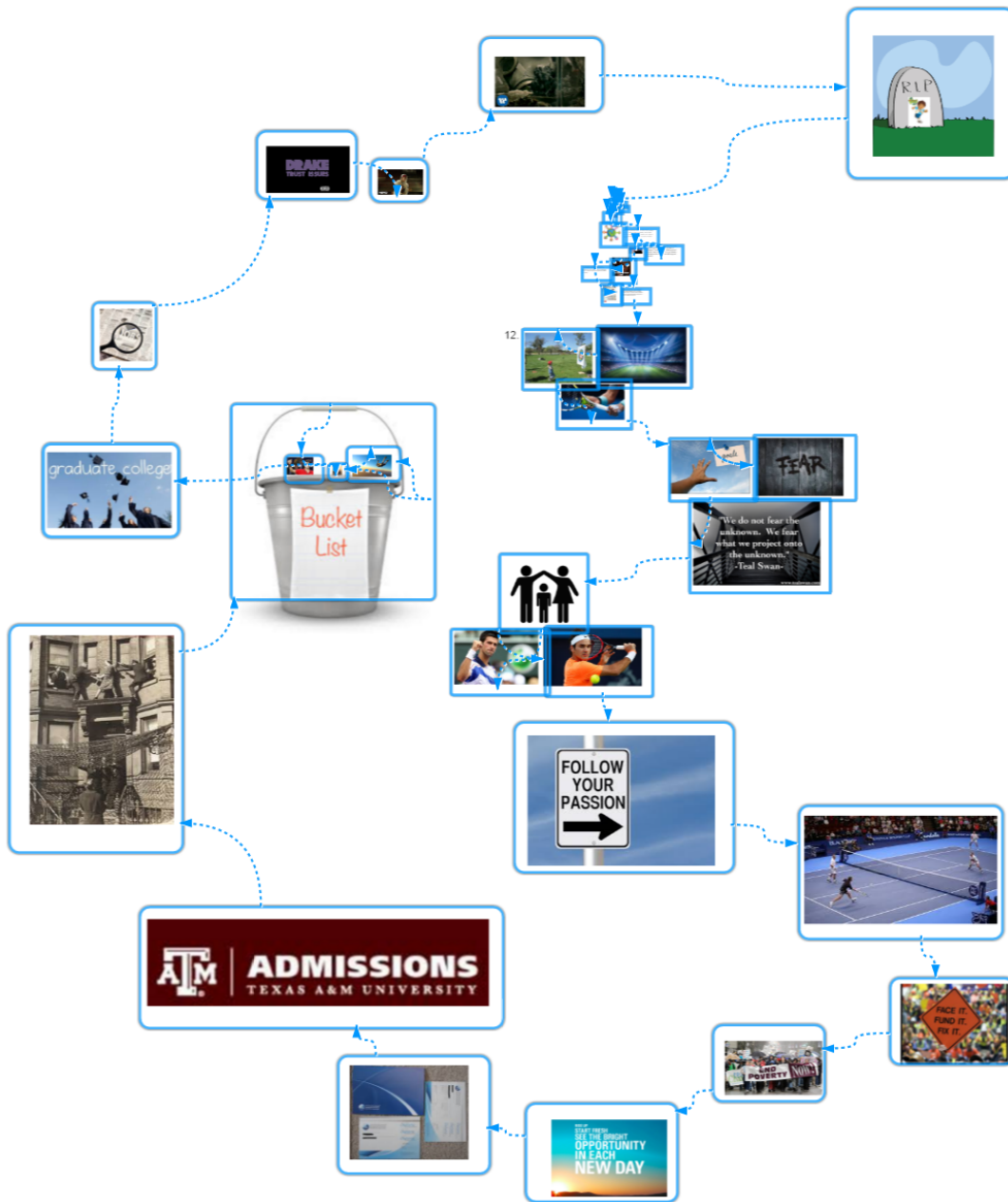


Figure 6.5: Multi-scale content organization in P23's Presentation (<http://ideamache.ecologylab.net/v/Nx8BJPBaUM/>)

Q12 P18: It was easier for me to visualize [frames]. When I went to [creating hypermedia pathways], it was easier for me to decide that what to group. It's

like those sketch marks that I did, which were in my head, that I could draw.

### 6.3 Hypermedia Pathway Navigation

In the interviews, participants explained how hypermedia pathway navigation helped authors, presenters and audiences.

#### 6.3.1 Presentation ‘Flow’

Some users mentioned ‘flow’, by which they mean their sense of connection among content frames as they sequence them in a presentation. They recognized this flow either in terms of their experiences of authoring content frame sequences or in terms of conceptual relationships connecting frames.

Q13 P12: *Flow*, ...it’s mimicking how [the work] itself was created, each step. From one presentation slide to another, it mimics the flow of the actual work. So one slide would represent one part of that deliverable that we worked on, and then the next, and so forth.

User find that it is hard to show the flow in the free-form space which doesn’t have hypermedia pathways:

Q14 P10: I’ve seen *IdeaMâché* at that time where [they] didn’t utilize [hypermedia pathways]. That’s very confusing, because there’s no organized structure [to show] where the flow goes. If I just hand that off to someone random, they would have no idea where to start and where to finish, in most cases. Unless you physically drew arrows everywhere to show them.

On the contrary, with hypermedia pathway navigations, the fluidity of ideas is enhanced and the flow is represented in a better way to the audience. Participants use this navigation to articulate relationships among presentation frames.

Q15 P22: The continuity is really cool. I like how when you're moving from side to side. Like there is a sense that this is all the same flow. As opposed to like PowerPoint, where you're literally just doing separate frame, separate frame, separate frame, and everything feels a little more disjointed.

Q16 P10: I wanted to physically show the teaching team the flow and the outline... I wanted to physically show them that rather than throwing things on them just like drawing arrows everywhere to do that. ... I guess the reason I try to do [hypermedia pathways] was to show the teaching team that this is the flow and this is the relationships between the different web page.

Q17 P16: I guess [hypermedia pathways navigation] also worked better with the project, instead of just viewing the whole thing at once. It gave you an order in which to go in, instead of just here is all of the information... Instead of the whole being viewed at one time, and then the reader have to find out where to start and where to go next from the starting point.

Hypermedia pathways can also help with reusing content in a presentation:

Q18 P16: If I was here in PowerPoint, ... I have to completely recopy these pictures into the next and into that slide instead of just being able to go back real quick then just take a quick peek at the pictures again or not at all, you can keep moving on to the project.

### **6.3.2 Animation for Navigation**

The animation in navigation shows a moving trace of transitions between frames. We designed this animated navigation to show changes of scale and spatial distance between

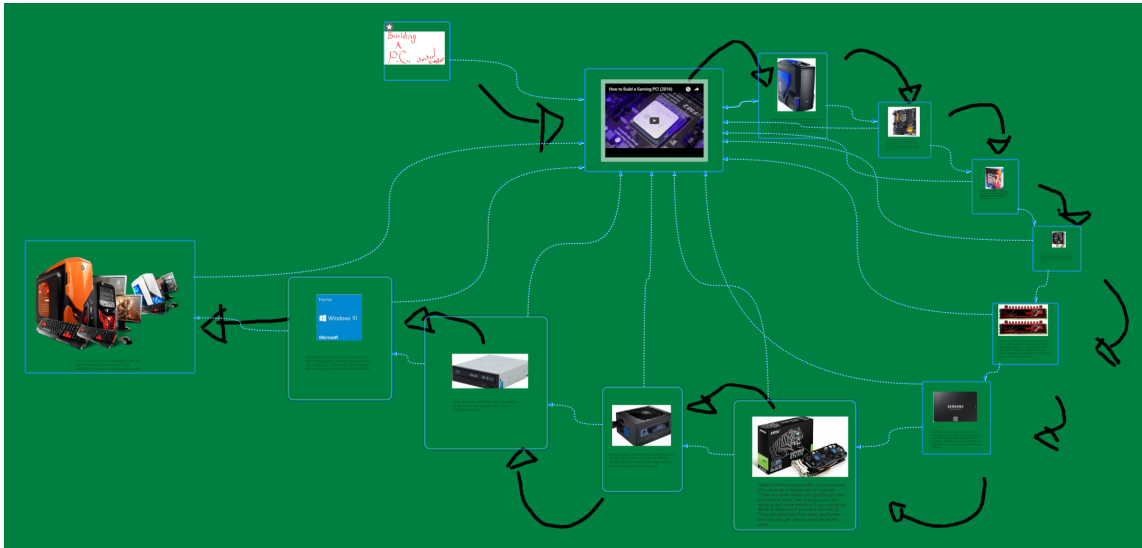


Figure 6.6: Participant 13’s presentation: *Building a gaming PC* (<http://ideamache.ecologylab.net/v/yjfozfGEEB/>)

frames. We found that this helps presenters to convey how each frame connects to the previous one.

Q19 P5: What I liked is this action of [transition animation]... On my last frame, I could immediately go back to the first. Making these big jumps, in a nice smooth way, is probably the biggest difference [between having animation or not].

Users found that sometimes their verbal description of the relationships among presentation frames could be omitted, since the spatial organization and animation already articulate those relationships.

Q20 P5: If I was in Google slides or PowerPoint, I would’ve paid more attention to how I started each slide. I think it’s not necessary [here], because I had already explained this whole diagram, and I had said what each part was. And then, once I did the transition, it was clear to the part I had zoomed

in on. Whereas with PowerPoint or Google slides, I would need to specify “Okay here’s what you’re looking at now, and how it relates to what you were looking at earlier.”

### 6.3.3 Situated Navigation

With free-form space, in conjunction with hypermedia pathways navigation, authors are not constrained by linear structure, which may hinder their presentation of ideas.

P13, for example, created a presentation about how to build a gaming PC. He used hypermedia pathways to link each detailed frame, which was about each part of a computer, to a video tutorial on how to assemble a PC. He thought this video tutorial could perform as a reference for each kind of computer part (See Figure 6.6).

Q21 P13: Some people may have never built a computer. They’ll look at this and be like, “What does this do?” ... They can always go back to the video [to] see how it’s installed. That’s why I put the video there.

The audiences also have the freedom of choosing their own paths for viewing presentation content.

Q22 P9: I want the user to be able to say: “Okay what do I want to look at? Do I want to look at what happens if they click this button, or that button, or this button?” It is just giving them a choice to determine what they want to look at.

Q23 P16: [Pathways navigation] just allowed for it to give [audiences] a starting point. And then they were able to go through the information at their own pace, but also have an order to it.

## 6.4 Improvisational Performance

While performing presentations, some participants improvised. In some cases, they improvised when answering unexpected questions from audiences. In other cases, they changed their plans in response to the reactions of audiences or when new ideas emerged.

Q24 P4: I did the problem statement and I talked about the first study. Then, I briefly introduced the video. That was impromptu.

In P22's final presentation of their game design project, we observed that the presenter spontaneously navigated content to further contextualize it. P22 panned and zoomed into a part of content which is relevant to the current frame, but not connected to the current frame directly. After this, he just jumped back to the frame which he talked about previously and continued his presentation from there.

Q25 P22: It was somewhat improvisational, . . . I wanted to show [we changed that colors for the teal blue, green tints]. [Directly panning and zooming to that part] was a quick way of doing it.

Q26 P17: I think [improvising] was a lot easier than using a normal presentation [tool]. I think if I actually had to spam enter [key] until I got there, it would have been really hard, especially since the transition between slides is kind of slow. But because, even in presentation mode, you can zoom out and drag and go to the next spot, it was pretty easy for me to go out of the main screen, find where I needed to be, and zoom in real quick on it, so that they could talk about it.

### 6.4.1 Anxiety

Although hypermedia pathways navigation provides benefits to presenters, negotiating branching pathways may increase their nervousness. Some presenters chose to use linear pathways to reduce risks and anxiety.

Q27 P21: I wanted to keep it super simple, because when we're out there, you're nervous. So I only wanted one link to the others. All we have to do is hit the down arrow —just go to every single one...If you would have a lot of different arrows, it might get hard. ...I didn't want a bunch of arrows blocking everything. Just to keep it super simple because we have four people up there. I just —the simplest is what we went with.

### 6.5 Ideation

New ideas sometimes emerge while authoring and delivering presentations, which can be a long process. As users are working, new ideas sometimes come to mind based on what they did before; thus, making presentations expandable becomes helpful for stimulating ideation.

Q28 P6: [The presentation authoring] was a very iterative process. It wasn't like we knew right away. We tried some things until we found something that we thought worked.

The ability to freely integrate new ideas into their work in relation to previous ideas facilitates users' creative processes.

Q29 P17: In every deliverable, we had to build upon the previous one [in the space to] add more about our work, [and] what we were doing. So making something expandable like that, would be a lot easier in here. ...It'd be more



tedious to insert a lot of details [in PowerPoint], because I have to update multiple things, whereas with this I just drop it and connect it. So, when you're building as you go, and you don't really know how it's going to evolve, this is a lot easier to work with, because it's a lot more adaptable.

Ideation also arises when users review their presentations with presentation frames and pathways. The easy transition between content editing and presentation frame editing helps stimulate the emergence of new ideas.

Q30 P20: I'm pretty sure I started drawing the boxes after I'd made the entire layout. I might have gone back and forth a couple of times [in the space], while repositioning some things, to make it look better in the [pathway]... I originally started out with the outline, then clicked and dragged multiple different ideas onto it, arranged it the way I wanted it to. Then [I] moved into [pathway editing], drew the [frames], drew the [connections], and then said, "I'm done." And then looked at it, to make sure it looked right. Then I go back and revise, if I need to.

Q31 P16: I played the presentation first. ... There was some pictures that when I was going through. I was like, "Oh this could go before or this could go after." Then I had rearranged them and then the blue boxes were like, shaped out to fit the picture. I played with it a lot before, I finally, got the order that I want.

Q32 P17: Lots of times, [I reviewed the presentation]. I reorganized those small pictures about ten times before. ... [Finally] I went through like the actual presentation multiple times before I was actually able to finish the presentation and like it.

## 7. DISCUSSION

We examine how the integration of free-form space with hypermedia pathways helps ideation and manage ambiguity, in three ways. First, free-form spaces articulate multiple relationships among content elements. Next, hypermedia pathways support managing the ambiguity of these free-form spaces. Finally, ideation happens both while authoring, and later, while performing a presentation.

### 7.1 Free-form Space: Articulating Multiple Relationships

Free-form web curation's ZUI affords unconstrained organization of content elements in 2D space, along with a range of variability in Z direction. This enables a panoply of relationships among elements to be articulated. It matches the underlying structures of knowledge, itself, particularly interdisciplinary structures, which most generally are *rhi-zomatic*, with multiple branches, rather than strictly hierarchical [42, 43]. This is mirrored by the associative structure of hypertext, itself, which Landow, citing Barthes, calls an 'ideal textuality', in which "the networks are many and interact, without any one of them being able to surpass the rest" [44].

#### 7.1.1 Ambiguity

Ambiguity means the capability of being understood in more than one way [45]. Therefore, ambiguity is often considered an anathema. To the contrary, according to Gaver et al., ambiguity can serve as a resource for design [8].

Ambiguity is not fuzziness or inconsistency. It enables people to make different interpretations of the same content. Thus, ambiguity can benefit both authors and audiences by letting them interpret content and relationships in multiple ways.

For example, misalignment of elements can express an author's uncertainty about

whether or not elements belong to the same sets [8]. The X and Y dimensions afford articulation of multiple relationships. The use of visual cues (e.g. arrows or frames) can assign one element to multiple groups, depicting multiple sets of relationships (see example Figure 7.1). Since authors are not constrained by a single expression of relationships among elements, free-form curation stimulates articulating multiple connections between content elements.

Free-form spaces support ambiguity in how they afford readings in different orders. This contrasts with slideware, which provides only a single reading sequence. It corresponds to Nelson's conception of hypertext [1]. Q22 and Q23 describe how authors use ambiguity, through branching pathways, to enable audiences to make their own routes through the content.

### **7.1.2 Spatial Organization of Presentation Content**

In slideware, users, from the beginning, must organize content into a linear sequence of content units. Slicing and dicing information into slides is imposed. This presentation creating procedure forces users into premature formalism, which has been shown to hinder users from developing new knowledge [5]. P4 said that creating signposts, for organizing a presentation, arose organically, rather than as an add-on process Q1. Marshall and Shipman proposed that spatial hypertext leaves structure implicit [6]. Thus, using free-form space for presentation authoring protects users from slideware's premature formalism problem.

Spatial organization takes advantage of human perceptual abilities [6]. P21 organized presentation content in the free-form space to mimic the look of a working desk (See Figure 1.1). This spatial organization is an instance of the *morphology* pattern [46]. The morphology pattern signifies visually arranged elements in a recognizable form, which may be concrete or abstract, to creatively integrate form and content. This kind of spatial

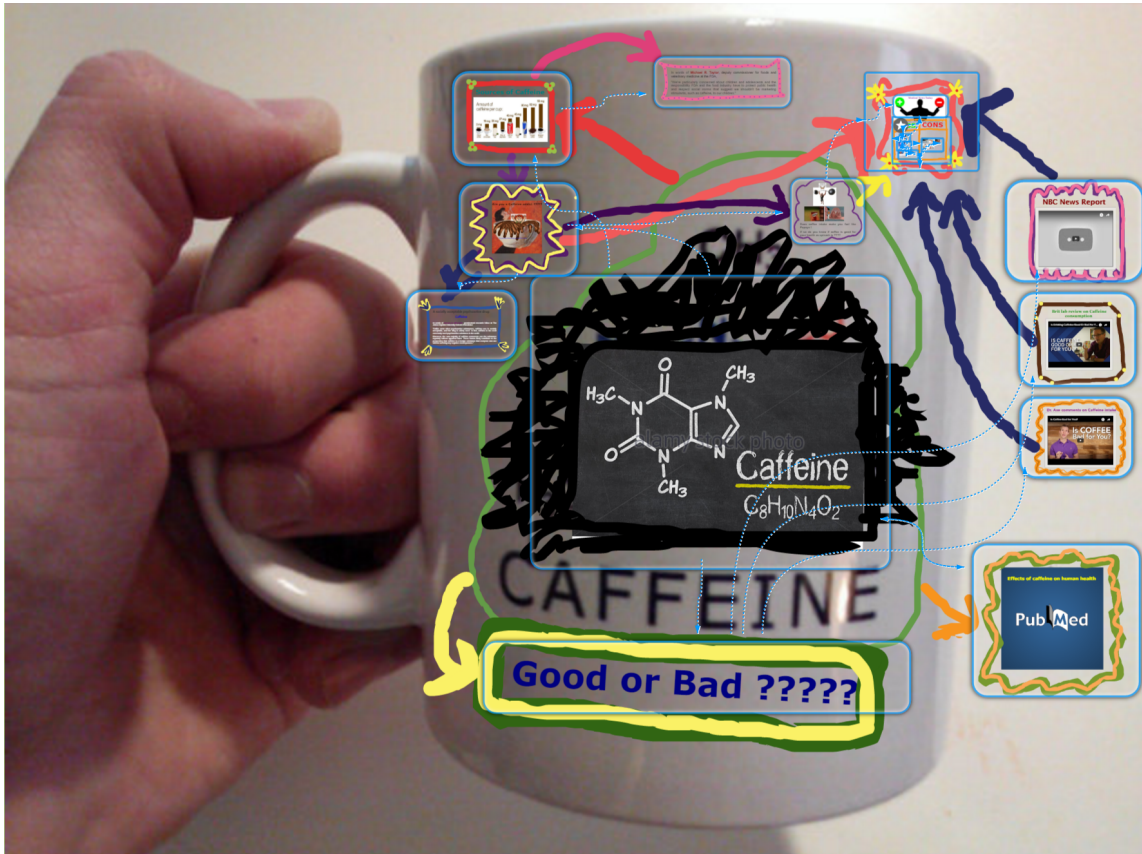


Figure 7.1: *Effects of Caffeine on Human Health*, P18's free-form curation (<http://ideamache.ecologylab.net/v/GgPhXKZ6Jj/>)

organization connects parts as a whole, while also leaving them individually distinguishable. This spatial organization of content stimulates visual thinking. At the same time, pathways enable authors to structure navigation.

### 7.1.3 Sketching

Sketching is a strategy of free-form web curation, beyond spatial hypertext. Goldschmidt observes, sketching can help with generating ideas, instead of just recording them [47]. In a design task, sketching reflects visual thinking and gives form to potentially meaningful clues. When users sketch dots, lines, and other marks, unplanned relation-

ships can emerge among the elements. In our study, participants used sketching to annotate, draw frames to group content elements, and link them with arrows (see Figure 7.1).

Compared to prior presentation support tools, sketching makes it easier for users to explicitly show multiple connections across slides. Our data Q10 and Q11 shows that users sketch before they define presentation sequences and create frames. Another use for sketching is to explicitly show connections among content elements (see example Figure 7.1).

Goldschmidt found that rapid sketching facilitates transformation. In our study, users quickly sketched groupings, as they authored presentation content Q12. This facilitates ongoing decision-making about relationships among elements.

## **7.2 Managing Ambiguity**

As we previously discussed, free-form spaces afford ambiguous layouts, which serve as a resource of design. At the same time, for performing presentations, the ambiguity needs to be managed, to simplify the presentation experience.

### **7.2.1 A Problem: Presentation Performance Anxiety**

Public Speaking Anxiety (PSA) commonly afflicts presenters. One study shows that approximately 70% of university students experience at least a moderate level of anxiety in oral presentations [34]. Speaking anxiety can lead to low quality presentation performances [35]. Further, Linder et al found that while participants in a seminar class found that free-form spaces, without presentation pathways, were beneficial for connecting ideas, they were afraid to use them for formal presentations [13]. A participant in the present study was confused by the ambiguity inherent in using free-form space, without hypermedia pathways, to present Q14.

### 7.2.2 Pathways for Presentation

To address performance anxiety, we provide pathways to help presenters manage ambiguity. Pathways gives support to presenters and audiences in two ways. Unitizing and linking content enables presenters to articulate specific pathways through free-form space from the infinite set of navigation possibilities. Pathways navigation provides users with constrained transitions.

By unitizing content and connecting frames, users are able to mitigate the ambiguity of the relationships among content elements. Users create pathways to constrain viewing to some particular order [Q15, 16, 17](#). P12 describes using spatial layout to show logical connections among parts, while using pathways to show the chronology of creating parts and illustrate underlying thought processes [Q13](#). Thus, combining spatial organization with hypermedia pathways supports authors in articulating multiple levels of structure.

Constrained transitions in pathways navigation help presenters, freeing them from on-the-fly pan and zoom manipulations. The animation reveals structural relationships between frames. Audiences gain perception about how two frames relate to each other, e.g. a zoom-in animation shows how a next frame provides details vis-a-vis an overview. Presenters found the animation across space reduces their need to verbally explain those relationships [Q20](#).

### 7.2.3 Choices in Pathways: Branching Pathways

Hypermedia pathways may be linear or branching. Branching pathways enable authors to set some frames to provide multiple choices for the next frame, during the performance of the presentation. Branching pathways enable authors to avoid slideware's overhead of repeated content [Q18](#).

Slideware's linear sequence does not support presenters responding to unexpected questions and comments, a need discovered by prior researchers [28] and expressed by

our own participants Q6.21. Users make ‘hidden slides’ to prepare for the unexpected, but to show them in slideware, they often need to perform ugly repeated slide navigation traversals.

Overview+detail frame organization is an example of how participants used branching pathways. For example, Figure 6.2, provides evidence of how users integrate free-form spatial organization with branching pathways Q3.4. An overview frame bounds detail frames, which are connected through branching pathways. The previous section connects its overview to the next section’s overview frame, which in turn, connects to a detail frame. The last detailed frame in a set links back to its overview to articulate content structure.

On the other hand, in our study, users also expressed anxiety about the complexity of branching pathways for performing presentations Q27. Branching pathway navigation is inherently more complex than linear pathway navigation. We recall that Tufte said, “the deepest reason for displays that portray complexity and intricacy is that the worlds we need to understand are complex and intricate” [48]. For some users, branching pathways enable directly representing the actual complexity of a presentation.

### **7.3 Ideation**

According to Kaufman et al.’s model of creativity, mini-c creativity involves personal experiences, while little-c involves sharing them with others [49]. Authoring a presentation in free-form space, in conjunction with hypermedia pathways, involves mini-c creative ideation, inasmuch as a user learns about a topic and develops ideas. When authors perform their presentations to audiences, they convey and share ideas. Mini-c ideation rises to the little-c level.

#### **7.3.1 Ideation in Authoring**

As we discussed before, the premature formalism in slideware produces a gap between the user’s goals and the system’s representation, since it interferes with how people develop

knowledge [5]. In contrast, the flexibility of authoring free-form spaces with hypermedia pathways interleaves iterative knowledge formation with presentation. For P17, using free-form space in conjunction with hypermedia pathways supported continuously inserting more details and content adaptation [Q29](#).

By constructing presentation frames and pathways, presentation structure can be different from the free-form space's structure. Presentation frames can easily be adapted, when content needs to be rearranged. Slideware lacks integrated, alternative representations for content structure and its presentation sequence. Users must go back and forth to revise content and its structure under different views. Participants found that their ideas evolved as they became involved in iterative cycles of spatially re/organizing content, organizing pathways, and performing them [Q30, 31, 32](#). In slideware, effort invested in the formalism of re-indenting and resequencing content can distract users from re-cognizing content relationships.

### **7.3.2 Ideation in Performance: Improvisation**

Improvisation involves reworking precomposed material and conceiving and shaping unanticipated ideas under the special conditions of performance [26]. In the performance of hypermedia pathways, in conjunction with a free-form space, the presenter is enabled to spontaneously pan and zoom the presentation view, beyond predefined sequences. P22 and P17 found this improvisation support improved presentation experiences [Q25, 26](#). The integration of spatial and node-link hypermedia content organization helps presenters spontaneously show connections and avoids slideware's difficulty in accessing a remote slide and then jumping back to the prior context.

### **7.4 Changes for Design: More than Presenting**

According to performance studies scholar, Schechner, creative *process* means 'revealing associations, following wherever they lead, to the very end' [50]. Authoring and per-



forming a presentation potentially functions as such a creative process of discovery. The problem is that prior approaches consider developing a presentation as a tightly specified task, not a creative one. Developing ideas and presentations are compartmentalized into discrete silos of experience. In combination with hypermedia pathways, free-form multi-scale spaces support users in revealing and developing relationships among elements. Through such processes, new ideas emerge.

Traditional presentation support tools, like PowerPoint and even Prezi and SlideSpace, are comparatively product-oriented. In slideware, users are forced to start by authoring each slide, from the beginning, on a line-to-line level. We observe that this adds the burden of needing to unitize content even before realizing the whole. Further, slideware's topic-subtopic, nested bullet points structure is ineffective for scientific presentations [12]. These shortcomings produce gaps between the user's goals and the system's representation. To overcome this problem, experts on creating effective presentations with slideware advocate that people start in a different medium, using pen and paper to design presentation content [31, 4]. Slideware's premature formalism forces users to focus on the product without the process.

Spatial content organization supports iterative knowledge formation, aka creative ideation. The potential for multiple interpretations through ambiguous relationships and the ability to manipulate them stimulates processes of engagement. Sketching amidst content also provides flexible means for interpretation and articulation. The more that ideation is supported continuously as a process, the more that new ideas will be allowed to emerge as people work. Hypermedia pathways provide structural support, with free-form space, through stages of knowledge development, enable users to define routes that manage the ambiguity for presentations.

Therefore, we recommend that future presentation tools provide more support for creating content rather than singly focusing on the final product, namely the performance of

presentations. Spatial content organization integrated with hypermedia pathways is a way for both stimulates ideation as well as provides well-organized performing experiences to the users.

## 8. SUMMARY AND CONCLUSIONS

In this research, we integrated hypermedia pathways into free-form spaces to enable well-organized presentation performance experiences, while at the same time supporting iterative ideation throughout the process. The spatial organization of content will protect authors from premature formalism and stimulate ideation, while hypermedia pathways will help presenters to perform well-organized presentations which convey the ambiguous and complex relationships to the audiences.

We ran a study, in a natural setting, which addresses students' actual challenges in creating project ideas and presenting them. The present study addressed university community members. Future research can address the potential for the integration of free-form space and hypermedia pathways to benefit iterative creative processes in many fields and at many levels.

## REFERENCES

- [1] T. H. Nelson, *Literary machines 93.1*. Milwaukee, USA: Mindful Pr, 1993.
- [2] J. Rosenberg, “Navigating nowhere / hypertext infrawhere,” *ACM SIGWEB Newsletter*, vol. 3, no. 3, pp. 16–19, 1994.
- [3] J. Nielsen *et al.*, *Hypertext and hypermedia*. Cambridge, USA: Academic Press, 1990.
- [4] E. R. Tufte, *The cognitive style of PowerPoint*. Cheshire, USA: Graphics Press Cheshire, CT, 2003.
- [5] F. M. Shipman III and C. C. Marshall, “Formality considered harmful: Experiences, emerging themes, and directions on the use of formal representations in interactive systems,” *Computer Supported Cooperative Work (CSCW)*, no. 4, pp. 333–352, 1999.
- [6] C. C. Marshall and F. M. Shipman III, “Spatial hypertext: Designing for change,” *Communications of the ACM*, vol. 38, no. 8, pp. 88–97, 1995.
- [7] A. Kerne, N. Lupfer, R. Linder, Y. Qu, A. Valdez, A. Jain, K. Keith, M. Carrasco, J. Vanegas, and A. Billingsley, “Strategies of free-form web curation: Processes of creative engagement with prior work,” *Proceedings of the ACM Creativity & Cognition*, 2017.
- [8] W. W. Gaver, J. Beaver, and S. Benford, “Ambiguity as a resource for design,” in *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 233–240, ACM, 2003.
- [9] A. Kerne, S. M. Smith, E. Koh, H. Choi, and R. Graeber, “An experimental method for measuring the emergence of new ideas in information discovery,” *International Journal of Human Computer Interaction*, vol. 24, no. 5, pp. 460–477, 2008.

- [10] J. Ayres, “Speech preparation processes and speech apprehension,” *Communication Education*, vol. 45, no. 3, pp. 228–235, 1996.
- [11] N. Duarte, *HBR guide to persuasive presentations*. Brighton, USA: Harvard Business Press, 2012.
- [12] M. Alley, *The craft of scientific presentations*. New York, USA: Springer, 1996.
- [13] R. Linder, N. Lupfer, A. Kerne, A. M. Webb, C. Hill, Y. Qu, K. Keith, M. Carrasco, and E. Kellogg, “Beyond slideware: How a free-form presentation medium stimulates free-form thinking in the classroom,” in *Proceedings of the 2015 ACM SIGCHI Conference on Creativity and Cognition*, pp. 285–294, ACM, 2015.
- [14] L. Lichtschlag, T. Karrer, and J. Borchers, “Fly: A tool to author planar presentations,” in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 547–556, ACM, 2009.
- [15] T. Moscovich, K. Scholz, J. F. Hughes, and D. Salesin, “Customizable presentations,” tech. rep., Technical Report CS-04-16, Computer Science Department, Brown University, 2004.
- [16] B. B. Bederson and J. D. Hollan, “Pad++: A zooming graphical interface for exploring alternate interface physics,” in *Proceedings of the 7th annual ACM symposium on User interface software and technology*, pp. 17–26, 1994.
- [17] L. E. Good, *Zoomable user interfaces for the authoring and delivery of slide presentations*. PhD thesis, University of Maryland, 2003.
- [18] Prezi.Inc, “Prezi.com,” 2009.
- [19] L. Lichtschlag, T. Hess, T. Karrer, and J. Borchers, “Fly: Studying recall, macrostructure understanding, and user experience of canvas presentations,” in *Proceedings of*

- the SIGCHI Conference on Human Factors in Computing Systems*, pp. 1307–1310, ACM, 2012.
- [20] D. Holman, P. Stojadinović, T. Karrer, and J. Borchers, “Fly: An organic presentation tool,” in *CHI’06 extended abstracts on human factors in computing systems*, pp. 863–868, ACM, 2006.
- [21] R. Spicer, Y.-R. Lin, A. Kelliher, and H. Sundaram, “Nextslideplease: Authoring and delivering agile multimedia presentations,” *ACM Transactions on Multimedia Computing, Communications, and Applications (TOMM)*, p. 53, 2012.
- [22] S. M. Drucker, G. Petschnigg, and M. Agrawala, “Comparing and managing multiple versions of slide presentations,” in *Proceedings of the 11th annual ACM symposium on User interface software and technology*, pp. 47–56, ACM, 2006.
- [23] J. Lanir, K. S. Booth, and A. Tang, “Multipresenter: A presentation system for (very) large display surfaces,” in *Proceedings of the 16th ACM international conference on MultiMedia*, pp. 519–528, ACM, 2008.
- [24] A. Kerne, A. M. Webb, S. M. Smith, R. Linder, N. Lupfer, Y. Qu, J. Moeller, and S. Damaraju, “Using metrics of curation to evaluate information-based ideation,” *ACM Transactions on Computer-Human Interaction*, no. 3, p. 14, 2014.
- [25] E. Goffman *et al.*, *The presentation of self in everyday life*. New York, USA: Random House, 1978.
- [26] P. F. Berliner, *Thinking in jazz: The infinite art of improvisation*. Chicago, USA: University of Chicago Press, 2009.
- [27] J. Yates and W. Orlikowski, “The powerpoint presentation and its corollaries: How genres shape communicative action in organizations,” *Communicative practices in*

- workplaces and the professions: Cultural perspectives on the regulation of discourse and organizations*, pp. 67–91, 2007.
- [28] C. Adams, “Powerpoint, habits of mind, and classroom culture,” *Journal of Curriculum studies*, vol. 38, no. 4, pp. 389–411, 2006.
- [29] M. Csikszentmihalyi, *Beyond boredom and anxiety*. The Jossey-Bass behavioral science series, Hoboken, USA: Jossey-Bass Publishers, 1975.
- [30] R. Schechner, *Performance studies: An introduction*. Abingdon, UK: Routledge, 2013.
- [31] G. Reynolds, *Presentation zen: Simple ideas on presentation design and delivery*. San Francisco, USA: New Riders, 2011.
- [32] M. Csikszentmihalyi and I. S. Csikszentmihalyi, *Optimal experience: Psychological studies of flow in consciousness*. Cambridge, UK: Cambridge university press, 1992.
- [33] I. J. Walker and S. M. Nordin-Bates, “Performance anxiety experiences of professional ballet dancers the importance of control,” *Journal of Dance Medicine & Science*, vol. 14, no. 4, pp. 133–145, 2010.
- [34] J. Elliot and L. Joyce, “Presentation anxiety: A challenge for some students and a pit of despair for others,” Available on: [http://www.isana.org.au/files/20051017165939\\_PresentationAnxiety.pdf](http://www.isana.org.au/files/20051017165939_PresentationAnxiety.pdf), 2005.
- [35] J. B. Bishop, K. W. Bauer, and E. T. Becker, “A survey of counseling needs of male and female college students,” *Journal of College Student Development*, vol. 39, no. 2, p. 205, 1998.
- [36] B. Saket, S. Yang, H. Tan, K. Yatani, and D. Edge, “Talkzones: Section-based time support for presentations,” in *Proceedings of the 16th international conference on*

- Human-computer interaction with mobile devices & services*, pp. 263–272, ACM, 2014.
- [37] C. Atkinson and R. E. Mayer, “Five ways to reduce powerpoint overload,” *Creative Commons*, 2004.
- [38] B. B. Bederson and A. Boltman, “Does animation help users build mental maps of spatial information?,” in *Proceeding of Information Visualization*, pp. 28–35, IEEE, 1999.
- [39] Y. S. Lincoln and E. G. Guba, *Naturalistic inquiry*, vol. 75. Thousand Oaks, USA: Sage, 1985.
- [40] S. Barab and K. Squire, “Design-based research: Putting a stake in the ground,” *The journal of the learning sciences*, vol. 13, no. 1, pp. 1–14, 2004.
- [41] K. Charmaz, *Constructing grounded theory*. Thousand Oaks, USA: Sage, 2014.
- [42] G. Deleuze and F. Guattari, *A thousand plateaus: Capitalism and schizophrenia*. London, United Kingdom: Bloomsbury Publishing, 1988.
- [43] M. Foucault, *The archaeology of knowledge*. New York, USA: Vintage, 2012.
- [44] G. P. Landow, *Hypertext 3.0: Critical theory and new media in an era of globalization*. Baltimore, USA: Johns Hopkins University Press, 2006.
- [45] O. E. Dictionary, “Oxford up, 2013,” in *Oxford Dictionary*, Web, 2013.
- [46] N. Lupfer, A. Kerne, A. M. Webb, and R. Linder, “Patterns of free-form curation: Visual thinking with web content,” in *Proceedings of the 2016 ACM on Multimedia Conference*, pp. 12–21, 2016.
- [47] G. Goldschmidt, “On visual design thinking: the vis kids of architecture,” *Design studies*, vol. 15, no. 2, pp. 158–174, 1994.



- [48] E. R. Tufte, "Envisioning information," *Optometry & Vision Science*, vol. 68, no. 4, pp. 322–324, 1991.
- [49] J. C. Kaufman and R. A. Beghetto, "Beyond big and little: The four c model of creativity.," *Review of General Psychology*, vol. 13, no. 1, p. 1, 2009.
- [50] R. Schechner, *Environmental theater*. Milwaukee, USA: Hal Leonard Corporation, 1994.

## APPENDIX A

### INTERVIEW QUESTIONS FOR USERS

#### *Introductory Questions*

1. What year and major are you?
2. What kinds of presentations you have made before? What tools do you use for making those presentations?
3. In what course and semester did you use *IdeaMâché*? From your perspective, what is the course about? What is the role of *IdeaMâché*?

#### Transition Questions(optional)

4. What was your role in your team for working on the presentation using *IdeaMâché*?

#### *Key Questions*

1. Authoring Presentation
2. Why did you use *IdeaMâché* for the final presentation?
3. When did you start authoring the presentation? How long did you spend on authoring?

Describe the process of authoring the presentation.

4. Tell me the story of how you (or your team) created it.
5. Did your prior work with IdeaMache play any role in how you created your presentation? If so, what role? Discuss.

6. What are the most difficult issues you encountered while authoring the presentation?
7. Open the the interview's presentation *Mâché* and look at it together Opportunistically ask the following  
  
[keep the conversation going and be comprehensive about editing presentation features - try to get the interviewee to talk about it]
8. What was the first thing you did? Why?
9. I like the layout of your content. Could you tell me how you decided the current layout?
10. Is there any special reasons for putting this content next to the other one? (Point to some specific contents)
11. How you create a frame and why you make this frame? (point to a specific frame)
12. Do you like the way of showing those frames? Why?
13. Did you modify your content after you creating the frame related to that content?
14. How you decide the sequence of the frames? Is the overall layout of your content related to how you created the sequence of frames? If so, how?
15. Do you like the way of showing those connections? why?
16. When you start creating connections? Why you link those two frames?
17. Did you modify the connections after the rehearsal and why you change it?
18. How you decide the start frame of your presentation?

19. Let's pretend you use PowerPoint or Google Slides for authoring this presentation, what kinds of changes will you make?
20. Looking at it now, do you notice anything that you forgot or missed about your authoring presentation process?

*Performing the presentation*

1. What do you think are the important parts of the presentation? Why?
2. Do you like the transition between the frames? Why?
3. Do you like the multiple choices of the next frame? Why? When will you use it or when will you not use it?
4. What did you use for control the presentation? Keyboard or Mouse? Which one you prefer and why?
5. How did the interaction way for moving forward of your presentation?
6. What do you think is the most difficult operations of delivering the presentation?
7. Let's pretend you use PowerPoint or Google Slides for delivering this presentation, what do you think will be the different?
8. Is there any situation during the presentation you unexpected?
9. Did you satisfied with the feedback from the audience?
10. What's your team member's feedback on the presentation you make?

*Ending Questions*

1. Are there things you wanted to do with this presentation (while editing and delivering) that you were unable to?

2. Is there anything else you would like to tell us about the *Mâché*, the presentation?
3. Thanks so much! Do you have any question for me?