HyperSlides: Dynamic Presentation Prototyping

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ABSTRACT

Presentations are a crucial form of modern communication, yet there is a dissonance between everyday practices with presentation tools and best practices from the presentation literature. We conducted a grounded theory study to gain a better understanding of the activity of presenting, discovering the potential for a more dynamic, automated, and story-centered approach to prototyping slide presentations that are themselves dynamic in their ability to help presenters rehearse and deliver their story. Our prototype tool for dynamic presentation prototyping, which we call HyperSlides, uses a simple markup language for the creation of hierarchically structured scenes, which are algorithmically transformed into hyperlinked slides of a consistent and minimalist style. Our evaluation suggests that HyperSlides helps idea organization, saves authoring time, creates aesthetic layouts, and supports more flexible rehearsal and delivery than linear slides, at the expense of reduced layout control and increased navigation demands.

Author Keywords

Presentations; Slideware; PowerPoint; Grounded Theory

ACM Classification Keywords

H5.2 Information interfaces and presentation: User Interfaces

INTRODUCTION

The activity of preparing and delivering presentations, whether to teach, inform, or persuade, is of critical importance across education, academia, and business. Current presentation software is dominated by Microsoft PowerPoint [29], but this application has given rise to a whole family of slideware including Apple Keynote [1]. The success of slideware can be measured by the 60 million monthly visitors to the SlideShare platform for web-based presentation sharing [43] and the 12 million English PowerPoint files indexed by Google as of January 2013.

Nevertheless, while slideware can lift the floor of public speaking, it can also lower the ceiling [37] by creating a dependency on slides that in many cases resemble text documents ("slideuments") [10]. Far from Dale Carnegie's 1930s ideal that visual materials will promote clarity [6], this has led to the problematic practice of peripheral computing

by audience members [19] who can simply read along rather than listen. In a critique of "The Cognitive Style of PowerPoint" [48], Edward Tufte further attacks the foreshortening of evidence and thought, low spatial resolution, single-path hierarchy, fragmented narratives, rapid temporal sequencing, chartjunk, formatting, and commercialism of PowerPoint. Don Norman makes the counterargument "In Defense of PowerPoint" [33], however, that "most people give poor talks" and the problem lies with the talk, not with the tool. Empirical studies also suggest that slides have a positive effect on learning outcomes when they are shared or printed for offline reading and review [22].

Even so, a wide range of technologies have been created to augment or replace slide presentations. Following Zoomable User Interface (ZUI) research [5] applied to presentations [15], the commercial Prezi application [40], the Fly research application [25], and the pptPlex add-in for PowerPoint [39] present alternatives to the 35mm slide metaphor in the form of zoomable canvases. As yet though, experimental comparisons of slide versus canvas presentations have not yielded significant differences in the recall of facts or structure [23], while decorative use of rotation has been shown to negatively impact spatial understanding [24].

Various projects have explored other aspects of presenting, including authoring with scanned paper [36]; interaction with paper representations of slides [31, 42]; gestural interaction [13]; non-linear navigation [30, 45]; multi-screen content [21]; mobile "crowd" feedback during delivery [47]; and automatic feedback on speech during rehearsal [20]. However, very few works have attempted to address all five canons of rhetoric formulated by Cicero [9], from the *invention* and *arrangement* of arguments through their elaboration in *style* and *memory* before final *delivery*. Similarly, presentation tools are "simply containers for ideas and assets" [10] and offer no guidance about how to communicate using such devices as the ethical, emotional, and logical means of persuasion defined by Aristotle [3].

Our goal was therefore to uncover the gap between actual presentation practices and the "best practices" advocated in the presentation literature, before designing tools that help presenters to bridge that gap. We began by conducting a grounded theory study [8], interviewing 20 people for whom presenting was a core competency. In this study, we identified the need for a more dynamic approach towards the rapid and iterative prototyping of slide presentations that themselves offer greater dynamism and flexibility in their support for planning, rehearsing, and delivering a story.

From the results of our grounded theory study we derived four implications for the design of dynamic presentation prototyping systems. We use these to motivate the design of our HyperSlides system, which leverages the PowerPoint application and document format for dynamic prototyping, while transforming the conventional slide metaphor to support more dynamic forms of rehearsal and delivery:

1. *Planning with points*. In HyperSlides, points to be communicated are hierarchically organized into scenes of a storyline using a lightweight text markup language.
2. *Styling as a service*. In HyperSlides, slides are generated from scenes, styled based on general design principles, and automatically hyperlinked to one another.
3. *Linking between scenes*. In HyperSlides, scenes connect to one another via verbal linkages and to a visual overview of the storyline for non-linear navigation.
4. *Expanding on demand*. In HyperSlides, scenes expand into points and points into supporting details that can be shown dynamically without breaking presentation flow.

To understand the experiences of approaching presentations in such a dynamic manner, we observed the use of HyperSlides in a 5-hour workshop with 12 students. We found that HyperSlides encourages many of the best practices for presentations identified through our grounded theory study and literature review, helping presenters to organize their thoughts, saving them authoring time, creating aesthetic layouts automatically, and supporting more flexible rehearsal and delivery than linear slides. These benefits come at the expense of reduced layout control during presentation authoring and increased navigation demands during delivery.

The contributions of this work are therefore: 1) the development of categories and implications from our grounded theory study, culminating in the notion of dynamic presentation prototyping; 2) the design of the HyperSlides system; and 3) the validation of HyperSlides in a user study that demonstrated dynamic practices in the authoring, rehearsal, and delivery of presentations under time pressure.

UNDERSTANDING THE ACTIVITY OF PRESENTING

To enrich our understanding of presentions, we conducted qualitative research with people for whom presenting was a practised (even if underdeveloped) competency. We adopted the constructivist approach to grounded theory [8], acknowledging that both researchers and participants construct theories through the analytic lens of their past interactions with people, perspectives, and practices. As such, we offer an interpretive and provisional account that helps us to understand the fundamental concerns and processes that constitute the activity of presenting.

Procedure

We began with eight interviews structured around open-ended questions eliciting reflections on participants' presentation experiences. These were recorded and transcribed for analysis. Line-by-line coding of theses transcripts resulted in 162 short, active phrases that distilled and defined processes in action and patterns between them.

Following initial interviews, we used affinity diagramming to cluster initial codes into related groups. We then created synthesized category labels as focused codes to be used in subsequent analysis. Reexamination of existing data confirmed our categorization had high levels of fit, relevance, and coverage. We then continued with 12 further interviews until we had saturated each of these categories.

Participants

We recruited 20 participants (5 female), of ages 25–55 (mean 35), from 10 nationalities. They comprised 6 industrial researchers working in design, development, and management, 6 student research interns with backgrounds in engineering and computer and social sciences, and 8 people working as teachers, pastors, and sales and business professionals. Our initial and subsequent theoretical sampling prioritized diversity of profession but unity of professional need to prepare and deliver presentations.

Categories

Through our grounded theory analysis, we developed eight categories that characterized the activity of presenting as experienced by our participants. All were used to inspire the design of the HyperSlides system, but here we present only the five categories that most directly illustrate the need for a more dynamic approach to presenting. Direct quotes are attributed to participants using the notation [PX] to refer to participant X, but all analysis closely follows participant quotes grounded in presentation experiences.

1. Setting goals given constraints

Presentations result from goal-directed activity constrained by parameters of the content, the audience, the schedule, the event, and the contexts of preparation and delivery. Mismatched goals and constraints cause problems, e.g.:

"I don't want to spend more time on my slides than the actual intellectual work I've put into it – it's like you see those presentations where people look like they obviously spent more time on their slides than the actual work." [P7]

Presentation goals can be explicitly constrained by event rules, either in time or slides (or both, as in the Pecha Kucha style of 20 slides for 20 seconds each [38]). They can also be influenced by the relative performance of peers and the intrinsic desire of the person to present.

For a presentation, "the message depends on the audience" [P4]. Presenters should therefore reflect on the relationship between different kinds of audience members and the content to be presented, anticipating and formulating responses to questions that could arise as a result.

However, sometimes "the audience is not big enough or the issue not large enough to use a lot of time on it" [P6]. Preparation time can be affected by anticipated differences in audience expertise, culture, language, and learning-style. The effort required depends on the readiness of content – "sometimes you are just scrambling to put something together" [P9] – as well as presenter – "if I'm forced to do something on short notice I feel very uncomfortable" [P4].

2. Telling stories with slides

Information and examples can be wrapped in a narrative and delivered through the interplay of visuals and speech. Successful communication has multiple points and layers that are connected by a sense of coherence and flow:

"I prefer to do very focused slides – images, words that are very brief and to the point so it avoids people spending all their time looking at the PowerPoint while you're talking and trying to communicate. Ideally it needs to be seamless in a transition, where if you are moving from three different points... your first point should logically lead into the second point... all three of them really work together to drive at the final conclusion or the original question. So really it should work together as a unit – three pieces of the same idea, just broken down." [P13]

Story development should begin before slide building. Starting with the goal in mind can help guide all subsequent activity, including crafting implicit messages, explicit takeaways, or rhetorical questions. Mapping points to slide titles also gives a provisional structure for elaboration.

Images and graphics can replace text in ways that "hit the right tones – inspiring, motivational" [P11]. The addition of a few words can aid communication clarity as well as helping people come up with questions. Effectiveness rises when such slides are concluded with "a powerful point or a summation that is left to sink in before moving on" [P5].

Presenters can "spend a lot of time on how to connect slides" [P8]. Leading with a question, hint, or concern prior to changing slides shows that the presenter is in control and avoids breaking the flow. Planning transition words helps both the presenter to consider why they are moving to the next topic and the audience to follow the progression.

Seeing and rearranging content in overview helps create a sense of flow, whether looking for stories in images or connecting descriptions of slide contents. Finally, the technique of "tying back to a general story or idea helps keep people in the outline of what's going on" [P6].

3. Preparing for structured spontaneity

Cycles of rehearsal and refinement can help consolidate the presentation structure in the mind of the presenter, encouraging a natural delivery free of reading and recital:

"I can sort of read stuff and without thinking about how to connect them – thinking I've connected them once, therefore they should make sense. But it's a lot less effective to the audience – I think it's a lot better if I'm delivering, making sense and connecting each point at a time. Then I think the audience has an easier time. It's a degree of familiarity but it's also the ability to talk about something and thinking ahead." [P9]

High-level rehearsal involves going back and forth at the macro level to internalize the presentation outline, and doing this many times "until you know in your head how you will transition from this idea to that idea" [P3]. This helps presenters to not think about the words but the flow, because "If you don't depend on the words then you don't have to worry about memorizing anything" [P15]. Memorization is sometimes employed just for the wordings of strong slide conclusions that set up the following slide.

Lower-level rehearsal uses slide visuals as cues for the recall of points to make verbally, treating the presentation as a "cheat sheet of minimum clues" [P14]. Strategies for learning these associations include the use of presenter notes, physical flashcards to drill points into short-term memory, and making redundant changes across notes and slideware. While more practice makes the delivery more intuitive, "the best thing is a well-spaced work flow that isn't consolidated into a single session of cramming" [P5]. While rehearsing, practicing speaking slides out loud highlights differences between written and spoken language, which supports rephrasing of notes to be spoken. A clear mental structure also supports performance-oriented rehearsals such as practice walking around, in front of a mirror, gesturing, or visualizing the delivery in their mind.

Reading from presenter notes typically results in "not a really good experience – it really stops the flow of things, the human-to-human interaction" [P17]. Instead, many presenters printed back-up information that could be re-read to remind the presenter just before the presentation, then left "lying on the podium just to be safe" [P14].

4. Orchestrating focus and flow

During delivery, the presenter must orchestrate the audience's attention using the combination of visuals, gestures, and speech, directing focus at key points and communicating a clear, purposeful flow from start to finish. Since breaking the flow is highly detrimental, presenters have devised coping strategies, e.g., preparing hyperlinks:

"I use a lot of references as well this one feature in PowerPoint that's very useful – I'm talking about a certain point and I need to develop it further so I just click at that point with the mouse and it jumps all the way to back-up pages with detailed information. I click another button and it goes back to the original page so it doesn't interrupt the whole sequence of the presentation." [P16]

Many presenters prepare such extra slides like an appendix at the end of their presentation. Such slides can be useful "in case people ask you for more data, more proof – you should always be able to support what you say" [P3]. Sometimes it is also desirable to show slides out of linear order as a way of making points spontaneously or in response to audience questions. It is possible to memorize slide numbers for direct keyboard navigation rather than skipping through slides in sequence, but this is onerous and can still result in "hopping around" when slide numbers are misremembered. Exiting a presentation to access additional files can result in "losing the whole audience while showing everyone how you organize your files" [P2]. Impromptu whiteboard sketches were often used as a fallback [P10].

One tactic to prevent the audience reading ahead is to show a headline as a reminder that prompts the presenter to speak freely about a topic, only showing bullet points afterwards as a recap. However, anxious presenters often forget what to say and prefer glancing back at detailed slides. Sometimes presenters also need to see the next slide before they know what to talk about, which can cause even larger problems if the presenter is surprised by what appears.

5. Influencing audience with timing
Communication takes place over time, and the presenter's timed rehearsals, attention to timekeeping, and rhythm of spoken delivery all affect audience perceptions. Even with good timekeeping, problems like slide skipping still occur:

"I don't often go over. I pay attention to presenter mode in PowerPoint – I do know how much time I have left. Very often they'll have questions – they'll just jump right into questions and so I'll just cut – I'll dynamically cut out material or I'll just be like, okay we don't have time for this stuff. And I'll just skip, skip, skip. Then I'll just get over to the important points." [P17]

The converse problem is also possible – stressed presenters can speak too fast, exhausting their slides and having to fill the remaining time unaided. Automatically advancing slides can help in some ways but become problematic as soon as there is deviation from the original plan.

During delivery, presenters can aim to hit particular topics by particular times. To end a talk gracefully, some presenters use handheld "clickers" that vibrate at fixed intervals (e.g., 5 or 2 minutes) before the end of the allotted time, letting you "feel when you are getting there" [P2]. Finishing on time can be seen as a measure of success for any presentation, but for some talks, this is even more critical when the alternative is being told to stop speaking.

Rapid transitions between slides can also be used to visually reinforce the logic of spoken arguments. For persuasive presentations in general, the main challenge is often not about content, but "building the right tones and crescendos" [P11] by varying the rhythm over time.

The density of slides or script text can also be used to make projections of the final speaking time, while iterative timed rehearsals reduce the uncertainty of how long each slide will take. Presenters who do not rehearse can overestimate the points they can cover and "end up skipping most of the bullet points on the slides" [P12].

The need for dynamic presentation prototyping
The categories presented in the previous section describe fundamental processes in the activity of presenting, many of which were described in terms of actions with slides in conventional slideware applications such as PowerPoint. The fundamental concern arising from this analysis can be expressed in terms of how interaction affordances and constraints shape the nature of presentation authoring, rehearsal, and delivery. In particular, the authoring environment of conventional slideware offers many affordances for graphical manipulation, while the slideshow mode is highly constrained by the linear way in which presentation slides are built and navigated, as well as the literal way in which all slide content must be presented (even during rehearsal when testing might be more valuable [7]).

Our notion of a dynamic approach to presentation prototyping reverses this balance by promoting tight constraints on authoring possibilities while opening up rich and differentiated interaction affordances for presentation rehearsal and delivery. Our argument is that given a fixed amount of time to prepare a presentation, the time saved by not directly manipulating text, images, and other slide "shapes" can be reallocated to two of the sub-activities shown by the grounded theory study to be of critical importance: *telling stories with slides* by thinking about the sequence, structure, and purpose of points to make; and *preparing for structured spontaneity* by mentally and verbally rehearsing how to add value to the points shown on the slides. Time spent on these sub-activities should result in better mastery of better material, creating freedom to be more dynamic, responsive, and improvisational during delivery: *orchestrating focus and flow*. All of these categories suggest some kind of prepared connection between points that can be dynamically revealed on demand either to test the presenter (during rehearsal) or share with the audience. This is further supported by the ability to show content in time with speech or pass over it due to time constraints: *influencing audience with timing*. When *setting goals given constraints* while planning and rehearsing the presentation, dynamic presentation prototyping should support the same kind of early, iterative, and responsive prototype delivery that characterizes agile software development practices [2].

Implications for design & Supporting literature
In the following sections, we map the concept of dynamic presentation prototyping onto four implications for the design of future tools. We motivate each with ideas from the popular and scientific literature we reviewed subsequently.

A. Planning with points
Presentation tools should help people to organize the points they wish to communicate, and "every once in a while being able to spit out a presentation" [P9]. Through lightweight authoring and the automatic generation of presentation documents that are sensitive to variations in audience and timing, planning and authoring should be possible even when distributed across devices and contexts.

Planning with points before committing them to slides avoids the problem of never seeing the whole story at once [49]. It also avoids slide procrastination – "fidgeting with and worrying about bullets and images on slides […] instead of how we craft the story that is most effective, memorable, and appropriate for our audience" [41]. Crafting messages should precede visual design [10], and each message should propel the audience closer to the destination of their "journey" [11].

Doing the "data dump" outside slideware supports the distillation and organization of ideas and helps the presenter to check whether their sequence of slides titles creates a meaningful "flow" [49]. The lightweight nature of such planning is well supported by the analog tools of "paper, a whiteboard, post-it notes, or a stick in the sand" [41]. Presentation applications are "simply containers for ideas and assets" generated through these creative processes [10].

An early focus on communicative substance without the distractions of visual style also allows greater attention to the language used, for example the crafting of "twitter-like headlines" that are concise, specific, and memorable [14].

B. Styling as a service

Presentation tools should be able to take a collection of points sourced from multiple people and documents and generate a presentation of those points with consistent styling. This styling should be quickly and easily customizable while conforming to best practices in the visual design of presentations.

Several existing presentation tools offer different environments for authoring and presentation. Beamer [4] and Slidy [44] use LaTeX and HTML markup respectively to specify the logical structure of a presentation before combining with a visual theme and "compiling" into slides. In code-based approaches, Impress.js [18] uses JavaScript to specify zoomable canvas presentations, and Slithy [52] uses Python to generate rich parameterized animations. Such textual specifications support a smooth transition from point outlines created in collaborative text editors such as Google Docs [16] to the markup of those points with styles.

Styling as a service should encourage the use of images as a way to have the audience "not only understand your point better but also have a more visceral and emotional connection to your idea" [41]. This view is supported by the Picture Superiority Effect: concepts presented as images are remembered for longer than concepts presented as words [32]. The Dual Coding theory of memory [35] – that information has both visual and verbal components that form separate representations in the mind, each of which can act as a cue for retrieval – adds that words and images used together will amplify their joint message. This Multimedia Effect has been demonstrated experimentally [26] and encoded in two principles of multimedia learning [28]: the Multiple Representation Principle (use both pictures and words) and the Continuity Principle (use them together). The remaining principles are the Split-Attention Principle (when using visual explanations, augment with speech rather than text), the Individual Differences Principle (these effects apply more for low-knowledge and high-spatial learners), and the Coherence Principle (use fewer rather than more words and pictures). These are based on theories of Cognitive Load [46] and ways of reducing it [27]. In other words, "only put elements on your slides that help the audience recall your message" [11].

In general, styling as a service should automatically exploit all of the "big four" principles of visual design: contrast, repetition, alignment, and proximity [41]. For example, when displaying text bullets, it should also use proportional spacing to "avoid anticipation of bullets to come" and avoid line-wrapping to "minimize eye sweeps" [49].

C. Linking between scenes

Presentation tools should help presenters to craft and connect the central "scenes" of a high-level narrative, encouraging planning of verbal linkages between scenes and striking the right balance between "storytelling and analysis" [P7]. Organization of points into scenes should also guide presenter choices about how deeply to explore each scene while completing their narrative on time.

The notion of a scene is borrowed from the dramatic arts as a coherent set of points that advance the higher-level story. Scenes are the foundations of the 16 "flow structures" presented in [49], examples of which include chronological, problem/solution, and opportunity/leverage. Appropriate scenes for a presentation can be discovered by clustering related points into 3-5 "Roman columns" of the presentation, providing a mental focus for both presenter (when learning the presentation) and audience (when following it) [49]. A hierarchical organization of both scenes and the points within them ensures that "all the supporting information hangs off one big idea" [11]. One pattern to organize groups of slides into higher-level scenes is bumper slides that give visual closure between sections [41, 49].

Various ways of verbally linking scenes, or using "internal linkages", include using an opening gambit (such as a question, factoid, or anecdote), making repeated references to the flow structure, making logical transitions between outbound and inbound topics, and closing with your call to action [49]. Presenting a visual road map or outline near the start and end of the presentation can help the audience create and retain a mental model of the presentation [49].

Linking between scenes both visually and verbally creates dynamic tension through contrast, especially when scenes alternate between "what is" and "what could be" [11]. Based on insights from mythological, literary, and cinematic structures, this "presentation form" uses these contrasts to create a clear beginning, middle, and end, via turning points that help to inject energy and emotion [11].

D. Expanding on demand

Presentation tools should support the dynamic expansion of points into sub-points, notes, media, files, or web pages that support the point being presented. As a presenter, the expansions of points and connections between scenes during rehearsal should help "get the structure in your head" [P3]. During delivery it can support dynamic content control in response to forgetting or audience reactions.

The flashcard-like method of testing recall of some target information given an initial cue is called cued-recall learning, and has been studied extensively [7]. The most family of virtual flashcard applications are based on the SuperMemo algorithm [51], and recent HCI work has explored the use of contextual flashcards to prepare to speak in a second language [12]. However, current presentation software does not support cued-recall learning.

Rehearsal practice is recommended to follow the "3 Rs of letting go" [10]: Reducing slide or script text after each rehearsal; Recording the verbalization of each rehearsal (speaking words aloud to slides [49]); and Repeating rehearsals over time. Expanding on demand would bring cued-recall testing of points and linkages to presentation rehearsal, supporting finer-grained testing than is possible with slide notes. Such planned practice is the only way to achieve effective spontaneity [10], while letting the presenter "add value beyond each bullet by discussing, interpreting, and providing supporting evidence" from memory [49].
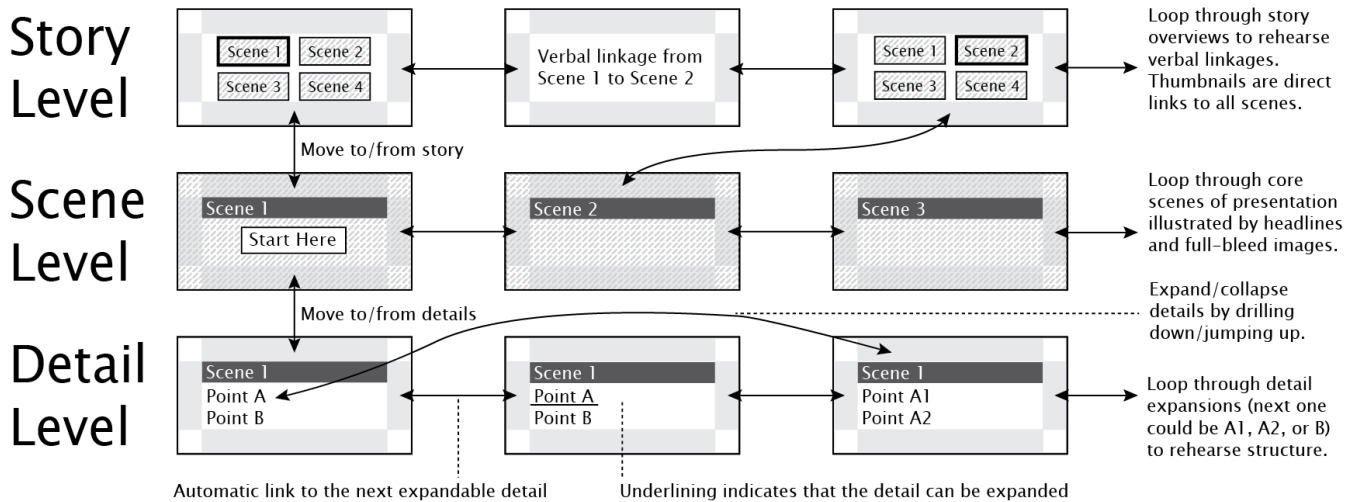
Figure 1. Topology of a HyperSlides presentation. Slide borders act as hyperlinks that support presentation traversal at three levels: core illustrated scenes, the high-level storyline, and low-level details expandable on demand

During delivery, the ability to expand points on demand gives the presenter freedom and flexibility to read the audience and present the right points to the right depth. This can occur following advice to "always speak 1:1" with audience members, "phrasing and pausing" to check understanding through eye contact and head nods [50].

DESIGN OF HYPERSLIDES
We designed our prototype HyperSlides system around the implications for design presented in the previous section. This system uses the Microsoft PowerPoint application and slide document format as a platform for prototyping presentations that are algorithmically transformed into slides but neither conceived nor navigated in the manner of conventional linear slides presentations. In the following sections, we describe the features of HyperSlides that support the dynamic prototyping of dynamic presentations.

A. Planning with points in HyperSlides
The title and bullet-like points of a HyperSlides presentation are created in a text file using a simple markup language (see Table 2). This supports the development of high-level scenes illustrated with full-bleed images, the expansion of scenes into points, the expansion of points into sub-points and supporting files, media, and web pages, and the preparation of verbal linkages between scenes. Such a text format supports highly lightweight authoring, but in the future could be performed through more visual means in a GUI or IDE.

B. Styling as a service in HyperSlides
The specification of a variety of style options is possible, including the font types and colors of title and body text, the size and color of the title background to create contrast when overlaid on a background image (as in Haiku deck [17]), and the slide aspect ratio and background color. Slide titles are automatically scaled to fill the space available. It is also possible to adjust the width of a special "hyperframe" – a set of transparent boxes added to the four edges of each slide, each of which can hyperlink to other slides in a richly interconnected slide network (see scene level of Figure 1).

Action	Syntax	Explanation
Create scenes	[Scene 1 < image1.jpg] [Scene 2 < image2.jpg]	Create scene slides with titles "Scene X" that have the background imageX.jpg.
Add details	[Scene 1 < image1.jpg] [> Point A] [>> Point A1] [>> Point A2] [> Point B]	Add Point A and Point B as details of Scene 1, with Point A1 and Point A2 sub-details of Point A. A third level of detail is possible using [>>>…], and so on.
Add hyperlinks	[> Point A >> http://url.tld] [> Point B >> anyfile.ext]	Link from Point A to a URL. Link from Point B to a file.
Embed media	[> Point C > media.ext]	Embed image or video into a slide linked from Point C.
Add verbal linkages	[Scene 1] {Linkage from Scene 1 to 2} [Scene 2]	Add verbal linkage from Scene 1 to Scene 2 (see Figure 1 for details).
Adjust styles	*styleParameter styleValue	Adjust visual properties (fonts, colors, spacing, etc.)
Add notes	This is a note.	Anything outside […] or {…} is ignored.

Table 2. HyperSlides markup language.

These hyperlinks provide the mechanism for more dynamic navigation between slides. They are generated according to a HyperSlides specification using the Open XML SDK 2.0 for Microsoft Office [34], which supports strongly-typed generation of the XML elements underlying the .pptx file format of PowerPoint 2007 onwards. In slideshow mode, these hyperlinks can be navigated using the mouse or touch.

C. Linking between scenes in HyperSlides
The scene level of Figure 1 shows how the core, illustrated scenes of the presentation connect to one another horizontally. Clicking the top border of a scene slide jumps to a hyperlinked "storyline" slide with the outbound scene highlighted. Clicking on any scene thumbnail jumps directly to that scene, while horizontal navigation reveals the verbal linkages planned for transitions between scenes. We call this the "story rehearsal path", intended for use during preparation but not delivery. From an illustrated scene, clicking the bottom border drops down to reveal the top level

of points for that scene. If the presenter reveals these points (rather than speaking to just the illustrated scenes), they must navigate back up to the scene level before advancing. This gives closure to each scene and prompts the speaker to say their prepared verbal linkage without slide text competing for the audience's attention.

D. Expanding on demand in HyperSlides

Any point can act as a hyperlink to an external file or web page. The detail level of Figure 1 shows how points can also act as internal hyperlinks to supporting points, descriptions, or media (images or videos). Once points have been expanded, clicking on the top border of the each slide will navigate back up the hierarchy. Navigating horizontally at the detail level follows the "detail rehearsal path", performing a depth-first traversal of all expandable points in the presentation, with "cue" slides using text underlines to indicate which point expansion the presenter should attempt to recall. The presenter should keep traversing this path until they can comfortably recall the structure and content of the points to be communicated. Slide notes are also generated automatically to show the inbound and outbound scene linkages and previews of point expansions.

HyperSlides Illustration

To generate a HyperSlides presentation, the HyperSlides executable file, the input text file named input.txt, and any hyperlinked files or media to embed in the presentation must be placed in the same folder. Double clicking on the executable regenerates the output.pptx file, which is then automatically opened in the installed version of PowerPoint (PowerPoint 2007 onwards). The annotated markup to the right could be used in as input.txt file that the HyperSlides executable would transform into the presentation in Figure 2.

Example input.txt file for a presentation about HyperSlides
{A new way to think about presentations}
✎ *opening verbal introduction*
[Presenting with HyperSlides < Presenting.jpg]
✎ *title and image of scene 1*
[> Dynamic Presentation Prototyping]
[>> Dynamic Prototyping of Presentations]
[>> Prototyping of Dynamic Presentations]
[> Practical Guidance > PresentationZen.jpg]
[> Empirical Grounding >> GroundedTheoryStudy.docx]
✎ *hyperlinked bullets, slides, and files of scene 1*
{Presentation slides are prototyped dynamically}
✎ *verbal transition to scene 2*
[Authoring < Prototyping.jpg]
[> Setting Goals given Constraints]
[> Telling Stories with Slides]
[> Planning with Points]
[> Styling as a Service]
[> Linking between Scenes]
{Presentation links are rehearsed dynamically}
[Rehearsal < Rehearsing.jpg]
[> Preparing for Structured Spontaneity]
[> Linking between Scenes]
[> Expanding on Demand (to learn the story)]
{Presentation itself is delivered dynamically}
[Delivery < Delivering.jpg]
[> Orchestrating Focus and Flow]
[> Influencing Audience with Timing]
[> Expanding on Demand (to tell the story)]
{Rapid iterative prototyping of flexible presentations}
✎ *closing verbal takeaway message*

Figure 2. Example slides and navigation paths of a HyperSlides presentation in the default visual style

EVALUATION OF HYPERSLIDES

We were interested in understanding how dynamically prototyping, rehearsing, and delivering presentations could be beneficial to presenters and the extent to which HyperSlides supports such dynamism in practice.

Procedure

We ran a 5-hour workshop in which 12 participants:

1. Learned the technical use of HyperSlides through a series of per-feature mini-lessons (30 minutes);
2. Authored and rehearsed an 8-10 minute HyperSlide presentation on a topic of their choice (2 hours);
3. Took turns delivering their HyperSlide presentation to the remaining workshop participants (2 hours);
4. Provided feedback through two 6-participant focus group discussions held in parallel (30 minutes).

Participants also voted for the top three presentations, with the three presentations receiving the most votes winning prizes equivalent to 150, 50, and 30 USD respectively. All participants received a free lunch and a 15 USD gift card.

Participants

We recruited 12 participants (5 female) of ages 22–26 (mean 23) who did not participate in our grounded theory study. All were students working in our lab from a variety of research, engineering, and design backgrounds. These students – speakers of English as a second language at the beginning of their careers – represent ideal candidates for evaluating tools that aim to support the development of better presentation communication skills. All were proficient in the technical use of PowerPoint or Keynote or both, but wanted to develop their presentation skills further.

Findings

Our high-level finding is that HyperSlides encourages many of the best practices for presentations identified through our grounded theory study and literature review, and that injecting dynamism into the processes of presentation authoring, rehearsal, and delivery resonates with presenter needs. We now discuss participant feedback in terms of our four motivating implications for design.

Planning with points

Participants reported that "writing the script is very simple and easy to learn" and it "definitely saves time compared to building your presentation with normal PowerPoint" – "if you want to make a quick presentation it's the easiest way". This might be due to lower start-up costs and greater fluidity – "it is very easy to get started from scratch. I just define the titles and it is very easy to change their order". Another positive aspect is that "you just think the structure and words you are going to say", not about the final styling.

The hierarchical structuring in particular was well received. One participant described how "the structure is very helpful in helping me organize my thoughts", while another said it makes them "think in a tree way, an organized way". Another described how it helps them to "see the tree and the flow of the presentation more easily than in normal PowerPoint" where "the content easily gets messed up". In contrast, HyperSlides "naturally makes a well-organized presentation. It's just like a mind map – it makes me think".

One suggested improvement to planning with points was to incorporate syntax highlighting into the text editor to support visual parsing of otherwise similar-looking text elements, or to develop a custom graphical editor that supported the mapping out of points and their relationships in space.

Styling as a service

Participants appreciated the style of the automatically generated PowerPoint files. In such HyperSlides presentations, "the title and images and items are very clear", "the layout is beautiful", and "you get all that from a list of points". In other words, "you can just type a few words and have a great PPT".

However, more work is needed to meet the expectations of experienced PowerPoint users. One noted that HyperSlides "has some restrictions on design", such as not being able to add background images to all slides. This design decision was deliberately taken to create contrast between illustrated scenes and subordinate slides of text points and embedded media. The addition of a template using a not-quite-full-bleed background image for text was the most highly requested additional feature, which was promising since participants rarely created such slides in their prior practice.

On the theme of "the templates were really great but maybe you could do more", participants suggested that it would be good to choose from designer-crafted visual styles, to help the user choose complementary style options, and to automatically match pictures to words.

Our participants also commented "perhaps HyperSlides makes things too simple" and that "(HyperSlides is) good to generate a PPT quickly then edit with PowerPoint". This is currently necessary to use advanced features like animation, smart art, and equations. As an alternative to opening the full PowerPoint application, users could "just use a GUI for just the little things, like arranging words with images".

These constraints of the current HyperSlides prototype mean that "the best case for this is a presentation we make in 30 minutes or so – not the super important one". Another participant said that "for a conference talk, I would use this to make prototypes until I had fixed the flow of the presentation, then copy and paste into a regular PPT to make it fancy". Even then, the fact that participants would consider real use of the current, early prototype in their everyday presentation practices is highly encouraging.

Linking between scenes

For one participant, "the most useful feature is the overview to learn and navigate through the structure" of the HyperSlides presentation. Another described how "the biggest difference is how we use the tree structure to navigate between slides", which "provides a great way to explore multimedia" organized into scenes. The verbal linkages between scenes were also found to be useful: "we can see the script of what we should talk about between slides. This can be not only for you, but also for other people who want to understand your thoughts more".

During the presentations, we observed presenters frequently navigating between scenes not horizontally, but vertically via the storyline overview. This was seen as helpful to the audience because "the tree structure is the real structure of slides", but ordinarily it is only the "linear structure" of slide sequences that is ever communicated to the audience. This structure was also seen to be of value to the presenter, who could use the combination of the presentation timer and the "current location" to "work out where to go next".

Expanding on demand
The ability to expand scenes and points on demand was found to be "more flexible than regular slides because it can go from this slide to A, or B, or C. That's really helpful". This technique is "better than the usual approach of hiding slides", and when used for rehearsal, it is "better than the normal way" of adding notes to the slides because this "cannot possibly just remind you about what you are going to say. Making the slide and the notes into two separate slides is much better". Another participant described how they "love" the simple rehearsal traversal just by "clicking right". An advantage for presentation delivery is that expansion can be used "whenever we forget what we want to say next".

However, while many participants "like the idea of combining your notes with your formal slides", some also accidentally navigated into the rehearsal path (revealing underlined points) during their presentations. Although this problem may disappear with additional practice, multiple participants suggested that we "separate the rehearsal mode and the delivery mode" because "during the presentation, if you make a mistake, it's not that easy to undo". One cause of navigation errors could be that "with a mouse, it's not always easy to get into a hot region", a problem that "would be better with a touch device" or using arrow keys to navigate. On any platform, the tree structure always carries the risk that "it's possible to get lost", so "maybe two levels of details are enough". A "breadcrumb trail you can hide" might also support location awareness – addressed by one participant by explicitly enumerating his points hierarchically. Tooltip navigation hints would also avoid exploratory clicks down the tree and back up again, although extra rehearsal could well ameliorate this problem.

Discussion
Our study confirmed the strength of a dynamic approach to presentations. Participants were able to naturally exercise some best presentation practices using HyperSlides, which was described as "like a textbook telling people how to give a presentation". The approach was found to be "suitable for more informal and flexible talks" compared with conventional linear presentations. Participants also found the resulting talks to be clear in both structure and style.

The main improvement suggested by study participants was the ability to generate different presentations for rehearsing, delivering, and sharing, to avoid the problems of accidentally navigating to slides intended only to support presentation rehearsal, or sharing media unnecessary for the core communication. A potential compromise is to mark up "next points" in a way that combines the simplicity of linear slides with the power of tree structures that expand on demand.

Another option, which we have implemented in a simplification of HyperSlides, is to omit dedicated rehearsal paths in ways that reduce the chances of novice users making navigation errors. This has several additional advantages:

1. At the detail level, the left hyperframe edge can be used to navigate up the hierarchy. This was suggested in the study as feeling more natural than using the top edge.
2. This frees the top hyperframe edge to link directly to the overview, no matter what the current detail level.
3. At the top-level of details directly beneath the scene slide, the right hyperframe edge is free to link to the next scene. This was suggested as an alternative to navigating up through the current scene when undesirable to do so.
4. The bottom edge of the top-level detail slide can link to the top edge of verbal linkage slide, whose bottom edge can then link to the next scene slide. This scene-detail-linkage-scene "downwards" rehearsal loop tests presenters in a way that complements bullet expansions.

CONCLUSIONS AND FUTURE DIRECTIONS
Following our grounded theory study and literature review, we propose a *dynamic approach* to presentation prototyping, rehearsal, and delivery that touches upon each of Cicero's five canons of rhetoric: invention and arrangement (*planning with points*), style (visual *styling as a service* and verbal *linking between scenes*), and memory and delivery (*expanding on demand*). In HyperSlides, the explicit encouragement of supporting links, illustrated scenes, and verbal linkages also promotes Aristotle's *ethos*, *pathos*, and *logos* to a greater extent than bullets and slide templates.

As we move forwards, we will continue to build tools that embody the ancient art of persuasion while advancing the state of the art in presentation technology. However, more work is required to address the limitations of the current system. For users with more demanding requirements on graphic design, animation, and layout, a more visual authoring environment might help. In the spirit of dynamic prototyping, algorithmic generation of "small multiples" – alternative design candidates shown side-by-side for comparison – could support the transformation of logically-structured points into expressive slides. Moving beyond slides, similar specifications could also be transformed into other multimedia representations (e.g., canvas-based). For all such approaches, more interactive guidance about how to construct the story behind the visuals could also be incorporated into the authoring process. In addition, more progressive guidance about how to move from a finished document to a prepared presentation should be investigated as a way to encourage greater investment in presentation rehearsal, with greater returns gained more efficiently. As with the HyperSlides system, our study also needs to be extended to fully examine the consequences of HyperSlides use in practice and to understand how and when it should be used in preference to more conventional slide authoring, as well as to suggest further implications for design. For now, the HyperSlides prototype represents a promising first step towards more dynamic prototyping of presentations that themselves offer greater dynamism and flexibility in their support for planning, rehearsing, and delivering a story.

ACKNOWLEDGMENTS

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