Towards an Evidence-Based Presentation Authoring Tool

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Abstract

It would be difficult to argue that any software tool plays a greater role in knowledge transfer than PowerPoint. Unfortunately, prevailing presentation authoring practices yield less than optimal results (as evidenced by the near universal understanding of the phrase 'Death by PowerPoint'). In this paper we describe our ongoing effort to develop an interactive presentation authoring aid that helps users craft an effective message and supporting visual media. More specifically, this software aid engages the user in a step-by-step dialog covering tasks ranging from the framing of an argument to the selection of appropriate data chart. We describe the results of preliminary experiments that indicate that such aids can provide benefits to both the speaker and the audience. Finally, we describe a practical approach to collecting the data required to support evidence-based presentation guidance.

Keywords: *presentation, PowerPoint, authoring aid*

Introduction

Organizational decision making, scientific progress, diplomatic initiatives, and commercial marketing campaigns are all highly dependent on the efficient and accurate communication of potentially complex ideas. Such knowledge is communicated in many different fashions (e.g., documents and email); however oral presentations provide a number of important advantages over other methods. For instance, presenters can utilize a variety of means to emphasize particularly important points, and they can respond immediately to the audience's need for additional detail or clarification.

Unfortunately, the typical briefing falls far short of the ideal. Worse yet, it has been widely recognized that such ineffective presentations can lead to unfortunate decisions with sometimes disastrous consequences. Visual communication guru Edward Tufte in particular has documented case studies providing evidence that modern slideware software such as PowerPoint may "reduce the analytic quality of serious presentations of evidence" [1]. Further, Tufte argues that slideware's dominant authoring path leads to the production of text-laden briefing materials that act more as a teleprompter than as a means for amplifying the speaker's arguments.

Others, such as cognitive scientist Donald Norman [2], have instead argued that the fault lies primarily with the speaker – pointing out that bad presentations substantially predate the invention of PowerPoint. Regardless of how much fault lies with slideware, it is clear that the prevailing presentation authoring conventions have set the stage for systemic underperformance in organizations that depend on the rapid and accurate communication of complex concepts.

Recognizing the risks posed by poor knowledge transfer in the US military, the Defense Advanced Research Projects Agency (DARPA) funded a dozen research projects with the goal of identifying methods that could revolutionize the creation and presentation of briefings and thereby support rapid and accurate knowledge exchange. This paper describes our research contribution to DARPA's effort, which has centered on the investigation of an authoring aid designed to address the typical PowerPoint user's lack of expertise in communication, information design, and pedagogy.

The next sections provide motivation for our approach as well as a summary of some of the most significant scientific foundations. Following this is a description of an interactive presentation-authoring methodology built upon these foundations. Next, we discuss a preliminary experiment that was conducted to evaluate the potential for improved knowledge transfer. We end by describing how we plan to develop the broad foundation of empirical evidence that will support better informed guidance going forward.

Background

There are many strong opinions about the use of PowerPoint and other slideware, but surprisingly little research. In fact, in an extensive survey of the texts employed in public speaking courses taught within the California State University system, Kammeyer [3] found that only 33% of textbooks contained any sourced

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recommendations and of those sources listed, only 35% were based on research findings.

However, the small base of presentation-specific research is buttressed by a diverse set of psychological theories and experimental studies that suggest ways to improve communication effectiveness.

Managing Cognitive Load

According to Cognitive Load Theory (CLT) working memory is limited in its ability to attend to and process incoming sensory data. Further, within CLT, knowledge is organized into schemas found in long-term memory, and these schemas can direct the processing of new information. More specifically, information linked to existing schema can be transferred to automatic processing – freeing capacity in working memory for other functions. CLT seeks to explain the way in which a learner's cognitive resources are focused and used during learning, and suggests that, for instruction to be effective, care must be taken to avoid overloading the mind's capacity to process information [4]. Speakers can accomplish this by managing two distinct types of cognitive load: (1) germane cognitive load, which is the load devoted to the processing, construction and automation of schemas; and (2) extraneous cognitive load, which is caused by factors that are not central to the material to be learned such as presentation methods or activities that split attention between multiple sources of information.

The implication for knowledge transfer via presentation is that, since people have only a limited processing capacity in working memory at any moment, the presentation should:

- be stripped of irrelevant detail (e.g., decoration or information that does not support the primary message)
- be segmented and sequenced in order to avoid overwhelming working memory, and
- ensure the audience has a sufficient foundation of knowledge to automate processing

Leveraging Multimedia

Mayer & Moreno [5] argue that narration and graphical images produce verbal and visual mental representations, which integrate with prior knowledge to construct new knowledge. Mayer & Moreno demonstrated experimentally that learning in multimedia environments can be enhanced through the use of explanatory images and animations. These experiments suggest that explanatory images allow people to construct an internal narrative describing how something works (e.g., lightning or a bicycle pump). These studies also provide support for the "dual coding" theory [6] by showing that the pairing of explanatory visuals with auditory narrative results in improved knowledge transfer relative to the use of any single modality on its own.

Sustaining Attention & Encouraging Memory

While most presenters either take the attention of their audience for granted or assume that it is out of their control, researchers are continuing to make progress in understanding what causes people to pay attention and remember information. The research literature suggests that successful presentation strategies might be built around the following ideas:

- **People will attend to a message if it is perceived to be in their self interest.** Most fundamentally, we pay attention to emotions, threats, and sex [7]. Can we eat it? Will it eat me? Can I mate with it? This means that audiences will show distinct interest in presentations that begin by alerting them to some danger or explicitly describe a benefit. Hamann et al. [8] showed that pleasant, aversive, and interesting pictures are more memorable than neutral pictures. Further, Kock et al. [9] demonstrated that showing a threatening image increases memory for mundane information presented before or after the image.
- **People attend to the new or unexpected.** Our biological perceptual systems are geared toward detecting novel stimuli [10]. This suggests that the use of standard presentation formats (e.g., bulleted lists) and clichéd images may have a significant negative impact on audience attention.
- **People attend to the credible.** Audiences will pay attention to messages delivered by sources of influential people. French and Raven, social power theorists, believe five factors influence professional credibility: rank, goodwill, expertise, image, and shared values [11].
- **People follow stories.** Mallon & Webb [12] among others (see [13] for a survey) describe research suggesting that a reliable approach to *sustaining* attention is to construct a presentation around a narrative structure. Heath & Heath [14] suggest that the building of anticipation or tension (as occurs in stories) can be a powerful method to encourage an audience to actively listen to a presentation.

Promoting Understanding

Recently, increased attention has been paid to the so-called "Curse of Knowledge" and its ramifications. According to Heath and Heath [14] after a person has thoroughly integrated new knowledge, it becomes hard for them to imagine not knowing it. As a result we become ineffective communicators of that knowledge. This is a

particular problem when decision makers must communicate with experts from fields they have had little direct experience with themselves. All too often these experts find it difficult to give intelligible answers because their experience renders them unable to fathom how little the decision maker knows. The result is communication lacking context and steeped in jargon and abstractions.

Further, many presenters falsely assume (due to the curse) that the issues they currently find interesting will be interesting to their audience. The results in this case can be overly long presentations that do not serve the needs of the audience, but rather blindly showcase the accomplishments of the speaker.

Researchers (e.g., Eppler [15]) have identified a range of other barriers to effective communication between experts and decision makers. One of the most significant issues relates to the common situation wherein a decision maker holds biases or strong views (with or without basis) that are difficult to dislodge. Recently Muldoon [16], Miller [17], and others have described how analogies, metaphors, alliteration, and parables can serve to "defamiliarize the world" and thereby force an audience to consider an idea from a fresh perspective. Abela [13] provides a survey of research that shows how these techniques support persuasion more broadly.

Presentation Slide Design

Michael Alley has investigated an alternative to the default PowerPoint slide layout, which he terms the "assertion-evidence design" [18] [19]. This approach employs succinct sentence headlines displayed along with a visual representation of evidence such as a picture or a graph. In multiple experiments Alley has found that students viewing presentations following this design were better able to recall the main assertion of slides than were those students viewing presentations employing phrase headlines and bulleted text.

Blokzijl and Andeweg [20] [21] have examined the effect of various slide designs on both the students' perceptions of PowerPoint presentations and degree to which those designs support knowledge transfer. Interestingly, the authors found that while students have a distinct preference for slides with visual support, the text only slides resulted in higher test scores. The author's go on to express their doubts that the results of Mayer & Moreno's controlled e-learning experiments [5] can be directly applied to live presentations due to a number of real-life complicating factors such as the speaker's oral delivery, eye contact, and the presence of an audience.

Key Challenges Faced by Presenters

In order to better understand where our authoring tool could provide the most assistance we conducted interviews with 10 people during their own presentation production efforts. The purposes of their presentations varied and included: project wrap-up, communicating strategic vision, and supporting research proposals.

The chief concerns of these presenters were consistent with the findings of Mackiewicz [22] and included the following:

- **Narrowing the focus of a presentation.** Presenters complained that they had much more information that they wanted (or felt they needed) to convey than would be feasible. Selecting which content to leave out was seen as being particularly challenging.
- **Applying guidelines found in popular books.** A number of the interviewed presenters had reviewed current bestselling books on presentation such as Presentation Zen [23] and Beyond Bullet Points [24]. While these presenters all expressed excitement upon learning the principles outlined in these books, the process of applying those guidelines proved much more challenging than they originally anticipated. One presenter provided the insight that the examples provided in these books were dominated by motivational types of presentations and these proved unhelpful in creating more technically oriented briefing materials.

  It is also worth noting that interviewees were able to recall only the most basic of presentation design guidelines from the books they had read. The principle that had the most resonance was related to the importance of reducing the volume of text and increasing the use of visuals in presentations. Unfortunately, selecting or creating appropriate visuals was found to be surprisingly time consuming and frustrating.
- **Overcoming momentum.** Several of the presenters interviewed described significant difficulty in adopting new authoring guidelines. Most of these presenters reported having developed templates or largely mechanical processes for efficiently converting reports into presentations and that while the new practices often seemed superior to their own, time pressures often pushed them back into the more familiar practices.

Our findings taken together with Mackiewicz's suggests that achieving significant improvements in presentations will require an approach that goes beyond the development of new templates, checklists, or slide layout tools such as PowerPoint 2007's SmartArt.

The Case for a Presentation Authoring Aid

One might argue that a number of the above challenges experienced by presenters could be best addressed

through more effective classroom education and instructional texts. However, the task of presentation design appears better suited to a job aid according to guidelines proposed by Rossett and Schafer [25]. According to the authors, job aids are more appropriate for tasks that: arise infrequently; are complex; include procedures that may change frequently; are accomplished in predictable situations; and are not conducted under severe time constraints.

A computer based authoring tool presents a number of opportunities as compared to traditional training approaches. By providing step by step guidance at the time of authoring it reduces the need for the presenter to recall previous learning or to rediscover the appropriate instructional texts. Further, an interactive aid offers the potential to provide guidance informed by the emerging context. For example, the knowledge that the user is preparing for a scientific briefing would lead to different human-computer dialog paths (and examples) than one would see if they were preparing a marketing pitch to corporate executives. We believe it is the intelligent exploitation of this contextual information that will make it possible for the average presenter to successfully apply seemingly complex and conflicting guidelines (e.g., *When is it useful and appropriate to make an emotional appeal, and what form should it take?)*

The Authoring Aid Prototype

We developed a proof-of-concept prototype in order to test two hypotheses. The first hypothesis was that an authoring aid could efficiently guide a presenter through key presentation decisions without hindering the creative process. Second, we wanted to see if the presentations created with the aid led to improved knowledge transfer from the speaker to their audience.

The prototype aid was designed to support users in the selection and application of a variety of well-founded principles starting with objective definition and continuing through presentation content organization and design. The overall human-computer dialog is designed to flow in a primarily forward fashion through the modules shown in Figure 1, with the always available option of returning to previous steps.

In many ways this interaction model is similar to Intuit's well known TurboTax™ software, where earlier stages allow the system to build an understanding of the user's situation so as to better structure the remaining dialog. In the following sections provide an overview of the individual dialog elements.

Presentation Context

The interaction with the user begins with the solicitation of basic information about the presentation event. These questions include: *"How much time will you have to present?", "How many people will be in the audience?", and "What is the mode of delivery (in-person; presentation by a surrogate; teleconference; stand-alone (with and without narration)?"*

This information affects the dialog in fairly obvious ways. For instance, knowing the available presentation time allows the system to use heuristics to assist the user in establishing the scope of their talk. Further, in this stage the user can import a written report if that is the focus of the presentation. This import process provides the system with the opportunity to extract key terms that can facilitate the later brainstorming process.

Objectives

In the next stage of processing, the system elicits both the user's general and specific objectives. General objectives are basically a functional description of the purpose for the talk (e.g., report project progress, discuss scientific findings, and facilitate problem solving). Specific objectives on the other hand describe the response that you seek from the audience. Figure 2 shows a prototype screen for this stage where the system encourages the author to describe their specific objectives using active and concrete words, and to think about these objectives from the perspective of the audience.

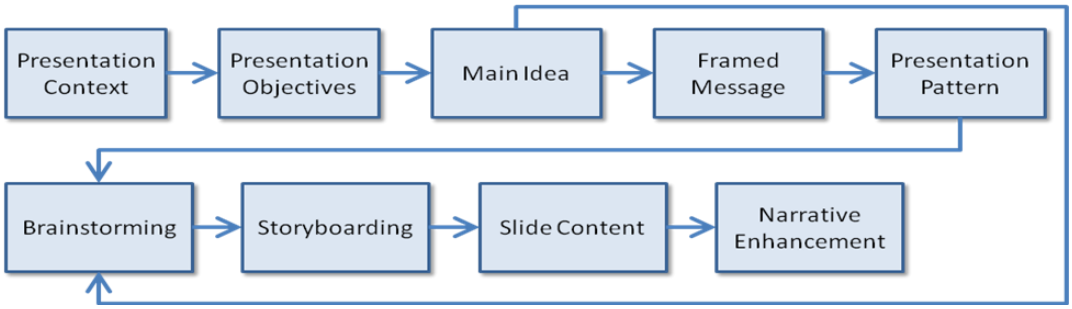

Figure 1. Stages of the Interactive Authoring Dialog

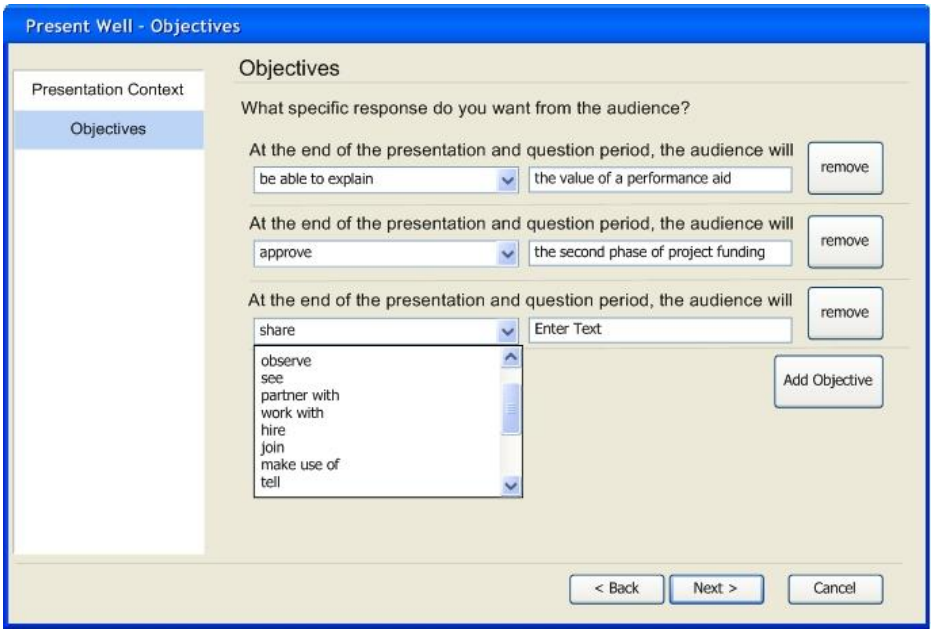

Figure 2. Soliciting Presentation Objectives

This process has two substantial effects. First, it establishes the end goal of the presentation, which in turn makes it easier for the user (with automated assistance) to decide which content should be excluded from a presentation (because it does not serve the specific objectives). Second, these objectives allow for the adaptation of future stages of the dialog.

Main Idea

At this point, the system provides the user with the opportunity to write a draft of their main idea. This part of the dialog proved challenging to design as we recognized early on that any particular question phrasing could lead to author confusion if asked in the wrong context. The system therefore takes advantage of its accumulated knowledge of the presenter's goals to choose an appropriate phrasing. For instance, if the system knows that the presentation is for a scientific conference, then it may ask *"What do your conclusion points mean collectively?"* If the system has additional information and knows that the author is presenting a work in progress it can instead ask *"What has been learned to date?"* or *"What are your expectations for the current experiments?"*

This example demonstrates an interesting aspect of the dialog as a whole. There are many circumstances where a user's response of "I don't know" is perfectly acceptable. Given such a response the authoring aid can: (1) provide further explanation, of what is sought; (2) try an alternative phrasing of the question; (3) move to the next stage of the dialog; or (4) jump to the brainstorming process (described below) and return to this step later.

Framed Message

In order for a presentation to succeed a speaker must position their main idea in a way that provides value to the audience. That is to say, the message must describe what the main idea means to the audience and their efforts to achieve their goals. Proper framing is perhaps the most often overlooked step in presentation authoring.

In this step the system first elicits the common interests of the audience at large, which is also likely to be the reason the meeting is being held. The authoring aid then asks the user to consider the range of perspectives from which their main idea may be viewed as well as any biases or concerns which may be held by the audience or specific decision makers. At the conclusion of this stage the user develops a message framing that makes their idea meaningful to the audience while simultaneously allowing the speaker to elicit the desired audience response.

A side effect of this dialog is the accumulation of knowledge regarding concerns that may be held by the audience. The authoring aid uses this information to facilitate later content elaboration stages as it affords the speaker the opportunity to anticipate and preempt questions with prepared briefing content.

Presentation Pattern

In this stage of the dialog the system helps the user identify an appropriate organization for the presentation. Identifying such a structure allows the author to group content into a logical progression, making it easier for the audience to follow the presentation. The presentation

pattern is also a stepping stone for authoring aid, allowing it to provide assistance in identifying, for instance, appropriate topic transitions. Examples of some presentation patterns include the following (see [26] for more examples):

- **Chronological Order.** This pattern organizes clusters of ideas into events in the order in which they occurred (or will occur). If this flow was applied to a scientific briefing, the author will be led to describe hypotheses, intermediate findings, changes in direction based on lessons learned, etc.
- **Spatial.** This pattern organizes ideas in line with a physical analogy, providing an intuitive spatial arrangement of your topic.
- **Problem and Solution.** This pattern structures the presentation around a description of a problem faced by your audience and the solution you offer.

Idea Brainstorming

In the brainstorming stage of the dialog the system encourages the user to consider a wide range of ideas that might be important to cover in the presentation in support of their message. The authoring aid utilizes any accumulated knowledge to facilitate this process. For instance, objective statements can be used to elicit supporting topic matter (see Figure 3). The brainstorming stage concludes with a clustering process wherein the user converges on a small handful of topics that are fundamental to their message.

Storyboarding

At this point in the dialog the user will begin to establish what slides are necessary to convey the main idea and the critical supporting points. More importantly, by mapping the identified idea clusters to aspects of a flow structure, the user begins to craft their narrative. This stage includes drafting slide titles as well as specifying what visual content will be used to support the idea or assertion being presented.

Slide Content Development

Next, the system assists the user in selecting appropriate visual matter that supports the point being made on a particular slide. For example, if the presentation is intended to coordinate some activity, the user might employ knowledge maps and heuristic sketches. On the other hand, if the intent is to introduce a novel idea, they might utilize a visual metaphor that allows the audience to bridge from the familiar to the new.

In the example shown in Figure 4 the user is seeking appropriate visual content for a slide whose title makes the assertion that “Storytelling Improves Idea Transfer”. As is shown, users can review advice as to which type of visual may be appropriate. Note that the aid asks the user to eliminate all possible visual presentations before considering text representations.

Having specified that the support for this particular slide is statistical, the user will be led to incrementally describe their need and in response the system will shrink the set of applicable diagrams (see Figure 5).

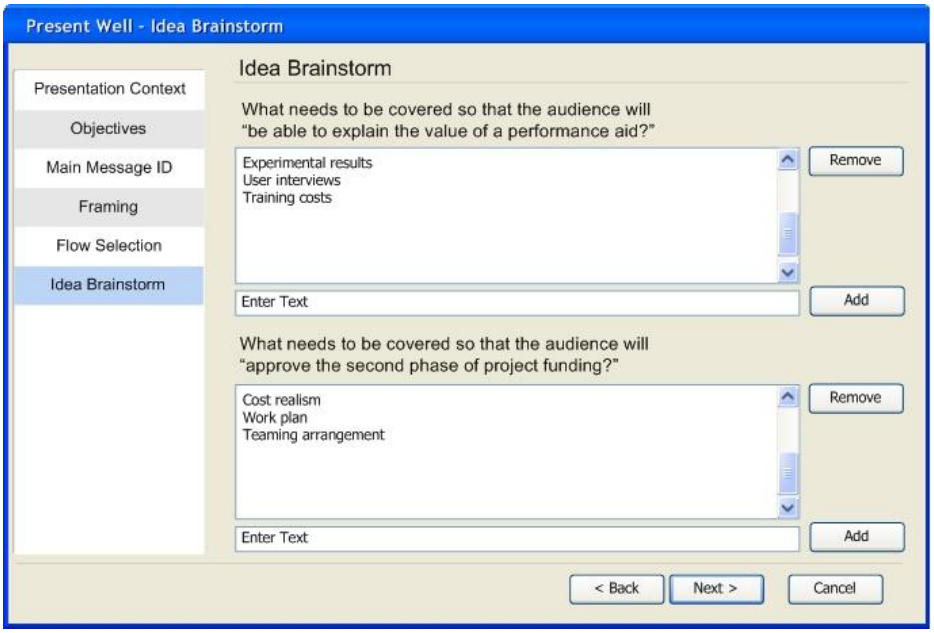

Figure 3. Brainstorming content ideas

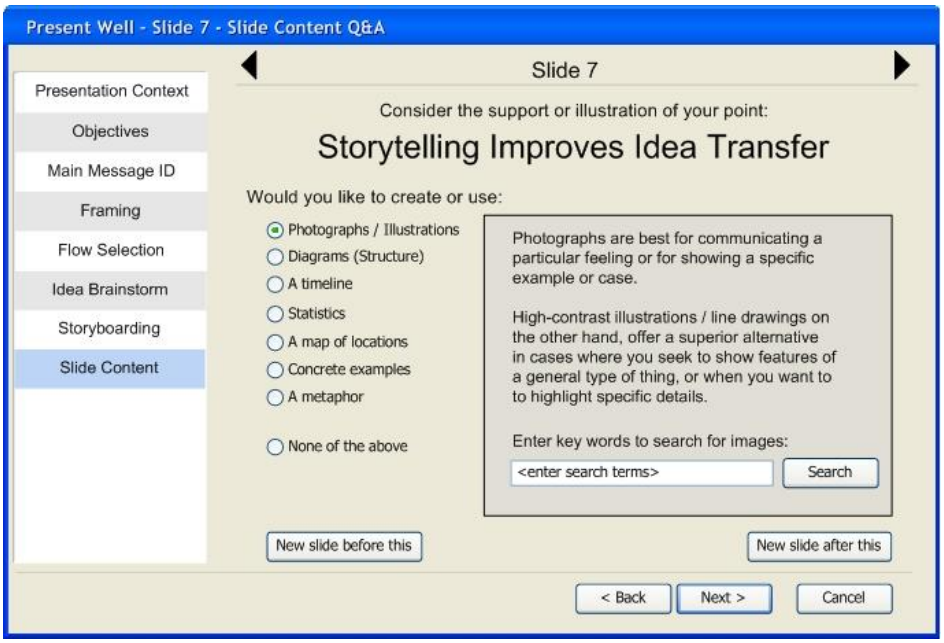

Figure 4. Selecting visuals to support a point

Figure 5. Selecting an Appropriate Data Graph

Narrative Enhancement

In the final stage of the dialog, the authoring aid assists the user in tasks such as creating effective presentation and slide titles, identifying appropriate topic transitions, etc. In addition, the system will help the user identify an appropriate opening and closing given their objectives, flow structure, and main message. As an example, the user may be led to consider different ways to establish their position as an authority worthy of the audience's attention.

Experiments

In order to test the hypothesis that the use of our authoring aid would ultimately result in improved knowledge transfer we conducted a preliminary online experiment. First, we asked a computer scientist to create a narrated 20-minute presentation of the ideas presented in

the paper "How to Make Risky Decisions Visually" [27] utilizing their normal authoring process. The presenter was not in any way involved in the writing of that paper or the associated research and had a moderate amount of public speaking experience. The resulting presentation material was largely text and, in our opinion, appeared consistent with the standard observed at scientific conferences.

After this presentation was completed we asked the presenter to create a second presentation, this time employing our authoring aid. Note also that gaps in the prototype were filled by a largely mechanical dialog conducted by a person familiar with the underlying human-machine dialog concept.

144 test subjects were recruited through Amazon.com's Mechanical Turk service [28]. Mechanical Turk provides a cost effective way to engage people over the Web to accomplish tasks that would be costly or impossible to automate. For the current research, Mechanical Turk provided an efficient means to prescreen the test population and manage the online delivery of pre-tests, narrated presentations, post-tests, as well as small payments (one dollar per qualified participant). Qualified participants were those located within the United States, and who had accurately answered a set of quality control questions.

The pre-test verified that the randomly selected control and experimental groups had roughly similar educational backgrounds as well as similar levels of the specific statistical knowledge employed in the post-test. The population of test subjects was distributed as follows according to our survey: 22% held advanced degrees, 33% held Bachelor's degrees, 33% were currently attending college, and the remainder had all graduated from high school.

The post-test evaluated fact recall as well as the participant's acquisition of problem solving skills. Given that the different authoring processes yielded substantially different presentations, the post-test questions were identified through consensus between the two presenters.

Results and Discussion

The results of the experiment were encouraging. Overall the viewers of the experimental (authoring-tool-aided) presentation scored 16% higher on the post-tests. Interestingly, on the subset of the questions requiring problem solving or inference, the experimental group scored 30% higher. It is worth noting that only one person in the control group achieved a perfect score on the post-test, while eight participants who viewed the authoring-tool-aided presentation achieved a perfect score.

However, the results were not uniformly positive. For one question (of 10) the results shifted dramatically in favor of the control (unaided) presentation (40% more participants of the control presentation selected the right answer). One possible explanation for this is that the wording of that particular question was very similar to that used in one segment of the control presentation, making the fact easier to recall.

Follow-up Interviews

We conducted an additional round of interviews with eight of the presenters questioned earlier in the project. These conversations focused on the presentation authoring process observed in our experiment. While the feedback on the utility of the authoring aid was generally positive, the interviewees identified a number of shortcomings that require our attention. In addition to the obvious need to cover a greater range of rhetorical methods, these presenters recommended the inclusion of:

- **More examples.** While the dialog was considered clear, our discussions revealed a broad agreement that a larger variety of examples would have made the process easier to follow.
- **Non-linear authoring.** Multiple people expressed an interest in utilizing parts of the dialog out of order and skipping others all together. For instance, three interviewees expressed an interest in skipping the brainstorming process either because it seemed unnecessary or because they were concerned that subsequent editing would be time consuming.
- **Easy content reorganization.** Multiple presenters suggested that it would be difficult to settle on a particular presentation organization without first plotting the content out in multiple storyboards. A potential concern for a computer based tool was the observation that paper-based sketching might be the quickest and easiest way to do this.

Future Work

We are currently one year into a three year research and development effort. The initial prototype and associated experiment have proved valuable in establishing the priorities and scope for a fully operational presentation authoring aid. Over the next two years we will be proceeding along two fronts. First, we will be working to enhance the dialog so that it better conforms to the needs of the presenter. This will include broader coverage of presentation development issues (e.g., methods for improving audience engagement or memory); a deeper library of examples; as well as improved flexibility.

Second, we will seek to bring together evidence of different types to form a foundation for our aid's recommendations. We will continue to utilize

inexpensive online tests – particularly to evaluate the relative effectiveness of individual presentation elements (e.g., diagram styles). However, online tests have a number of limitations and we will therefore conduct in-person experiments utilizing speakers that present the same material to multiple audiences (e.g., lecturers and sales people). In some of the tests we will be able to conduct tests and surveys to evaluate knowledge transfer and audience attitudes. In other cases this will be impractical, however valuable evidence can still be collected from presenters based on their own perceptions of what worked and did not work in their presentations.

Conclusions

This paper describes an effort to improve the person-to-person communication of complex ideas and plans through the use of an interactive presentation authoring aid. It is argued that a just-in-time aid offers distinct advantages over training based approaches to filling the skill-gap in rhetoric, graphic design, and pedagogy.

Experiments were conducted involving 144 participants and it was shown that considerable improvements in knowledge transfer are possible without abandoning widely used slideware such as PowerPoint. This experiment also demonstrated to us that online communities present an opportunity to collect empirical evidence regarding presentation characteristics (e.g., title styles, slide design, color usage, and data charts) at low costs.

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