

# PitchPerfect: Integrated Rehearsal Environment for Structured Presentation Preparation

Ha Trinh<sup>1,2</sup>

<sup>1</sup> Microsoft Research  
Beijing, China

hatrinh@computing.dundee.ac.uk, koji@microsoft.com, darren.edge@microsoft.com

Koji Yatani<sup>1,2</sup>

<sup>2</sup> University of Dundee  
Dundee, UK

Darren Edge<sup>1</sup>

## ABSTRACT

Rehearsal is a critical component of preparing to give an oral presentation, yet it is frequently abbreviated, performed in ways that are inefficient or ineffective, or simply omitted. We conducted an exploratory study to understand the relationship between the theory and practice of presentation rehearsal, classifying our qualitative results into five themes to motivate more structured rehearsal support deeply integrated in slide presentation software. In a within-subject study ( $N=12$ ) comparing against participants' existing rehearsal practices, we found that our resulting PitchPerfect system significantly improved overall presentation quality and content coverage as well as provided greater support for content mastery, time management, and confidence building.

## Author Keywords

Presentation rehearsal; Slideware; PowerPoint

## ACM Classification Keywords

H.5.2. Information interfaces and presentation: User Interfaces.

## INTRODUCTION

Oral presentations are an integral part of academic and professional life, with virtually all related literature advocating proper rehearsal as a cornerstone of success. Appropriate rehearsal strategies potentially enable presenters to increase content familiarity, identify verbal transition issues, improve time management, and practice vocal delivery and stage presence [11, 33, 34]. Research in public speaking pedagogy has also highlighted practice time as a significant predictor of presentation quality [27].

Despite the importance of rehearsal, survey studies show it is often neglected [15, 9]. An extensive survey of 2,501 professionals [15] revealed that 35% of respondents rarely or never rehearse for their presentations. Factors contributing to rehearsal avoidance include insufficient preparation time, limited tool support, inadequate presentation training, and unawareness of expert recommendations. The intrinsic factor of communication apprehension can also lead to rehearsal avoidance, often resulting in degraded performance [3].

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from [Permissions@acm.org](mailto:Permissions@acm.org). *CHI 2014*, April 26 - May 01 2014, Toronto, ON, Canada  
Copyright is held by the owner/author(s). Publication rights licensed to ACM. ACM 978-1-4503-2473-1/14/04...\$15.00.  
<http://dx.doi.org/10.1145/2556288.2557286>

Our research explores how technology could facilitate a more manageable and efficient approach to presentation rehearsal than is supported in existing presentation software. We began with an interview study of 16 presenters, eliciting the problems, practices, and concerns that shape their rehearsal experiences. Five themes emerged to describe fundamental processes that structure the activity of rehearsal. Inspired by these findings and our literature survey, we developed PitchPerfect – a system offering a structured approach to presentation rehearsal. Our system integrates a range of targeted rehearsal tools to progressively develop the presenter's confidence to speak spontaneously and fluently within a prepared structure. Implemented as an add-in for Microsoft PowerPoint 2013 [22], PitchPerfect comprises:

1. *Extended authoring*. Planning of verbal content, flow, and timing in parallel with visual slide design, through use of element notes, flow paths, and slide time targets.
2. *Cued-recall testing*. Rapid recall practice to master the flow of visual content and its associated verbal notes.
3. *Scaffolded speech rehearsal*. Realistic spoken rehearsal supported by visual time guides and structured notes, with the ability to progressively withdraw scaffolding support using an automatic note compression technique.

In a two-session study with 12 participants, we compared structured rehearsal with PitchPerfect against existing practices with PowerPoint. We measured the overall experiences of both presenters and audience through subjective ratings of participants' presentation videos and qualitative analysis of semi-structured interviews. Results showed that PitchPerfect led to small but significant differences in overall presentation quality and content coverage. Qualitative findings indicated a strong user preference toward PitchPerfect, confirming its benefits in terms of content mastery, time management, confidence building, and preparation time efficiency. We show that PitchPerfect can encourage many practices recommended in the literature while providing greater support than conventional presentation tools. Our contributions include:

1. Derivation of five grounded themes that characterize rehearsal practices and motivate integrated tool support;
2. Development of the PitchPerfect system to support structured rehearsal in an integrated environment;
3. Validation of PitchPerfect in a comparative study that demonstrates its potential to improve the overall experiences of both presenters and audiences.

## RELATED WORK

We divide the related work into three sections. We discuss recommendations on how to learn presentations, and explain the relationship between rehearsal and presentation quality, before concluding with a review of rehearsal tool support.

### Learning and presentations

The needs of audiences learning from presentations are tightly intertwined with the needs of presenters preparing to deliver such presentations. Nancy Duarte [10] suggests that the fear of failing to remember what to say in the moment discourages presenters from giving up text-heavy slides, which then fail to result in audience connection. Her “3 Rs of Letting Go” is a systematic way to help presenters speak naturally to slides that visually complement their narration:

1. *Reduce* reliance on slide text by rehearsing with a single highlighted word per bullet until only the highlighted words are needed as prompts (or better, use images);
2. *Record* spoken rehearsals, using a script or notes if required, listening back in idle moments to absorb content auditorily and further reduce text reliance;
3. *Repeat* the presentation by speaking to it, writing it down, and reciting it mentally many times, and continue until the key points and flow are committed to memory.

When presenters are no longer dependent on their slides, they become free to leave the lectern and engage directly with the audience [28]. Reduced slide text also avoids the involuntary audience reflex of reading the slide, allowing presenters to draw attention with interpretations, examples, and other details that justify their presence and enhance their credibility [33]. A special case of adding value to slides is through closure – saying something conclusive before moving to the next slide rather than “rebooting” with an empty transition such as, “Now I’d like to talk about...” [34]. Repeated mental review in a slideshow mode can help reveal problems with such transitions, as well as overall flow [11].

While mentally reviewing slides is helpful, “a truly effective presentation is impossible” without verbalization: speaking aloud, accompanied by slides, just as intended when in front of the audience [33]. Reluctance to verbalize can stem from feelings of self-consciousness, anxiety, and foolishness, leading to the suboptimal, disembodied practice of speaking *about* slides rather than speaking *to* slides [33].

Advice for spoken rehearsals is to practice first with the clock counting up, trimming content until the talk fits within the desired timeframe, then practicing with a timer counting down until the talk fits the timeframe consistently [11]. An advantage of recording such rehearsals is to identify unconscious use of filler words [2]. These can be remediated through the strategy of “phrase and pause” [34], which adds animation to the presenter’s voice and reduces the audience’s sensory overload [34]. Video-taping rehearsals provides an additional opportunity to check stage presence, eye contact, facial expressions, gestures, and ease of movement [11], but risks making the presenter self-conscious and nervous [34].

### Learning through multimedia

Many of these recommendations on how and why to avoid text-heavy slides is further supported by cognitive science. Replacing text with images is motivated by the Picture Superiority Effect – concepts are remembered for longer when presented as images rather than words [24]. Slides designed in a minimalist manner can thus serve as instant visual mnemonics [33]. Reviewing materials both visually and auditorily is also supported by the Dual Coding theory of memory [26], in which visual and verbal information are encoded in separate mental representations that act as cues for the recall of one another. A benefit of this practice is that the same effects apply to the audience during delivery, summarized by the principles of Multimedia Learning [19]:

1. *Multiple Representation*: use both pictures and words;
2. *Continuity*: use pictures and words at the same time;
3. *Coherence*: use fewer words and pictures at a time;
4. *Split Attention*: augment pictures with speech not text;
5. *Individual Differences*: applies more to visual learners.

The “Beyond Bullet Points” method [2] is explicitly based on these principles, encouraging presenters to communicate one idea per slide and to clearly differentiate the roles of slide visuals and speaker notes by first building their slides in the Notes Page (handout) view, rather than in the Normal view.

### Learning through cued-recall

Once visuals have been added to slides, the challenge is then to mentally associate these visuals with the script or notes. One approach is cued-recall learning [6], in which the learner attempts to recall a target item (e.g., speaker notes) given a cue (e.g., slide visuals). Such learning leverages two effects:

1. *Testing effect*: tests strengthen memory more than extra study, even without spoken or written responses;
2. *Spacing effect*: for a given time of exposure, multiple short exposures are better than one long exposure.

Typical cued-recall systems progressively increase test intervals to optimize for long-term learning efficiency. However, for specific short-term needs, it is often effective to test the same items multiple times in the same session [29]. This is called *overlearning*, and can have confidence-boosting effects when preparing to speak under stressful circumstances (e.g., second language conversations [12]). Another common strategy is to rehearse in the slideshow mode without notes to encourage higher levels of content mastery than is required in practice [11].

### Rehearsal and Presentation Quality

Previous research has reported consistent findings on the impact of rehearsal on presentation performance [3, 21, 27]. In a study with 119 students, positive correlations were found between presentation quality and rehearsal time (both silent and spoken), number of verbal rehearsals (alone and to an audience), and preparation of speaking notes [21]. Similarly, after an analysis of speech preparation journal entries from 95 students, rehearsal time was suggested as a significant predictor of presentation quality [27].

Related research has examined the relationship among communication apprehension (CA), speech preparation practices, and public speaking competency [3, 4]. Affecting at least 20% of the population, CA can be defined as fear or anxiety in either real or anticipated communication with others [20]. Students with high CA have also been found to spend more preparation time on non-communicative tasks (e.g., writing notes) in avoidance of rehearsal [3]. As a result, they required substantially greater preparation time but received lower speech grades than their low apprehensive peers, who focused their time on rehearsals. These findings indicate that presentation success is determined more by preparation strategy than duration. To complicate the issue, a significant, positive correlation has been found between CA and public speaking procrastination [4]. Consequently, presenters with high CA tend to reserve inadequate time for preparation, leading to poor delivery quality. Appropriate “anti-procrastination” strategies, such as dividing a rehearsal into an incremental series of small and targeted components, could be beneficial for such apprehensive presenters [4].

### **Presentation Rehearsal Systems**

Commercial slideware packages, including Microsoft PowerPoint [22] and Apple Keynote [1], provide timing, audio recording, and presenter view features to aid rehearsal. However, very little work has been published on the usability of these facilities or their use in practice.

Several projects have addressed the need for effective feedback mechanisms in presentation rehearsal. In the Presentation Sensei system [18], speech and image processing are used to provide automatic feedback on the presenter’s speaking rate, eye contact, frequency of verbal fillers and timing. Hypervideo techniques have also been used to create a peer-review support framework for the collection and organization of audience comments during and after rehearsal [25]. While appropriate feedback strategies are undoubtedly useful, they implicitly assume that the presenter is sufficiently prepared to perform a full timed and recorded spoken rehearsal of their intended final delivery. The question remains as to how technology can help presenters move beyond the completion of slide authoring to reach such an advanced stage of readiness.

Several presentation tools, such as NextSlidePlease [30] and HyperSlides [13], also incorporate facilities for rehearsal. NextSlidePlease allows the presenter to specify individual slide time budgets in the authoring environment. During rehearsal and delivery, the system displays visual feedback on time expenditure at both slide and overall presentation levels, thereby facilitating time management. HyperSlides enables the creation of hierarchically structured scenes and expandable points in a presentation where each point can be dynamically revealed on demand. In rehearsal, this flexible structure opens up opportunities for cued-recall testing [6] of points to be communicated. However, no existing system gives explicit and systematic support that progressively guides presenters through the different stages of rehearsal.

### **REHEARSAL IN PRACTICE: AN EXPLORATORY STUDY**

To gain an insight into the problem of presentation rehearsal, we conducted an interview study exploring the practices of presentation preparation. Our aim was to identify fundamental concerns that shape the activity of rehearsing, as well as discrepancies between everyday practices with presentation systems and best practices from the literature.

#### **Participants**

We recruited 16 students and professionals (4 female, 12 male, ages 21–40+, PA1–16). Our participants comprised 7 native English speakers and 9 non-native English speakers from 4 nationalities, with backgrounds in computer science, physics, life science, and finance. They had diverse linguistic, cultural, and educational backgrounds as well as presentation experience levels, in ways that might influence presentation preparation strategies and desired tool support.

#### **Procedure and Findings**

We conducted semi-structured interviews with open-ended questions about the participants’ presentation experiences, focusing on post-authoring preparation strategies and related supporting tools. The interviews were recorded, transcribed and coded using thematic analysis techniques [5]. Our initial open coding resulted in 113 process codes capturing actions in data. We categorized these codes into five overarching themes that help to structure the activity of rehearsing.

##### *1. Appropriating notes with personal notations*

As a common tactic in presentation planning, writing and styling speaking notes assists presenters in verbally expanding on visual elements (e.g., bullet points and images on a presentation slide), both during rehearsal and delivery:

*“I wrote down just short explanations next to each bullet point ... what for each one I was trying to say but in my words, not in formal words like you put on the slide.” [PA6]*

Presenters utilize various means of note taking, from paper notebooks, physical cue cards, and annotated slide printouts, to digital documents and slide note sections in slideware. While some presenters prepare verbose notes or scripts, others prefer just “*slightly more expanded bullet points*” [PA5] or even more condensed notes containing only keywords and referable values. Specific wordings are sometimes scripted and memorized for a strong introduction and conclusion, or for a verbal transition that “*leads from one slide to the other*” [PA2]. Creative use of notes includes cumulative timing targets that prompt and remind the presenters of a specific point in the presentation time by which they should have arrived at a particular slide.

During rehearsal and especially during delivery, the ability to quickly refer to notes corresponding to the point being communicated is of critical importance. Although existing slideware allows presenters to view on-screen notes during a presentation, these notes are often “*hidden away*” [PA6]. Various ad-hoc strategies are used to overcome this issue, such as segmenting notes with colors, highlighting keywords or styling slide content notes and transition notes differently.

## 2. Tuning cued-recall through rapid practice

Presenters often treat visual elements, e.g., bullet points or images on a slide, as prompts for retrieval of verbal content. Rapid, mental rehearsal enables presenters to review and refine the intended visual-verbal associations, “making sure what I want to say is reflected on the slides” [PA4], as well as practice recalling verbal points from visual cues:

*“I just have a quick scan on my slides to remind me in each slide what I should do. So actually I've already got a structure, so I review stuff just to make sure that I don't forget the points.”* [PA9]

Mentally rehearsing visual elements also allows presenters to check and absorb the presentation flow, ensuring they “know the ordering of the slides, which is important” [PA1]. Anxious or unprepared presenters may have to “look often at the slides to make me remember what I want to say” [PA11], causing unpleasantness for both presenter and audience.

## 3. Scaffolding realistic delivery in rehearsal

As a step closer to realistic delivery, presenters often perform end-to-end rehearsals, speaking full sentences verbally or mentally, with support from private notes and time guides:

*“I'll have slides on my TV and the notes in front of me. I'll time myself and I'll start working my way through the presentation. And at the end of it, I'll check my time. I'll check if there's anything I need to change, then go back and do it again.”* [PA2]

Prior to full rehearsal, presenters may derive an initial timing plan based on their knowledge of slide and note content as well as previous presentation experiences. During and after rehearsal, these timing targets provide presenters with guidance on “roughly how long I should spend on a particular area” [PA1], assisting them in adjusting the amount of presentation content in accordance with time constraints. Developing realistic time estimates is a time-consuming process, “because you need to go through the presentation yourself 2 or 3 times to understand how long you are going to spend on each slide” [PA7]. Existing tools for time tracking range from a watch to timing features in slideware, which allow presenters to check individual slide timings in addition to overall presentation duration.

Detailed speaking notes, e.g., complete scripts, may be used in initial rehearsals, while repeated rehearsals with more condensed notes help to reduce the presenter's note reliance. These notes can also be specially structured to aid presenters in controlling speaking rate: “the way I've done it, it's 3 or 4 words, so you can take a little break after every one” [PA7].

Besides timing control, end-to-end rehearsal helps presenters refine the presentation flow and practice verbal transitions between slides. These can be scripted beforehand in notes or improvised from the next slide preview in slideware.

## 4. Committing provisional speech for judgment

Performing full verbal rehearsal allows presenters to obtain feedback on various aspects of their presentation, from slide content, flow, and pacing to vocal delivery, wording, and pronunciation issues. Such feedback may come from an audience or from self-judgment on recorded speech:

*“So I'll hit the record on the presenter mode...So what it does is it records the audio along with the timing of the slides as well. So I will go and I'll get the presentation to my laptop screen, talking at the screen as if I'm giving a presentation. And then I'll play back and listen and I'll look at these areas where I delayed or skipped over things too quickly.”* [PA1]

While a few presenters who have recorded rehearsal praise its benefits, this practice is often neglected. Common reasons include lack of suitable environments and equipment for recording, “feeling stupid speaking to a recorder” [PA4], “sounded awful” [PA3], and presenters who “never saw the point of doing that” [PA2]. As a tedious and time-consuming task, recording and reviewing spoken rehearsal is often skipped under time pressure. Second language presenters tend to be even more reluctant to record rehearsals due to language barriers. Instead, silent rehearsal, described as “just look at my slides and think about what I want to say” [PA12], is a less overwhelming and hence a more common practice.

Although errors detected through recorded rehearsal can help presenters highlight areas for improvement, they can also lower their self-confidence, because “if I don't think about having made mistakes during rehearsal, I won't be dwelling about whether I will make mistakes in the real thing” [PA5].

## 5. Reducing notes, times, and errors until ready

Presenters often aim to reduce rehearsal times, errors, and note details through iterative rehearsals. Manually condensing notes in each iteration is a frequently described strategy to help decrease presenters' note reliance:

*“I generally write out cue cards... I then use them when I'm rehearsing it. And then I sort of reduce them to just very small pointers that remind me of what was in the original cue cards. Then eventually I'll use something on the slides as a reminder of what the pointers were. So it is a very convoluted kind of method, starting with putting a lot of notes in, then moving down to having none but cues on the slides.”* [PA5]

By improving timing accuracy, by aiming for successive error-free rehearsals, and by practicing with increasingly compressed notes, presenters can decrease their speech anxiety and progressively build up their confidence to deliver a timely and fluent speech in a natural and spontaneous manner. Producing artefacts that embody different levels of readiness (e.g., notes at different levels of detail) also supports all future deliveries (e.g., falling back to appropriately reduced notes rather than the complete script).

## DESIGN OF PITCHPERFECT

Informed by the findings of our interview study and literature review, we designed PitchPerfect as rehearsal environment embedded within Microsoft PowerPoint. We now present an overview of the supported activities and interaction design.

### Structured Presentation Preparation

PitchPerfect incorporates three-level support for presentation preparation: planning verbal delivery with three forms of *extended authoring*, forming mental associations with two forms of *cued-recall testing*, and verbalizing within a *scaffolded speech rehearsal* environment.



**Figure 1. Extended authoring mode with (a) visualized flow path; (b) element notes; and (c) time target.**

At the bottom level of planning, extended authoring enables the presenter to prepare to verbally expand on slide visuals with element notes, arrange the speaking order of slide visuals with flow paths, and specify a timing plan with time targets for both individual slides and the overall presentation. Compared to existing slide notes, our element notes provide enhanced support for creating visual-verbal associations by allowing for attachment of speaking notes to specific slide visuals (e.g., titles, bullet points, images, shapes, or groups).

At the middle level of memory-building, PitchPerfect uses a flashcard-like approach for cued-recall testing of element notes and flow paths. Element note rehearsal allows presenters to practice recalling their intended speaking points for each visual element. Flow path rehearsal trains the presenter’s ability to recall the content of visual elements and the verbal path through them. Together, they help presenters to drill both visual and verbal points into their memory, refining if necessary, before progressing to verbalization.

At the top level of speech rehearsal, PitchPerfect allows presenters to verbalize with scaffolding support from element notes and time guides specified and refined at lower levels. Our system visualizes actual slide timings versus time targets, aiding time management. In addition, PitchPerfect accounts for trial and error during speaking by supporting record-review-revise cycles for speech at various levels. To help presenters reduce their note reliance, we also incorporate note compression capabilities, which applies NLP techniques to trim note text while retaining key words.

Together, these support mechanisms form a structured approach to presentation rehearsal that guides presenters through the processes of preparation in ways that conform to recommendations from the literature while offering greater support than conventional presentation tools. Although we target formal, time-controlled presentations, we anticipate that the mental associations formed during rehearsal would also provide a platform for more improvisational delivery of the same content. We now describe the three core features.

### Extended Authoring

The presenter begins by authoring PowerPoint slides as usual, then proceeds to extended authoring by clicking the corresponding control on the PowerPoint ribbon. As the presenter selects a slide, a visualized flow path through all visual elements of the slide is automatically generated and overlaid on the slide, representing a default speaking order of the slide visuals (Figure 1a). An element note placeholder is automatically created for each node of the flow path and displayed on the side panel (Figure 1b). The presenter can edit these notes to specify how they intend to elaborate upon each visual element with speech. These element notes are initially arranged according to the chronological creation order of their associated visual elements. They can be manually rearranged through drag-and-drop operations on the element note list to reflect the intended speaking order, or deleted if desired. The flow path automatically updates.

In addition to element notes for slide visuals, we also attach a special “transition note” to the end of the note list (shown as an icon in the bottom-right slide corner, Figure 1). This encourages the presenter to prepare a verbal linkage to the next slide – a key way to create a smoothly flowing delivery.

In parallel to creating, editing, and authoring element notes, the presenter can also set time targets for the overall presentation and individual slides. The overall presentation time target can be entered into a designated control on the PowerPoint ribbon while slide time targets can be automatically calculated by evenly distributing the overall time across slides. The presenter can manually adjust time targets of specific slides on the element notes side panel (Figure 1c). As the presenter modifies a slide time target, all other device-generated slide time targets will be updated accordingly. In addition to helping the presenter stay or get back on track during delivery, such time targets can also assist the presenter in preparing an appropriate amount of content for the slide. These time targets can also be adjusted in the three rehearsal modes described next.

### Cued-recall Testing

PitchPerfect has two targeted cued-recall rehearsal modes. In the element note rehearsal mode, presenters train themselves to recall the contents of element notes (i.e., their intended speaking points) for each visual element. Interaction proceeds with the system highlighting a visual element and prompting the presenter to anticipate the associated element note (Figure 2a). The presenter then presses the right arrow key to reveal the associated element notes and mentally compare them to what they had anticipated. If the presenter correctly anticipated the actual element notes, they can proceed to the next visual element specified in the flow path. Otherwise, they can press the left arrow key to navigate back, and repeat the process. Training to a level of reliable error-free completion can increase the presenter's confidence that they will be able to recall their verbal points even when under real delivery pressure. This process also helps to identify visuals that did not support recall. In this and all other targeted rehearsal modes, it is always possible to rapidly exit the rehearsal environment, make refinements to slide visuals and notes, then rehearse again in an iterative cycle.

In the flow path rehearsal mode, presenters train themselves to recall the visual elements on a slide and their intended speaking order. Interaction proceeds in a similar fashion to the element note rehearsal, with the system hiding visual elements further along the flow path and prompting the presenter to anticipate what is coming next (see Figure 2b). A press of the right arrow key then reveals the target visual element along with its associated note. This process enables the presenter to check and commit the presentation flow and visual contents into memory. This in turn helps delivery of the presentation without constant reference to the slides.

### Scaffolded Speech Rehearsal

This rehearsal mode encourages the presenter to practice timed and recorded verbalization. The element notes and time targets specified in the extended authoring stage are shown to guide the exploration of how to speak about each visual element and for how long (Figure 2c). We arrange all the element notes of a slide onto a single note page, segmenting them by colored headings to facilitate note retrieval. These combined notes provide a big picture of all speaking points for the slide, helping the presenter smoothly connect points with speech. While the presenter is speaking, we continuously update time information on two time bars: a *slide time bar* displaying the speaking time of the current slide relative to its time target (Figure 2i), and a *presentation time bar* showing the cumulative timed recordings of all slides relative to the presentation time budget (Figure 2ii). We also display a *presentation target bar* of all time targets, allowing the presenter to compare planned versus actual timings (Figure 2iii).

We capture the presenter's speech through auto-recording with silence detection. As the presenter starts speaking, their speech is detected using the Microsoft Speech Recognition API [23]. A new recording segment is immediately added to

the existing recording of the slide, as shown on the slide time bar. As soon as any pause exceeds two seconds, recording and timing stop. A pause marker is added to the slide time bar to indicate the end of the current recording segment, as shown in Figure 2iv. All non-speech durations are therefore not included in cumulative time totals. The purpose of this feature is to reduce the pressure on the presenter, helping them review notes and slides or think about what they want to say without the constant feeling of time ticking by.

At any time, the presenter can click on a recording segment for playback or deletion, with the most recent one selected by default. This allows the presenters to review and revise parts that they did not say well enough without having to re-record the entire slide or presentation. Double-clicking on a slide on the presentation time bar enables the presenter to select the entire slide recording for playback or deletion. Manual recording controls can also be used at any time.

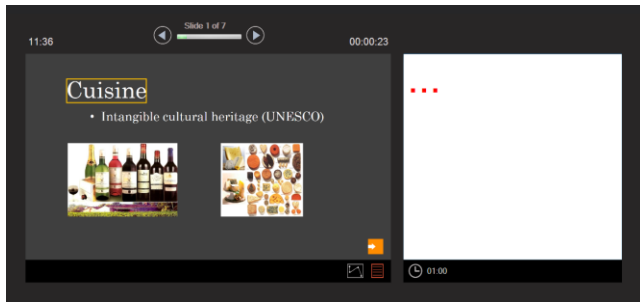
The accumulated speech intervals recorded in this manner comprise an "ideal delivery" containing little or no disruptive pauses, performed in an ideal environment with support from both time guides and speaking notes. In each successive rehearsal, the presenter can aim to approach this ideal delivery while reducing rehearsal times, errors, and note reliance. To help the presenter gradually lessen their note reliance, we developed an automatic compression method.

### Note Compression

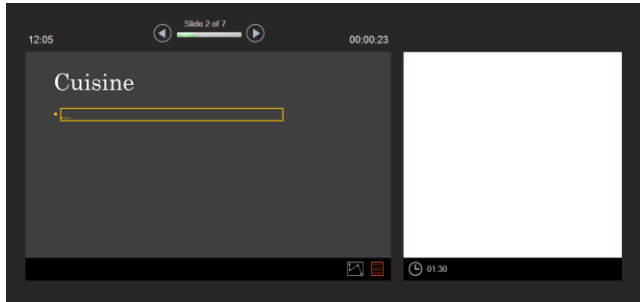
With note compression, we aim to progressively reduce the text of the notes across successive rehearsals, while preserving essential information. We view this as a simplified problem of automatic sentence compression addressed in previous research [7]. Our purpose is to retain words that can act as appropriate cues for recall of original notes (i.e., the intended speaking points) rather than to ensure the grammatical correctness of the compressed notes. Thus, we adopted a basic telegraphic text reduction approach [16].

Unlike statistical methods using word frequencies [7, 14], in this approach the judgment of importance of information is based upon linguistic criteria drawn from cognitive and information retrieval research [17, 32]. Our compression algorithm is guided as follows:

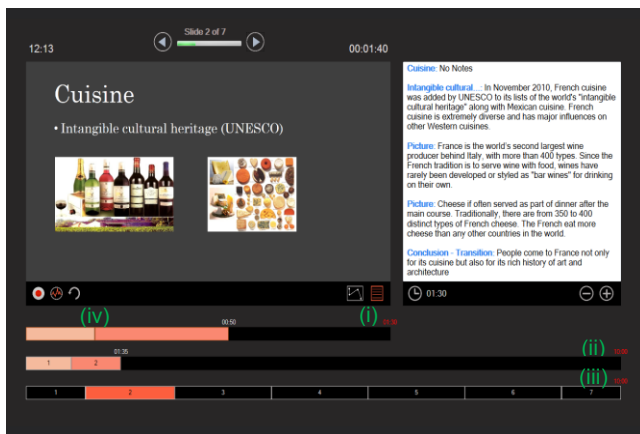
1. Words are filtered based on their ability to act as retrieval cues for target text (e.g., nouns generally contribute most, adjectives and adverbs less, and verbs the least [17]; subject nouns are better cues than object nouns [32]).
2. Number, comparative and superlative phrases should be retained as they tend to convey important information.
3. The number of compression levels and the compression rates should be carefully considered to avoid dramatic note reduction between two consecutive levels, thereby allowing a gradual process of withdrawing note support.



(a) Element Note Rehearsal



(b) Flow Path Rehearsal



(c) Timed Speech Rehearsal

**Figure 2. Three targeted modes in PitchPerfect supporting cued-recall testing and recorded spoken rehearsal.**

Level 1: Original notes "French cuisine is renowned for being one of the finest in the world."
Level 2: Nouns - proper nouns - verbs - adjectives - adverbs - numbers "French cuisine is renowned ... being one ... finest ... world."
Level 3: Nouns - proper nouns - adjectives - comparative, superlative and number phrases "French cuisine ... renowned ... one ... finest ... world."
Level 4: Subject nouns - proper nouns - comparative, superlative and number phrases "... cuisine ... one ... finest ..."
Level 5: No notes

**Figure 3. Five levels of notes in PitchPerfect: An example showing how a sentence is compressed at each level.**

To compress a sentence in the notes, our system analyzes the grammatical structure of the sentence using the Stanford Part-of-Speech (POS) tagger [33] and typed dependency parser [8]. At each compression level, the system removes a new set of words according to a pre-defined set of rules.

To tune the compression levels, we collected over 8000 PowerPoint presentations using Microsoft Bing web search and extracted all slide note text. 21% of the presentations contained notes, resulting in a notes corpus of 1.1M words in total. We analyzed the grammatical structure of these notes and computed the POS tag frequencies on the corpus. We experimented with removing different POS tags from the corpus following our first principle while calculating the resulting compression rates based on the POS tag frequencies. Through this process, we derived five levels of compression rates (0%, 33%, 54%, 82%, and 100%).

In PitchPerfect, the presenters can set a global level for all slide notes using controls in the PowerPoint ribbon. In the speech rehearsal mode, they can move between different note levels for a specific slide by pressing the associated buttons on the slide note pane. Figure 3 shows an example.

### EVALUATION OF PITCHPERFECT

We conducted a user study comparing the structured approach of PitchPerfect against participants' existing practices with PowerPoint. Our focus was to examine whether structured rehearsal with PitchPerfect can improve both the presenter experience of presentation preparation and presentation quality perceived by an audience.

### Procedure

From our interviews, we learned that delivering a presentation created by somebody else is a common scenario. We therefore focused our evaluation purely on rehearsal and delivery of prefabricated presentation material, which would also support controlled comparisons with existing approaches to rehearsal. We therefore asked each participant to rehearse and deliver two 10-minute presentations on similar topics (French and Italian culture) in English. Each slide deck contained 7 slides with 27 visual elements in total, including headings, bullet points and images. Supporting notes formed approximately 900 words, containing 27 key points for all the visual elements.

The study was a within-subject, baseline-intervention design across two sessions. Each session lasted between 90-120 minutes, with 1-6 days between sessions. The ordering of slide decks was counterbalanced across participants. We adopted the baseline-intervention design because counterbalancing the conditions could risk the transfer of rehearsal approaches from the PitchPerfect to the PowerPoint condition, which would not provide an accurate picture of existing practices. We also expected the learning effect from the PowerPoint condition to be minimal with experienced presenters, controlling any potential threat to validity.

**Session 1:** In this baseline session, we asked participants to rehearse and deliver the presentation using their own



preparation strategies with PowerPoint. Notes had been added to the corresponding slide note sections in PowerPoint in advance. All points in the notes were arranged in the intended speaking order and clearly separated by blank lines.

At the beginning of the session, we gave participants the scenario of preparing to present a pre-made slide deck. We instructed them to cover the key points in the notes to the best of their ability given the preparation time available. We also introduced participants to the three rehearsal support features of PowerPoint 2013: timing, recording, and presenter view. The session was set up with two screens, allowing the participants to rehearse with the presenter view should they wish. We explained that they could use any subset of these features or other approaches according to their preferences. Following this introduction, we allowed participants one hour to rehearse before giving a final, video-recorded presentation. We concluded with a semi-structured interview probing their preparation strategies and task experiences.

**Session 2:** In this intervention session, we asked participants to rehearse and deliver the presentation in a structured way using PitchPerfect. All key points in the notes were attached to the corresponding visual elements beforehand.

We gave participants the same scenario as in Session 1, followed by an introduction to the element notes and the three rehearsal modes of PitchPerfect, which lasted approximately 10 minutes. Following this introduction, we allowed participants one hour to rehearse before giving a final, video-recorded presentation. We divided this 1 hour into three ordered sections: 10 minutes using the element notes, 20 minutes using the cued-recall testing modes, and 30 minutes using the speech rehearsal mode. In the cued-recall testing modes, we instructed participants to use either or both the element note rehearsal and the flow path rehearsal, in any order they liked. We asked participants at the end of the time allocated to each section to move on to the next. The interview protocol followed that of Session 1 and prompted critical reflection on the use of PitchPerfect.

In both sessions, participants used the same tool to deliver their presentations (i.e., the presenter view of PowerPoint with the presence of notes, timer, and next slide preview).

### **Participants**

We recruited 12 students and researchers with technical backgrounds and varying levels of presentation experience (3 female, 9 male, ages 22-32, mean 24, PB1-12). All spoke English in their work environment, 7 as a second language. All were frequent users of PowerPoint or Keynote or both.

### **Presentation Ratings**

We recruited three raters (2 female, 1 male, R1-3) to independently evaluate the relative quality of the 12 pairs of video-recorded presentations. The raters were research students working in our lab and blind to the study protocol. Raters compared each presentation pair (PowerPoint vs. PitchPerfect) on six criteria: organization, content coverage, note reliance, speech, timing and pacing, and overall quality.

Each criterion was judged on a 4-point ordinal scale of “no difference”, “slight difference”, “moderate difference”, and “substantial difference”, with the superior presentation indicated in the case of perceived differences. We later converted results into a 7-point numeric scale ranging -3 to 3 (negative values favor PowerPoint, positive PitchPerfect).

For content coverage, we gave raters a checklist of the 27 key points in the notes that should be covered in each presentation. We asked raters to award one point for each piece of content presented in its entirety (but not necessarily word-for-word). We calculated the average content coverage score across the three raters for each recorded presentation and used them for comparison.

### **Results**

We performed Shapiro-Wilk tests to check the normality of our data. Parametric tests were used for normally distributed data and non-parametric tests were used otherwise.

Average content coverage was 19.36 ( $SD$  5.17) with PowerPoint and 21.83 ( $SD$  3.68) with PitchPerfect. Analysis using repeated measures ANOVA showed a significant difference between the two conditions ( $F_{1,11} = 9.57, p < .01$ , partial  $\eta^2 = 0.47$ ).

For overall quality, a t-test on the average ratings of the three raters showed a significant difference between the two conditions in favor of PitchPerfect ( $p < .05$ ). Wilcoxon signed-rank tests on the ratings of each rater indicated that R1 and R2 had significant preferences for the PitchPerfect presentations ( $p = .04$  for both), but not in R3's ratings ( $p = .5$ ). The inter-rater reliability of the three raters was moderate (Cronbach's  $\alpha = 0.482$ ), but explained by the inherent difficulty of the rating task, the subjective rating criteria, and the limited training given to raters. Despite this, PitchPerfect achieved significantly higher average ratings and was preferred by the majority of the raters, showing potential to improve overall talk quality. No significant differences were found in the other four quality criteria.

### **Qualitative Findings**

We performed high-level coding on the transcribed interviews, and found that all participants reported strong preference toward PitchPerfect and their reasons.

#### *Planning Visual-Verbal Associations with Element Notes*

Participants appreciated the ability to connect slide visuals and intended speaking points using element notes. With conventional slide notes, “sometimes you don't remember what note is assigned to what element” [PB5]. Participants had to manually organize and style slide notes into element-based subsections, often discouraging them “from taking notes in the first place” [PB9]. In contrast, our element notes provided a “nice, clean and simple” [PB8] way of structuring notes, making “the idea more clear” [PB5]. Participants could quickly refer to specific segments, making it “easier to find” what they want [PB2], and allowing them to “focus on just one particular part of the slide” [PB12].



The clear ordering of the notes and the visual flow paths also helped participants to learn and absorb the presentation flow: *“every time I see a slide, there was a map hidden in my mind”* [PB1]. One participant suggested that these features would be most useful when learning slides made by others.

A recommended improvement for the element notes was to allow adding and ordering of note sections without attaching them to a visual element. This feature could be particularly beneficial for presenters with minimal slide visuals.

#### **Mastering Content with Cued-recall Testing**

By allowing presenters to quickly step through each slide visual and element note in the intended speaking order, our cued-recall testing enabled them to *“get the structure of the PPT faster”* [PB3]. Moreover, by hiding slide visuals and element notes, this process encouraged participants to actively recall what to say for each element – *“because if I can see all of them, I will be lazy, I will just read it and won’t think about it”* [PB6]. As a result, they developed *“a deeper understanding or feeling of what I should say”* [PB3]. Through cued-recall practices, participants could also highlight *“which part I didn’t remember well”*, allowing them to *“strengthen the memory of that part”* [PB2] and subsequently increase their confidence in content mastery.

#### **Reducing Note Reliance with Note Compression**

Practicing with note compression was reported to be helpful, mainly by native English speaking participants. It provided useful cues for recall of verbal notes – *“it’s amazing that the shown words are very important words”* [PB6]. It also helped with *“memorizing key points”* [PB9] as opposed to relying on the notes during delivery. Participants often described the process of manually condensing notes for their own presentations as *“really tedious and time consuming”* [PB10], and felt that our note compression would greatly reduce this effort. Repeated practices with compressed notes was another effective method PitchPerfect offered to build confidence – *“when I look at the few keywords of a sentence and I can say the whole sentence, I think it makes me feel very confident”* [PB6]. An area for improvements pointed out by participants was that note compression operated on individual sentences rather than the whole note, sometimes making note recall *“a little bit difficult”* [PB10] when the logical connections between sentences became unclear.

#### **Encouraging Recorded Spoken Rehearsal**

Participants commented that recording their rehearsal with PowerPoint was generally unnecessary unless they wanted to elicit feedback from others, because *“I don’t have time to re-watch my recording”* [PB1]. Many of them reported to often rehearse mentally, or just *“normally whisper”* [PB10].

In contrast, the recording environment in PitchPerfect encouraged participants to perform recorded verbalization, thanks to the multiple benefits it offered. The auto-recording with silence detection provided a more accurate estimate of presentation length compared to conventional recording facilities, *“because when you do rehearsal, you have a lot of*

*empty voice time, and you have pauses”* [PB1]. The ability to account for trial and error during speaking was also well received, because *“every time I was thinking about how to change or edit my voice, it provides me with a function that I can delete some period of my voice or I can add something”* [PB1]. Cycles of record-review-revise for speech at both segment and slide levels helped participants to quickly check their speaking rate and identify wording issues, highlighting *“which word and which sentence I want to adjust”* [PB2].

Several participants noticed that they had to speak louder because otherwise, PitchPerfect did not record their speech. But, they enjoyed the experience because *“it encouraged me to properly practice it instead of just whispering”* [PB9]. Visualization of pauses during recording also helped participants identify problem areas because *“you can see the points when I was obviously hesitating”* [PB8].

Many participants reported an increase in confidence arising specifically from the spoken rehearsal mode. One of our participants, who was originally very reluctant to rehearse aloud, expressed how PitchPerfect would influence his future behavior: *“I used not to speak aloud...If I have this tool, it would be very helpful because I can edit my voice. But if I don’t have this tool, I will find a way to edit my voice”* [PB1].

#### **Improving Time Management**

Time keeping was a major concern for participants. In PitchPerfect, breaking down the presentation time budget into slide time targets helped participants to *“control the time for each slide better”* [PB4]. Visualizations of time expenditure relative to the time targets also enhanced participants’ time awareness: *“the bar is growing and growing, it can push you”* [PB7]. Visual time guides also helped participants to dynamically adjust speech, whether they should be *“more detailed or less detailed”* [PB7]. Time information also helped with speaking rate and pace control – *“I was a bit more paced and taking time before moving on to the next point, whereas normally I’d just ramble and get it out as quickly as possible”* [PB11].

#### **Breaking Down Rehearsal into Achievable Milestones**

Participants appreciated the structured rehearsal approach in PitchPerfect and reported that the explicit and achievable goals set by each stage would encourage them to rehearse: *“each step we have a very clear destination or target...I think if we finish these targets it will be truly helpful”* [PB3]. Clear indications of readiness also helped participants to *“estimate what score I can get”* [PB7], whereas *“[with PowerPoint] you are not sure after 1 hour how well you are prepared”* [PB2]. Rehearsing with PitchPerfect also improved preparation time efficiency, allowing them to *“make full use of the time – every minute I do things”* [PB7]. Participants, as a result, described their experiences with PitchPerfect as *“happier”* [PB7] since it *“focused my mind”* [PB10], let them feel *“more relaxed,”* and *“not so worried”* [PB2]. PitchPerfect thus progressively guided participants through the set of efficient training for confident delivery.

## CONCLUSIONS AND FUTURE WORK

This work uncovers mismatches between best rehearsal practices as recommended in the presentation literature, the actual rehearsal practices, and support for rehearsal in conventional slideware. The result of this exploration is PitchPerfect: an integrated rehearsal environment with three targeted rehearsal modes for structured presentation preparation in PowerPoint. Our user study with 12 participants demonstrated that PitchPerfect led to small but significant improvements in perceived presentation quality and coverage of prepared content after a single hour of use, arising from more effective support for the presenter's content mastery, time management, and confidence building.

We aim to integrate our system into a persuasive rehearsal framework, employing personalization techniques to tailor our support for each individual presenter and providing appropriate feedback and reminder mechanisms at all stages of the preparation process. We also plan to examine the effectiveness of a structured rehearsal approach in more naturalistic settings through a longitudinal deployment.

## REFERENCES

1. Apple Keynote. <http://www.apple.com/iwork/keynote>.
2. Atkinson, C. (2005). *Beyond bullet points: Using Microsoft PowerPoint to create presentations that inform, motivate, and inspire*. Microsoft Press.
3. Ayres, J. (1996). Speech preparation processes and speech apprehension. *Communication Education*, 45, 228-235.
4. Behnke, R. R., Sawyer, C. R. (1999). Public speaking procrastination as a correlate of public speaking communication apprehension and self-perceived public speaking competency. *Communication Research Reports*, 16(1), 40-47.
5. Braun, V., Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101.
6. Carpenter, S. K., Pashler, H., Wixted, J. T., Vul. E. (1998). The effect of tests on learning and forgetting. *Memory & Cognition*, 36(2), 438-448.
7. Clarke, J., Lapata, M. (2006). Models for sentence compression: A comparison across domains, training requirements and evaluation measures. *ACL'06*.
8. De Marneffe, M.C., Manning, C. (2008). The Stanford typed dependency representation. *Coling'08*.
9. Distinction Communication, Inc. (2009). Executive survey. <http://www.distinction-services.com>.
10. Duarte, N. (2008). *Slide:ology: The art and science of creating great presentations*. O'Reilly Media.
11. Duarte, N. (2012). *HBR guides to persuasive presentation*. HBR Press.
12. Edge, D., Fitchett, S., Whitney, M., Landay, J. (2012). MemReflex: Adaptive flashcard for mobile microlearning. *MobileHCI'12*, 431-440.
13. Edge, D., Savage, J., Yatani, K. (2013). HyperSlides: dynamic presentation prototyping. *CHI'13*, 671-680.
14. Filippova, K., Strube, M (2008). Dependency tree based sentence compression. *INLG'08*.
15. Goodman, A. (2006). *Why bad presentations happen to good causes*. Andy Goodman & Cause Communication.
16. Grefenstette, G. (1998). Producing intelligent telegraphic text reduction to provide an audio scanning service for the blind. *AAAI'98*, 111-118.
17. Jing, Y., Croft, B. (1994). An association thesaurus for information retrieval. *RIAO'94*.
18. Kurihara, K., Goto, M., Ogata, J., Matsusaka, Y., Igarashi, T. (2007). Presentation sensei: A presentation training system using speech and image processing. *ICMI'07*.
19. Mayer, R. E. (2001). *Multimedia learning*. New York: Cambridge University Press.
20. McCroskey, J. C. (1978). Validity of the PCRA as an index of oral communication apprehension. *Communication Monographs*, 45, 192-203.
21. Menzel, K. E., Correll, L. J. (1994). The relationship between preparation and performance in public speaking. *Communication Education*, 43, 17-26.
22. Microsoft PowerPoint. <http://office.microsoft.com/en-us/powerpoint>.
23. Microsoft Speech Platform SDK. [http://msdn.microsoft.com/en-us/library/hh361572\(v=office.14\).aspx](http://msdn.microsoft.com/en-us/library/hh361572(v=office.14).aspx).
24. Nelson, D.L., Reed, U.S., Walling, J.R. (1976). Pictorial superiority effect. *Journal of Experimental Psychology: Human Learning & Memory*, 2, 523-528.
25. Okamoto, R., Kashihara, A. (2011). Back-review support method for presentation rehearsal support system. *KES'11*. Springer Berlin Heidelberg, 165-175.
26. Paivio, A. (1990). *Mental representation: A dual coding approach*. Oxford University Press.
27. Pearson, J.C., Child, J.T., Kahl, D.H. (2006). Preparation meeting opportunity: How do college students prepare for public speeches?. *Communication Quarterly*, 54(3), 351-366.
28. Reynolds, G. (2012). *Presentation Zen: Simple ideas on presentation design and delivery*. New Riders.
29. Rohrer, D., Taylor, K., Pashler, H., Wixted, J. T., Cepeda, N. J. (2005). The effect of overlearning on long-term retention. *Applied Cognitive Psychology*, 19, 361-374.
30. Spicer, R., Lin, Y. R., Kelliher, A., Sundaram, H. (2012). NextSlidePlease: Authoring and delivering agile multimedia presentations. *TOMCCAP*, 8(4).
31. Thios, S. J. (1975). Memory for general and specific sentences. *Memory & Cognition*, 3(1), 175-177.
32. Toutanova, K., Klein, D., Manning, C., Singer, Y. (2003). Feature-rich part-of-speech tagging with a cyclic dependency network. *HLT-NAACL'03*, 252-259.
33. Weissman, J. (2009). *Presenting to win: the art of telling your story*. FT Press.
34. Weissman, J. (2009). *The power presenter: techniques, styles, and strategies from America's top speaking coach*. Wiley.