Memory Maps: Helping Engineering Students Fashion Words on the Spot in Their Technical Presentations

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Work in Progress: Memory Maps as a Means to Help Engineering Students Fashion Words on the Spot in Their Technical Presentations

Summary and Introduction

In public speaking, the words that the speaker says traditionally arise from one of four sources: (1) reciting from memory; (2) reading from a script or notecards; (3) fashioning on the spot with no planning (impromptu); or (4) fashioning on the spot but after practice with a planned structure (extemporaneous).[1] Historically, the public speaking courses that engineering students take in high school or in colleges of liberal arts advocate that students use either a script or notecards to come up with their words. While such a strategy might be appropriate for a liberal arts student making a political speech, the strategy is not appropriate for an engineering student giving a technical presentation. Put simply, in most of their technical presentations, engineers will not carry credibility by reading scripts or speaking from note cards.

As this paper shows, expert speakers in engineering and science typically fashion sentences on the spot, but do so after practice with a planned structure. However, as our interviews of engineering students have uncovered, this delivery style is daunting to those without experience in public speaking. Not surprisingly, to simulate this delivery style of fashioning words on the spot, many engineering students (and professionals for that matter) load their slides with bulleted lists to provide the words that note cards in a public speaking class supply.[2] However, this alternative delivery style of reading from bullet-laden slides does not engage or support the comprehension of the audience.[2-7]

This paper first discusses the advantages and disadvantages of these four sources of words in an engineering presentation. Next, the paper discusses the source of words that expert presenters in science and engineering draw upon: fashioning sentences on the spot, but after planning and practice. To help students achieve this delivery style of fashioning sentences on the spot, our paper introduces a new preparation strategy, which we call a memory map. A memory map is a sequence of images used *during the preparation of a talk* to help the engineering student recall the sequences of ideas during the actual delivery of the talk. This paper concludes with a progress report on our study to determine whether memory maps would be an effective means to help engineering students fashion words on the spot.

Advantages and Disadvantages of Different Sources of a Speaker's Words

In the popular textbook *The Art of Public Speaking*, Stephen Lucas identifies four sources for the words that a speaker says in a public speech: (1) reciting from memory; (2) reading from a script or notecards; (3) fashioning on the spot with no planning (impromptu); or (4) fashioning on the spot but after practice with a planned structure (extemporaneous).[1] For engineers and scientists, each of these four sources has distinct advantages and disadvantages.[7]

Reciting from memory has the advantages of allowing the speaker to make good eye contact and deliver the talk in an engaging manner. However, one big disadvantage is that the method requires much more preparation time than engineers can afford, especially given how often engineers are called upon to speak. Second, reciting from memory does not allow for on-the-spot changes, which engineers have to make when questions interrupt the talk.[8] Such interruptions are common in industry talks.

Reading from a script or from note cards has the advantage that the speaker is assured of conveying the desired text (script) or at least the sequence of ideas (note cards). In all types of presentations, one large disadvantage is that this delivery style often results in the speaker making too little eye contact with the audience and too much eye contact with the script or note cards. This lack of eye contact with the audience has a significant negative effect on the audience's comprehension and memory of the information. In addition, with this delivery style, the speaker does not show ownership of the information. This ownership is a special expectation in engineering and science because audiences have to believe in the speaker. Put another way, audiences cannot perform the experiments or perform the computations during the presentation—therefore, to trust the results, audiences have to trust the speaker.[7]

Speaking impromptu has the advantages of not requiring any preparation time on the part of the speaker and of allowing the speaker to make effective eye contact with the audience. The disadvantages, though, are numerous. Because of the complexity of engineering, the talk will likely lack the organization needed for the audience to follow the work.[1,7] In addition, the talk will likely contain only superficial content. Moreover, the talk will likely not emphasize the most important messages.

Speaking extemporaneously has the advantages that (1) the speaker shows ownership of the information, (2) the speaker has the potential to make effective eye contact with the audience, and (3) the speaker could adjust the talk if circumstances called for that. One disadvantage is that this style of delivery requires much preparation. A second disadvantage is that novice speakers often lack the confidence that they will remember the planned and practiced sequence of ideas.

What Expert Engineering Speakers Do: Fashioning Sentences on the Spot

Historical writings reveal that the best speakers of science and engineering do not read from manuscripts or speak from note cards or projections of bulleted lists.[7] Rather, these speakers fashion sentences on the spot, but after practice with a planned structure. Michael Faraday, the famous physicist, strongly recommended this strategy,[9] as did the renowned biologist P.B. Medawar.[10]

In addition, Richard Feynman, who is considered one of the greatest speakers of science on the twentieth century, brought to class only one sheet of notes, which he discreetly placed out of view on the podium.[11] More to the point, when Feynman spoke to the audience, he moved away from the podium and made eye contact with his listeners. Likewise, Einstein brought to class only one card, which he kept out of view in his pocket.[12] Like Feynman's notes, Einstein's notes were only for occasional referral. Even more impressive, the famous physicist Ludwig Boltzmann did not use notes for any of his talks. Those talks included his university lectures that spanned four years and included such varied topics as classical mechanics, electrodynamics, and the kinetic theory of gasses.[13] One might assume that Boltzmann did not prepare for these talks.

However, according to one of his most famous students, the physicist Lise Meitner, Boltzmann's lectures were "the most beautiful and stimulating thing I have ever heard."[14]

In addition, we interviewed four popular TED.com speakers in engineering and science to determine how these speakers came up with their words. One speaker was Brian Cox, the physicist who has become the *de facto* spokesperson for the Large Hadron Collider. In 2008, Cox gave a talk on the Large Hadron Collider. At TED.com, his talk has been viewed more than 2.7 million times.[15] According to Cox, in his preparation for a talk, he divides the talk into sections, but does not memorize the wording for each section. As Cox writes, "My talks look spontaneous because they are, but within a structure that stops me wandering off."[16]

A second TED speaker whom we contacted was Sheila Patek, an assistant professor of biology, who gave a TED talk in 2004 on measuring the world's fastest feeding strikes of animals. Patek's TED talk has been viewed more than 850,000 times.[17] Patek provided an interesting interview because she was so young, only in her twenties, at the time of her talk. While Patek plans the organization of her talks and writes down key phrases, she says that she never writes a talk out word for word. "It has to be spontaneous," she said, "or I lose confidence about my memory."[18] To give her confidence in remembering her sequence of ideas, Patek practices from her planned outline. The beginning she practices as many as fifteen times, while the middle she usually practices only three times. As was clear on her TED.com talk, Patek did not carry note cards and she did not read from slides. In fact, most of her slides did not contain words.

Our third TED.com speaker was Hans Rosling, a well-known world health statistician. Rosling's 2006 TED.com talk has been viewed more than 9 million times.[19] In our interview with Rosling,[20] he compared a scientist preparing to give a talk as being similar to a skier preparing for a slalom run. In preparing for a slalom run, the skier thinks about "going here and then going here and then going here." In a similar fashion, the scientist thinks about the planned ideas that he or she intends to give. Rosling claimed that when he has prepared well, he "never uses any notes, because when you use notes, you lose your authority."[20]

The fourth TED.com speaker that we interviewed was Jill Bolte Taylor, the neuroscientist whose TED talk in 2008 is the most popular TED talk, having been viewed more than 16 million times.[21] Taylor's talk concerned the stroke that she suffered and her perspective as a neuroscientist on that stroke. Unlike the three previous TED speakers whom we interviewed, Taylor did not fashion words on the spot.[22] Instead, she memorized her 18-minute talk. Taylor said that she normally fashions sentences on the spot for the sequence of ideas that she has planned and committed to memory. However, she did not have confidence that she could do so in this TED talk. One reason was that the time limit for this talk was so stringent: just 18 minutes for a story that she normally takes an hour to tell. Second, because of the residual effects of the stroke, she did not have confidence that she could fashion sentences on the spot. To commit her talk to memory, Taylor said that she practiced the talk multiple times per day for three months. Although the result of Taylor's effort was a tour de force, engineers do not have time for Taylor's type of commitment, especially given how much they are called upon to speak.[7] As she stated, Taylor herself normally fashions sentences on the spot, but after planning and practice.

This section has shown that the overwhelming strategy adopted by these expert speakers from engineering and science has been to fashion sentences on the spot, but after practice with a planned structure.[7] Interestingly, *The Art of Public Speaking* by Stephen Lucas and *Public*

Speaking for College & Career by Hamilton Gregory contradict this finding. According to Lucas,[1] the precision of engineering talks requires that engineers read their talk. Gregory asserts that scientific conferences prefer a speaker to read because the talks are later printed or posted in full-text. [23] These practices are not corroborated by our observations or the observations of engineering faculty or professionals with whom we have consulted. Although other public speaking texts advocate an extemporaneous style, most of those such as *The Art of the Speaker* by Chris Johnstone give instructions for preparing extensive speaking notes.[24] Even when advocating extemporaneous delivery for other disciplines, Lucas advocates detailed speaking notes.[1] Even more surprising, Gregory states that speaking without notes is not an acceptable approach.[23] Put another way, the delivery recommendations of textbooks for traditional public speaking courses disagree with the practices of expert speakers in engineering and science.

Common Practice in the Public Speaking Classroom: Reading from Scripts or Note Cards

We have observed that when giving a talk many students read from cards, a script, or bullets on a slide. At Pennsylvania State University, which is a large land-grant institution, all students are required to take a public speaking course. Serving over 2,100 students each semester, most of the 75 sections of this course contain students from a variety of majors, including engineering. However, 7 to 10 special sections of this course are dedicated to engineering students. In these engineering sections, we teach the students to fashion sentences on the spot after planning and practice. Although the recommendation to students in all sections of this course is to speak extemporaneously, the textbook used in the regular sections advises the creation and use of speaking notes.[24] These speaking notes, which are described as condensed versions of a preparation outline, contain the following: key words or phrases for points, sub-points, transitions, statistics, and delivery cues (such as stage directions).

Perhaps because of this recommendation of speaking notes, observations from a speaking contest associated with the course reveal that the overwhelming majority of students read from a script, rely on a stack of note cards, or read bulleted lists projected on a screen. The speaking contest, which is sponsored by *The New York Times*, invites the top one or two speaker from each section to deliver a talk that combines the problem speech with the policy (solution) speech. (If given in engineering, this speech would be called a proposal talk.) According to observations of seven judges from the contest, more than three-fourths of the contestants obtain most of their words by reading from a script, relying on a stack of note cards, or paraphrasing bulleted lists projected on a screen.

In other words, students learning from the regular sections of this public speaking course adopt a delivery style that relies on reading notes. Although this delivery style is in line with the recommendations of most public speaking texts, it contrasts sharply with the recommendations of expert speakers in engineering and science.

Fashioning Sentences on the Spot: A Challenge for Novice Engineering Speakers

In the engineering sections of the required public speaking course at Pennsylvania State University, we have the students present as expert presenters in science and engineering do: fashioning sentences on the spot, but after planning and practice. The students do not carry note

cards or read from a script. Because the students have already gone through first-year engineering design, they are accustomed to this constraint.

What the students are not accustomed to, though, is our requirement that they design visual aids using the assertion-evidence approach.[7] In this approach, the slides have a succinct sentence headline that states the main takeaway of the slide (scene). That takeaway is supported then by visual evidence—bulleted lists are not used. Because this approach has so few words on the slides, the students have to fashion almost all of the sentences on the spot.

In our sections of the course, we have chosen the assertion-evidence approach for three reasons. First, the approach has its roots at Lawrence Livermore National Laboratory,[7] which means that the approach was designed with scientists and engineers in mind. Second, test results show that audiences learn technical information more deeply when the slides follow the assertion-evidence approach, as opposed to the common practice of having a phrase or question headline supported by a bulleted list (or a bulleted list and a graphic).[25] Third, test results also show that engineering students learn the content of the presentation more deeply when they create slides that follow the assertion-evidence approach, as opposed to the common practice approach.[26]

Interviews of twenty engineering students who had delivered a successful 8-10 minute talk in the course revealed the following about fashioning words on the spot. First, all twenty students claimed to have delivered almost all of their talks by fashioning sentences on the spot, but after significant planning and practice. Several mentioned committing to memory a few sentences—usually the first and last sentences as well as a couple of transitional phrases.

As far as remembering the sequence of ideas in the presentation, several discussed the importance of the images (visual evidence) that they had on their slides. Those images served as a mnemonic for what they had to say. Two students pointed out that the images they knew best were the ones that they had drawn themselves.

As far as practicing, one student claimed to have practiced the talk 10 times all the way through. Another student recounted that she had practiced the beginning portion 7-8 times, the middle 3-4 times, and the conclusion 3-4 times. The remaining students cited various numbers of times that they had practiced their talks—some alone in their rooms, others in front of friends.

Interestingly, every student claimed that using the assertion-evidence approach required much more practice than the ubiquitous approach of following PowerPoint's defaults and placing the sequence of ideas for the talk into bulleted lists. As mentioned, this assertion-evidence approach compelled students to fashion sentences on the spot in the manner of expert presenters of science and engineering.

For engineering students that we interviewed, fashioning sentences on the spot, even after practice with a planned structure, was challenging. The challenge was two-fold. The first was remembering the sequence of ideas that the presenter wanted to communicate, and the second was having the confidence to fashion a sentence on the spot to convey each remembered idea.

Memory Maps: An Aid to Fashioning Sentences on the Spot

This paper proposes a new strategy to help engineering students fashion sentences on the spot after those students have planned the presentation. This strategy, which we call a memory

map, helps the students recall the sequence of ideas for the talk. Arising from the Method of Loci, [27] the memory map calls for a series of images to be positioned on a sheet of paper. Each image corresponds to an idea or set of ideas for the talk. The map then serves as a learning guide for the speaker to practice with before the presentation.

Shown in Figure 1 is a sample memory map, which we created as a model, for the first speaking assignment of the course: introduction of a colleague. The occasion is such that the person making the introduction does not use notes or slides. As stated, the memory map is a memory tool to help person making the introduction remember what to say. In this memory map, the images are arranged in three columns, and the sequence of the presentation goes from the left column to the right. Key transition words are positioned at the top of each column.
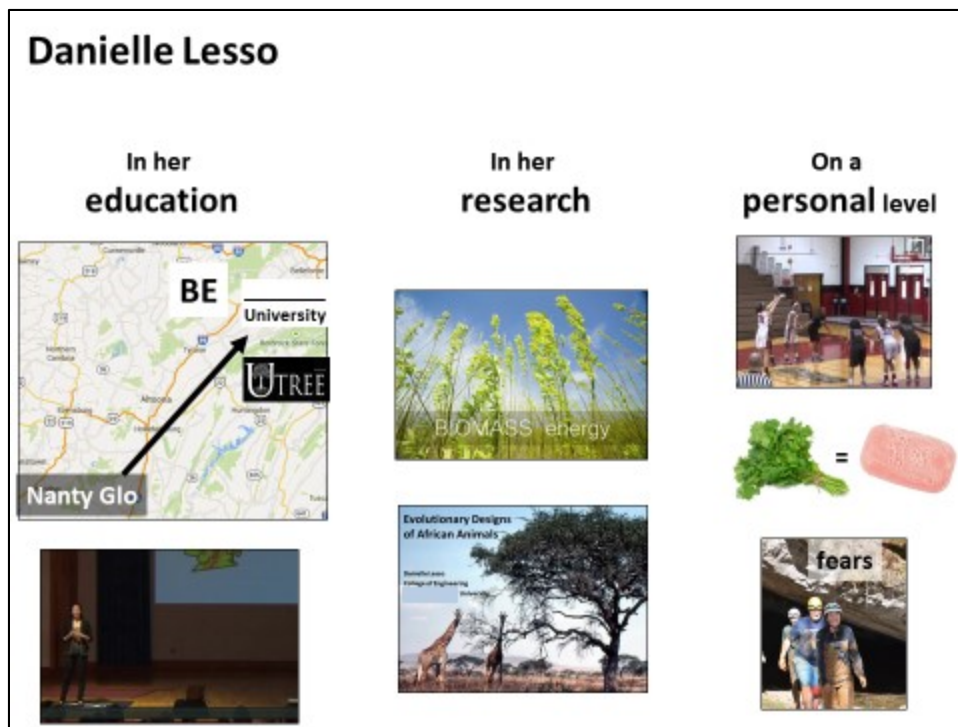

Figure 1. Memory map for introduction of Danielle Lesso.[28] This introduction has three parts: her education, her research, and a slice of her personal interests.

As shown in the memory map of Figure 1, the speech of introduction has three parts: the education of the colleague (Danielle Lesso), her research, and her personal interests. Created in PowerPoint, this memory map arranges memorable images in a way that the speaker can recall the sequence of ideas. For her education, the map shows that Danielle came from the town of Nanty Glo to Penn State, where she majored in biological engineering and participated in a student organization called UTREE. The bottom image of the first column shows that Danielle competing in a speaking contest, in which she presented her undergraduate research. That detail makes a nice transition to the second column, which shows Danielle's research in biological engineering (top) and education research (bottom). The third column shows three personal aspects of Danielle: she plays basketball; she does not care for cilantro (it tastes like soap to her), and she is claustrophobic (a fear she has tried to allay by exploring a cave).

Shown in Figure 2 is a memory map for a presentation that proposes a semester research topic in our engineering presentations course. Although the presentation is short (no more than 2.5 minutes), a significant challenge of this presentation is that the student has to convey seven messages: (1) reason to care about the research area, (2) overall scope of your research, (3) the scope of the problem talk, (4) scope of the solution talk, (5) key limitation(s) of the research, (6) information that a reference source will provide, and (7) credibility of that source. Because the list of messages is long and the student is allowed only two assertion-evidence slides, remembering all seven messages is a challenge. Shown in the upper left is an entry point statistic (message 1) from *National Geographic*—namely, that the average number of acres in the western United States has recently increased from 4-5 million acres to 9 million acres. The image to the right shows the talk's first slide with message 2 as the headline. The box to the right of the slide provides notes for the next three messages (messages 3-5). Shown below is the second slide of the talk, with numbers indicating parts of the slide to discuss messages 6 and 7. The talk concludes with a repetition of the talk's opening statistic. Created in PowerPoint by arranging thumbnails onto a slide, this memory map includes details that the speaker wanted to convey and a sequence that the speaker wanted to follow.
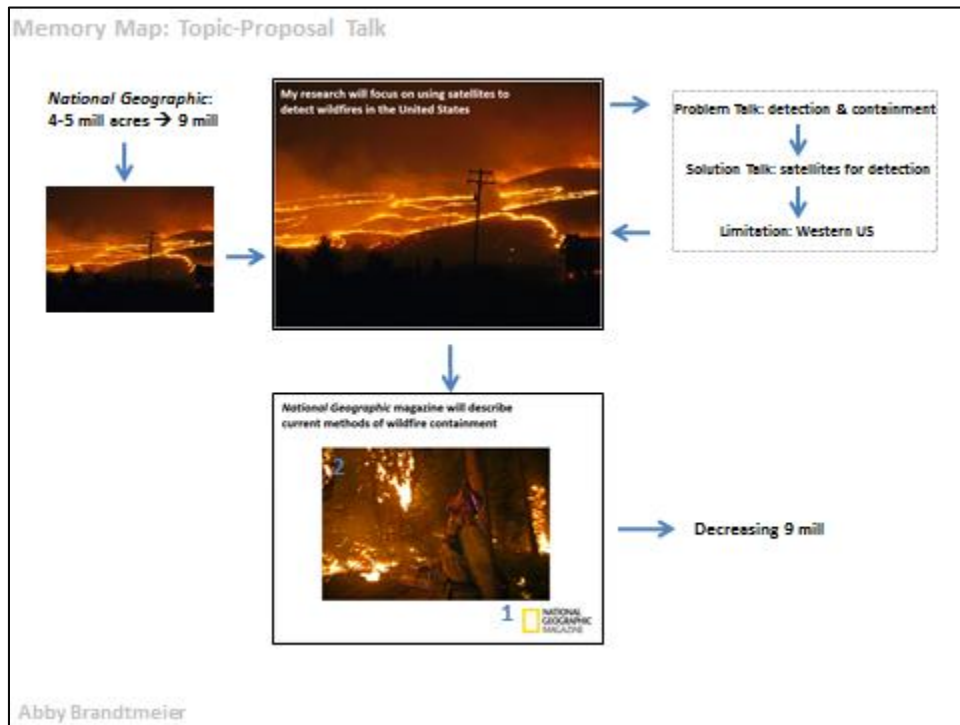

Figure 2. Memory map for a topic-proposal talk in our engineering presentations course.[29] Like many proposal talks, a challenge of this talk was that the speaker needed to communicate several required messages to the audience.

Shown in Figure 3 is a memory map that we created for a student presentation in our course. This presentation identifies a societal problem—a later talk in the course will then present an engineering solution that addresses that problem. Compared with the first two talks discussed in this section, this presentation is longer (6-7 minutes). To help the audience understand the talk, the student presenter is allowed several assertion-evidence scenes, with each

scene containing a sentence-assertion headline supported by visual evidence. Although the student has the scaffolding of assertion-evidence slides to convey the most important messages of the talk, the student still must fashion wording to many sentences. Typically, for each sentence written at the top of an assertion-evidence slide, the speaker fashions an additional ten sentences to explain the visual evidence and make a transition to the next scene (slide). Shown in the upper left is are slides for the introduction of the talk. Where a stacking of the same occurs means that the scene (slide) has animations. The three columns of slides in the middle portion of the map represent the three supporting main points of the talk. The bottom right shows the conclusion of the talk. Created in PowerPoint by arranging thumbnails onto a slide, this memory map shows the sequence of ideas that the speaker wanted to follow. The map also reminds the speaker of animations that will occur.
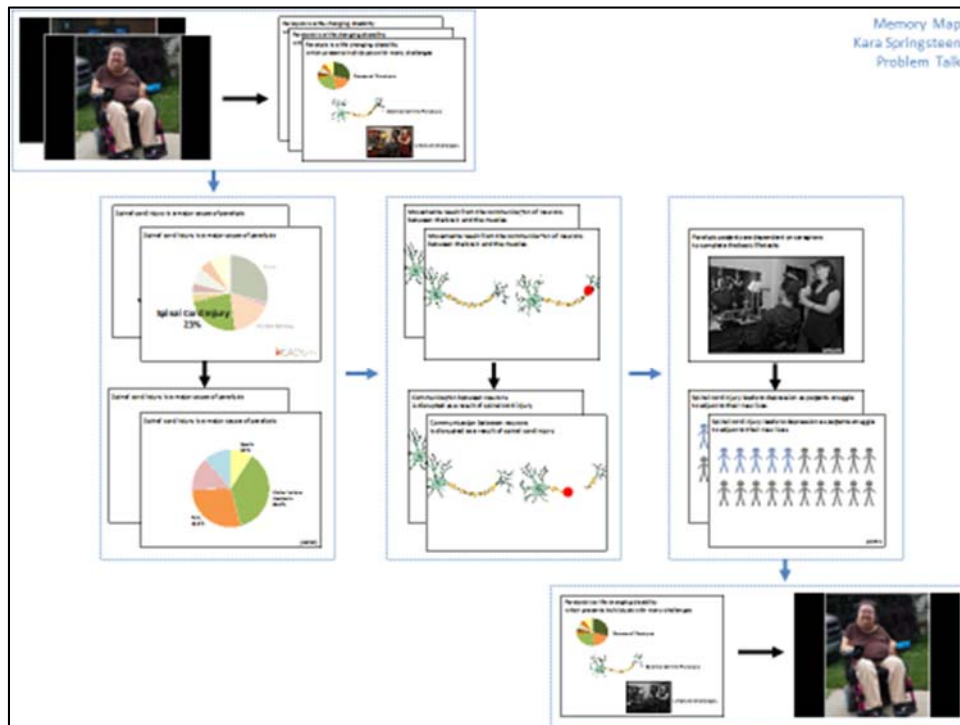

Figure 3. Memory map for a problem talk in our engineering presentations course.[30-31] This memory map positioned the slides of the talk in a way to show the introduction (top left), the three main points of the middle (three columns in middle portion of slide), and the conclusion (bottom right).

Conclusion: Plan to Assess the Effectiveness of Memory Maps

For memory maps to be effective for engineering students, the maps not only should help engineering students fashion words on the spot in a presentation, but also should be easy enough to create that the student perceives the amount of effort spent making the memory map as worthwhile. Otherwise, few students will adopt the practice.

To test the effectiveness of memory maps, we have currently asked the students in four of the eleven engineering sections in the presentations course to use memory maps in their first

three presentations of the semester: a 75-second speech of introduction, a 2.5 minute topic-proposal talk with two slides, and a 6-7 minute problem talk with about several slides. Four sections translates to more than 100 students participating in our study. For each of the three assignments, we have been collecting the memory maps and have begun looking for best practices in the maps. In assessing the effectiveness of a map, we will consider how well the students did at recalling ideas for that talk. At the end of the three assignments, we will survey the students to find out their perspective on using the memory maps. Survey questions will include the following:

1. In general, how helpful were the memory maps in preparing you to deliver the presentations?
2. For which of the three assignments (speech of introduction, topic-proposal talk, problem talk) were the memory maps particularly helpful?
3. When trying to recall the sequence of ideas in the talk, did you find yourself remembering aspects of the maps? If so, for which types of details did you rely on the maps?
4. Do you envision yourself creating a memory map for a future presentation? If so, what type of talk?

As stated, memory maps are designed to help the engineering student presenter remember the sequence of ideas in the talk. At the 2015 ASEE Conference, we will present the preliminary results of our study on how well using memory maps accomplishes this goal.

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