2006-911: THE ONE-MINUTE ENGINEER: GETTING DESIGN CLASS OUT OF THE STARTING BLOCKS

Beverly Jaeger, Northeastern University

BEVERLY K.JAEGER is a member of Northeastern University's Gateway Team. The focus of this team is on providing a consistent, comprehensive, and constructive educational experience in engineering that endorses the student-centered and professionally-oriented mission of Northeastern University. She teaches Engineering Design and Engineering Problem Solving to first-year engineering students and has served as a coordinator for multiple sections of these courses as well.

Sven Bilen, Pennsylvania State University

SVEN G. BILÉN is an Associate Professor of Engineering Design and Electrical Engineering at Penn State. His educational research interests include developing techniques for enhancing engineering design education, teaching technological entrepreneurship, and global product design. He is course chair for ED&G 100: Introduction to Engineering Design. He is member of IEEE, AIAA, AGU, ASEE, URSI, and Sigma Xi.

The One-Minute Engineer: Getting Design Class out of the Starting Blocks

Beverly K. Jaeger* and Sven G. Bilén+
***Northeastern University, +The Pennsylvania State University**

Abstract

Recent trends in engineering education have resulted in academics more closely scrutinizing the education process itself in the ongoing quest for "a better way" to teach and train our future engineers. This search has revealed that potential opportunities for improvement to student learning lie within the mesh of the class structure itself. Educators have begun incorporating more active learning techniques and methods into the class structure, thereby making the students more responsible for aspects of their own education. In keeping with this trend and its effectiveness, we have developed a pedagogical tool, called the "One-Minute Engineer" (OME), which is simple in its application, but which serves to stimulate class involvement on the part of the students, as well as to motivate them –and ourselves as educators– to become more "curious observers" of our world. The OME method uses the initial minutes of class as a catalyst for the rest of the day's activities in the Engineering Design course. The OME is a brief educational moment in which either students or, occasionally, the professor presents a short overview of an engineering topic. It works as an abbreviated "show and tell" session for the class and the results from its use have been promising in terms of participation, feedback, and student interaction, as well as achieving defined educational objectives. By design, the OME is informal and informative, and it also can be fun.

The OME, described in detail in this paper, was first piloted in an Engineering Design course at Northeastern University (NU) in 2004. Informal feedback was obtained on its effectiveness as a supplemental teaching and classroom engagement method; the students' responses were encouraging and enlightening. Following collaboration on the details, procedures, and protocol, the OME was adopted in a first-year Introduction to Engineering Design course at The Pennsylvania State University (Penn State, PSU), during Spring 2005, where more formal data was collected. The student feedback from Penn State was both positive and informative. Penn State outcomes show that 93% of the students agreed that they felt more aware of engineering issues because of OME and over 82% found OME to be useful and interesting. On the basis of these survey results and a review of the more detailed written feedback from the students at Penn State, One-Minute Engineer was again implemented at NU in Fall 2005, with modifications to meet the needs of the course and to address some of the insightful requests from the Penn State students. The data and written feedback from the 2005 NU classes supported the Penn State findings that the OME provides significant increases in student awareness of engineering history, their surroundings, and current events. As the structure of the OME ensures it has minimal impact on class flow, the OME becomes a educational device to stimulate student awareness about engineering with very little sacrifice of class time.

Introduction

In addition to conveying engineering content, teaching first-year engineering students entails its own specific educational issues, some of which are: (1) attracting and maintaining the students' interest and attention at a quality level, (2) helping students generate a sense of relevance between class and engineering in the real world, (3) building a foundation to their technical

presentation skills, (4) motivating them to be interested and inspired by engineering as a career, (5) making them feel part of the new academic world they are entering, and (6) allowing them to contribute to and participate in their own education. The OME also has the potential to harnesses additional learning dimensions in the multiplicity of learning styles found among the students in our classrooms.[5]

This paper will outline how the One-Minute Engineer is set up and administered, explain the motivation for adopting the OME, detail the developed topic areas, present and discuss the feedback results from Penn State and NU, describe the benefits it has brought to the overall class experience, and provide advice, insights, considerations, and suggestions for its implementation and future development.

One-Minute Engineer Description

The OME, a short presentation of 1-3 minutes' duration at the beginning of class, is intended to provide first-year engineering students with a brief overview of various aspects of engineering that they *themselves* find interesting. The instructions provided to them were as follows:

GEU 110 Engineering Design
One-Minute Engineer

Fall 2005

Due: on selected date **Professor Jaeger**

Overview:

Each student will prepare a "One-Minute Engineer" (OME) piece for presentation to the class. You may work in pairs or individually on this. These presentations should be coordinated with Professor Jaeger before your proposed presentation day. The only write up required is an e-mail at least 24 hours prior to the class for feedback and final approval. OME presentations should be short (one minute ideally…three minutes maximum for pairs). You are encouraged to use physical and visual aids in your presentations, but if you elect to do so, you are still expected to be mindful of the time constraints imposed on the exercise.

Once you have established a potential topic, e-mail your professor 24 hours or more before class time for approval and an exchange of ideas for the OME presentation.

Your OME may deal with a topic in one of the following categories of topics, or you may suggest an additional engineering category for approval:

Product or Device Presentation: "The Demo Minute"

Demonstrate a device or product and the engineering principles used in its operation. Choose a design that interests you personally and comment on what you regard as its commendable features. The device need not be just for business purposes; its functionality may be through its entertainment value or simplifying everyday tasks. This is similar to the "I like…" element of your first assignment of the semester in which you described the features of a familiar item.

…

…

Newsworthy: Current Events or World News

Discuss current or world events that in some way relate to engineering. Without limiting your areas of interest, you may like to consider offering solutions to a societal problem that has developed or perhaps discuss how a disaster was prevented or could have been managed.

Vocabulary: Word of the Day

Introduce one or more relatively unfamiliar terms used in engineering that you think will ignite or stimulate the class' interest in engineering. The word itself may be new to you or it may be that its application creates the new association. Explain and demonstrate as appropriate.

Biography: Engineers with an Impact

Present an individual or group who has influenced the field of engineering, how their work made an impact and what, if any, device or system they invented. You may choose a person or team of interest to you –or someone who is in the *field* of engineering that interests you.

All students participating in this exercise will receive credit in their final grade where adequate work is presented. Details presented in OMEs may form the subject matter of quizzes or tests throughout the course.

As noted above, there are four general themes that we have established for the OME. A list of examples of each theme is seen below in Table 1. The first theme, as noted, is a product or device demonstration, known as *The Demo Minute*. In this segment, an interesting product or revolutionary device is presented and discussed. The students make demo selections from their own personal encounters or from research, or the professor may choose a device to connect to the day's class topic. The second theme allows the students to consider *Newsworthy* topics that relate to engineering. The students are encouraged to render brief opinions about the subject matter –typically trying to formulate a solution to a problem that has occurred in local, national, or world news.[1] Third, to foster vocabulary development, there is *Word of the Day,* in which a variety of engineering taxonomy can be formally introduced to the students throughout the semester. This is typically accompanied by examples of the selected word's use. Finally, there is a *Biography* section in which students may choose to research and present material about famous (or not-so-famous) engineers and their contributions. While not yet implemented, a possible fifth theme of the OME involves glimpses into *Engineering History* to learn about past challenges and successes, a critical component of engineering education.[1,4] As illustrated in Table 1 below, a student's choice of topic may overlap across more than one of these theme categories.

Objectives and Motivation for One-Minute Engineer

Given that the OME is presented at the beginning of class, students are motivated to arrive early and, therefore, this previously unutilized time can be used by students to learn something new, to begin to focus on engineering, and to become engaged in preparation for the day's work. Through OME they acquire a personal connection and involvement with the class and with one another because they are allowed and encouraged to choose their own topics and to conduct OME in self-selected pairs, if they so choose. Whether carried out in partners or otherwise solo, through the OME the class as a whole gets to learn what is interesting to each of the presenters.

Another motivator and benefit of OME is that it helps to develop the students' presentation skills and enhance their proficiency and comfort level when discussing engineering principles.[2,3] This "communication education" is facilitated in a manner that requires the students to focus on and be discerning about the most pertinent elements of their topic to accommodate the abbreviated time frame, while at the same time present something that is familiar or interesting to them. Given that the presentations are student-led, a further associated benefit is that class members acquire a more personal sense of presentation etiquette, as they are encouraged to attend, listen to, and respect their fellow students' presentations.

Table 1. Examples of Categories and Student-selected Topics for One-Minute Engineer Presentations.

Demo Minute	Newsworthy	Word of the Day	Biography
Flybar1200 pogo stick	Hurricane Katrina flooding*	levee*	Henry Ford
physics of guitar strings*	Jet Blue emergency landing	timbre*	Alexander Graham Bell
engineered athletic apparel*	Boston's Big Dig traffic routes	bionics*	George W. Ferris
bat-inspired security search*	ethics and privacy in security*	kinetoscope*	Thomas Edison*
Scuderi split cycle engine*	fuel economy in our society*	psychrometry	Nike: Rudy, Bowerman
innovative liquid body armor*	flexible protection in combat*	ornithopter*	Leonardo daVinci*
Velcro discovery and design	Taipei 101 tallest building	wing warping*	Wright Brothers*
Taylormade Quad R7 golf club	Millau (France) Viaduct	super heterodyne*	Edwin H. Armstrong*
survey of pump design*	X-Prize Innovation Foundation	peristaltic*	Kelly Johnson

***On same line indicates topic categories or terms that were combined in one OME session.**

OME Topic Areas

Initially, some students expressed concern about identifying a suitable topic for their OME contribution. To ease this apprehension they were also given the option to seek out ideas from the professor and/or to draw topics from class. However, as the term progressed, this perceived problem did not seem to eventuate because the students' confidence and comfort levels expanded once OMEs were underway. This apparent relief came about from the students reportedly looking around, discussing ideas with one another, reading literature, searching online for current events and engineering ideas, and observing the variety of approved topics presented as seen above in Table 1. As such, all students selected their own topics, many of which fortuitously aligned well with the assigned class material.

Assessments and Results

As outlined in Table 2, the OME assessment methods have developed in three progressive stages in conjunction with the evolution of the One-Minute Engineer activity. Initially, collecting feedback at NU was informal and open-ended, whereas the next time at Penn State a more structured survey was administered. In the final research stage at NU, all participants completed both a pre-course and post-course questionnaire. The statistically significant results were drawn from this last phase; however, the student feedback from the earlier stages was invaluable for OME development, improvement, assessment, evaluation, and administration.

Table 2. Type and Level of Assessment of OME over the Course of its Development.

Phase	Univ. & Term	Pre-Course	Post-Course	Likert 5-pt Scale	Open-Ended Questions
I	NU: F '03-04	~	√	~	√
II	PSU: S 2005	~	√	√	√
III	NU: F 2005	√	√	√	√

Phase I, NU: In an effort to develop and improve public speaking, the Demo Minute[2] was initiated at Northeastern University, which subsequently spawned what is now the OME. At the end of the course in which the Demo Minute was introduced, the engineering students were asked to respond to the following:

> *"Throughout this course, you were steadily exposed to more challenging and extensive presentation and speaking roles and opportunities. How did this affect your experience in Engineering Design? If you participated in the Demo Minute, please write your thoughts on that experience as well."*

Overwhelmingly positive responses inspired the continuation of the Demo Minute, which expanded to include additional categories of *Newsworthy* and *Word of the Day* and a more formal request for specific class participation in the next Engineering Design course at Northeastern University. During that time, the author from Penn State learned of this technique and collaborated with the author from NU to use OME in the first-year program at Penn State.

Phase II, Penn State: The OME was then conducted at Penn State in the Introduction to Engineering Design course, with the addition of the *Biography* category. Students were later asked to complete a Likert-type survey, rating their agreement with the following statements:

> *"Due to the activities of the One-Minute Engineer presentations, I feel more aware of engineering issues in my surroundings."* and *"The One-Minute Engineer presentations are useful and interesting."*

As seen in Figure 1 below, results from the post-course survey showed that that 93% of the students agreed or strongly agreed that they felt more aware of engineering issues because of OME and over 82% of students found OME to be useful and interesting.

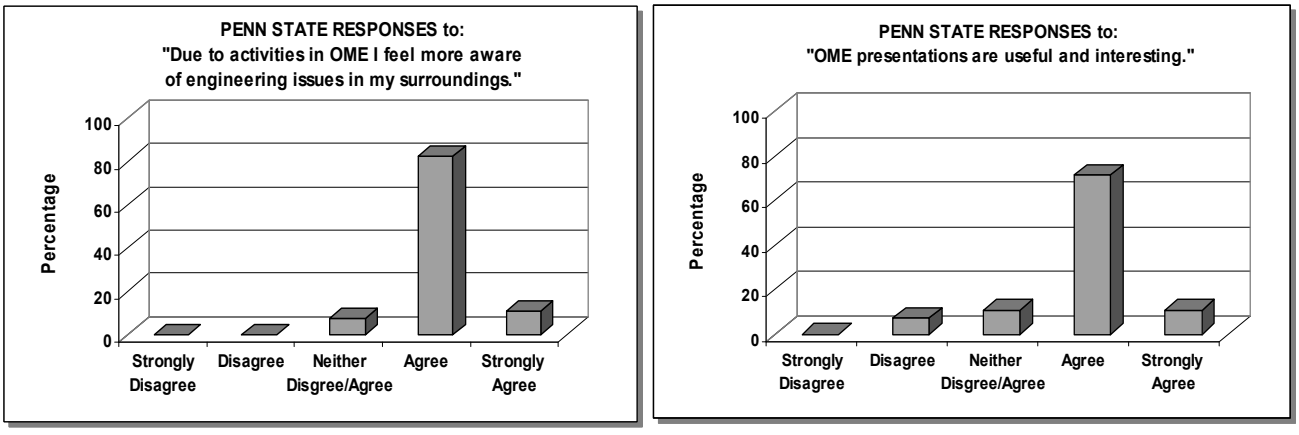

Figure 1. Post-course survey results following the use of OME in Introduction to Engineering Design at Penn State.

The Penn State students were also asked which OME form they chose to present –and why. They also responded to which form was their favorite to watch– and why. The results from these questions will be presented below with those from their NU counterparts, as the outcome profiles were similar. Finally, they were also asked to provide suggestions for ways to improve and for other forms of One-Minute Engineer presentations. While the majority of respondents stated "none" or left this section blank, a few comments that were noted from the Penn State students are interesting for their potential to aid in planning subsequent OME programs. Those comments were:

"Start at an earlier point in the semester."

"Enforce the time limit, so that only important info is discussed."

"Include movies" and "Discuss ways to improve existing items."

Phase III, NU: The next and most recent iteration occurred at Northeastern University early in the Fall 2005 semester. This version of OME saw its instructions further clarified with a more defined time limit set for the presentations. In this phase, the professor also demonstrated by providing an initial example One-Minute Engineer presentation to show the class how one might proceed in its application.

A pre-course survey was administered, with the following questions posed to the students for self-report on a 5-point Likert scale:

"I feel aware of engineering issues in history."

"I feel aware of engineering issues in my surroundings."

"I feel aware of the engineering issues in current world events."

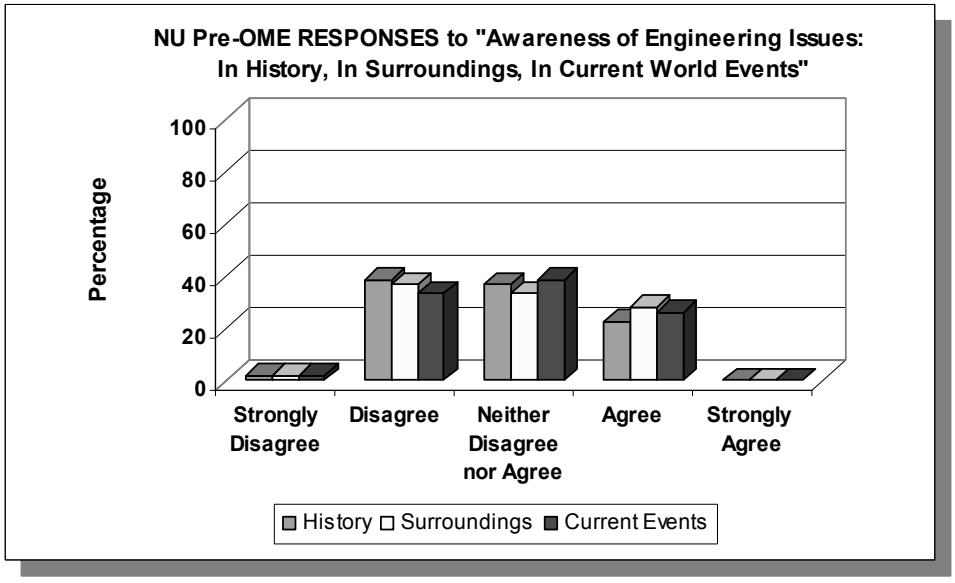

Figure 2. Results of survey administered at the beginning of the NU design course.

As shown in Figure 2 above, at the beginning of the semester, fewer than 26% of the students indicated that they were aware of engineering issues across the general areas of history, in their surroundings, and in current world events.

Following this survey being undertaken, students then received instructions and signed up for an OME presentation date. There was an average of two OMEs scheduled per week. At the end of the semester, follow-up OME assessment was administered, asking the students to rate their level of agreement with the following:

> *"Due to the activities of the One-Minute Engineer presentations, I feel aware of engineering issues in history."*
>
> *"Due to the activities of the One-Minute Engineer presentations, I feel aware of engineering issues in my surroundings.*
>
> *"Due to the activities of the One-Minute Engineer presentations, I feel aware of engineering issues in current world events."*

The compiled results of this questionnaire are presented in Figure 3:

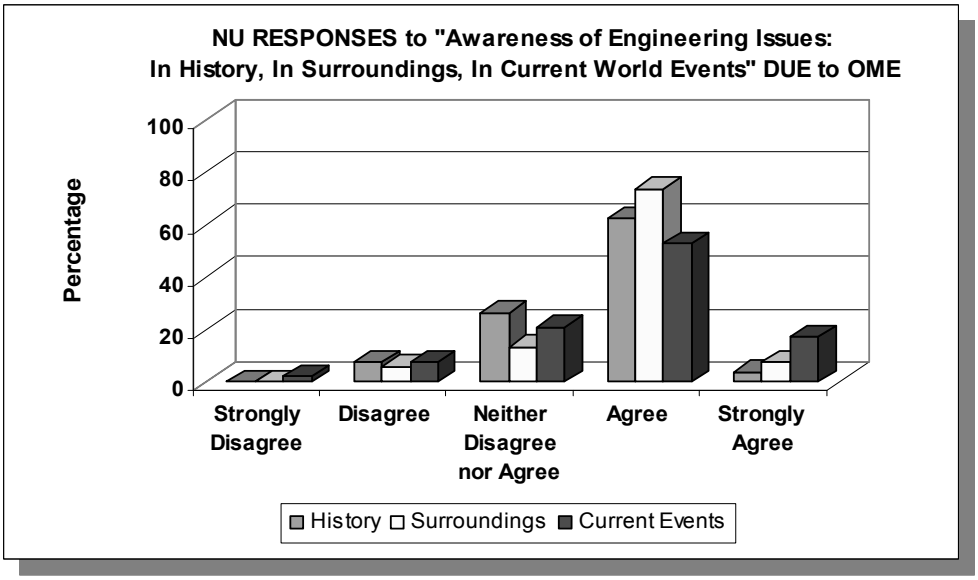

Figure 3. Results of survey administered at the end of all OME presentations at NU.

As seen in Figure 3, after the OME presentations had been completed, over 72% of the NU students agreed (or strongly agreed) that they were aware of engineering issues across the general areas of history, their surroundings and current world events due to the activities they participated in and from being exposed to the One-Minute Engineer. This is an appreciable shift from the responses given at the beginning of the semester, as seen in Figure 2 above.

This is not a surprising outcome and, without a doubt, a substantial portion of the progress in the students' awareness of engineering issues and events may also be attributed to the multiple elements of the design course and the engineering program in general and not just the OME alone. However, despite this consideration and allowance, we believe the results here and those

presented below suggest that this tool is a worthwhile supplement and adjunct to the other activities in successful engineering programs. As will be identified later, additional open-ended feedback from the students supports this conclusion as well.

Combined University Data on Interests

When students were queried on which OME they chose and why, the results were varied. The selection was often based on reported personal interest, expedience, or anticipated class interest, with no particular pattern or correlation being evident. More connected responses were found in the collective Penn State and NU responses to "Which was your favorite OME to watch and why?" Figure 4 presents these responses. Here a profile emerges that can be readily evaluated. *Product/Device* was most popular, followed by *Newsworthy* topics. The reasons provided, somewhat naturally, were that these were *"more interesting"* and *"easy to relate to."* As shown in Table 1 above, *Word of the Day* was most often presented as a supplementary element to another topic and accordingly did not earn many individual votes.

Although there were many *Biographies* presented, the students did not find them as engaging as the others. Neither unusual nor surprising, this opinion encourages us to generate motivation or seek more interesting presentation methods for this invaluable source of engineering education. Despite this lower rating, one item of note from the *Biography* presentations was the insight it provided into the OME's potential to provide a personal connection between the individual student and engineering. This is suggested by supplementary data collected whereby the majority of the biographies presented by female students were *about* women engineers. Given that the majority of famous engineers from the past have been male (men being more likely specifically follow the chosen field of engineering, whereas women usually engaged in engineering "incidentally" without being formally trained as engineers), this more detailed research to find such "rarer" or uncommon subjects may be indicative that the female students were searching for ways to connect on a more personal level to the engineering discipline.

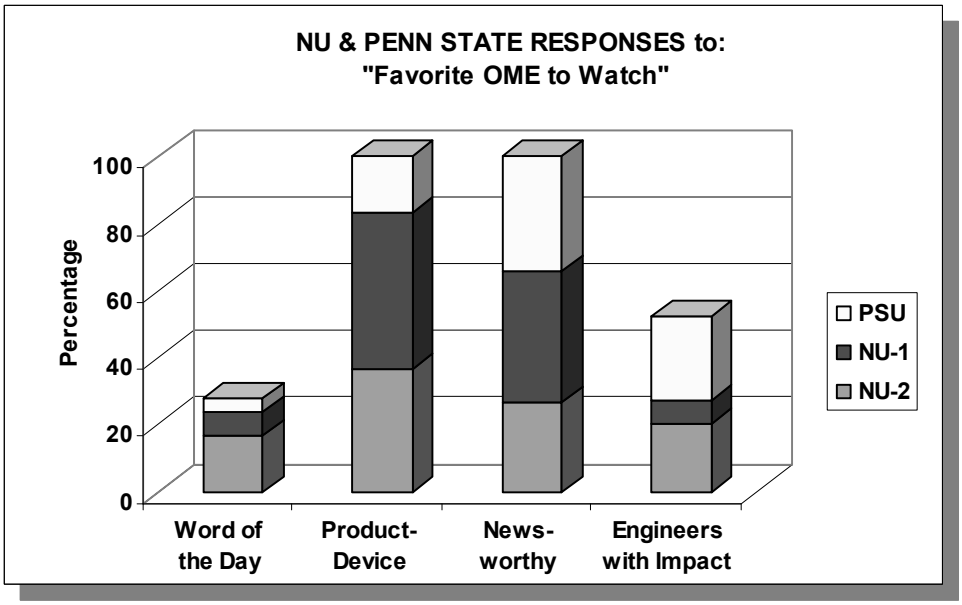

Figure 4. Results from questions about students' favorite One-Minute Engineer category.

Benefits and Objectives

Students. In the end-of-semester survey, the students were also asked the following question: *"Beyond the educational value of the OME content, what do* you *think were some of the objectives for having the One-Minute Engineer?"* This was included in order to have students consider the many objectives that could be met in the OME, without the professor explicitly outlining all the other goals to them. We felt that if the students could identify the goals and benefits of the OME for themselves, this would provide a more quantifiable and reliable guide as to their acceptance and/or appreciation of the concept. Many students identified *enhanced public speaking* as the primary objective followed by *remaining aware of their surroundings* as the next significant objective. The participants also named several other possible objectives that were more *de facto* advantages of the OME, these advantages being realized as presenters and as listeners. As set out in Figure 5 below, the students also identified a variety of supplementary and constructive objectives. We believe the range and diversity of these responses to support our contention that OME adds value to the students' educational experience on multiple levels. Finally, while not mentioned directly by the students themselves, on a further positive note, it was customary for listeners to applaud their classmates after each presentation, making it an immediate pleasant outcome for the presenters and a morale boost for the class as a whole.

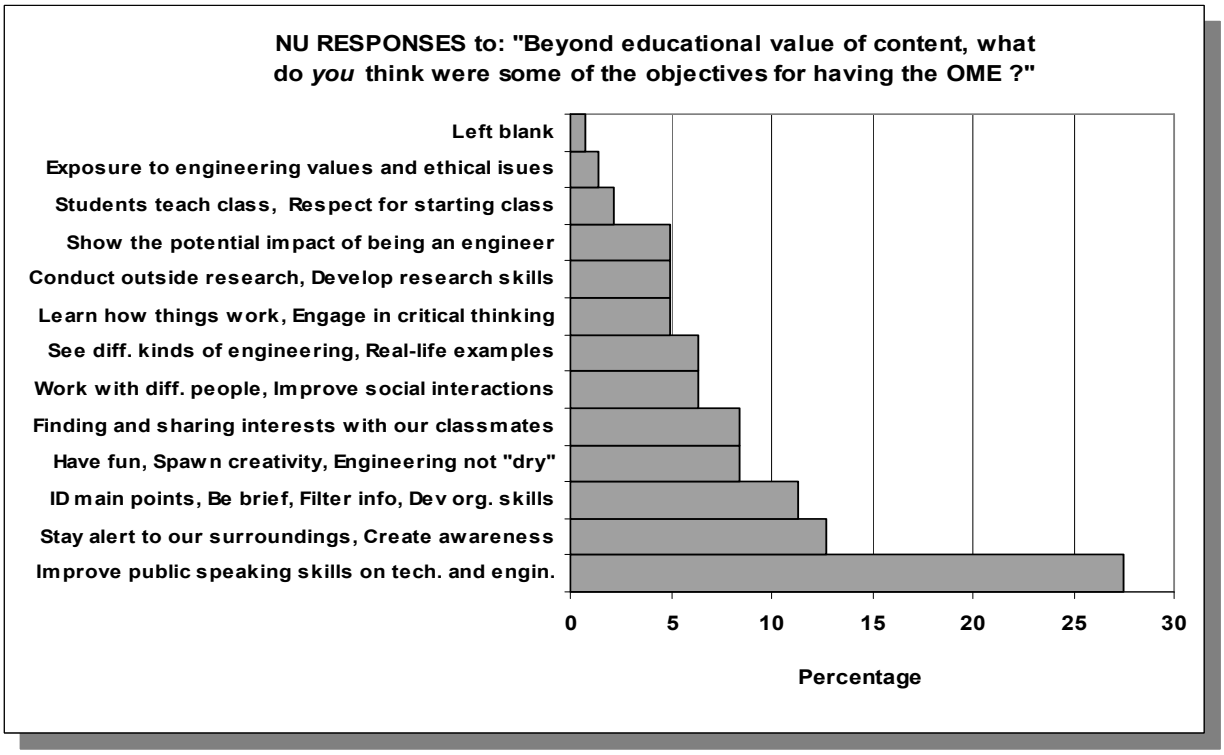

Figure 5. Responses to the survey question concerning the students' perceived objectives for the OME.

Professors. Tapping into the students' own areas of interests provided many benefits to us as educators, both in terms of the topics chosen and the communication with the students about their choices. In addition to enhancing the knowledge base of the students, we as professors were also exposed to new and interesting facts, concepts, designs, and devices to enhance our own knowledge reservoir for teaching and application. The requirement to make an OME proposal by sending an advance e-mail had two advantages. First, the professor was able to have informal e-mail exchanges with the students, which paved the communication paths in a

non-threatening and supportive way. Second, by being advised of the topics prior to the class we were also able to build in "teaching moments" by mapping the presentations to related engineering concepts from class.

Also, because the students were allowed to select their own topics, they were usually aligned closely with their interests and/or experiences. For example, students interested in pursuing aerospace engineering often chose topics related to that field (e.g., fighter planes, space missions). Thus the professor is able to ensure class content has at least some element of personal interest to each student without the necessity of intuitive guessing, which can be "hit or miss". It also allows the professor to get to know something of interest to each student, which can often be a great help in developing rapport. Additionally, other students in the class get to know something about their fellow classmates.

A further benefit for the professors was that the students were the ones to "kick off" class each day, with each person or team bringing their own energy and individual flair to the class atmosphere. As noted in the Objectives section, this also seemed to instill a greater sense of empathetic etiquette for being punctual and attentive for the sake of the presenter and the class at large. It also provided the students with a break from the monotony of professor-led classes, with a fresh and new beginning with each student presenter.

Recommendations:

Our progressive and iterative trial implementations of the OME have yielded the following ideas and recommendations from students and professors:

Students. When polled on ways to improve the OME, the majority of students from both Northeastern and Penn State left this section blank or stated that it was "good the way it is." However, certain suggestions recurred across class sections and were worthy of consideration. They included the following:

"More visuals" ... "I'd like to see more demos"

"Allow more time" ... "Make it the Two-Minute Engineer"

"Give more examples" ... "Show us more than one sample OME"

"Make it more interactive" ... "Encourage more class involvement"

Incorporating any of these suggestions will involve additional time outlay from the class, yet will likely enhance the quality and variety of the OMEs. Professors can make their own determination of which adjustments are appropriate according to their own course schedule, class dynamics, and timing.

Professors. As educators, a few additional advisory thoughts emerge from the data, feedback, and our reflection on the OME to further improve it as a design course asset. Some further modifications may involve the following: (1) Identify the main objectives clearly to the students at the beginning of the semester and emphasize supplemental *goals* for the OME, beyond the details of administration and assignment criteria, (2) Incorporate N^{th} generation designs, i.e. the evolution of a design through the iterative engineering process. Students have stated that they enjoy examining how a design changes over time, (3) Emphasize the value of the Biography category and consider ways to make it simultaneously engaging, informative, and relevant. (4) Consider *dis*allowing PowerPoint as the presentation format. While it may be

easy to create slides, and it could be more attractive and clearer as a visual aid, it can be time-consuming to set up and disassemble and it tends to compete with the intention of OME being informal and conversational. Since other presentations in the course do provide for the use of PowerPoint slide presentation format, this media can be reserved for those more suitable times.

Conclusions

From all indications, the One-Minute Engineer can be an effective tool to integrate into an introductory engineering design –or similar– course along with other methods of educational engagement. From the students' responses and the professors' observations, the OME has served to (1) supplement course content, (2) focus student interest and attention at a quality level, (3) contribute to the critical sense of relevance between academics and practice in engineering, (4) encourage and enable the practice of technical presentation skills, (5) inspire students to enjoy and become involved in engineering, (6) help students connect with their classmates, their professor, and their profession and express their interests at the same time, and (7) involve them in the education of themselves and their peers. In particular, we believe that by allowing our students to participate in their own learning, we are providing a supplemental mode of instruction that recognizes that classrooms contain all types of learning styles.[5]

Subsidiary benefits from the OME also arose from the interaction between the professor and the students, either by e-mail or in the discussion process. From a teaching standpoint, it was easy to get excited about a subject and to give credit to the students in a constructive way by knowing the topic in advance. We as professors were able to translate the content of the presentation into educational opportunities on many occasions, with the students themselves earning the credit and kudos for initiating the topic.

Since this dual-university collaboration and progressive development of the One-Minute Engineer has been undertaken, it has also proven to be beneficial for the participating faculty as both an educational aid and in terms of iterating and updating the OME features and its administration. Both authors found that potential improvements were more readily identifiable with feedback from the other instructor's experiences in addition to student responses. As such, we recommend this type of cross-institutional collaboration when developing new educational techniques. We hope others will take advantage of and enjoy this instructional tool and benefit from our efforts and experiences in creating, revising, and updating the One-Minute Engineer.

References

[1] Ferguson, E.U. (1993). How engineers lose touch. *American Heritage: Invention & Technology, 8, Winter 1993.*

[2] Jaeger, B.K. (2004). Incremental skill development: Public speaking and technical presentation in engineering design. *American Society for Engineering Education, New England Division*.

[3] Linsky, E. & Gergi G. (2004). Introducing Presentation Skills in Freshman Engineering. *Proceedings of ASEE Conference, 2004*.

[4] Petroski, H. (2005). Refractions - Keeping things in perspective: To become good future engineers, students must learn about the past. *ASEE Prism, 14:7, March 2005*.

[5] Rosati, P.A. (1996). Comparisons of Learning Preferences in an Engineering Program. *Proceedings of the 1996 Frontiers in Education Conference.*

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