AC 2009-211: ENGINEERING TOOLS SEMINAR: AN INNOVATIVE NEW COURSE TO PREPARE STUDENTS FOR THE RIGORS OF THE MECHANICAL ENGINEERING PROGRAM

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Engineering Tools Seminar: An Innovative New Course to Prepare Students for the Rigors of the Mechanical Engineering Program

Abstract

The Department of Engineering Mechanics at the United States Air Force Academy debuted Engineering Tools Seminar (ETS) in the spring of 2008. ETS is a hands-on course that exposes 3rd-year undergraduate students to manufacturing processes, but ETS is unique in its treatment of other essential "tools" such as computer software, technical communication and engineering ethics. ETS was created to bolster sagging enrollment, deliberately address neglected content, and fulfill student requests for an introductory manufacturing course. Students enrolled in the department's three curricula suggested that an equipment training course prior to their senior year would streamline the training process, eliminating ad-hoc training that occurs in other courses, their capstone courses, or on their own time. Such a deliberate process would produce well-trained, productive students that could hit the ground running in their capstone courses.

The manufacturing processes presented include wood working, machining, welding and composite lay-up. In addition, software tools are introduced and compared including Microsoft Excel®, MatLAB®, MathCAD®, and Inventor®. Key aspects of technical communication including reading, writing and presenting are introduced and practiced. Finally, a two-lesson seminar on engineering ethics completes the content. A small desk set is constructed by the students as a capstone project, and draws on many of the skills learned throughout the course. To evaluate the course, students were surveyed frequently and faculty feedback was collected. The results presented show that the welding, machining and Excel® content was very successful, while general organization and some content could be improved in future offerings.

Introduction

The United States Air Force Academy located near Colorado Springs, Colorado, hosts up to 4400 undergraduate students. Graduates of the academy receive a Bachelor of Science degree in one of 32 academic majors, are commissioned as Second Lieutenants in the US Air Force and have a compulsory five year service commitment. Thus, students are virtually guaranteed employment as long as they graduate and remain in good standing. Students select a major of their choosing; however, a demanding core curriculum consumes the majority of their allotted credit hours and addresses a broad scope of subjects that give all graduates an aptitude in the basic sciences, engineering, humanities and social sciences.

Although the core curriculum includes several engineering courses, the Department of Engineering Mechanics diligently recruits students to join one of our three programs; Engineering Mechanics, Mechanical Engineering, or Systems Engineering (Mechanical). Despite our recruiting efforts, enrollment in these majors has declined recently due in part to development of a Systems Engineering track, competition from other academic departments and lack of tangible incentives for choosing a more difficult major. Unlike many engineering programs at civilian institutions, our department cannot offer summer internship programs, a recruiting tool used to introduce students to real world engineering problems and aid in the job search process. Some cadets are given the opportunity to do some industry related engineering through the Cadet Summer Research Program (CSRP), but the vast majority spend their summers accomplishing generic Air Force internships at various bases around the world. Consequently, there has not previously been any set-in-stone opportunity for exposure to basic engineering tools normally afforded by engineering internships at civilian institutions.

The number of graduates from the Department of Engineering Mechanics has declined steadily over the past 5 years such that in 2008 the number of graduates was 48% of what it was in 2004. A number of initiatives have been designed to reverse this trend; among them is the creation of a new course, Engineering Tools Seminar (ETS). ETS has a number of goals, but a central goal is to emphasize the “fun” in engineering. Those of us in academia would not be here if we didn’t believe engineering was fun, but stressed-out students need to be reminded. One of the primary attractions to Mechanical Engineering that few subjects can equal is the hands-on perception equaling “fun”. Unfortunately, this silver bullet of recruiting is often buried under a mass of differential equations and bending moment diagrams, and as face time and resources become scarcer, opportunities for hands-on experiences are reduced further. Setting aside an entire course dedicated to these hands-on experiences is one way to ensure fun remains in engineering education.

Highlighting the “fun” in engineering is a strategic-level goal of ETS aimed at improving enrollment in the important majors that our department services. At the tactical level, the purpose of the course is to create a centralized opportunity to train students in skills that are necessary, but not often allowed for in other demanding courses. The current ad-hoc approach consists of “just-in-time” training of small groups of students, one tool at a time. The new paradigm will train all students en-masse on all of the equipment, saving time for the students as well as faculty and staff, and ensuring all students have an equal opportunity to learn these skills. Up until the initial offering of this course, these skills were learned via “on-the-job training”, in other courses, or “out-of-hide,” frequently incorrectly.

Students today have vastly superior computer skills than students 10 or 20 years ago did, but there may be a tradeoff between that and craftsmanship. As our culture’s reliance on information technology increases and high schools across the country reduce opportunities for industrial arts electives[1], there may be a noticeable shift in the skill sets of incoming undergraduate students. Evidence of such a shift was present during this research: during one of the first lessons, the authors discovered a handful of students who could not operate a pair of “Vice Grips”. This revelation prompted another experiment; a class-wide race to drive a nail into a block of wood and then remove it. The sometimes comical results revealed a wide range of skill level among the students. The authors concluded that one cannot underestimate the manufacturing skill of a new engineering student.

In addition to the above-mentioned motivations, the creation of ETS has been requested by the students for several years. In November of 2006 creation of the course began in earnest after cadets again beseeched the department to add content of this nature to the curriculum. The course’s genesis was delayed for years because of institutional limits on course loads of the students; adding such a course would necessitate removing something else from the curriculum. As a compromise, the course was offered for zero credits, and no outside work was required of the students. The result is an innovative new course that reminds students, faculty and staff how much fun engineering is.

Description of the Course

Undergraduate courses in manufacturing processes are somewhat common, and have been well documented in the literature[2-5]. Most of these courses focus exclusively on manufacturing skills and go into great detail on a variety of manufacturing processes while providing equipment training. Engineering tools seminar was initially envisioned as such a course; however, as the course was developed we recognized an opportunity to create a learning experience that addressed several shortcomings in engineering education beyond manufacturing skills[6-8]. Throughout the development process, experts in the department offered their opinions on not only the manufacturing content but also other noted areas where cadets were lacking instruction. As a result, in addition to manufacturing skills, computer problem solving, computer aided design, technical communication and ethical decision making skills were incorporated. While there are examples in the literature of manufacturing courses that include some of these topics[9,10], ETS is unique in the broad coverage of all of these oft-neglected skills.

Small class sizes of 6-8 students per class reduced the conflicts arising from limited shop equipment; the obvious disadvantage of this was the increased teaching burden on the faculty and lab technicians. The course was scheduled, on average, for 2.5 hours per week in a classroom embedded in the Applied Mechanics Laboratory. Such proximity enabled timely transition between classroom and lab topics. No work outside of class, or prior preparation was expected of the students, so that no course credit was offered; the course is, however, a requirement for the Mechanical Engineering, and Engineering Mechanics majors. Despite the restrictions on homework, students were expected to accomplish a final capstone project within the time available during regularly scheduled class.

Most lessons were taught by subject matter experts throughout the department, and not by the particular instructors assigned to each class. For example, the machine shop lessons were taught by one of the lab technicians, an expert machinist, while the Excel lessons were taught by a faculty member with a special affinity for it.

The course content was developed systematically by creating course objectives (table 1) from the program outcomes; individual lesson plans were then developed to meet the course objectives. This process highlighted some outcomes that could be addressed more deliberately in our engineering programs. Specifically engineering ethics, technical communication and computer problem solving were identified as subjects that, although ubiquitous in our program, are not often singled out as specific topics of study, or as essential skills to be honed. Therefore, we made it a top priority to elaborate on these important subjects in this course.

Table 1: Course Objectives

Upon completion of the course, students should…

- Know the various equipment options available for manufacturing.
- Demonstrate safe operation of the most commonly used manufacturing tools and use the appropriate techniques to create an original product.
- Demonstrate proper lab etiquette to include use of appropriate safety procedures and respect for equipment and other users.
- Know the advantages and disadvantages of some of the software options available for solving engineering problems.
- Demonstrate the ability to solve simple engineering problems using available computer software.
- Demonstrate the ability to clearly communicate the results of their engineering work, orally and in writing.
- Understand the ethical challenges facing engineering professionals and Air Force officers.

Lesson plans were proposed by subject matter experts within the department, and lessons were apportioned appropriately. Lessons included classroom and laboratory instruction as well as designated time for students to practice the skills presented. In addition, optional lessons were scheduled throughout the semester to enable students to explore subjects in greater depth (Table 2). To the extent possible, subjects were presented deliberately with a combination of breadth and depth. For example, the woodshop content included a brief description and demonstration of over 20 common woodworking tools, but only the table saw, drill press, router and orbital sander were given an in-depth treatment that included hands-on practice for the students. These particular tools were elaborated on because of their relevance to the final project.

Table 2: Lesson Content

Topic	Lessons	Optional Lessons
Introduction & Lab Safety	1	
Wood working	3	1
Metal Working	4	2
Welding & Torch Cutting	3	2
Automotive Test Facility Tour	1	
Composites Materials	3	
Final Project Time	1	2
Computer Problem Solving	5	
Computer Aided Design	3	1
Technical Communication	2	
Engineering Ethics	2	
Guest Speaker and Field Trip	2	
Totals	30	8

At the suggestion of the Department Head the course developers resisted the urge to fill all available lessons; this flexibility allowed cadets to further develop skills in particular areas of interest. The content of most lessons is self-explanatory, although some topics warrant detailed explanation.

The “Computer Problem Solving” lessons consisted of two parts; an in-depth tutorial in Microsoft Excel® (to include programming in Visual Basic for Applications (VBA)), and a brief “compare & contrast” of the capabilities of MatLAB® and MathCAD®. All students in our programs have Excel on their issued computers, and it is commonly used in many courses. Furthermore, most students are ignorant of its many features and capabilities. These two factors made it the highest priority for a special tutorial. Use of MatLAB® and MathCAD® within the department is limited to a few elective courses. Although these tools may not be required, they may nevertheless be very useful in other courses. Therefore, a brief introduction was warranted. A “mini-capstone” project was incorporated into this block which employed beam bending analysis (a topic with which all cadets were familiar). Figure 1 depicts the features of the spreadsheet including VBA functions, sub-routines, scroll bars and buttons which allowed real-time interaction to change the location and magnitude of the point load.

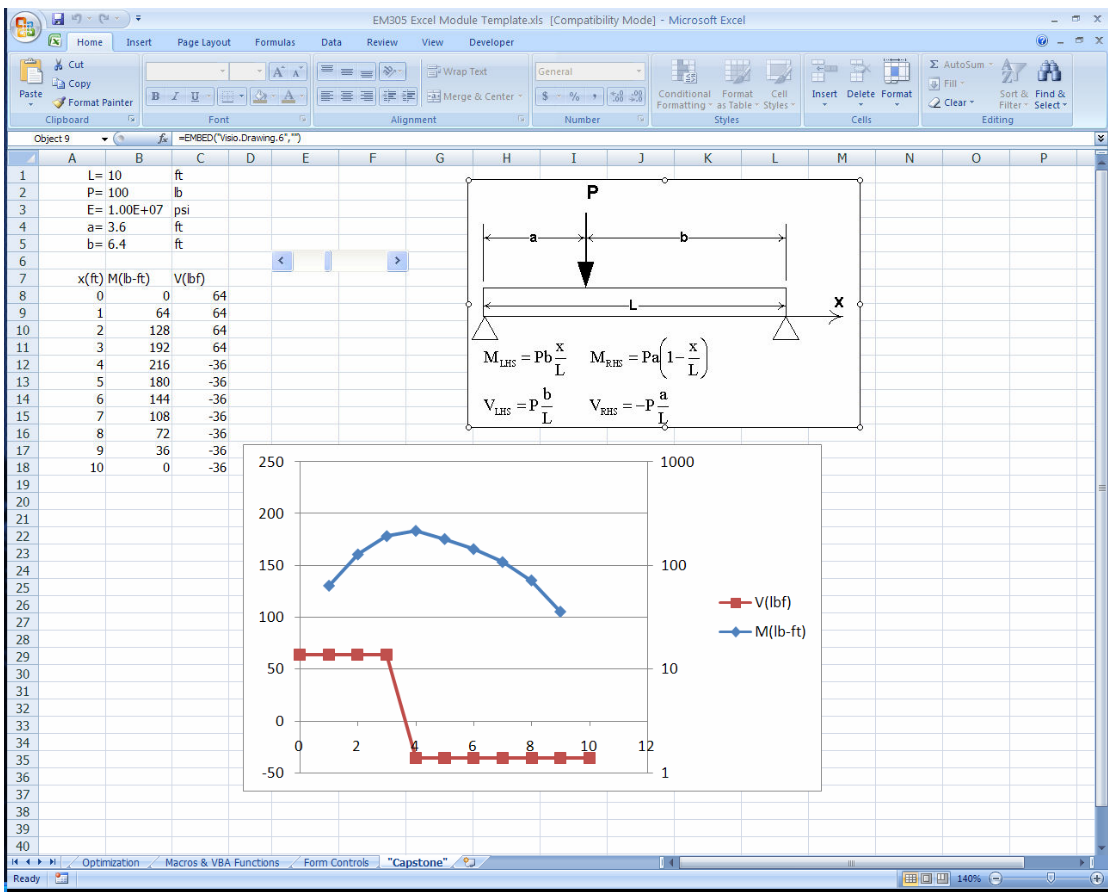

Figure 1: Computer Problem Solving “Mini-Capstone”

The "Computer Aided Design" lessons consisted of a 3-hour tutorial in Autodesk Inventor®, which was the primary CAD software available to our students. The tutorial consisted of a step-by-step guide through the process of drawing the components of the final project, and assembling them. This process was of adequate complexity to cover most of the important features of the software.

The "Technical Communication" content was broken into the three sub-categories of presentation, reading and writing. Lesson plans were created in collaboration with our Department of English and Fine Arts and included a number of exercises that instructors could assign to students to practice the skills. For example, one such exercise consisted of a verbose memo that students were instructed to revise by identifying and highlighting the key points while eliminating unnecessary language.

The topic of ethics in engineering has previously been discussed in our statics and strength of materials course. This treatment is unfortunately brief, and in the event that an instructor falls behind during a semester, it is easily squeezed out by other content that is more likely to appear on the exam. By including "Engineering Ethics" in our engineering tools seminar, students have the opportunity to consider important issues without the distractions present in other courses such as grades and other technical content. The topic was approached by viewing the well-known fictional case-study, *Incident at Morales*[11], with intermittent pauses for classroom discussion.

The final capstone project for the course was envisioned as an object that would enable the students to practice the skills they had learned, be an attractive keepsake that would tacitly advertise for the course and our department, and be fun to build. Therefore, the project's design requirements were:

- Incorporate as many tools/skills as possible
- Appropriate manufacturing difficulty
- Manufacturable in less than 10 hours by novice craftsmen
- Attractive
- Useful
- Low cost

A number of concepts were considered for the final project, but ultimately, the desk set shown in figure 2 was chosen based on the criteria listed above. The desk set had five main components to be manufactured, and a number of opportunities for students to exercise creativity in personalizing their design. The wood base is the main component, crafted from oak. Students cut a piece to size on the table saw, finished the edges and created pockets with the table router and hand-held router, drilled the pen-holder hole on the drill press and did finishing with an orbital sander, and by hand. The two brass plates were rough cut on the band saw, precisely shaped to size on the milling machine, and then polished. Finally, the plates were personalized with students' names on the CNC machining center. The brass penholder was turned by students on the lathe. The final element consists of two pieces of carbon that lay in the two pockets, adding a decorative touch, and "wow" factor. Students were given a basic layout for the desk set, but were encouraged to exercise their creativity to make reasonable modifications to the design. The final cost of materials for the desk set was $12.40 per unit.

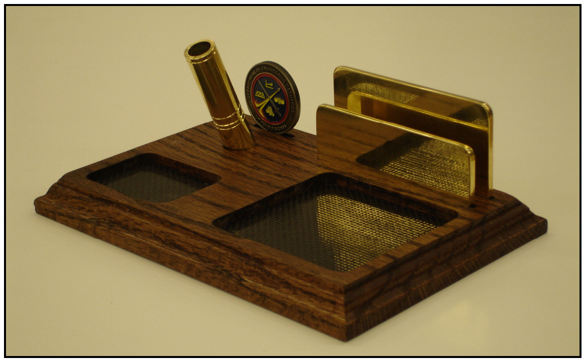

Figure 2. The final project is a "desk set" that displays business cards, a pen, sticky notes, paper clips and a commemorative coin.

Assessment of the Course

Assessment of Engineering Tools Seminar was accomplished by faculty and cadets alike. Faculty members have shared anecdotes with the authors highlighting cadets using knowledge gained from this seminar immediately in other courses. During a block on heat transfer in our Thermal Fluid Sciences curriculum all of the project groups utilized lessons learned in Microsoft Excel® and VBA when performing laboratory data analysis.

Cadet assessment was accomplished through in-class surveys at the end of each major block of material. Students were asked to evaluate strengths and weaknesses of material presented and to assess their comfort level with operation of the discussed tools. Space was given under each question for cadets to provide comments explaining their answers. Table 3 shows a sample survey from the Woodshop sequence.

Table 3: Sample Survey

EM 305Z – Engineering Tools Seminar Mid Course Critique – **Woodshop** (Lessons 1 – 5) Note: The purpose of this feedback form is to assess the effectiveness of the lesson pertaining to the woodshop. Please direct your evaluation specifically at those lessons. If you have comments about other lessons, please include those on the back of this page. 5 = Strongly Agree 4 = Agree 3 = Neutral 2 = Disagree 1 = Strongly Disagree 1) The lesson content covered an adequate **breadth** of material: 5 4 3 2 1 N/A 2) The lesson content covered an adequate **depth** of material: 5 4 3 2 1 N/A 3) The lesson content adequately prepared me to complete the project: 5 4 3 2 1 N/A 4) I had sufficient time in class to complete the project: 5 4 3 2 1 N/A 5) I can safely operate the table saw: 5 4 3 2 1 N/A 6) I can safely operate a router: 5 4 3 2 1 N/A 7) I can safely operate the drill press: 5 4 3 2 1 N/A 8) I would feel comfortable working on a personal project in the woodshop: 5 4 3 2 1 N/A Additional Comments:

The results of similar surveys for each block are summarized in figure 3.

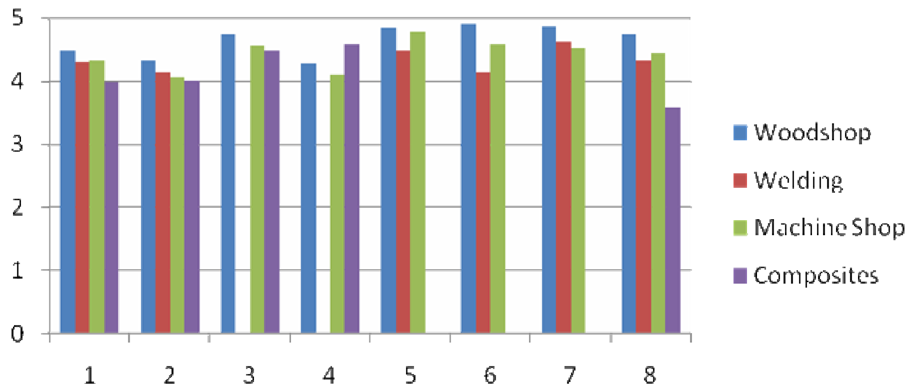

Figure 3. Results of student surveys. Questions were similar for the various topics and are summarized:

1 & 2: Breadth and depth of material covered, respectively.
3: Did the instruction adequately prepare you to complete the project?
4: Was enough time allotted to complete that portion of the project?
5 - 7: Students rated their level of comfort with the operation of specific tools.
8: Did the content adequately prepare you to complete a project on your own?

The woodshop lessons were the most highly rated. This is probably due to the fact that most students had some exposure to wood tools in the past and were not intimidated by these tools, as they tended to be in other areas. Students gave many comments on the woodshop lessons. For the most part they were satisfied with the amount and content of instruction but found the time allotted to practice and construct their projects lacking. Cadets felt they spent a significant amount of time waiting for tools. Most faculty members disagree with the student's assessment that time was insufficient, pointing out that very few students used the optional lessons, and thus must not have been too rushed. The difficulty of the wood portion of the project was judged to be moderate with several cadets commenting they wished the project was more difficult.

The next major block of instruction was welding. Welding was not a requirement for their project, but cadets were given the opportunity to weld using MIG and TIG welders and shown how to use the plasma cutter. This block was rated highly due to the amount of practice time. The lab tech demonstrated each machine and then allowed each cadet to practice. Time was not an issue and comments provided by the cadets showed they appreciated the amount of hands-on operation time. Most cadets felt they developed an appreciation for the art of welding and looked forward to doing it again at some point. Many students commented they would need additional guidance on what machine settings to apply if they were starting a welding job from scratch. The variances in class size had the greatest impact during the welding lessons because only one welder and lab tech were available. As expected, the class with 9 students had significantly less practice time than the class with 6 students. An alternative organizational structure could alleviate this problem.

The machine shop lessons were also highly regarded. The cadets appreciated the instruction but felt the parts they manufactured did not adequately test their abilities. This was a direct result of the design of the desk set project, which did not require complex machining. The two brass plates were easily cut and milled and the lathe work required for the pen holders was straightforward. Such a simple design was intentionally selected by the faculty because of skepticism in the student's collective ability to complete a more complex project within the allotted time, on the machines available. A more complex design may be attempted in the future. Several cadets commented they would be interested in an advanced demonstration of the mill's capability. Several cadets failed to appreciate the intricacies associated with metal work, such as the choice of cutting tool speed. Since the project required only a simple cut, no setting adjustments were required.

While the composites lab was well received, many students felt it was too regimented. The lab tech walked them through a demonstration of composite lay-up and then cadets, in teams of two, constructed their own under close scrutiny. It was difficult to fit the instruction and lay-up in the allotted three lessons. The cadets felt it was rushed and involved too much "hand holding."

The next several blocks consisted of classroom instruction highlighting computer problem solving, an introduction to computer aided design software and a discussion on technical communication and ethics in engineering. The results of the surveys given on these topics are shown below in Figure 4.

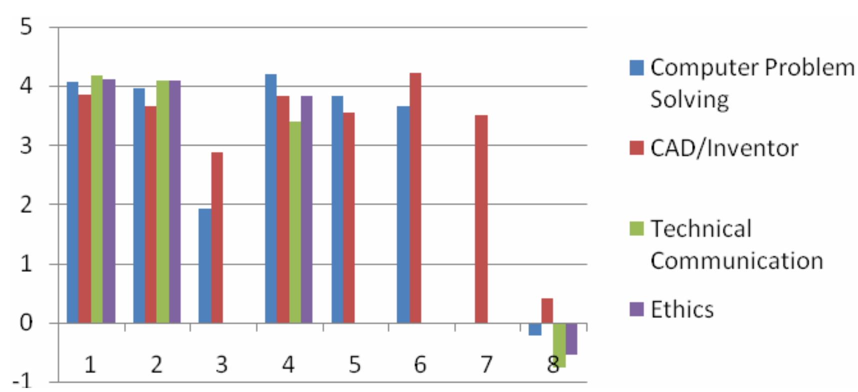

Figure 4. Results of student surveys. Questions were similar for the various topics and are summarized:

1 & 2: Adequate breadth and depth of lesson content, respectively.
3: Were optional lessons used to learn more about the software?
4 - 7: Lesson specific questions assessing comfort with material.
8: Should more or fewer lessons be allotted for this subject?

Space was left for cadets to provide additional comments on each question.

During the five lessons on computer problem solving, cadets were exposed to some of the advanced features of Microsoft Excel ®and given a MathCAD® and MatLAB® demonstration. Three days were spent exploring Excel and the result was a spreadsheet that plotted shear force and bending moment diagrams. The same plot was generated using MathCAD® and MatLAB® and so students discovered pros and cons of each package. As these lessons followed closely on the heels of shop time, faculty members expected a revolt, but were pleasantly surprised by cadet reaction. While the cadets didn't enjoy these lessons as much as being in the shop they realized the utility and value. Cadets commented they would have preferred to spend more time learning MatLAB® as most already had a handle on Excel®. Many students noted that these topics would be more useful to them if they were presented earlier in the semester, so they could be used in courses they were taking concurrently.

Comments on the CAD lessons were similar. Most complained about the small number of lessons and felt that while the overview was good, the lack of practice time offset the content covered. The power of Inventor® was displayed but additional time to explore the intricacies of the program was needed. An interesting contrast to the Excel® lessons revealed a valuable teaching tool. For the Excel® lessons, the instructors provided a "memory jogger" handout (Figure 5) that summarized the required keystrokes to perform the actions presented, while no such memory jogger was used during the Inventor® lessons. As a result, the difference between the lessons was vast. During the Excel® lessons, if a student fell behind, he/she could easily catch up by following the memory jogger, while during the Inventor® lessons once a student fell behind, they were lost for the remainder of the lesson. By the end of the lesson, most students had given up, and were merely watching the instructor, rather than using the software themselves.

<u>Matrix Operations</u>
Addition/Subtraction
- Enter the matrices you want to add – make sure they are compatible.
  - Highlight the cells where you would like the result to be displayed then type the equation (i.e. =D6:F8+D10:F12)
    - Don't hit enter, hit "CTRL+Shift+Enter"

Inverse – calculate the inverse of a matrix
- Enter the matrix with one number per cell, highlight the cells where you would like the inverse matrix to be displayed. If you entered a 3x3 matrix, you must highlight a 3x3 group of cells for the output.
  - Click the "*fx*" button in the function bar, search for "MINVERSE" and select it
    - In the "Array" box, highlight the matrix you want to invert.
      - Don't hit "OK", instead hit "ctrl+shift+enter"

Multiplication – multiply two matrices (remember your rules for matrix multiplication: columns of A = Rows of B, etc.)
- Enter two matrices that are compatible, select the cells where the result will be displayed, again the cells you select must be the same size as the result
  - Click the "*fx*" button, search for and select "MMULT"
    - Enter "Array1" and "Array2"
      - Don't hit "OK", instead hit "ctrl+shift+enter"

<u>Optimization</u>
Goal Seek – Solve a transcendental function iteratively
- Enter the function to solve with the variable to solve for (i.e. "X" and X^2 – 2x + 3). Create an initial "guess" by entering the value of the variable (X).
- Select the "Data" tab, in the "Data Tools" menu, select "What-If Analysis", then "Goal Seek"
  - Enter the cell that contains result of the function in the "Set Cell:" box
    - Enter the desired value of the function (usually zero) in the "To Value:" box
      - Enter the cell that contains the variable (X) in the "By changing cell:" box

Figure 5. Excerpt from the Excel® memory jogger issued to students.

The final block, technical communication and engineering ethics, generated little response on the surveys. Most cadets felt less time could have been spent in these areas since ethics/human responsibility is well communicated to the future Air Force officers in other academic courses and military training.

At the conclusion of the semester cadets were given a final survey in which they evaluated the usefulness of each block of material, indicated whether they would add or subtract lessons from each block, and provided overall comments. The highly rated blocks included machine shop, welding and composites. Survey results indicate, not surprisingly, that students would prefer additional time to work on the project while spending less time in the classroom.

Lessons Learned and Recommendations for Future Work

This class was a rousing success but left room for improvement. Cadets loved the hands-on nature and the lack of grades capped the experience. There were several positive outcomes. One benefit was cadets met and talked with the lab technicians with whom they will be interacting during their senior year capstone course. This introduction should "grease-the-skids" and help develop working relationships. We found in the past students were hesitant to approach the lab techs with questions and this introduction should alleviate that timidity. Cadets spend significant amounts of time learning how to use the equipment during the beginning of the capstone experience. Hopefully, this introduction to the tools will reduce that spin-up time.

There were several times the students were log jammed at certain pieces of tooling. This logjam could potentially be eliminated by purchasing additional equipment (not feasible financially) or better sequencing students such that only one or two worked on a particular piece of equipment at a time.

There are both positives and negatives associated with the project. The wood base was a big hit, and involved the use of several tools while provided the opportunity for lots of practice on the tools before constructing the final product. The metal portion of the project was not very involved, and cadets complained about this. A project which included more advanced machining could be developed.

The lessons on various software packages were more successful when the cadets were supplied a quick reference guide. The instructor-generated guide walked the cadets through every step of programming required and included all details such as which menu options or buttons to click on. If they fell behind the instructor, who was demonstrating each of the steps, it was easy for them to catch up by referring to the guide. A reference guide was not provided for the Inventor lessons and as a result, if students fell behind, it was almost impossible to catch up and many eventually gave up. This will be rectified in future offerings.

Placement of lessons within the syllabus is also up for debate. For the initial offering, all of the shop lessons were front-loaded. However, when this class is offered next, the plan is to move the CAD and computer problem solving lessons to the front. The benefits are twofold. First, the cadets will draw their project in CAD and refer to these drawings later on when constructing. This will help to enforce the design-build process. Also, placing the computer problem solving block at the beginning of the class will allow the cadets to implement lessons learned in other class homework and projects as the semester progresses. Several cadets commented on the utility of the lessons and their immediate value for other courses. After the initial pilot offering this past spring, future offerings are anticipated for the fall term of the junior year to prepare cadets earlier.

This course imposed a serious time drain on our lab technicians. We decided that we wanted the introduction to each manufacturing process or tool to be accomplished by an expert. As a result the lab technicians presented the material for the woodshop, welding, machine shop and composites demonstrations. While the individual faculty members assigned to the course could have presented the material, most have only limited manufacturing experience and even that tends to be in one area. We wanted the cadets to learn from the experts. Though the time commitment of the lab techs is significant, hopefully this investment in well-trained students will result in an overall time savings in the long term.

It is not uncommon for schools to have a sign on the door to their machine shops reading, "No students permitted in lab unless lab techs are present." While that policy is understandable, our department operates under a different mantra: cadets are allowed in the lab even when faculty and staff are not present. Safety concerns are alleviated through use of a "buddy" system and 24 hour video surveillance. A benefit of this course is the training provided to the cadets allowing them to use more tools while in the lab even when lacking expert presence. All of our majors are issued a lab badge listing every tool in the shop. As students are trained on the equipment the slot next to that particular tool is filled in. Cadets and their buddy are only allowed to operate those tools on which both are trained. Cadets have appreciated the flexibility this "open door" policy allows when working on capstone and course projects well into the evening.

Having completed one semester and launching the second offering the faculty are excited to see realization of the course goals. While it is too early to see what impact this course will have on enrollment in the Mechanical Engineering major it is great to hear cadets sharing positive anecdotes regarding this class. Cadets from other majors have attempted to take this course leading us to believe that our students are talking about and hopefully recruiting potential engineering majors. As our capstone programs get into full swing we will be carefully observing the skill sets cadets are displaying to see what impact this course had on them.

Acknowledgments

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