Introduction

Teaching is not my regular job. Or at least it wasn’t. One of the wonderful opportunities in the Army is the chance to get selected as a rotating faculty member at The United States Military Academy (USMA) at West Point. When I was accepted, I was overjoyed. With the appointment as an instructor at USMA came a fully funded masters degree and the opportunity to present structural steel design to undergraduate cadets. But somewhere between graduate school and West Point, I realized I would not be presenting, rather I would be teaching. I had plenty of experience speaking in front of groups, giving presentations, and briefing military superiors, but now I would be teaching. Teaching is something different. Teaching sparks learning where a brief or presentation imparts information, and this is a fundamental difference. While I knew I could present, I became anxious because I was not confident I could teach.

Upon looking back over my first semester, I realize there were two things that not only prepared me to teach but also improved my teaching skills more quickly than I thought possible. First, I got some formal teacher training at USMA. Second, I applied this formal training and my previous Army experience to improve my teaching throughout my first semester. Specifically, I focused on planning and preparing each class, turning each class into a performance, and using administrative tasks as teaching opportunities. By using these improvement strategies, I have achieved good results for my first semester and have formed a solid base to continue my improvement for the rest of my assignment as an instructor. My goal is to provide you with my perspective on how to form a plan to improve your teaching no matter how new you are to the profession.

Formal Education Training

As I made my cross-country road trip from Palo Alto, California to West Point, New York, my improvement as an instructor was already being planned for me. With a large rotating faculty (most USMA instructors serve only three years as an instructor and then return to a more traditional Army officer role), the senior leaders at the Department of Civil and Mechanical Engineering at USMA understand that their new instructors need some formal training before they begin to teach. I, along with all new instructors at West Point, was required to participate in the department’s annual Instructor Summer Workshop (ISW). This formal teaching education was invaluable in transforming me from an Army orator to a West Point instructor. ISW gave me two opportunities: first, it exposed me to teaching theories and techniques I had not yet considered, and second, it gave me the opportunity to practice teaching in front of experienced instructors who provided me with valuable feedback.
During ISW, I was exposed to a vast curriculum of teaching principles including Felder’s learning styles, Bloom’s Taxonomy, classroom assessment techniques, effective questioning, and active learning. As a new instructor, I was not expected to master all the valuable information that went racing past me. But this formal training left me with a binder of information that I used as reference throughout my first semester. Furthermore, I chose to complete some additional readings given in the course so I could better understand how to teach. ISW helped me initially develop my personal teaching style by showing me what teaching methods and practices were already available and where to go to get more information on them.

ISW also required me initially practice my newly developed teaching style. During ISW I taught five classes to senior instructors and my peers. There is no substitute for this type of practice and feedback. At the end of ISW, I had 28 formal assessments that I keep as a part of my record of teaching those particular classes (See Enclosure 1 for an example). The assessments covered both course content and my presentation of the content. Before I planned, prepared and performed these specific class sessions during the semester, I referred back to each evaluation to refresh my memory on what presentation methods were effective and which were not.

What if your department or school does not offer such a workshop for teaching theory and practice? Here are my recommendations. First take advantage of any teaching center your institution may have. From brown bag lunch seminars, formal classes, mentoring programs and libraries of data, I have found the university teaching centers an invaluable source of information and education training. Many offer newsletters and websites that are full of information. For that matter you may even be able to use other institutions’ websites to get teaching information you need and ideas to try in class.

Another source of teaching information and practice are teaching seminars that are offered by professional societies. I had the pleasure of working with the American Society of Civil Engineers (ASCE) to help run the Excellence in Civil Engineering Education (EXCEED) workshop. This was a one-week workshop where much of the theory covered in ISW was presented, and the participants were permitted to give classes of their choosing to receive feedback. So check with your professional societies (like ASEE and ASCE) and see what they offer.

What about feedback from other instructors? How do you convince another instructor to give you the honest feedback that you need? How can they make time in their busy schedules for you? My experience has been that if you invite other instructors, they will come. And if you are willing to accept honest and professional constructive criticism, then they will give it. However, to maximize your accessibility to assessors, try the following techniques. Videotape your class and then allow assessors to watch the tape at a convenient time and provide you feedback. Schedule a rehearsal of your class when one or more evaluators are available to get multiple feedbacks. Additionally, ask assessors to fill out a standard assessment form to give them an idea of the type of feedback you would like. If your department or institution does not have a standard form, see Enclosure 1 for the form we use in our department. And finally, advertise your normal classes and ask evaluators to attend and provide feedback to improve your course content and instructional style.
Learning to teach and practicing my techniques were important, but they were only the first part of my transformation from Army engineer and graduate student to instructor. As good and as specific as the training was, I still had thirty classes I had to be prepared to teach. Thankfully, my course director already set the course content and schedule; therefore, I was allowed to focus on improving my classroom techniques during each session I taught. I used my department’s teaching model to help me deliberately plan, prepare and perform each class. Since I only had six semesters to teach, I felt that I better start the process of improving with every class. See figure 1 for my interpretation of the USMA teaching model as applied to my teaching improvement strategy. This model, and the role it’s played in improving my techniques, is the focus of the rest of this paper.

![Figure 1. Teaching Improvement Model](image)

Planning a Class

With my initial formal training completed, I was ready to start planning and preparing for my classes. This is where my professional Army experience was helpful. In the Army, instead of combining the planning and preparation tasks, we make a distinction between these phases and perform them separately. See the definitions of each stage in figure 2. This distinction allows Army leaders to first conceptually envision what an operation will look like, and then physically predict what it will look like before its actual execution. Since this philosophy works well in battlefield conditions, I figured its application in the academic realm would also be successful. So I began to plan my classes. I found two particularly useful planning tools already being used in my department. They were the lesson objective and board notes.

“Planning is the means by which the commander envisions a desired outcome, lays out effective ways of achieving it . . .”³

-US Army Field Manual 3-0

“Preparation consists of activities . . . including, but not limited to, the following: plan refinement, rehearsals, reconnaissance, coordination, inspections, and movement.”³

-US Army Field Manual 3-0

Figure 2. US Army Definitions of “Planning” and “Preparation”
Using Lesson Objectives

Lesson objectives are not a new topic within academia, and are often provided to students without ever again referring to them. However, I found lesson objectives are not just for students. The clearly defined lesson objectives developed for my course eased my class planning. For example, I knew I needed to teach a tension member analysis class. But what helped me understand what to teach were the following lesson objectives:

1. Define tension members and connecting elements.
2. Describe the limit state of tension yielding in tension members.
3. Describe the limit state of tension fracture in tension members.
4. Describe the shear lag effect, and explain how shear lag is accounted for in the analysis of tension members.

By clearly understanding and using these objectives, my planning was focused and well organized. Furthermore, the lesson objectives gave both my students and me a common point of departure for the class. I knew specifically what I was planning to teach and the students knew the topics for which they were accountable, whether or not those topics were covered in the lecture.

"I think the class lessons are great. Checking out the lesson objectives and then paying attention in class gets me through pretty well."

-Cadet Feedback, CE404

Paying attention to the lesson objectives also aided in my arrangement of board notes that had already been developed for the course (see Enclosure 2 for sample board notes).

Using Board Notes

Board notes are a specific agenda for the scheduled class that include illustrative examples and related references. Board notes were the lynchpin of my pre-class planning. They helped me organize the lesson and served as a quality control tool to ensure that my plan covered all the lesson material needed. The board notes also served as an initial indicator for the length of the class. When I began my preparation, I knew how to pace my presentation based on the length and number of boards included in my board notes (our department classrooms have standard sized chalk boards that correspond to the size of our board notes). Whether you prefer overhead transparencies, computer generated slides, or some other presentation medium, using some form of lecture or board notes are a must for presenting a lecture. Always try to correlate the general time of the lecture to the quantity of the presentation medium you will be using. This will give you a leg up when you start your preparation.

Board notes also provide continuity in the planning function by providing a historical reference on what I planned to cover during the class. Since they are used in hard copy format, I can make handwritten changes to them before or after the lecture. The board notes then become
Preparing a Class Session

Preparing a class requires the actions of gathering and coordinating the resources needed to perform the class as well as rehearsing the class. While coordinating and gathering resources are important, I have found that rehearsals have been the most important aspect of my class preparation.

Rehearsing

After completing my class planning, I typically rehearse in my classroom the afternoon before my class is scheduled. My rehearsal consists of performing the lesson in the empty classroom including presenting material verbally, writing on the boards, asking planned questions, and answering expected questions. Rehearsals also allow me to judge how to best perform the class in the particular setting I will use. I will draw pre-positioned boards and test the suitability of the classroom’s facilities. Once my rehearsal is done, I look at my boards to ensure all students will be able to read them. If I need to make adjustments, I do so on my board notes. Rehearsal time is also a good time to have an evaluator observe your class and provide formal or informal feedback on your classroom skills. Overall, the key is to try and get in the room where you will perform the class and rehearse it before the class arrives. There is no substitute for a rehearsal in any operation and, if pressed for time, I would cut some planning instead of my rehearsal. If a class is not properly prepared, even the best planning will not save it from a less than polished performance.

“Each class session is well prepared and answers questions from the previous lesson. I like the way it is going.”

-Cadet Feedback, CE404
rehearsals that include final set up of the classroom. I also have full access to the room. Although these arrangements facilitate rehearsals, a rehearsal can be done in a room or location that closely approximates your actual classroom. The most important aspect of a rehearsal is choreographing the verbal (information and questions), written, and other presentation media so all elements are well coordinated. Rehearsals truly could be done anywhere, but bringing all the elements of a dynamic and interactive class together in the environment where they will occur adds a valuable dimension.

Refreshing

As a final preparation, I “load my class into RAM.” This simply means I sit down shortly before class and write out, by memory, the board notes for the planned session. This 20-minute exercise is merely a technique I use to focus myself and freshen my memory directly before class. Once in a while I even come up with a better way to present material based on the way I recall it from my previous planning and preparation. While it may be a bit risky to try and change the way I am going to present a class right before the class meets, I have had good success doing this.

I have one word of warning about refreshing a class. Some may be tempted to use this as a substitute for their “rehearsal,” but I encourage taking the time and effort for a full rehearsal, as discussed above. Refreshing a class is getting ready to perform a class, not preparing one.

Performing a Class

Perform a class you say? I do. In his book Mastering the Techniques of Teaching, Lowman says, “College classrooms are fundamentally dramatic arenas in which the teacher is the focal point, like the actor or orator on a stage.” The best planned and rehearsed class may never be remembered if it is not performed in a manner that inspires the students to pay attention and learn the material. Three general ways I strive to inspire my students to do this are to make my performance interesting, to make the course material real, and to regularly ask for their feedback.

Making the Performance Interesting

What makes a presentation interesting to you? I suggest that first you think of a presentation outside the classroom setting. Why is a museum, art gallery, aquarium, national park, or amusement park interesting? When I try to isolate what makes these presentations interesting to me, I realize that they stimulate multiple senses and make me want to interact with others around me. My goal was to apply these qualities to my classroom performance.

To stimulate multiple senses, I relied on using varied media both in the classroom and the lab. I used the spoken word to stimulate hearing; chalkboards, electronic slides, demonstrations, and posters to stimulate visual senses; and hands-on demonstrations to stimulate tactile experiences. While the staple of my course is the spoken word, physical demonstrations have proven to be the most beneficial way to teach tough concepts in the classroom. For example, to get a student to understand moment of inertia have them try to bend a ruler about its weak axis.
and then its strong axis. This simple demonstration involves seeing and feeling something that when explained verbally can be quite confusing. Many simple demonstrations like this one exist and can be employed with minimal assets and preparation. So I encourage you to look for simple demonstrations that allow students to see and feel the course material. Possible sources of inspiration are your own creativity, other instructors, seminars, and conferences.

“[I most like] The parts where objects are used to visually represent what is going on, like the L shapes bending about the z axis. I need the visual stuff.”

-Cadet Feedback, CE404

Stimulating Interaction

Another benefit of the demonstration is the spontaneous interaction it encourages among the students. They will converse with one another and the instructor about what they have seen and felt in a demonstration. These supplemental discussions may also generate additional student questions. Now you have them, their interest is piqued, so how do you maintain their interest and spark further interaction? Or how do you get their interest if you have no demonstrations available? Simply ask the students a question.

I can think of no better way to get students to be actively engaged in the class. For a wonderful discussion of how and why to use questions in the classroom, I recommend reading Wankat and Oreovicz, Chapter 6, Section 6.4². I have used questioning to wake sleeping students, spark group discussions, get students involved in problem solving, and to quickly assess student knowledge and learning. Through the use of good questions, you can put on quite a performance and further facilitate the students’ active participation in class.

To help me ask good questions to capture the students’ interest, I adopted my department’s technique of including good questions on my board notes (see the narrative portion of the board notes in Enclosure 2 for some examples). These scripted “spontaneous” questions allow me to plant questions at an appropriate time during the lecture in effort to encourage student participation and to highlight important concepts.

“[The part of the course that I have liked the most so far is the class participation opportunities. It helps me to learn.”

-Cadet Feedback, CE404

Another form of question I like to use is a short written quiz. Short quiz questions involve no calculations, but rather qualitative questions about the assigned reading or review material covered in the previous class. Although I have chosen to assign a small amount of points to the quiz to reward good performance, my primary reason for the quiz is to encourage thought about the material and to spark interest in the day’s lesson. After collecting the quiz I ask a question like, “So what is the answer to the quiz?” or “Why would I ask you that
question?” This is a nice way to get students’ attention to start the class and immediately have the students interacting.

Using physical demonstrations, written questions and verbal questions may grab students’ interest at a fixed moment in time, but is this enough? I don’t think it is. My next goal in my class performance is to get them interested in the class material as it applies to uses outside the classroom. I want them to understand that the class can prepare them for life after academics.

Making the Class Real

This is where I like to make the course real. The idea is to convince students that my coursework has value that will carry on in future education as well as a profession that is a great value to society. In other words, this isn’t a “check the block” exercise. Its purpose is to gain useful knowledge and skill. The use of the following three programs have helped to make the course real: (1) field trips, (2) lectures from outside practicing professionals, and (3) hands-on laboratory exercises.

The field trip is a tried and true way of showing students how the classroom applies to the rest of society. Our field trip was to a mall with an exposed steel structure. The beauty of this trip was that it is the same every year and is not difficult to repeat each term. Many times structural engineering and construction courses see projects under construction, which are good, but each term the trip must change as the construction evolves and eventually must end. The key is trying to find an existing project that does not change. This greatly reduces the overhead of the field trip. Even better is to find such a structure or location right on campus to minimize travel requirements. If all else fails, do a virtual tour with photos and video. This approach may be even better suited to some classes that do not lend themselves to obvious physical applications near campus. The object is to show the student how the education gained in your class can apply to their future professions.

Another real dimension was added to the course with a guest lecturer. My course director chose a lecturer that was a recent graduate of a structural engineering program. He felt selecting a recent graduate was more important than getting a prominent professional in the field. Having a recent graduate lecture allowed the students to see what they may be doing with our course material after graduation. The added benefit of getting a more recent graduate is that he or she is typically more available at a smaller expense. Another possibility is to have your class attend a guest lecture in a related course or event. Keep your eyes on the topics of lectures for other on-campus courses as well as off campus events. You may be able to find a lecture that applies to your course materials at a very low overhead. Additionally, emphasizing that other courses and

“The aspect of this class that is the most helpful for my learning is when you apply the concepts we are learning in class to real world situations. This helps me see exactly why the stuff we are learning is so important to design.”

-Cadet Feedback, CE404
organizations find topics in your student’s discipline important will help add realism to the
course.

Finally, and perhaps the most convenient way to add realism to a course, is to do some
hands-on laboratory work. At fist this conjures up visions of high-tech lab equipment with all
the associated support staff and knowledge to run the lab. While we used such facilities and
professional help in our course, there are also opportunities to turn any classroom into a
laboratory. In-class demonstrations mentioned earlier could be turned into in-class labs if some
method of predicting the demonstrated behavior can be shown. There are also computer
simulations that can be used as the demonstration. Predicting behavior resulting from a
simulation can at least verify to a student that in-class methods are supported by the creators and
users of software as well as help highlight differences in methods of predicting behavior.

Receiving Feedback

Once my students were drawn into an active classroom environment through an
interesting performance and out of class applications, they became more willing to interact not
only with each other but with me as well. So to help to continuously improve my course and
teaching style, as well as to further stimulate student involvement in the course, I asked them to
submit regular feedback on my performance. This task was relatively simple for me to
implement and the students to perform, because the USMA Center for Teaching Excellence
(CTE) operates a web-based anonymous interim course feedback system. This system allowed
me to poll my students at the end of each block about course content and my teaching style via
email. I would then receive their anonymous responses from the CTE website via email (see
Figure 3 for an example). I then classified their responses into general areas and then provided
feedback to my students based on their suggestions or recommendations. All of the feedback
inserts in this paper are examples of this system. This interim course feedback was a great way
to ensure I received plenty of timely input from my students in order to adjust my teaching style
and course to meet their needs before the semester ended.

Figure 3. Anonymous Interim Course Feedback
Obtaining Educational Value from Administrative Tasks

Low administrative overhead (with respect to time) is a must if you are to have enough time to plan, prepare and present a class in the fashion I am advocating. However, let us not forget the value of the administrative tasks necessary to run a class. Yes, I mean value. Simply declaring course administrative tasks a necessary evil will cause you to miss some important educational benefits they offer. In my first semester, I learned several good lessons pertaining to grading and forming design teams. Armed with a plan for these tasks going into the course, I was much better prepared to perform them efficiently. Performing my administrative tasks efficiently meant I could continue to use my time to prepare for my in-class performances. Furthermore, I was able to reinforce some important educational concepts for the students as a result of these seemingly mundane tasks.

Grading

I heard that grading was the beast of the new instructor schedule. With weekly homework, frequent quizzes, design problems, and exams, how was I going to get through all the grading? The first thing I did was adjust my attitude toward the task. Basically, I had to personalize each homework assignment instead of just looking at the grading task as a stack of papers I had to wade through. This was an administrative attitude I used to help me during my two previous assignments as an Army personnel officer. As a personnel officer, I had a never-ending stack of performance reports, awards, and assignment requests to process not unlike the many grading requirements during a normal engineering course. The key was to realize that a piece of paper represents the hopes and dreams of each person behind it and should be treated as such. Likewise, each homework assignment or design problem provided me an opportunity to assess student learning as well as provide students feedback in written form. I was committed to provide concise written feedback on every assignment and offer each student the opportunity to discuss the feedback directly with me. This accessibility reinforced the personal benefit that I hoped each student would get from the class.

To handle the time pressure of grading and providing feedback on homework, I used three methods to speed up the process. First I worked each homework assignment myself before the assignment was due. This required time up front, but caused me to fully understand the problem and saved me time when I graded the students’ work. Working the problems also assisted my course director in developing cut-sheets (See Enclosure 3 for an example cut-sheet). A cut-sheet is a predetermined plan of allocating credit or deductions to certain concepts annotated on the approved solution to a problem. The cut-sheets helped me grade consistently and recognize common errors as well as diagnose uncommon errors. Second, I learned to first evaluate only five to ten percent of the homework assignments before I began grading. This helped me validate the cut-sheet without having to go back to regrade any assignments. Finally, I learned to grade one problem for the entire course at a time. This kept all the processes, common errors and numeric values fresh in my mind and allowed me to complete the grading without having to constantly refer to the cut-sheet. I also found this process so thorough that I received very few requests to adjust any grading from my students.
Forming Design Teams

Design team formation was also an administrative area used to improve the student experience. My course director and I initially assigned students to design teams randomly and then moved members as needed to ensure each team had members with the appropriate skills necessary to complete the design. For example, we ensured each team had a student who had taken a computer-drafting course so the team could complete the drafting requirements in the design.

Another option of building teams is to allow the students to select their own teams. However, my course director noted that many complaints were received when allowing students to select their teams from students who claimed to be at a disadvantage because they did not know many people in the class. After using an industry web-based leadership bulletin board to poll engineering professionals about methods for selecting the design teams, I found that most industry professionals preferred to have the instructor select the teams or to have them randomly assigned, because this paralleled how teams would be formed in industry. They felt learning to work with others outside the student’s comfort zone would serve as an important lesson in leadership. Therefore, I would feel comfortable using this method again to enhance the educational experience for students in the course.

To help alleviate the concern that some students would be forced to work with non-performing partners, we used peer evaluations to give the students in each group the opportunity to assign credit for those who did more work than others. This was another avenue to help empower the students and provide me with valuable feedback on student performance. Additionally, it exposed the students to peer and self-evaluations. This is a device they will see being used industry.

Conclusion

As my semester concludes, I look forward to receiving the end of course evaluations from my students. Had I not had any formal instruction on how to teach or began my first semester with a plan to improve my performance with each class, I’m not sure I could say I looked forward to the students’ final evaluations. But since I planned, prepared, performed each class and received interim feedback from my students, peers and senior instructors, I feel I significantly improved my skills as an instructor in a short amount of time. And, perhaps more importantly, I have implemented a personal teaching model that will continue to help me throughout my career.

Bibliography

Acknowledgements

I wish to thank my course director, Major Chris Schirner, in helping me become an instructor in such a short amount of time. Without his guidance, excellent course development and accomplished administration, I would not have been able to focus so much of my time on improving my teaching skills. Additionally, I would like to thank the senior leadership of the Civil Engineering Division of the Department of Civil and Mechanical Engineering at the United States Military Academy. Their foresight in emphasizing teaching in the department sets the conditions required to accomplish the recommendations I have made in this paper. And finally I owe my deepest appreciation to my wife Kristi who not only performed editorial duties for this paper, but allowed me the time and support to write it.

Craig Quadrato

Captain Craig Quadrato is a United States Army Officer serving as an instructor at the United States Military Academy. Craig currently teaches structural steel design and the civil engineering capstone design project as well as advises cadets for the ASCE steel bridge design competition. His previous military assignments include: platoon leader and executive officer, 864th Engineer Battalion at Fort Lewis, Washington; Brigade Personnel Officer, Engineer Brigade, 2nd Infantry Division at Camp Howze Korea, and Company Commander, B Company, 52nd Engineer Battalion at Fort Carson, Colorado. Craig is a 1991 graduate of the United States Military Academy with a Bachelor of Science degree in Civil Engineering. He holds Master of Science degrees in Engineering Management from the University of Missouri and Structural Engineering and Construction Engineering Management from Stanford University. Craig lives in New Windsor, New York with his wife Kristi.
Enclosure 1

Assessment Form

TEACHING ASSESSMENT WORKSHEET

INSTRUCTOR: CPT QUADRATO

LESSON TOPIC: DESIGN STRENGTH OF BEAMS

DATE: 3/19/2001

STRENGTHS:
1. GOOD USE OF IBC TO INTRODUCE CLASS.
2. GOOD USE OF BEAM WALK ANALOGY
3. NICE "PICTURE" OF LTB USING RUBBER BEAM
4. USE OF METAL DECK TO ANSWER PUZZLE WEED QUESTION
5. GREAT ANSWER FOR LOCAL BUCKLING AFFECTING STRENGTH
6. LTB X-AXIS
7. NO LTB Y-AXIS
8. EFFECT OF UNBRACED LENGTH

AREAS FOR IMPROVEMENT:
13. 6 MINUTES ON REVIEW BOARD
14. STRAIN HARDENING → RETURN TO ELASTO-PLASTIC ASSUMPTION
15. EMPHASIZE Mr AND HOW TO GET IT.
16. HAVE M = 2x Fy POSTED IN INSTRUCTOR LRFD
17. FLAWS ACCOUNTED FOR WITH Φ FACTOR.
18. YOU CAN READ THE TABLE AFTER CLASS AND FIND THAT OUT
19. OVERALL BOARD ORGANIZATION → SAVED 3 MIDDLE BOARDS FOR LAST 5 MINUTES OF CLASS → qM, GRAPH
20. REFINE QUESTIONS TO GET ANSWERS MORE QUICKLY
# Enclosure 1 (con’t)

## Assessment Form

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<thead>
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<th>25</th>
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<tbody>
<tr>
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<tr>
<th>Technical Expertise</th>
<th>Good</th>
<th>Excellent</th>
<th>Remarks</th>
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</thead>
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<td>Command of the Subject Matter</td>
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<td></td>
<td></td>
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<th>Lesson Organization</th>
<th>Organization of Boards &amp; Classroom Activities</th>
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<th>USE MIDDLE BOARDS EFFECTIVELY</th>
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<th>Enthusiasm, Energy, and Confidence</th>
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<td></td>
</tr>
<tr>
<td>Clarity of Presentation (boards, viewgraphs, etc.)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Clarity &amp; Precision of Explanations</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Voice (volume, speed, variation)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Questioning &amp; Answering Questions</td>
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<tr>
<td>Contact with Students</td>
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<td>Visual Aids and Demonstrations</td>
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<tr>
<td>Time Management</td>
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<tr>
<td>Appropriate Use of Textbook</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

## The Classroom Environment

| Classroom Appearance | ✓ | | |

### Overall Assessment:

Are the students who attended this class adequately prepared to accomplish the Lesson Objectives?

- [ ] No
- [ ] Not sure
- [X] Yes

Specific areas on which to focus during your next class:

1. **Positioning of Information on the Boards / Clarity**
2. **Refine Questions to get quicker, on-target responses**
3. 

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Enclosure 2

Board Notes

Three boards to be built during a lecture

Narrative comments and questions to be asked

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Copyright © 2002 American Society for Engineering Education
Points for whole problem

Reference:\Z-spartacus\cme\CME.2\CE 404\CE404_02-1\Problem Sets\AISC_GetShapes.m

10 pts] 2. Beam-COLUMN Design. Column B21 is one component of Frame 2 from Problem #1. To continue the frame design, use the Visual Analysis output to choose a column.

GIVEN: Shown below is the Visual Analysis output for Column B21 from a 1st order analysis. Use the Frame 2 figure from Problem #1 to gather pertinent data about the rigid frame. Members are oriented for x-axis bending in the plane of the paper and are made of A572 Grade 50 steel. Out of the plane of the paper, the column is part of a braced frame.

Member Extreme Results

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<th>Member</th>
<th>Load Case</th>
<th>Axial</th>
<th>V_y</th>
<th>M_z</th>
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<tbody>
<tr>
<td>B21</td>
<td>A4-1</td>
<td>-80.11</td>
<td>-1.8879</td>
<td>-25.17</td>
</tr>
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<td></td>
<td>A4-2</td>
<td>-171.94</td>
<td>-5.6214</td>
<td>-74.95</td>
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<tr>
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<td>A4-3 L</td>
<td>-182.37</td>
<td>-2.2605</td>
<td>-30.14</td>
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<tr>
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<td>A4-3 W</td>
<td>-164.97</td>
<td>-4.0686</td>
<td>-54.25</td>
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<tr>
<td></td>
<td>A4-4</td>
<td>-132.25</td>
<td>-8.9742</td>
<td>-119.65</td>
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<td></td>
<td>A4-6</td>
<td>-63.43</td>
<td>-7.4636</td>
<td>-99.51</td>
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</tbody>
</table>

FIND: Choose the lightest preliminary W shape for member B21 using the $P_{eq}$ method. Do not use the interaction equation to check the preliminary member (you will do this as part of EDP Submittal #4).

Use the procedure outline found on LRFD page 3-11 [$P_{eq}$ Tab]:

1. With the known value of $KL$ (effective length), select a first approximate value of $m$ from Table 3.2. Let $u = 2$.

For a first story column in a rigid frame, assume $K_x$: $K_x := 2.0$

For a braced frame out-of-plane, $K_y = 1.0$: $K_y := 1.0$

From the frame figure, determine $L$: $L := 13.33$ ft

Assume the $y$-axis buckling governs: $K_y \cdot L = 13.33$ ft

From Table 3-2 (1st Approximation), interpolate $m$ between 1.7 (for $KL = 14$) and 1.8 (KL = 12): $m := 1.73$

$\frac{1.7}{.7} = \frac{1.8}{m}$, $\theta \leq$
Enclosure 3 (con't)

Cut-Sheet

CE404 Problem Set #8  Due 19/20 November 2001  Solution, Page 6 of 11

2. Solve for $P_{ueq} = P_u + M_{ux}(m) + M_{uy}(m)(u)$.

Note that $M_{uy}$ = 0 for a braced frame out-of-plane, and the V.A. moments are values for $M_{ux}$. We cannot rule out LCC A4-2, A4-3L, or A4-4.

$$P_{ueq} := \max \left( \begin{array}{c} 172 + 75 \cdot m + 0 \\ 183 + 30 \cdot m + 0 \\ 132 + 120 \cdot m + 0 \end{array} \right) \text{kips}$$

$$P_{ueq} = 340 \text{kips}$$

3. From the appropriate Column Load Table, select a tentative section to support $P_{ueq}$.

$$\text{W14x48} \quad \phi P_n = 358 \text{kips}$$
$$\text{W12x45} \quad \phi P_n = 341 \text{kips}$$
$$\text{W10x45} \quad \phi P_n = 355 \text{kips}$$
$$\text{W8x48} \quad \phi P_n = 388 \text{kips}$$

LIGHTEST NOT SELECTED (L)  
PHN NOT INTERPOLATED (L)

4. Based on the section selected in Step 3, select a "subsequent approximate" value of $m$ from Table 3.2 and a $u$ value from the column load table.

Verify that $KL_{eq}$ for x-axis buckling does not govern:

$$rx/ry := 2.15$$
$$KL_{eq} := \frac{K_x \cdot L}{rx/ry}$$

$$KL_{eq} = 12.4 \text{ ft}$$

$K_y \cdot L = 13.33 \text{ ft} \text{ still governs.}$

From Table 3-2 (Subsequent Approximation),
interpolate $m$ between 1.8 and 1.9:

$$m := 1.83$$

$u$ is not needed since $M_{uy} = 0$.

5. With the values selected in Step 4, solve for $P_{ueq}$.

$$P_{ueq} := \max \left( \begin{array}{c} 172 + 75 \cdot m + 0 \\ 183 + 30 \cdot m + 0 \\ 132 + 120 \cdot m + 0 \end{array} \right) \text{kips}$$

$$P_{ueq} = 352 \text{kips}$$

6. Repeat Steps 3 and 4 until the values of $m$ and $u$ stabilize.

For a W10x45, $\phi P_n = 355 \text{kips} > P_{ueq} = 352 \text{kips}$.

A W10x45 is O.K for a trial member.