30 April 2017

MINUTES OF USMA CHEMICAL ENGINEERING ADVISORY BOARD MEETING

The chemical engineering advisory board met on 14 April 2017 to assess the chemical engineering academic program for USMA undergraduates and to provide guidance to the ongoing efforts for improving the program. The composition of the advisory board is listed in Appendix 1. The agenda for the day is listed below.

Time	Event	Location
0730-0745	Shuttle at Buffalo Soldiers Field	BSF
0745-0800	Arrival	CLS Conference room
0800-0830	Session 1: Introductory remarks and ABET orientation	CLS Conference room
0830-0920	Session 2: Program assessment Student Outcomes Assessment Discussion of Program Objectives	CLS Conference room
0920-0930	Board Surveys	Survey Parts 1 and 2
0930-0950	Session 3: CH367 Overview	CLS Conference Room
1010-1050	Career Panel	CLS Conference Room
1100-1140	Cadet Discussions	CLS Conference Room
1200-1245	Lunch and Firstie Resume Round Robin	West Point Club
1300-1330	Board backbrief on cadet interactions	West Point Club
1340-1430	Session 4: Future Challenges	CLS Conference Room
1430-1455	Admin and Unit Ops Lab tour	Bartlett Hall (Optional)
1500-1530	Wrap-up	CLS Conference Room

Session 1: Introduction and ABET Orientation. The chemical engineering program is at about the midway point between the last ABET accreditation and the next. The next record year is the Academic Year (AY) 2020 (fall 2019-spring 2020). The next ABET visit will be in the fall of 2020 (AY2021). This timeline, in conjunction with the curriculum change timelines of USMA, implies that any curricular changes that would be in effect for the next ABET visit/record year, must already have been approved.

Session 2: Program Assessment. The board reviewed the USMA mission and vision and the chemical engineering mission and vision in order to consider modifications. No changes to the chemical engineering program's mission or vision were recommended.

The board reviewed the Student Outcomes and Program Objectives. The board reviewed various metrics to assess whether the chemical engineering program is satisfying the outcomes and objectives. USMA chemical engineering graduates are expected to possess the following capabilities (student outcomes) as a result of their academic program.

1. Apply knowledge of mathematics, science, and engineering.
2. Design and conduct experiments, as well as analyze and interpret data.
3. Design a system, component, or process to meet desired needs within economic, environmental, social, political, ethical, health and safety, manufacturing, and sustainability constraints.
4. Function on multidisciplinary teams.
5. Identify, formulate, and solve engineering problems.
6. Understand professional and ethical responsibilities.
7. Communicate effectively.
8. Understand the impact of engineering solutions in a global economic, environmental, and societal context.
9. Recognize the need and develop the skills required for life-long learning.
10. Demonstrate knowledge of contemporary issues.
11. Demonstrate an ability to use techniques, skills, and modern engineering tools necessary for engineering practice.

The ChE course curriculum at USMA is focused on the following specific areas of math and science. Appendix 2 lists required ChE courses.

a. General, organic, and physical chemistry.
b. Material and energy balances on chemical processes, including safety and environmental factors.
c. Thermodynamics of physical and chemical equilibria.
d. Heat, mass, and momentum transfer.
e. Chemical reaction engineering.
f. Continuous and staged separation operations.
g. Process dynamics and control.
h. Modern experimental and computing techniques.
i. Process design.

Current possible elective concentrations include materials engineering, nuclear engineering, decision analysis, advanced control systems, energy conversion systems, power systems, alternative energy engineering, and industrial engineering. Proposed for the future are concentrations in bioengineering and environmental engineering.

ADVISORY BOARD EVALUATION METRICS

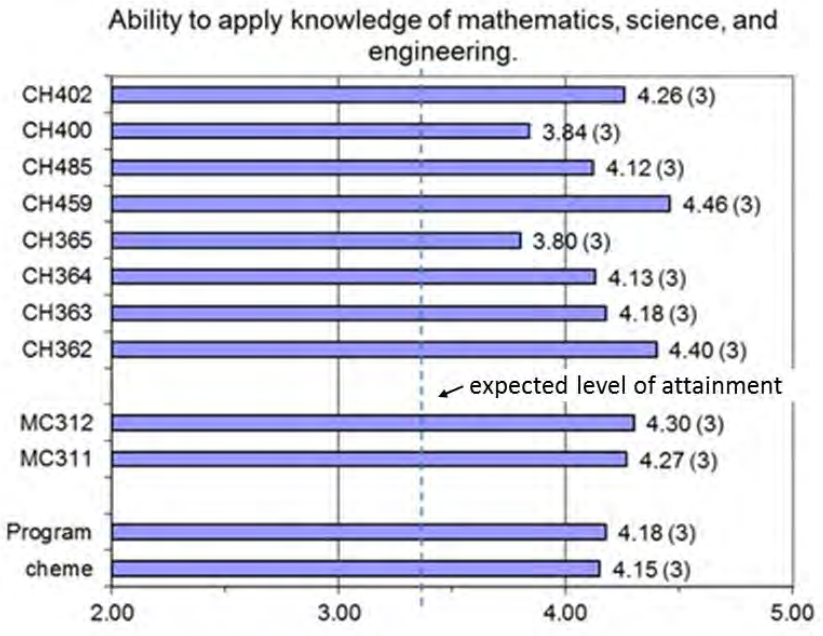
The advisory board reviewed an extensive packet of data from AY2016 in order to provide feedback and consider possible modifications to various aspects of the program. The five main sources of data used by the advisory board to evaluate the extent to which the chemical engineering program satisfies the mission and vision are:

- Cadet course grade performance in chemical engineering classes at the Academy
- Cadet semester end-of-course evaluations
- Cadet assessment of ABET outcomes
- Cadet performance on the 'Fundamental of Engineering (FE)' exam
- Numerical evaluations supplied by the Advisory Board to the program

Other data sources that influence the evaluation of the program include periodic survey results by graduates that are mandated by the Army at the 3 and 5 year points post-graduation, as well as the cadet program exit survey at graduation. Beside the survey results of the advisory board, surveys are also conducted of the program faculty, cadets while in school, and cadets upon graduation.
Sample data are shown and summarized here.

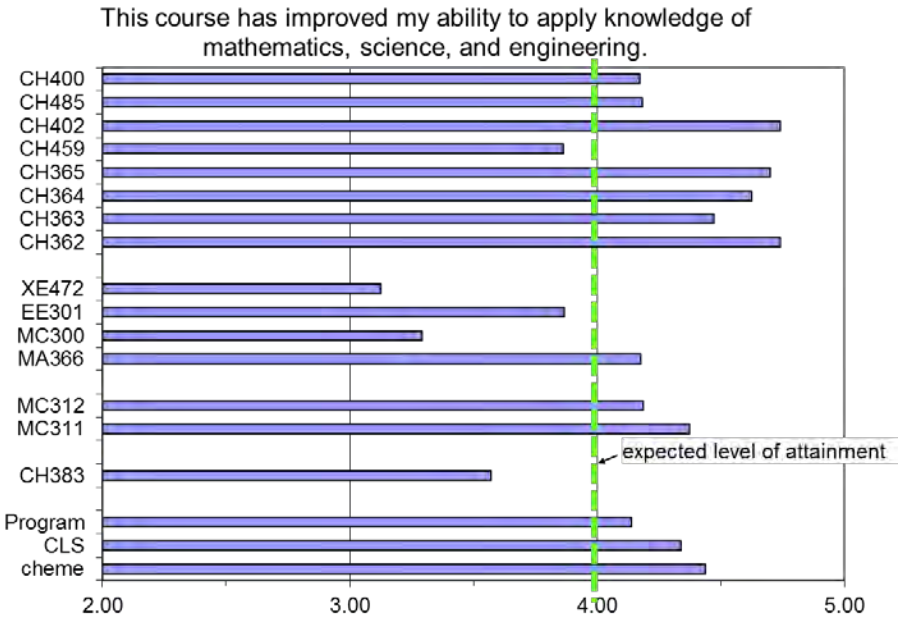
Chemical Engineering Course Grade Performance

Below are the aggregate course grades achieved by cadets in the ChE program for the Class of 2016. Each of the courses resulted in aggregate grades above the expected level of attainment (3.25). The courses with the highest grades were: ChemE Lab (CH459), Mass and Energy Balances (CH362) and Chemical Engineering Process Design (CH402). The lowest grades were: Chemical Engineering Thermodynamics (CH365), Chemical Engineering Professional Practice (CH400), Heat & Mass Transfer (CH485), and Chemical Reaction Engineering (CH364).

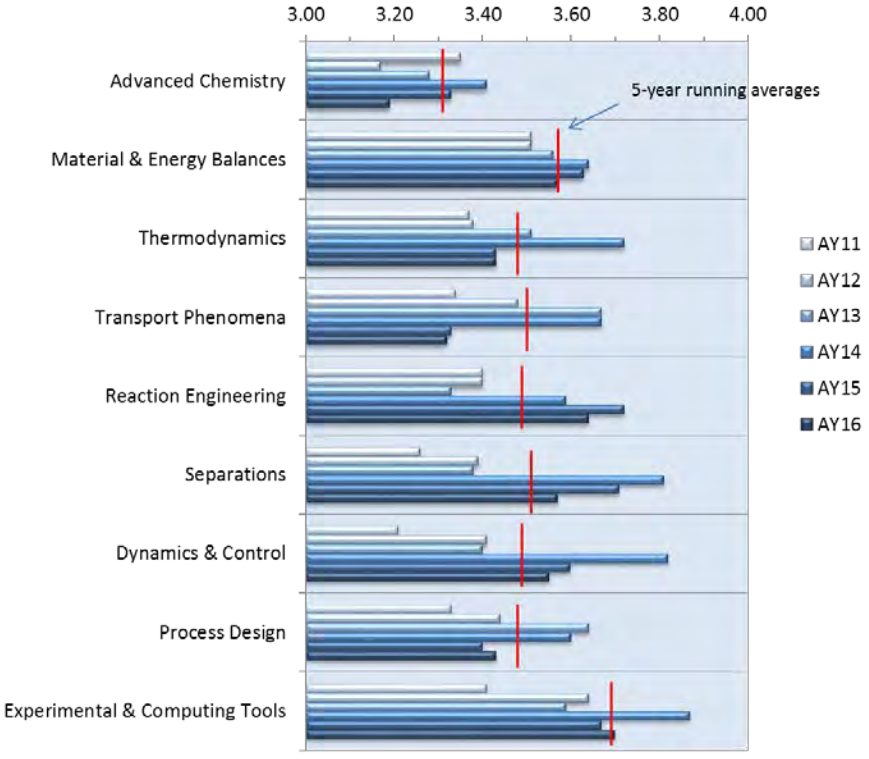


Chemical Engineering End-of-course Student Assessments

The end of course survey of cadets provided information on how well the cadets felt that each course achieved the student outcomes. Sample survey results are plotted in the graph below. The highest ranked courses were Mass and Energy Balances (CH362), Chemical Engineering Process Design (CH402), and Chemical Engineering Thermodynamics (CH365). The lowest ranked scores, which did not meet the expected levels of attainment, were Dynamic Modeling and Control (XE472), Physical Chemistry 1 (CH481), Fundamentals of Engineering Mechanics and Design (MC300), and Organic Chemistry I (CH383).

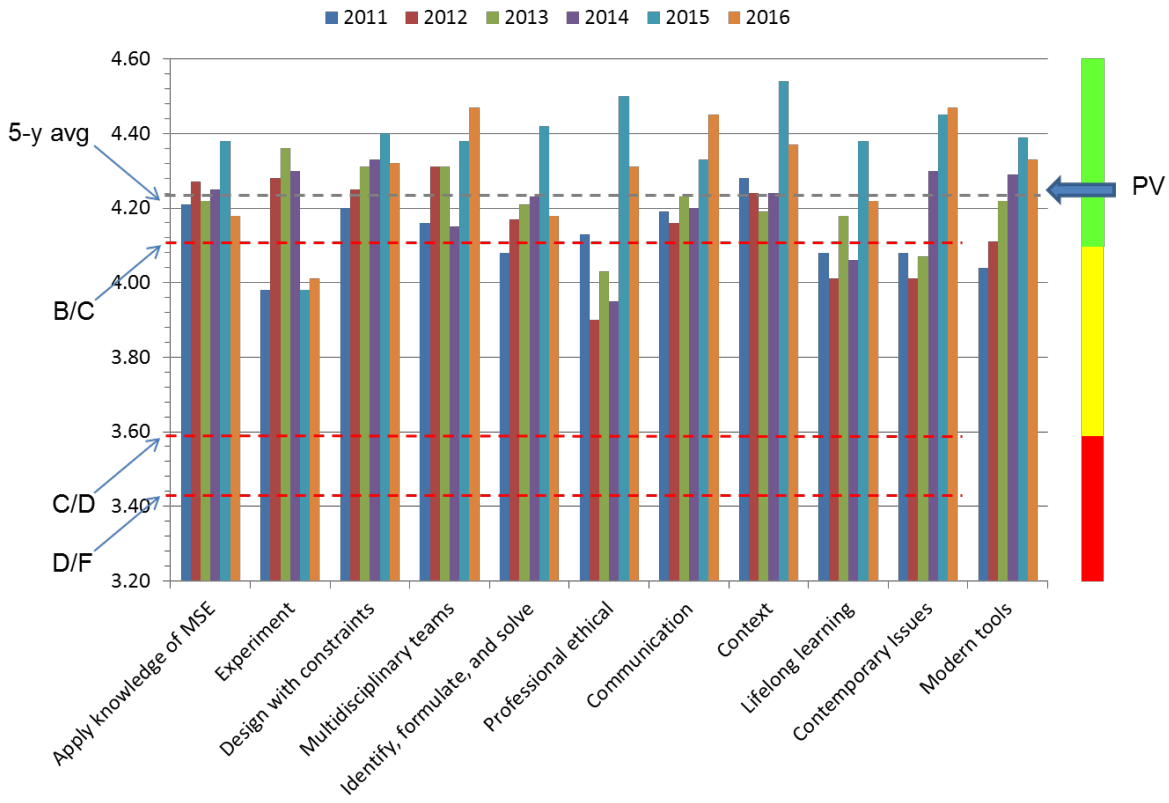


Course GPAs over a 5 year period, parsed from cadet transcripts, are presented in the graph below. Over the period, the highest grades were achieved in: Experimentation and Computing Tools, Transport Phenomena, and Material & Energy Balances. The lowest grades were in: Chemistry, Process Design, and Dynamics & Control.



Cadet Assessment of Student Outcomes

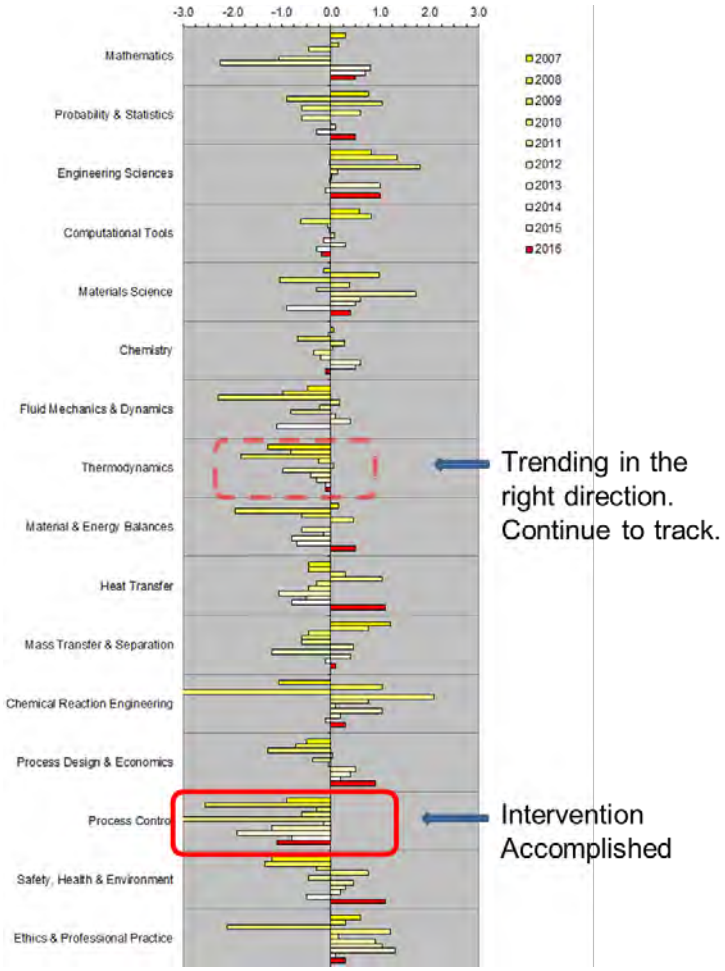
The 5-year summary of cadet assessments concerning their perception of whether the ABET objectives were satisfied is plotted in the graph below. Program averages are shown for all courses containing embedded indicators. The green, yellow, and red bars on the right are meant to mimic a process control indicator, where the 2016 score is the measured process variable, and the 5-year average is our performance goal. In the language of process control, our indicator is "in the green." The "low alarm" is indicated with "LA" and would trigger some kind of process response. None of the expected outcomes were felt to be unmet by the cadets. The ABET objectives that were scored the lowest by the students were: Professional ethics, and Experimentation capability.



Cadet Performance on the Fundamentals of Engineering (FE) Exam

The USMA ChE program encourages students to take the FE exam as the first step in professional licensing and registration, and also as a means for the faculty to compare cadet performance with others throughout the country who take the same exam at the same time.

The cadets who took the 2016 FE exam, in aggregate, had a passing rate of 79%, which was equivalent to that of all the people who took the exam in 2016. The normalized performance of USMA cadets versus others taking the exam is presented in the graph below. Areas in which USMA cadets excelled, compared to their peers, were: Engineering Sciences, Heat Transfer, and Safety, Health, and Environment. Areas needing improvement include Process Control.



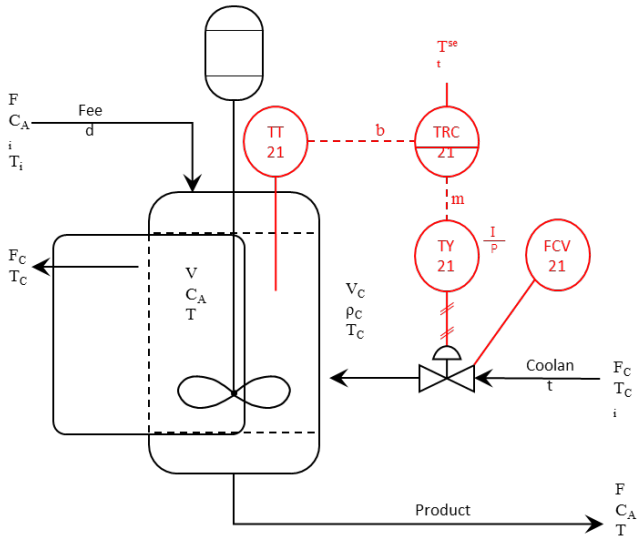
Advisory Board Discussion of Program Objectives. The Advisory Board reviewed and discussed the Program Objectives. No changes to the objectives were recommended. The objectives will remain:

During a career as commissioned officers in the United States Army and beyond, program graduates:

1. Demonstrate effective leadership and chemical engineering expertise.
2. Contribute to the solution of infrastructure and operational problems in a complex operational environment.
3. Succeed in graduate school or advanced study programs.
4. Advance their careers through clear and precise technical communication.

Session 3: CH367 Overview.

The advisory board was given an update on the new controls course, CH367 Introduction to Automatic Process Control. The course has been approved for the Class of 2020 and so will be taught beginning the Spring of AY19. A brief description of a capstone project and objectives were presented and feedback was requested. The capstone diagram and proposed objectives are shown below. The feedback provided by the board is annotated in Appendix 3.



Proposed CH367 capstone project objectives.

1. Write a descriptive interpretation of each element in a control loop.
2. Draw a complete Laplace block diagram for an actual control loop.
3. Design and implement a PI controller for a chemical reactor, and implement a numerical solution to the equations that describe the process dynamics.
4. Tune a controller.

ADVISORY BOARD INTERACTION WITH CADETS

Advisory board members interacted with the entire 3rd and 4th year classes (Cows and Firsties) of cadets in a session segmented into 3 parts: 1) questions the advisory board addressed to the cadets, and 2) questions the cadets addressed to the advisory board. Advisory Board members then had lunch with chemical engineering cadets at the West Point Club followed by the third part 3) a review of the First Class cadets' resumes. Key questions addressed by the advisory board to the cadets are listed below. A summary of the discussions/responses between the advisory board and cadets is shown in Appendix 4.

The review of cadets' resumes took the form of short (~ 5-10 minute) 'mock interview' between the board members and the cadets. The board was asked to treat the time as though the cadets were looking for a job and to ask questions based on their particular current positions and jobs. Feedback from the board was very positive for this event.

Session 4: Future Challenges

The board was presented with some information on challenges for the program to address in the coming years. While the program and the department will have plenty of chemical engineers to choose from to teach the chemical engineering courses, the department as a whole is going to be short faculty to teach the general chemistry and biology courses in the next few years. As a result, our program's ability to introduce any new courses or electives is going to be severely limited.

The board was also refreshed on the impact of the academy's curriculum change during AY16. This opened up some potential opportunities (limited in the short term), especially concerning the issue of writing within the major. The removal of an upper-level writing course led to the proposal of a 1.0-1.5 credit hour technical writing course within the major. This option was met favorably by the board and has been proposed. The limits within the department have put this on hold but the recommendation will remain for the future.

The board was also made aware of potential accreditation changes forthcoming from ABET. If implemented, there may be other opportunities in the future that might include an increase in the number of electives available within the department, addition of a second semester of design, and addition of a 'measurements' course to improve cadet understanding of measuring and errors. These have the same obstacles already mentioned, but will remain open possibilities. All options were met with general approval by the board but would be revisited for priority in the future as resources become available.

The board was also presented with some administrative recommendations. The first recommendation was to increase the pool of advisory board members that the program could draw on. This would allow members, if they wished, only to come every other year or so, easing travel burdens, while still allowing a good number (7-10) to be able to visit in a given year. This could also allow for members that couldn't come a particular year because of timing. The recommendation was generally approved, and the additional benefit of possibly being able to 'tailor' the board members for a given year (for example, a year of only 'recent' graduates for interaction with cadets) was proposed.

The recommendation of coinciding the advisory board meeting with the USMA Projects Day in the spring was made. Projects Day is a day set aside near the end of the spring semester during which cadets who have been conducting independent research or have been on AIADs or done capstone projects, present their work in a poster format. The program may have enough money to have 1-2 board members come a day early and be part of the judging for that day. This recommendation was very favorably received.

APPENDIX 1: ADVISORY BOARD COMPOSITION

This year's attendees are designated with a check mark (✓).

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Donald C. Glaser President, Simulation Solutions, Inc. 179 Avenue at the Common Shrewsbury, NJ 07702 732-389-5400 dglaser@simulation-solutions.com	**Matt Garvey** Simulation Solutions, Inc. Shrewsbury, NJ mgarvey@simulation-solutions.com	

APPENDIX 2: REQUIRED COURSES FOR CHEMICAL ENGINEERS AT USMA

Required Courses * (for classes 2017, 2018, 2019)	
MA366	Engineering Mathematics with Applications
CH362	Mass & Energy Balances
CH363	Separation Processes
CH364	Chemical Reaction Engineering
XE472	Dynamic Modeling & Control
CH485	Heat & Mass Transfer
CH459	Chemical Engineering Laboratory
CH402	Chemical Engineering Process Design
CH400	Professional Practice
MC311	Thermal-Fluid Systems I
MC312	Thermal-Fluid Systems II
EE301	Fundamentals of Electrical Engineering
MC300	Fundamentals of Engineering Mechanics & Design (Statics & Dynamics)
CH365	Chemical Engineering Thermodynamics
CH383	Organic Chemistry 1

Required Courses * (for classes 2020+)	
MA366/MA365	Engineering Mathematics with Applications
CH362	Mass & Energy Balances
CH363	Separation Processes
CH364	Chemical Reaction Engineering
~~XE472~~	~~Dynamic Modeling & Control~~ **CH367 Introduction to Automatic Process Control**
CH485	Heat & Mass Transfer
CH459	Chemical Engineering Laboratory
CH402	Chemical Engineering Process Design
CH400	Professional Practice
MC311	Thermal-Fluid Systems I
MC312	Thermal-Fluid Systems II
EE301	Fundamentals of Electrical Engineering
MC300	Fundamentals of Engineering Mechanics & Design (Statics & Dynamics)
CH365	Chemical Engineering Thermodynamics
CH383	Organic Chemistry 1

APPENDIX 3: ADVISORY BOARD FEEDBACK ON CH367

Kevin Shipe: “This course seems like a move in the right direction for controls application. It would be interesting to see if this could be expanded to include or culminate in a real world reactor model implemented by the cadets. Also, will they physically get to tune a controller at the end or just simulate? For added practical application, maybe include fail safe creation and implementation.”

Tony Hatfield: “Being new, I wasn’t very well versed on the past issues with this course. I will say that seeing new engineers come into Lilly this class sounds very interesting and has great potential. My process controls course years ago was all theory with very little practical problems or applications. There was some discussion during the morning having discussions about adding Emergency Pressure Relief into the design. Considerations might include Pressure Relief Valve on the vessel or Pressure Safety Valve on the coolant system.”

Paul Dietrich: “Continue interview prep during lunch with cadets – positive.”

Lucy Hair: “Consider Seborg or Martin text.” “Process focused vs mechanical focused.”

APPENDIX 4: ADVISORY BOARD CADET DISCUSSION MINUTES

What courses do you feel are particularly good or bad in the program?

XE472: Little relevance to the chemical engineering major

MC300: Either taken too late in the program when all the material has already been covered or not worth it at all because it was all covered in physics class

Some cadets felt the 7.5 hour requirement for research would exclude some cadets from doing research while the focus should be on a viable deliverable vs time.

Cadets would like to see some chemical engineering electives available.

A longer capstone project would be good.

Possibly some work in the separations class in conjunction with the lab course to give some sense of the relevance of separations near the beginning of the course. Separations textbook was difficult "firehose".

What do you think about the chemical engineering faculty overall?

Answers ranged from they were the best cadets had interacted with at the Academy to some of them didn't seem interested in cadets at all.

Other board feedback:

Kevin Shipe: "Resume interview part was a great addition. Having more time with the cadets made a big difference."

Tony Hatfield: "I thought the cadets were very professional and handled themselves very well during the interactive sessions." "It sounds like the interview/resume section was new. I thought that worked well and was time well spent."

Lucy Hair: "My discussion with cadets just strengthens my belief that 2nd semester organic [chemistry] would be helpful." Suggestion for next year: "Exposure of the board to cadets' papers or process designs."

Advisory Board Feedback on Cadet Interviews – Notes from Dr. Biaglow

These were notes taken by Dr. Biaglow during the back-brief after the cadet interviews.

Paul – Resume exercise was excellent and forced cadets to focus.

Tony – PE process showed up on resumes with FE. This is important. It helps keep engineers plugged in to the field while they are in the Army.

Kevin – Do they have the ability to go back and learn what they need to know? They need to be able to learn new technology. Cameron-Brooks put him (Kevin) in front of 12 companies. They were most interested in leader and problem solving skills.

Paul – Take a look at the job they are applying for and re-craft the exercise. Also, they have maybe five minutes to convince the interviewer that they are the person.

Kevin – Cadets should keep tabs on what they do every year. This is very important for the OER process.

Kisondra – It is OK to have white space on a resume. Do not put junk in there.

Tony – Volunteer activities, etc. (not OK?), experience relevant to job OK. Do not use a resume to convince the reader that you are a great guy.

Kevin – Five minutes is sufficient for the interviews. Technical skills are important. Also, do you jibe with the company's culture?

Paul – Look at the corporation. Exxon is a rigid company with a distinct culture. Skills are what I can do on my own.

Sustain this exercise!! (All board members were unanimous.)

Tony – Cadets complained about time requirement in research courses.

Advisory Board Meeting 4-14-17 (1)
Kirsten - Distillation.
FRI Fractional Research Incorporated
CII / PIP process industries progra-
Construction Industry Institute.

Mission

Tony Economic optimization or economics that contribute to solutions is an inherent part of what we do.

Abet changes driven by research organizations & universities.
UNM needs to be more driven by the student needs.

Paul, Lucy Some discussions of chemistry in program. Essentially, Lucy & Paul are concerned that there is not enough chemistry especially organic.

The chemists work for the engineers which reflects were the skills are needed.

Paul What evidence do we see in graduates. Mine the data and compare.

Advisory Board Meeting
Feedback on cadet interactions 4-14-17 (2)

Paul — Cadet resumes - forced cadet to focus

Tony — If others have it, family need to have it. As long as he can pass the PE (Grant) he is golden. How will you remain plugged in? He can reconnect during PE.

Kevin — You (Kevin) are you plugged in to Chemical engineering? Do you have the ability to go back and learn what you need to know? You need to be able to learn new technologies. Cameron Brooks put Kevin in front of 12 companies. Leader skills and solving problems

Paul — Take a look at the job they are applying for and re-craft. You have maybe five minutes to convince the interviewer you are the person.

Kevin — OER - 1st bullet me page. This is what we did. Bullet points of what you did. Keep track on what you do every year. Important for OER process

Kassandra — It's ok to have white space. Do not put junk in there.

Tony — Volunteer activities, etc. Experiences relevant to job OK Do not try to convince that you are a great guy.

Kevin — 5 minutes sufficient - technical is really - Do you jibe with cultures?

Paul — Look at the corporation. Exon is a rigid company distinct cultures. Taco - This is what I can do on my own.

sustain this exercise! Board members were unanimous.

Tony — Computer skills very important. Needs to be a separate

Tony — Cadets complained about this requirement in research courses.