Chemical Engineering

Advisory Board Meeting

14 April 2017

United States Military Academy
Department of Chemistry and Life Science

Advisory Board Meeting Agenda

14 April 2017

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

Potential Topics of Discussion

- Open professional discussion with cows and firsties (J-hour and lunch)
- Overview of CH367, review of history, place in curriculum, current proposed lesson blocks)
- Rotating board members and possible broader field of members
- Tour and overview of experiment in subbasement
- Potential ABET 3 & 5 changes – reduction of ET credits to 45; possible change of elective requirements?
- Additional elective offerings discussion: chemical explosives, numerical solutions, bioengineering sequence
- Possible curricular changes: writing course, second design semester,
- Résumé speed discussion with Firsties

Chemical Engineering

Advisory Board Meeting

14 April 2017

1. Introductory Remarks

United States Military Academy
Department of Chemistry and Life Science

Thank You! Advisory Board 2016-2017

Kevin Shipe ✓ Automation Innovation Engineer NALCO Champion 7705 Hwy 90A, Sugarland, TX 77498 281-263-7335 kevin.a.shipe@gmail.com	**Lucy Hair** ✓ EleCent Team Leader CPOIS Program Lawrence Livermore National Lab 925-423-8545 hair1@llnl.gov	**COL (Ret) Paul Dietrich** ✓ 3855 Victory Blvd Staten Island, NY 10314-6716 718-698-8526 paul@the-dietrichs.com
LTC Andrew Pfluger✓ US Army Student Detachment Colorado School of Mines 845-545-2235 andrew.r.pfluger.mil@mail.mil	**Anthony Pavone** ✓ Process Economics Program HIS Chemicals (650) 384-4311 tonypavone@ihs.com	**Kisondra Waters** ✓ Principal Analyst, Competitive Cost & Margin Analytics, HIS Chemical 1 N Lexington Ave, 17th Floor, White Plains NY 10601, 650-714-1751 kisondra@gmail.com
Anthony Hatfield✓ Eli Lilly Hatfield_Anthony@lilly.com	**COL (Ret) Vance P. (Phil) Visser** 2925 Thomas Smith Lane, Williamsburg, VA 23185 philvisser@yahoo.com 757-254-3017	**COL (Ret) Dwight Springer** Former Deputy Head Chemistry and Life Science US Military Academy 817-431-5331 dss5456@verizon.net
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	

Thank you!

- For the opportunity to show you America's Military Academy
- For your service and insights to help our program improve
- For the time you have dedicated to this visit
- For your dedication to the profession

USMA MISSION

To *educate, train, and inspire*

the Corps of Cadets so that each graduate

is a commissioned *leader of character*

committed to the values of

Duty, Honor, Country

and prepared for a career of professional

excellence and service to the Nation as

an officer in the United States Army.

USMA VISION

Within an Army in transition,
West Point is the preeminent leader development and academic institution whose graduates thrive in tomorrow's complex security environments,
and are inspired to a lifetime of service to our Army and the Nation as leaders of character.

"Inspired to serve."

PROGRAM VISION

We envision an Army that is prepared for all dimensions of modern warfare, drawing upon disciplined, highly trained chemical engineers to develop solutions to the challenges facing the nation.

PROGRAM MISSION

The mission of the chemical engineering program is to prepare commissioned leaders of character who are proficient in applying chemical and engineering principles to solve problems in a complex operational environment.

ABET | Engineering Technology Accreditation Commission

Accredited 1 October 2012 to present

Next Record Year: AY2019-2020

Next ABET Visit: Fall 2020

Why ABET Accreditation?

- An external certification of quality
- Keeps us in touch with the engineering profession
- Helps USMA (and ChemE) recruiting (classes of 2019 and 2020 each signed 30+ plebes – new highs; 95 total)
- Provides important opportunities for graduates
- Allows USMA engineering majors to take the Fundamentals of Engineering Examination
- It is required by Army Regulations (10-87).
- Almost everything that ABET expects us to do is something we should be doing anyway.

Thoughts to Consider

- The ABET process is expensive in terms of faculty time
  - USMA is a small undergraduate college with limited human resources (faculty) and high faculty turnover
- The ABET accreditation is important to the institution and to the Army (so we tend to do it well)
- The only way we can be successful with ABET is to orient our program processes around the ABET criteria
  - By doubling up our efforts we obtain some efficiency
  - Much of what follows is oriented around the ABET processes and terminology
  - We need to be strategic in deciding on new initiatives

Why ABET Accreditation?

- It's what we should do anyway. A discipline of best practices for engineering educational excellence:
  - Precisely (re)define success and how to measure it
  - Decide how to achieve it and allocate resources
  - Collect key data, systematically evaluate, decide how to improve
  - Execute improvements and check progress
- Contributes to quality admissions:
  - Parents and applicants expect it
  - Foundation for grad school and PE certification
- Keeps us engaged with the world:
  - A natural way to benchmark with others
  - Helps articulate educational standards to the Army

ABET History

- Established in NY as Engineers Council for Professional Development (ECPD) in 1932 by seven engineering societies
- Original focus on guidance, education, recognition
- Evaluated first engineering degree programs in 1936
- Became Accreditation Board for Engineering and Technology (ABET) in 1980
- Became ABET, Inc. in 2005 with 28 member societies
- Currently accredits 3,100 programs at more than 670 colleges and universities in 24 countries

ABET Organization

- Board of Directors – approves policies, procedures, and accreditation criteria
- ABET Commissions – propose policies, procedures, and criteria; deliberate and make accreditation decisions for programs
  - Engineering Accreditation Commission (EAC)
  - Computing Accreditation Commission (CAC)
  - Technology Accreditation Commission (TAC)
  - Applied Science Accreditation Commission (ASAC)
- Professional Societies provide Program Evaluators and Program Criteria
- Goal is assurance of quality improvement in applied science, computing, engineering, and technology education
- ABET accredits programs, not institutions

USMA ABET Accreditation

- Four programs initially accredited in 1985 (with introduction of majors into curriculum)
  - Civil Engineering
  - Electrical Engineering
  - Engineering Management
  - Mechanical Engineering
- Three programs initially accredited in 1997
  - Computer Science
  - Environmental Engineering
  - Systems Engineering
- Two programs initially accredited in 2008
  - Information Technology
  - Nuclear Engineering
- One program initially accredited in 2015
  - Chemical Engineering (retroactive to class of 2013)

ABET Processes & Procedures

There are nine individual criteria used as the core of determining program accreditation:

– the *first eight are common*

and

– the *last is program-specific* – this criterion defines disciplinary differences between programs

ABET Criteria

I. General Criteria for Baccalaureate Level Programs

1. Students
2. Program Educational Objectives
3. Student Outcomes
4. Continuous Improvement
5. Curriculum
6. Faculty
7. Facilities
8. Support

III. Program Criteria

– Curriculum – Basic Math and Science; design, analysis and control; hazards associated with processes

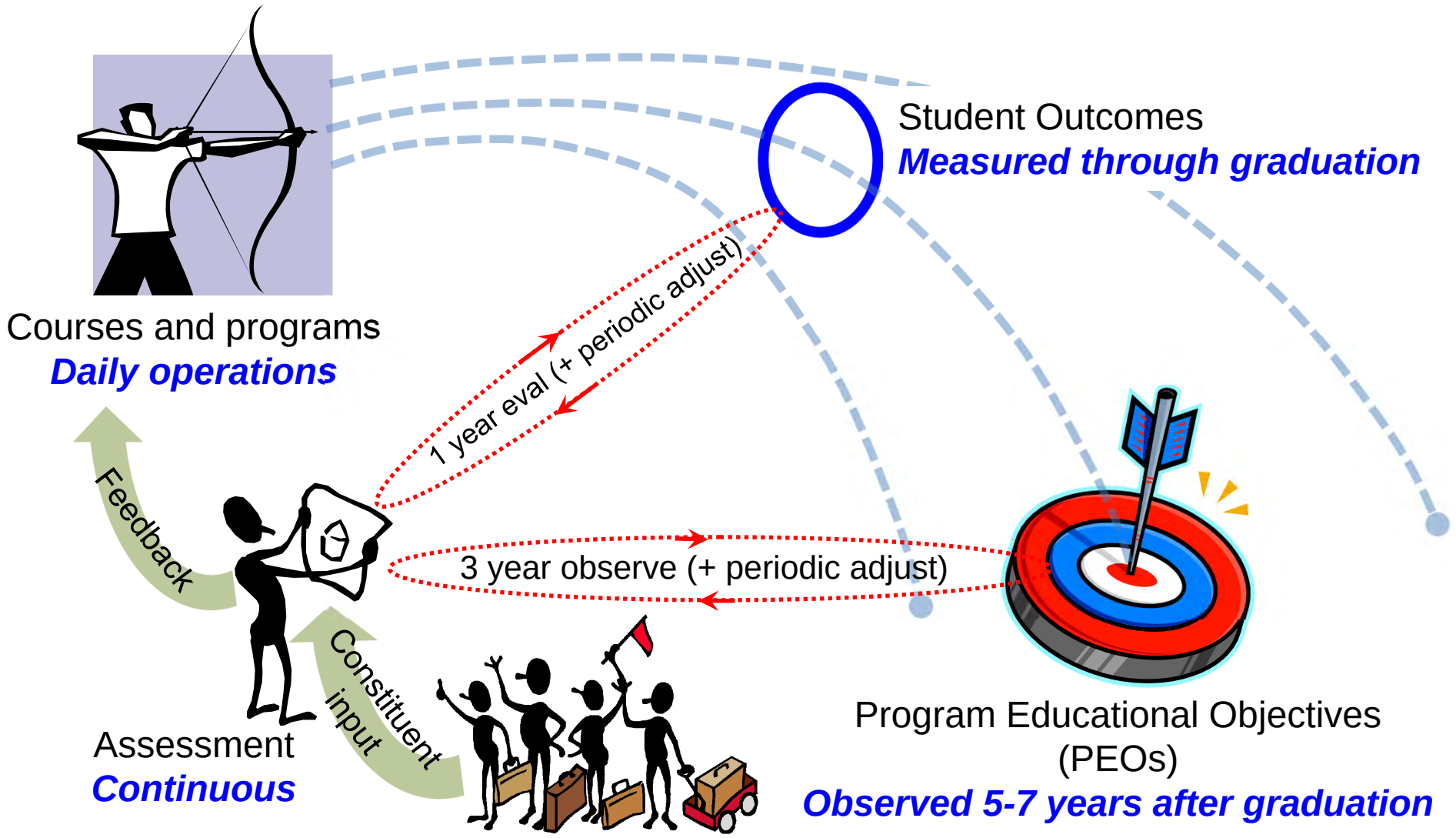
Harmonized Criteria

Terms You Should Know

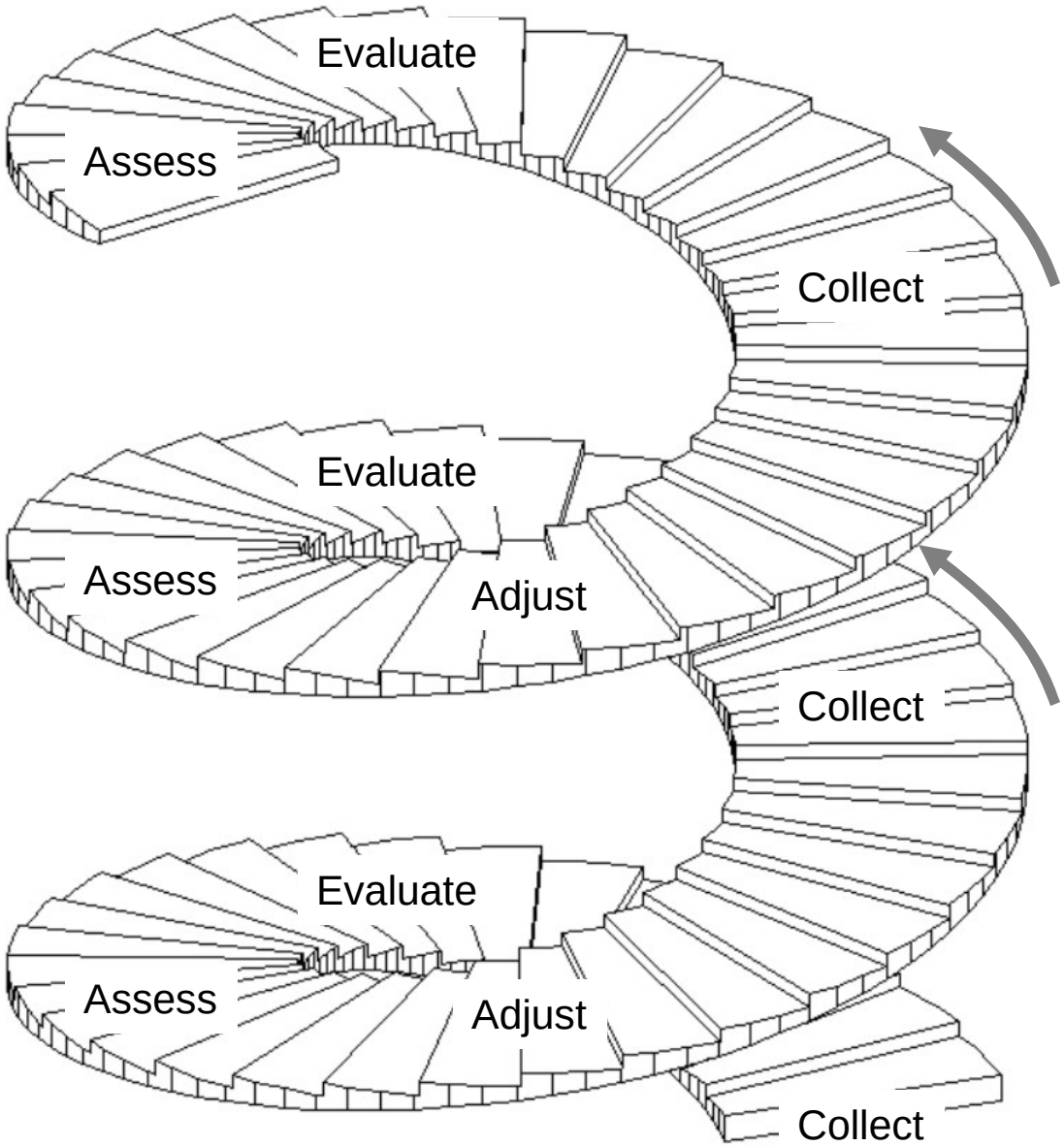
- **Program Educational Objectives (PEOs)**
  - Gleaned by asking *program constituents*
    - For us: Army, profession, graduate schools, other
  - **Our external *Advisory Board* a key resource.**
  - Desired professional accomplishments of graduates **5-7 years after graduation**
  - Adjust every 3 years or so…

- **Student Outcomes**
  - What students should be able to do **at graduation**
  - Must be **measurable**
  - Designed to lead naturally to the PEOs
  - Assess/evaluate some fraction yearly.
- **Assessment → Continuous improvement**
  - Collect meaningful data to evaluate performance indicators (PIs)
  - Assess PIs for outcome attainment → information → COAs for change
  - Implement change
  - Assess its effects and level of success ("closing the loop")
  - Repeat all the above
  - Periodically check and adjust both Student Outcomes and PEOs

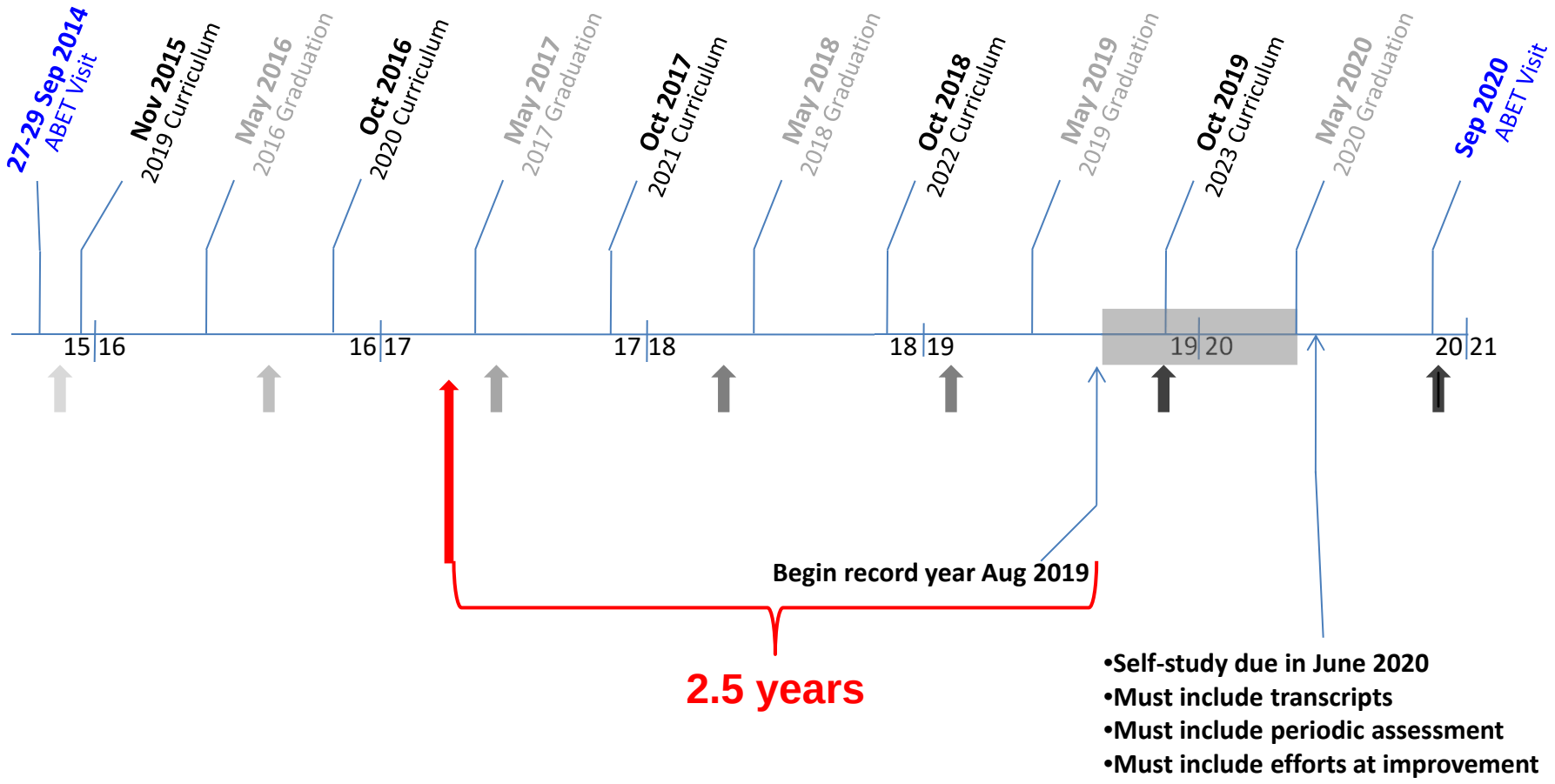
Assessment → Improvement



Assessment Cycle



Timeline for Curricular Actions



Advisory Board Findings

Excerpts from Minutes of 4-5 November 2014

• The USMA program satisfies Army requirements while complying with ABET guidelines.

• As a result of the review of student course grade performance, student performance on the FE exam, and survey results of graduating seniors and graduated Army officers, we find the curriculum amply satisfies the ABET and USMA program objectives.

• Program provides a comprehensive student immersion in chemical engineering theory and practice.

• Cadets felt that the more generic aspects of a chemical engineering education would likely be useful within their first 5 years of active duty

- there remain questions about specific chemical engineering practice areas in the Army in general, and especially within the first 5 years of active duty service.

Advisory Board Findings

Excerpts from Minutes of 8 April 2016

• The USMA program satisfies ABET requirements while meeting the mission and vision of both the Army and the Academy.

• ChE courses required at USMA cover the spectrum of topics relevant to ChE practice, both within the Army and in the private sector.

• The USMA cadets interviewed are the finest group of young people the Board members individually and collectively have been privileged to meet.

• The Chemistry and Life Sciences department has been diligent in assessing conformance to objectives, and has a demonstrated track record in continuously improving the program.

• The enrichment opportunities afforded by summer internships are outstanding.

Advisory Board Opportunities for Improvements

Excerpts from Minutes of 8 April 2016

• There are problems in the course content and applications in the process controls course. Cadets report a perception of the course being too theoretical, inadequate in practical applications, and focused on mechanical controls and robotics, rather than process industry controls

• More effective technical communication training should be provided. Consideration of a technical writing course (CH300) would improve the program, and should also cover the effective visual display of technical information (Edward Tufte program).

• The proposed bioengineering concentration is important, and should incorporate topics that other schools have determined to be important in their bioengineering concentrations that were established years ago.

End of Section 1

Chemical Engineering

Advisory Board Meeting

14 April 2017

2. Program Assessment

United States Military Academy
Department of Chemistry and Life Science

Student Outcomes

Identical to ABET a-k as described on slide 11

On completion of the chemical engineering program, our graduates will be able to:	
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.

Student Outcomes

Additional outcomes articulated by the program as described on slide 11

12. The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, including:	
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.

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

***Not including prerequisites**

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

***Not including prerequisites**

Assessment

CHEME Coursework Embedded Indicators

MECHE Coursework Embedded Indicators

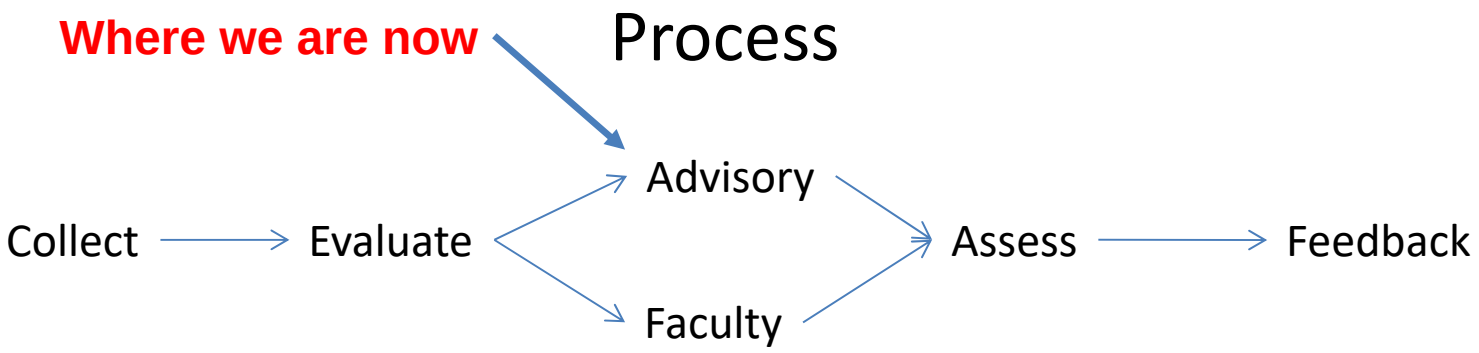
Fundamentals of Engineering Exam Topics

Participation in FE Exam (not pass rate)

Student end of semester surveys

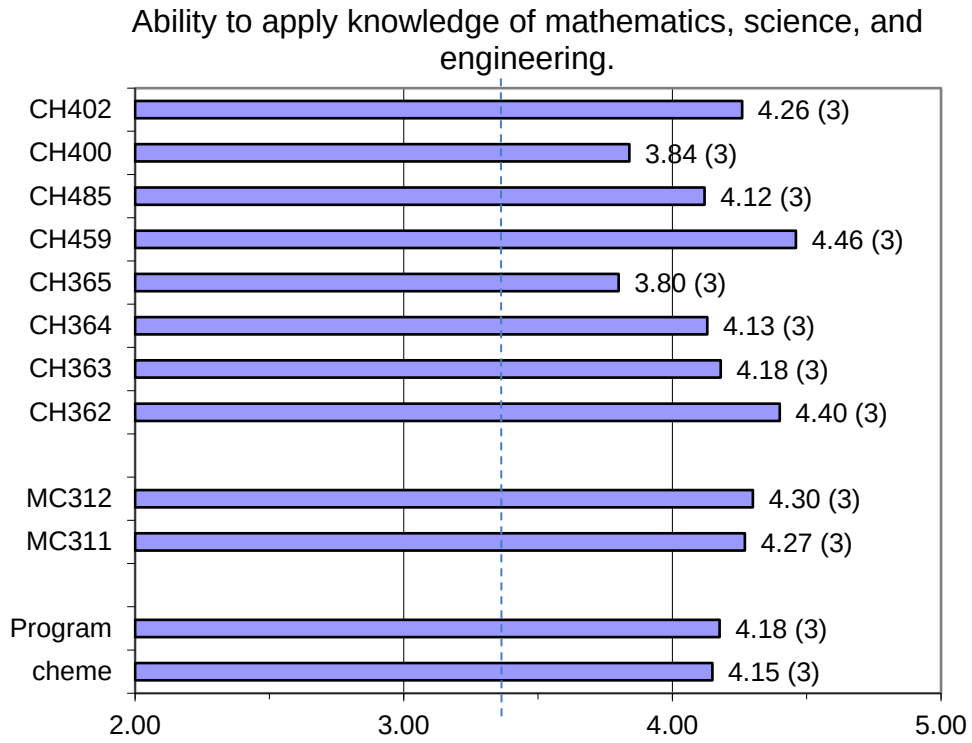
Student CHEME Program Exit Surveys

Course Grades



Example Data: Coursework Embedded Indicators

Student Outcome 1

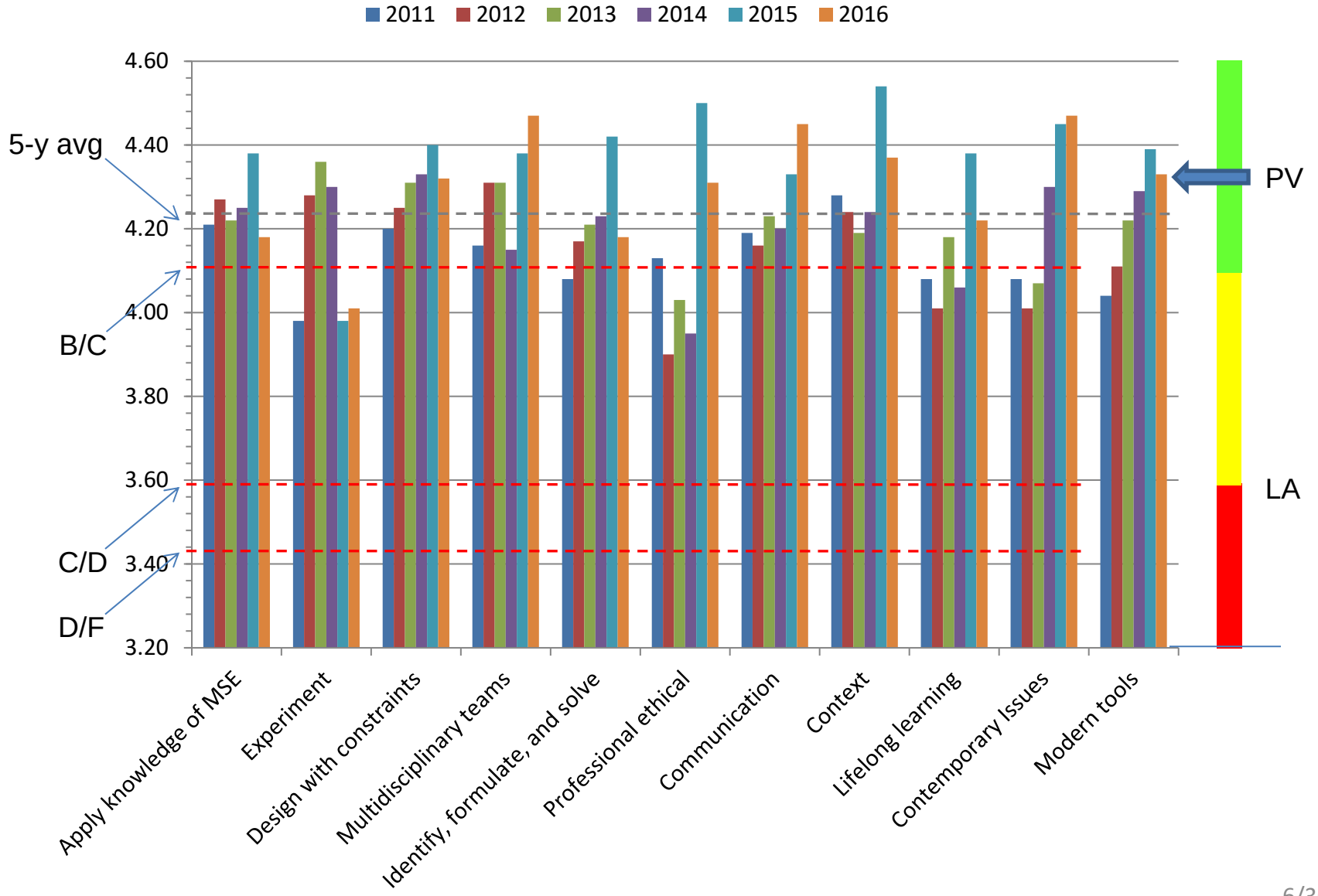


Values in parentheses are coverage ratings from Table 5-3 in the Self Study, page 5-9

Data shown here is for Class of 2016
Similar data is collected for all 11 ABET outcomes

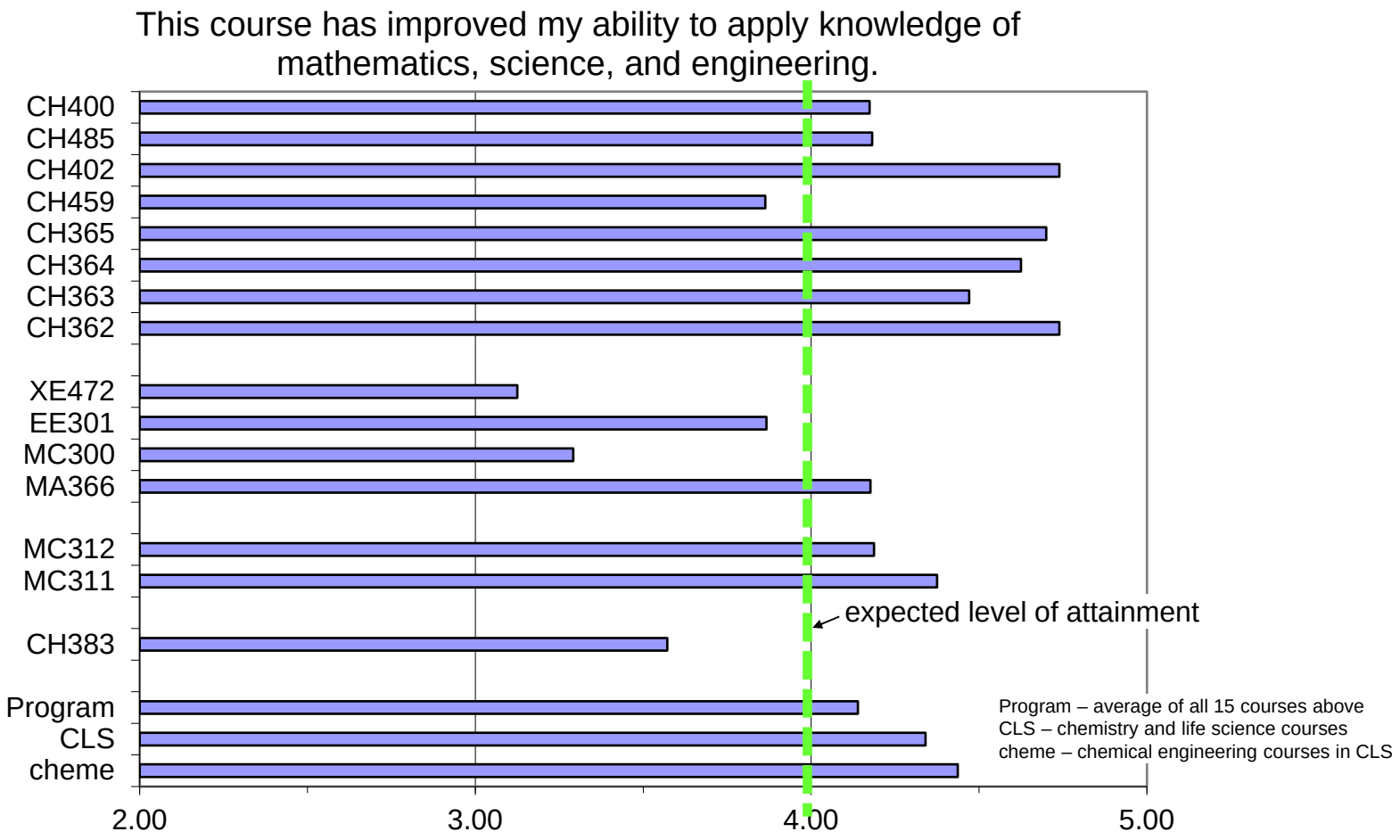
Performance on Embedded Indicators

Program Averages AY2011 to AY2016



Example Data: End-of-Semester Surveys

Student Outcome 1

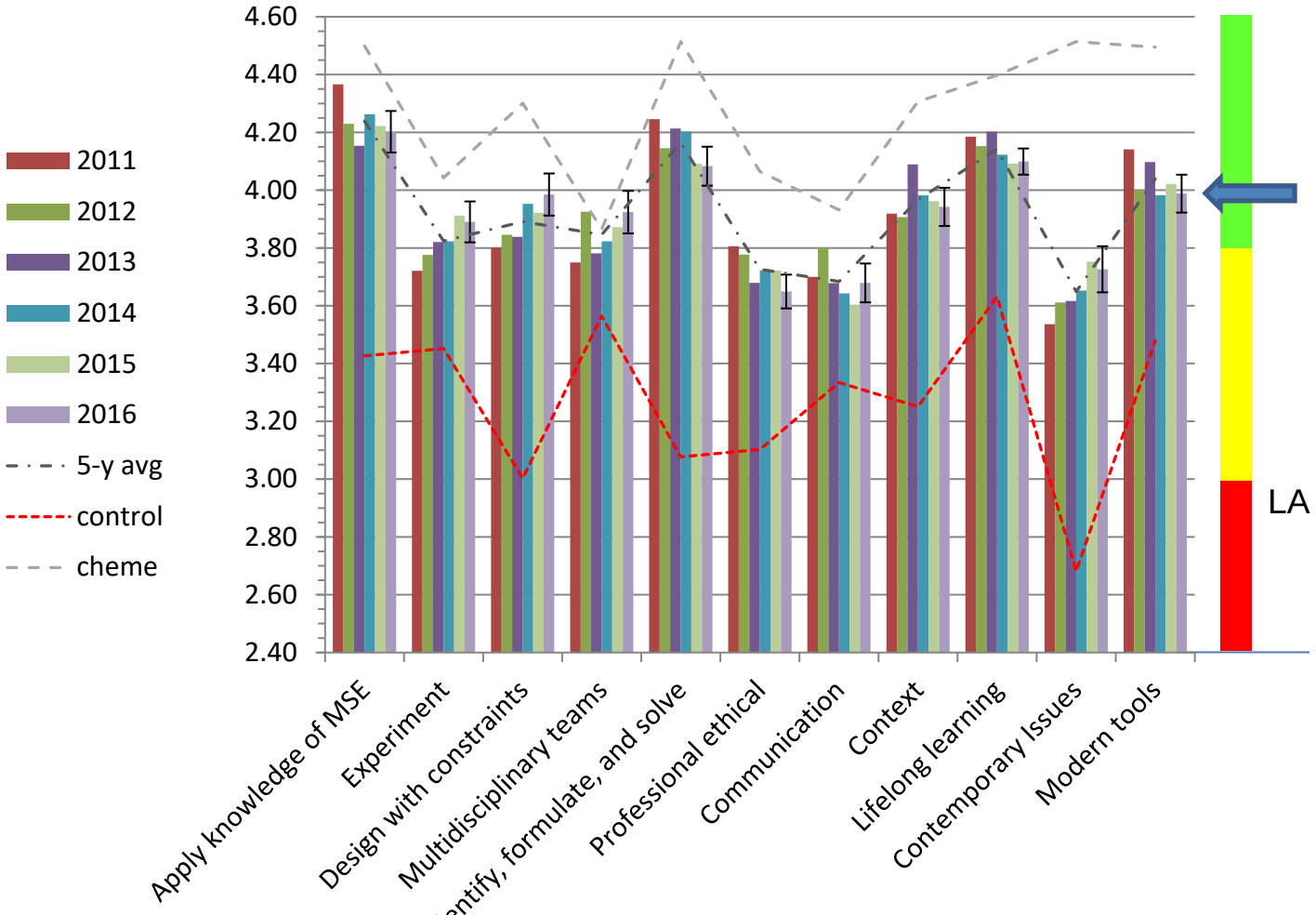


Data shown here is for Class of 2016

Similar data is collected for all 11 ABET outcomes

End-of-Semester Surveys

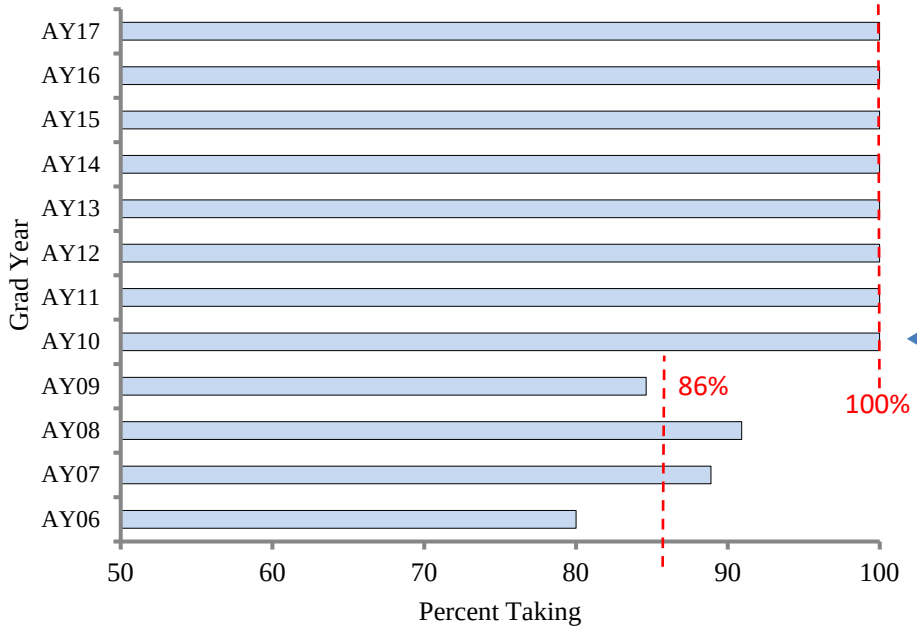
Normalized Program Averages from AY11-16



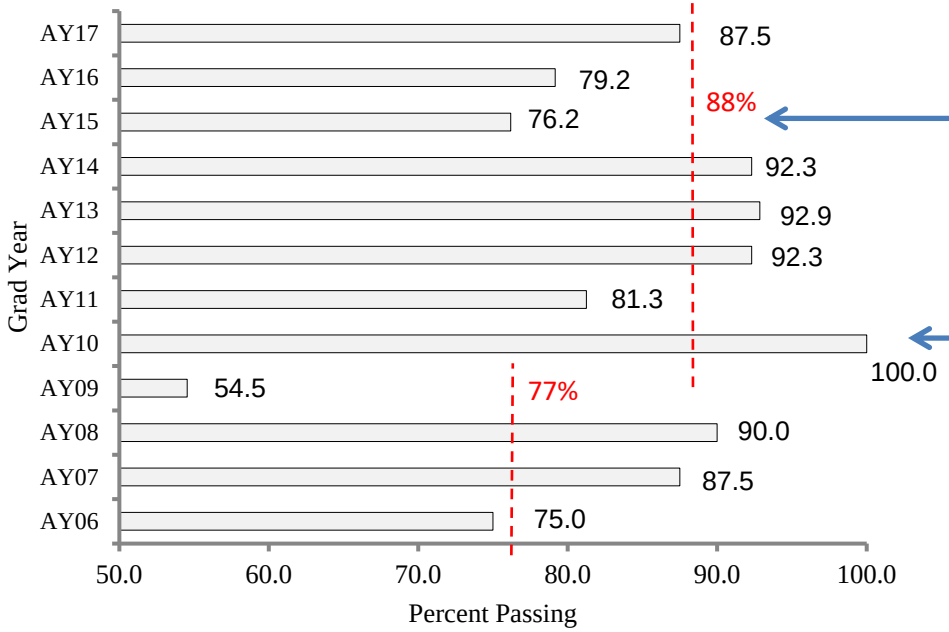
Fundamentals of Engineering Exam

Outcome 9: Recognizing the Need and Develop the Skills for Life-long Learning

Percent taking



Percent passing



CH400 Initiated

Electronic Testing

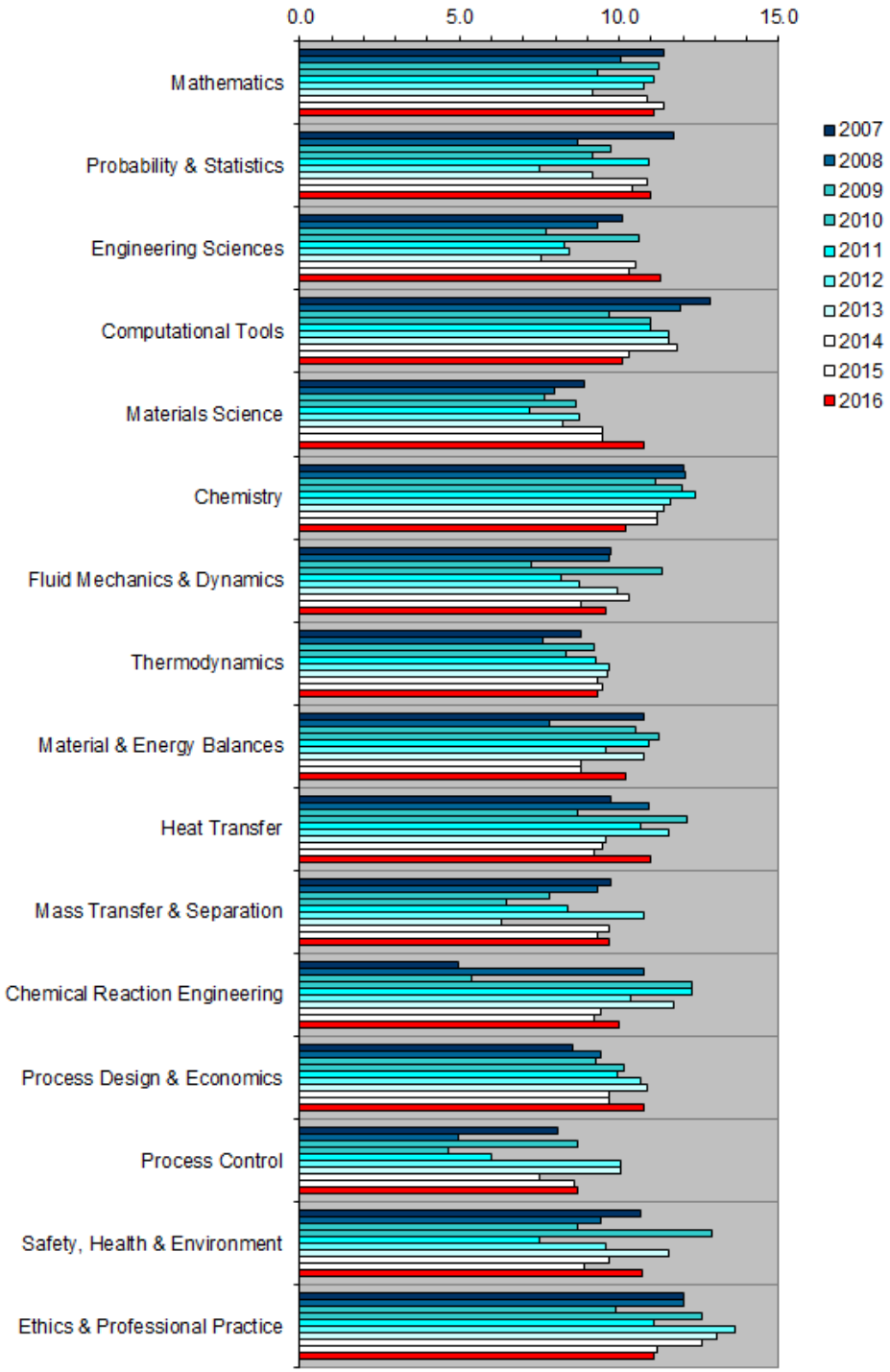
National, (+/- ~1%):

2016	79.0%
2015	77.4%
2014	89.0%
2013	86.3%
2012	85.1%
2011	87.0%
2010	87.0%
2009	84.0%
2008	87.0%
2007	87.0%
2006	87.0%

Outcome 12 Evaluation

Performance Indicators AY07 to AY16

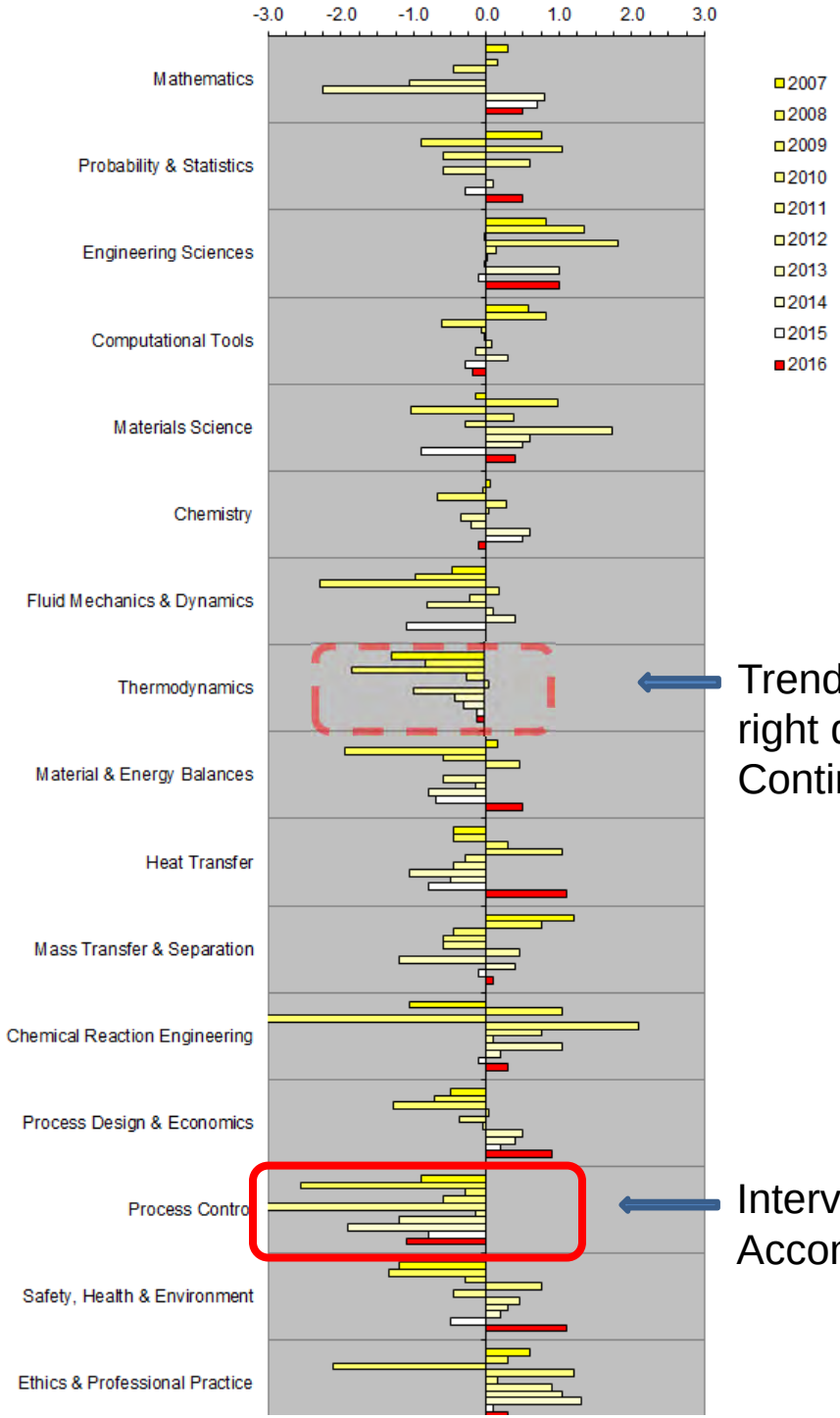
FEE Results



Year-to-year variations in the difficulty of the exam are accounted for by normalizing with national average (next slide).

Topical Outcomes Evaluation

Deviations from National Averages AY07 to AY16

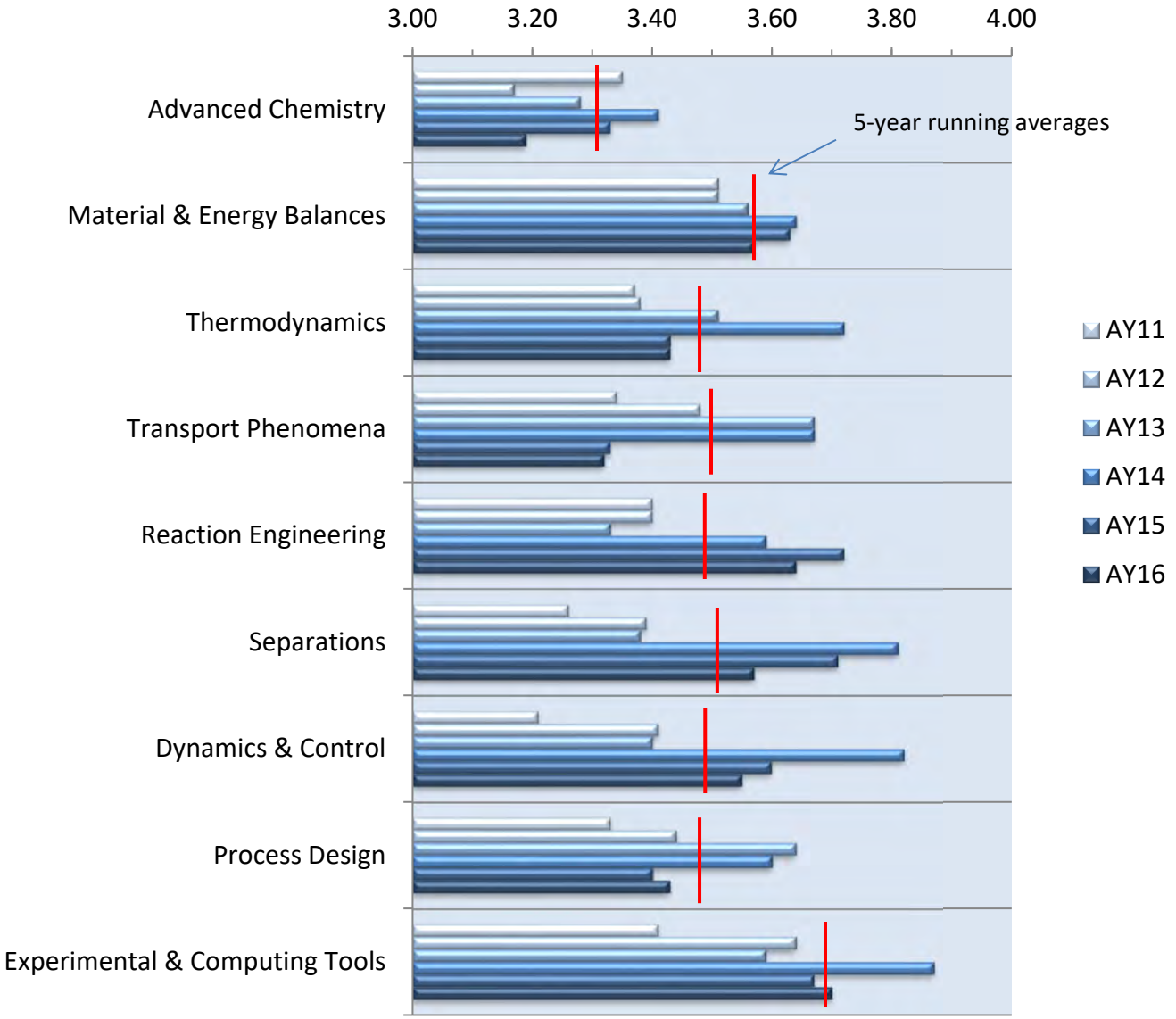


Trending in the right direction. Continue to track.

Intervention Accomplished

Topical Outcomes Evaluation

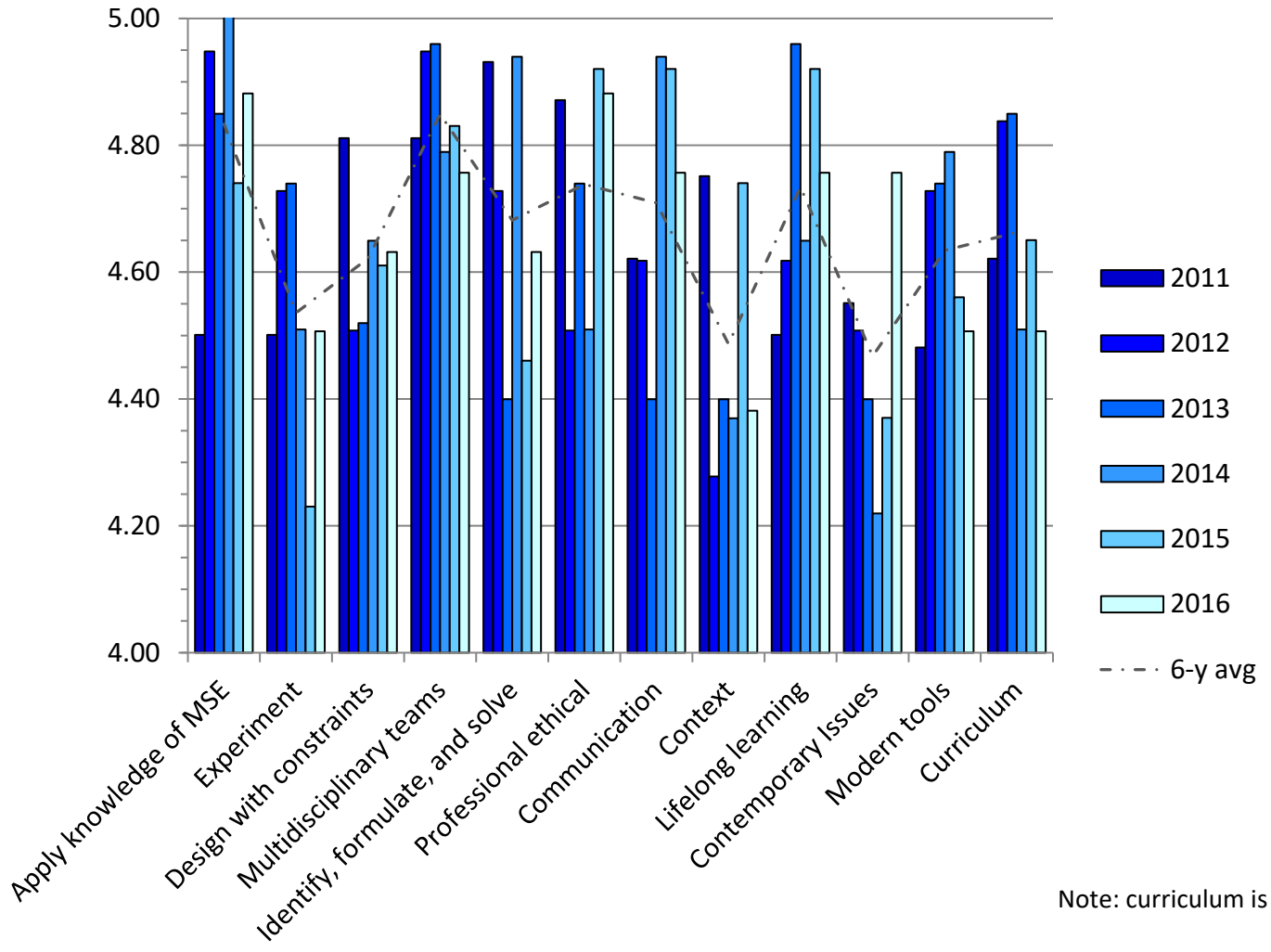
Average Course GPA from Transcripts, AY2011 to AY2016



Advisory Board Student Outcomes Surveys

Normalized Program Averages from AY10-16

Data are normalized to compensate your year-to-year fluctuations in the survey average.

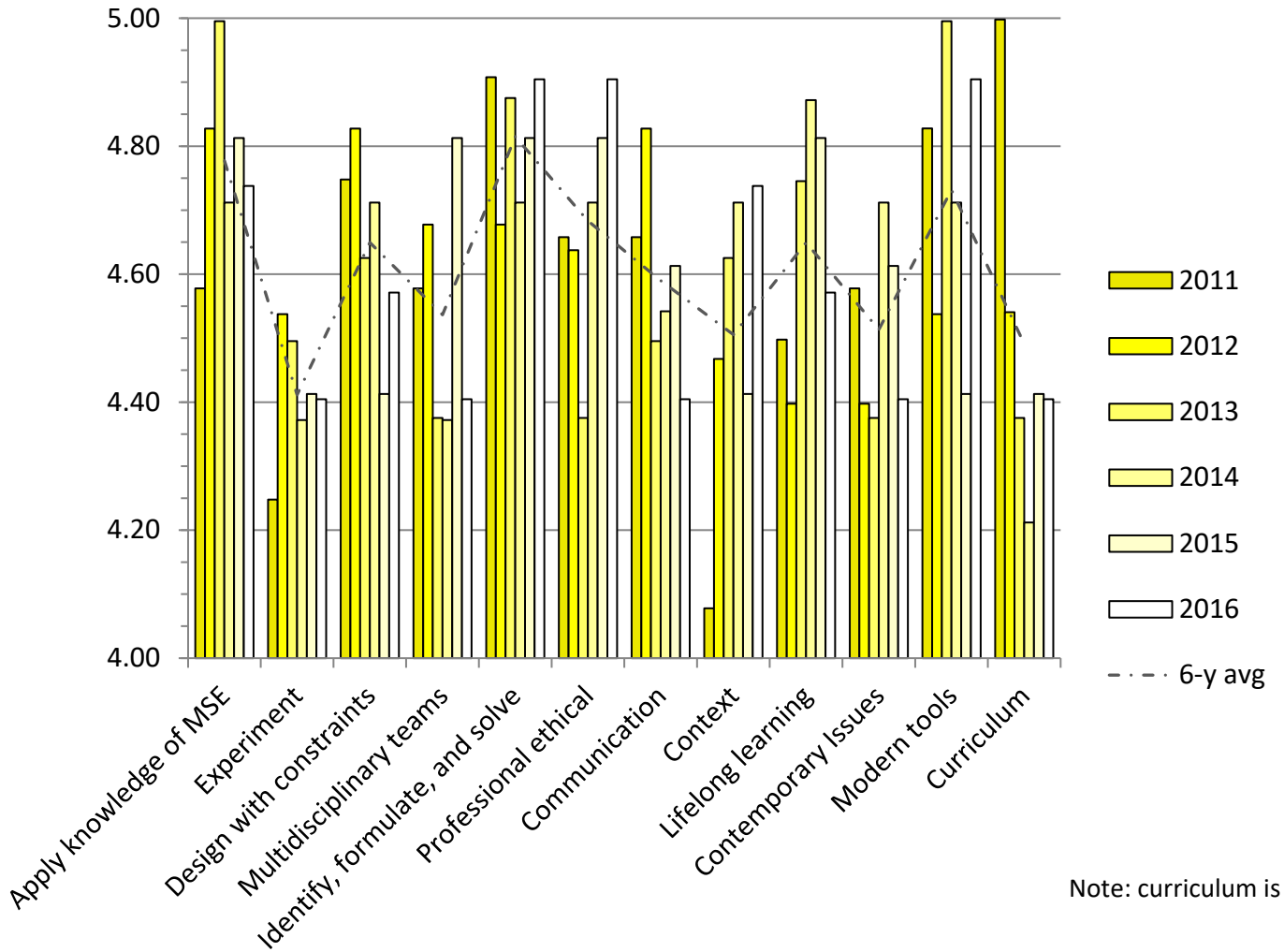


Note: curriculum is outcome 12

Faculty Student Outcomes Surveys

Normalized Program Averages from AY10-16

Data are normalized to compensate your year-to-year fluctuations in the survey average.



Note: curriculum is outcome 12

Advisory Board Completes Survey Part 1

ABET Criterion 2: Objectives

The program must have published program educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies, and these criteria.

There must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of these program educational objectives that ensures they remain consistent with the institutional mission, the program's constituents' needs, and these criteria.

(ABET EAC Criteria)

Program Objectives (Current Redbook)

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

1. Contribute to the solution of infrastructure and operational problems in a complex operational environment.

2. Succeed in graduate school or advanced study programs.

3. Advance their careers through clear and precise technical communication.

4. Demonstrate effective leadership and chemical engineering expertise.

Program Objectives (Current Redbook)

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.

Advisory Board Recommended: October 2012

Assessment Instruments for Objectives

Program Surveys

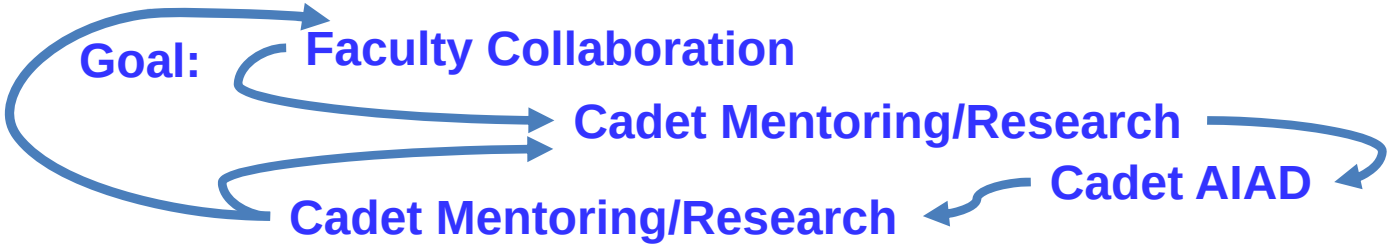
Program Advisory Board Surveys
Program Faculty Surveys
Program Cadet Surveys

Strategy going forward:

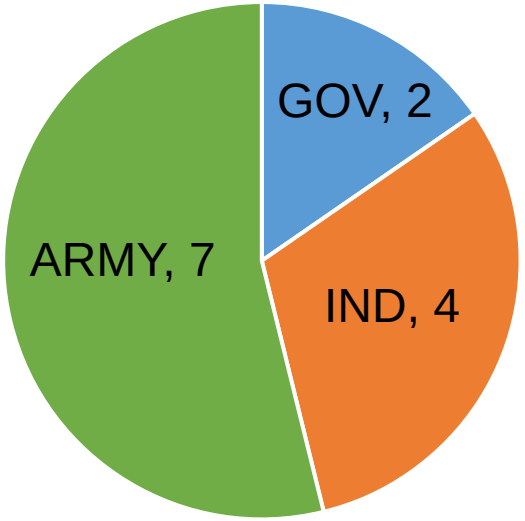
Assess consistency with the mission of the institution and the needs of the constituencies improve objectives.

Enrichment Opportunities

Advanced Individual Academic Development (AIAD)



- Lawrence Livermore National Lab
- Sandia National Lab
- Army Research Labs
- Picatinny Arsenal
- BAE Systems – Radford AAP
- BAE Systems – Holston AAP
- Southern Polymer
- Uniform Color Company
- Renewable Energy Group



13 fully funded internships
16+ available

CHEME AIADS 2017

	IAD(A)	CADET	PN_ID	DEPARTMENT	LOCATION
1	14213	INZINGA, CHRISTOPHER	C30716521	Chemistry & Life Science	RADFORD VA, UNITED STATES
2	14213	MAHR, HUGH	C46490071	Chemistry & Life Science	RADFORD VA, UNITED STATES
3	14213	ONAKA, KENJI	C47915105	Chemistry & Life Science	KINGSPORT TN UNITED STATES
4	14214	PONTIUS, DAVID	C13282792	Chemistry & Life Science	RENEWABLE ENERGY GROUP
5	14214	SCHWARZMAN, SARAH	C57499315	Chemistry & Life Science	RENEWABLE ENERGY GROUP
6	14214	MARTIN, JACQUELINE	C58907922	Chemistry & Life Science	RENEWABLE ENERGY GROUP
7	14215	COOPER, LAUREN	C75124712	Chemistry & Life Science	AUDIA, WASHINGTON PENN
8	14216	NIEHOF, ROBERT	C81482975	Chemistry & Life Science	PICATINNY ARSENAL, NEW JERSEY
9	14217	MEDICI, FRANK	C17179951	Chemistry & Life Science	AUDIA, SOUTHERN POLYMER
10	14217	RABBIA, DANIEL	C39375125	Chemistry & Life Science	AUDIA, SOUTHERN POLYMER
11	14219	PALMER, JESSE	C06769786	Chemistry & Life Science	ARL ADELPHI, MARYLAND
12	14219	BURNS, ALVIN	C20528450	Chemistry & Life Science	ARL ADELPHI, MARYLAND
13	14219	HARKINS, SAWYER	C54449973	Chemistry & Life Science	ARL ADELPHI, MARYLAND
14	14219	MORTIMER, DADE	C91580900	Chemistry & Life Science	ARL ADELPHI, MARYLAND
15	14212	BUI, JACK		PANE	LLNL
16	14212	SOWATZKE, ZACH		PANE	SANDIA

Advisory Board Completes Survey Part 2

Chemical Engineering

Advisory Board Meeting

14 April 2017

3. Introduction to Automatic Process Control

United States Military Academy
Department of Chemistry and Life Science

Former Proposed Change 1

CH367 Introduction to Automatic Process Control

~~CH366~~ Chemical Engineering Process Control

Accomplished!

- Key potential shortcoming in response to assessment of chemical engineering control theory is apparent in the data.

- Demonstrated effort at continuous program improvement is critical to ABET accreditation (Criterion 4).

- Making this change is not a silver bullet (does not guarantee accreditation). But, it does demonstrate we are responding to the data.

- Loss of XE472 and interdisciplinary nature of program is a concern.

Intimately connected with assessment. Having collected data over a long period of time, response to data is critical. This rationale for creating and altering courses was pivotal in last ABET visit.

Brief on CH367 Status

Lunch – West Point Club

http://www.westpointmwr.com/club/index.html

Chemical Engineering

Advisory Board Meeting

14 April 2017

4. Future Challenges

United States Military Academy
Department of Chemistry and Life Science

Academic Excellence

#1 Most Accessible Professors

#2 Best College Library

#2 Top Public Schools (Liberal Arts)

#3 Best Undergrad Engineering Program

#4 Civil Engineering Program

#7 Mechanical Engineering Program

#19 National Liberal Arts College

#1 Public College in the country

#6 Liberal Arts Universities

#11 In the Northeast

#14 Overall College in the country

Strategic Influence

Governmental Strategic Guidance
- President
- Congress
- Department of Defense
- Government Agencies (e.g., NSA, FBI, CIA, …)

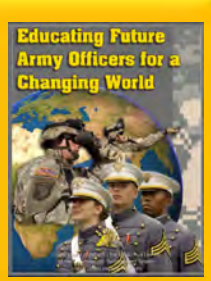
Department of the Army
- Army Goals and Priorities
- Army Regulations
- Army Doctrine

Higher Education Communities
- Professional Societies
- Accreditation Agencies
- Best Practices
- Peer Institutions

West Point Mission and Strategic Plan

Academic Program Vision and Strategic Plan

Academic Program Goals



- Core Courses
- Academic Majors
- Enrichment Experiences

Chemical Engineering Faculty

Can we support critical courses?

	AY17	AY18	AY19	AY20	AY21	AY22
Biaglow	X	X	X	X	X	X
Lachance	a	a	?	?	?	?
Winter	X					
Bull	X	X	?	?		
Kalainoff	b	b	b	?	?	?
Armstrong	X	X	X	X	X	?
White	X	X	X			
Onwuanumkpe	X	X	X			
Nagelli	X	X	X	X	X	X
James		X	?	X	X	X
Miller, A.		X	X	X		
Pfluger			X	X	X	
Corrigan			X	X	X	
Totals	9	10	9	7	6	3+

a – available to teach; currently in registrar's office
b – available to teach; currently acting department deputy

? – uncertain status

Current Curriculum

CEN1 - Class of 2020

4th Class Year Fall Term	Spring Term	3rd Class Year Fall Term	Spring Term	2nd Class Year Fall Term	Spring Term	1st Class Year Fall Term	Spring Term
E **MA103** 4.0	*E* **MA104** 4.5	*E* **MA205** 4.5	*R* **CH362** 3.5	*R* **EE301** 3.5	*D* **MC300** 3.0	*D,R* **CH459** 3.5	**CH402** 3.0
/D **EV203/ CH101** 4.0	*D/R* **CH101/ PH205** 4.0	*R* **PH205/ PH206** 4.0	*R/* **PH206/ EV203** 4.0	*R* **CH363** 3.5	*R* **CH364** 3.5	**CH365** 3.0	**CH400** 1.5
EN101 3.0	**EN102** 3.0	*R* **CH102** 4	**MA366** 3.0	*R* **CH383** 3.5	**MC312** 3.0	*R* **CH485** 3.5	**Engr Elective** 3.0
IT105 3.0	**PL100** 3.0	*E* **DFL1** 4.0	**PY201** 3.0	*D* **MC311** 3.5	**CH367** 3.0	**Engr Elective** 3.0	*D* **LW403** 3.5
HI105 3.0	**HI108** 3.0	*R* **SS201** 3.5	*E* **DFL2** 4.0	**MA206** 3.0	**SS307** 3.0	**Engr Elective** 3.0	*R* **HI302** 3.0
			R **SS202** 3.5	**PL300** 3.0			**MX400** 3.0

We began the major with 5 chemical engineering courses taught in the department.

With advisory board support, we now have **nine**.

Chemical Engineering

United States Military Academy

Example Schedule for Chemical Engineering, Classes of 2020 and Beyond**

Fall Term	Course		Credit	Spring	Course		Credit
4th CLASS			Hours	Term			Hours
MA103	Math. Modeling & Intro. Calculus		4.5	MA104	Calculus I		4.5
CH101	General Chemistry I		4.0	CH102	General Chemistry II		4.0
EN101	Composition		3.0	EN102	Literature		3.0
HI107	Western Civilization		3.0	HI108	Regional Studies in World History		3.0
IT105	Introduction to Computing & IT		3.0	PL100	General Psychology		3.0
PE11x	Combatives / Boxing / Movement		0.5	MS100	Introduction to Warfighting		1.5
				PE150	Fundamentals/Personal Fitness		1.5
3rd CLASS		Total	18.0			Total	20.5
MA205	Calculus II		4.0	*CH362*	*Mass and Energy Balances*		*3.5*
PH205	Physics I		4.0	*MA366*	*Applied Engineering Math*		*3.0*
Lx203	Foreign Language		4.0	PH206	Physics II		4.0
SS201	Economics		3.0	Lx204	Foreign Language		4.0
PY201	Philosophy		3.0	SS202	American Politics		3.0
MS200	Fundamentals: Army Operations		1.5	EV203	Physical Geography		3.0
				PE 2xx	Lifetime Physical Activity		0.5
2nd CLASS		Total	19.5			Total	21.0
CH363	*Separation Processes*		*3.5*	*CH364*	*Chemical Reaction Engineering*		*3.5*
EE301	*Fundamentals of Electrical Engineering*		*3.5*	*XE472*	*Dynamic Modeling and Control*		*3.0*
CH383	*Organic Chemistry 1*		*3.5*	*ME312*	*Thermal-Fluid Systems 2*		*3.0*
MC311	*Thermal-Fluid Systems 1*		*3.5*	*MC300*	*Fundamentals of Eng. Mech. & Design*		*3.0*
PL300	Military Leadership		3.0	*Elective*	*Engineering Elective 1*		*3.0*
MA206	Probability and Statistics		3.0	MS300	Platoon Operations		1.5
PE32x	Survival Swimming		0.5	PE360	Combat Applications		0.5
1st CLASS		Total	20.5			Total	17.5
CH459	*Chemical Engineering Laboratory*		*3.5*	*CH402*	*Chemical Engineering Process Design*		*3.5*
CH365	*Chemical Engineering Thermodynamics*		*3.0*	*CH400*	*Chemical Engineering Prof. Practice*		*1.5*
CH485	*Heat & Mass Transfer*		*3.5*	*Elective*	*Engineering Elective 3*		*3.0*
Elective	*Engineering Elective 2*		*3.0*	HI302	History of the Military Art		3.0
SS307	International Relations		3.0	LW403	Constitutional & Military Law		3.0
PE450	Army Fitness Development		1.5	MX400	Officership		3.0
		Total	17.5			Total	17.0

** Desired 8TAP

15 Required Courses

Mass and Energy Balances (CH362):
Introduction to chemical engineering calculations.

Vector Calculus and Introduction to Partial Differential Equations (MA366):
Mathematical techniques needed for the study of chemical engineering electives.

Organic Chemistry I (CH383):
Introduction to reaction mechanisms and structure-function relationships in organic molecules.

Fundamentals of Electrical Engineering (EE301):
Introduces electrical circuit theory and analysis.

Thermal-Fluid Systems I and II (MC311 & MC312):
Integrated study of thermodynamics and fluid systems.

Chemical Reaction Engineering (CH364):
Teaches selection, design, and operation of chemical reactors.

Introduction to Automatic Process Control (CH367):
Introduction to dynamic modeling and control of engineering linear systems.

Fundamentals of Engineering Mechanics and Design (MC300):
Study of deformable engineering structures such as trusses, frames, and vessels.

Chemical Engineering Thermodynamics (CH365):
Expands on the specific thermodynamic properties of chemical reactions.

Chemical Engineering Laboratory (CH459):
Provides laboratory experience in operating large chemical processes.

Heat and Mass Transfer (CH485):
Introduces the mathematical modeling of heat and mass movement.

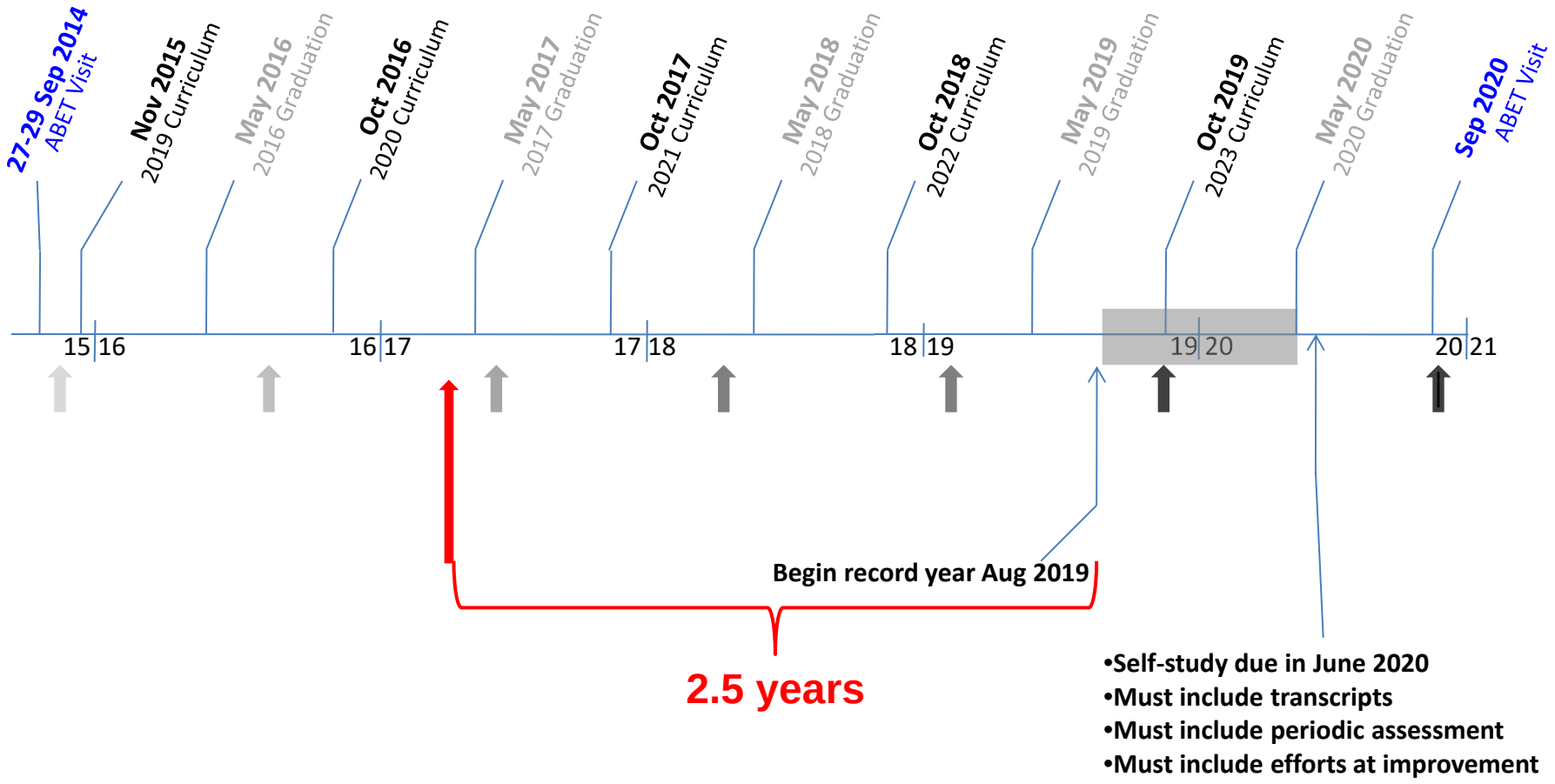
Chemical Engineering Process Design (CH402):
Introduction to the concept of chemical processes and design.

Chemical Engineering Seminar (CH400):
Helps cadets prepare for the FE Exam and introduction to the practice of chemical engineering.

Recent Curriculum Changes and Ongoing Impact

- Plebes choose majors prior to Spring Break
  - Additional administrative requirements
  - **Trend of more changes of major (both into and out of)**
- Removal of EN302 and HI301 core courses
  - More electives required for validations
  - 'Writing Across the Curriculum'
- MA205, CH102, PH206 no longer required core courses
  - remain prerequisites for chemical engineering courses
- Introduction of CH275 – Introductory Biology
  - Acceptable alternative to CH102?
- 'Flexible' science scheduling
  - Ordering of prerequisites – program has no control

Timeline for Curricular Actions



Proposed Curriculum Change 1

CH300 Technical Writing

- Response to curriculum changes.

- Perceived shortcoming in cadet writing ability across the Corps

- Dean is currently requiring us to sacrifice technical content from one of our courses to address perceived shortcoming.

- Opportunity for us to engage in engineering-specific communication skills
    - USMA objective
    - ABET Criterion
    - PROGRAM Objective (advisory board)

Apparently unconnected with program assessment. Anecdotal evidence driving the assessment at USMA level. This approach has some risks associated with ABET. However, our choices are limited and we would like to make the best of it.

Proposed Curriculum Change 2

Addition of CH401 Chemical Engineering Design Principles

Assign 3.0 credit hours in AY2019

Reason - bolster the USMA chemical engineering performance on design principles in embedded indicators

Precedent - Parity with other USMA programs

1. EE400 – EE Professional Considerations
2. CS400 – Computer Science Seminar
3. MX400 – Officership

Proposed Curriculum Change 3

CH359 Engineering Measurements

- Response to observations in CH459.
- Improvements needed in cadet understanding of basic measurements and measuring devices.
- Improvement needed in cadet understanding of measurement error.
- Opportunity for us to enhance the controls thread.
- Opportunity to fill hole left by removal of CH371 Analytical Chemistry (2010).

Electives Proposals

- Cadets have expressed ongoing interest in more chemical engineering electives
- Currently have 3 engineering electives in our major (to meet ABET requirements)
- Possible (probable?) upcoming ABET change to Criteria 3 & 5 may lower the required number of strictly engineering credit hours
  - This may allow some flexibility for cadets
  - A few potential options
  - What sorts of ChE electives would be most useful?

Engineering Concentrations

Pre-approved elective sequences,
but ultimately cadet choice (can choose any 3)

Materials Engineering
MC364 Mechanics of Materials
MC380 Engineering Materials
Open Elective

Nuclear Engineering
NE300 Nuclear Reactor Analysis
NE350 Nuclear Reactor Design
NE450 Nuclear Systems Design

Decision Analysis
SE301 Foundations of Engineering Design & Systems Management
SE 481 Systems Simulation
EM484 Dynamic Systems Analysis

Advanced Control Systems
EE360 Digital Computer Logic
EM484 Dynamic Systems Analysis
XE475 Mechatronics

Energy Conversion Systems
EE377 Electrical Power Generation
ME472 Energy Conversion Systems
ME480 Heat Transfer

Power Systems
ME306 Dynamics
ME491 Mechanical Power Plants
EE377 Electrical Power Generation
XE442 Alternative Energy Engineering

Industrial Engineering
SE301 Foundations of Engineering Design & Systems Management
EM411 Project Management
EM420 Production Operations Management

Other Advanced Engineering Electives
Satisfy prerequisites
Engineering Science or design = 3.0 credits
Program director approval

Proposed Bioengineering Electives

- Proposed courses as a potential Engineering Sequence
  - Meet engineering sequence requirement for life scientists
  - Electives for chemical engineers
  - Initial proposal (working DRAFTS)
    - Modeling and Analysis of Biological Systems
    - Forces, Fields, and Flows in Biological Systems
    - Biological Systems Design

Other Electives

- Numerical Methods for Chemical Engineering Problems
  - Enhance cadet experience with calculational tools (MMA, Matlab)
  - Ready to execute
- Chemical Explosives
  - Taught before, ready to execute with instructor prep
- If ABET criteria change…
  - Allow (mandate?) an additional chemistry elective? (Orgo II? Analytical? Biology? Polymers? PChem?)

Proposal

- Proposal:
  - Increase the pool of advisory board members
  - Rotate on-site visiting members on bi-annual basis (i.e., visit ~every other year)
- Rationale:
  - Ease traveling for board members
  - New/broader/different experiences for interface with cadets
  - Some cost efficiencies (couldn't support larger pool every year)

Some Administrative

- Next Advisory Board on-site
  - Late April/Early May 2018
  - Coincide with USMA Projects Day – invite 1-2 board members to come a day early and participate as a judge?
- Travel Paperwork
- Tour of Unit Operations Lab – now operational

End of Section 4

Revised

Chemical Engineering

Advisory Board Meeting

14 April 2017

5. Supplemental Slides

United States Military Academy
Department of Chemistry and Life Science

ABET Criterion 2: Objectives

Change as of 2013-2014:

~~The program must have an assessment and evaluation process that periodically documents and demonstrates the degree to which the objectives are attained.~~

No longer required.

NEEDED?

(ABET EAC Criteria)

Accreditation AAR

- Self-study review and Q&A 15 June to 27 September.
- Site visit 28-30 September
  - Document audit
  - Tour of facilities
  - Interviews
- The review process went *extremely well*
  - No shortcomings in program – completely “clean”
  - Very impressed with curriculum, cadets, faculty, and facilities
  - Positive feedback to cadets
- Next level review – ABET “editors”
  - Review self-study and findings from visit
  - Recommendation in July 2015
  - Backdate accreditation to October 2012
- PEV feedback was that we should streamline our student outcomes

Topical (Criterion "9") Outcomes Evaluation

FE Exam Pass Rates for USMA Engineers in the Graduating Class of 2012

Discipline-Specific Results Reported by the National Council for Engineering Education

Fundamentals of Engineering Exam 6 April 2013

	USMA			National		
Major	**Took**	**Passed**	**Percent**	**Took**	**Passed**	**Percent**
Mechanical	66	54	82%	5406	4468	83%
Civil	44	42	95%	5312	6638	80%
Electrical	25	22	88%	1060	1472	72%
Eng. Management	43	27	63%	53	33	62%
Systems	47	39	83%	53	43	81%
Chemical	***12***	***11***	***92%***	***1507***	***1301***	***86%***
Environmental	17	17	100%	629	551	88%
Nuclear[a]	14	12	86%	18	16	89%

Slide taken out in revised slides?

[a] No discipline-specific exam offered.

USMA engineers scored at or above the national average in all disciplines.

Student Outcomes 12-20

Analysis of Transcripts (Course Grades for Chemical Engineers)

Slide removed?

0-4 “GPA” scale

Course ⌀	Advanced Chemistry	Material & Energy Bal.	Thermodynamics	Transport	Reaction Engineering	Separations	Dynamics & Control	Process Design	Experiment & Compute
CH383 Organic Chemistry I	3.05								
CH481 Physical Chemistry I	3.77		3.77						
CH362 Mass & Energy Balances		3.64							
CH363 Separation Processes						3.72			
CH364 Chem. Reaction					3.28				
CH459 Chem. Laboratory									3.87
CH485 Heat and Mass Transfer				3.77					
CH400 Chemical Engineering Sem.			3.90		3.90	3.90	3.90		
CH402 Chem. Process Des.								3.23	
MA366 Engineering Math									
MC311 Thermal-Fluid Systems I			3.64	3.64					
MC312 Thermal-Fluid Systems II			3.59	3.59					
MC300 Fund. Eng. Mech. & Des.									
EE301 Intro. to Electrical Engineering									
XE472 Modeling & Control							3.44		
Average Grade 2014	3.41	3.64	3.72	3.67	3.59	3.81	3.82	3.23	3.87
Standard Deviation 2014	0.66	0.67	0.60	0.52	0.51	0.42	0.48	0.61	0.44

Survey of Chemical Engineering Curricula

(Internal Study, July – Aug 2012; Occhlogross & Rosa, *J. Chem. Eng. Ed.,* Sum 1996, pp. 184-187)

What the other guys are doing.

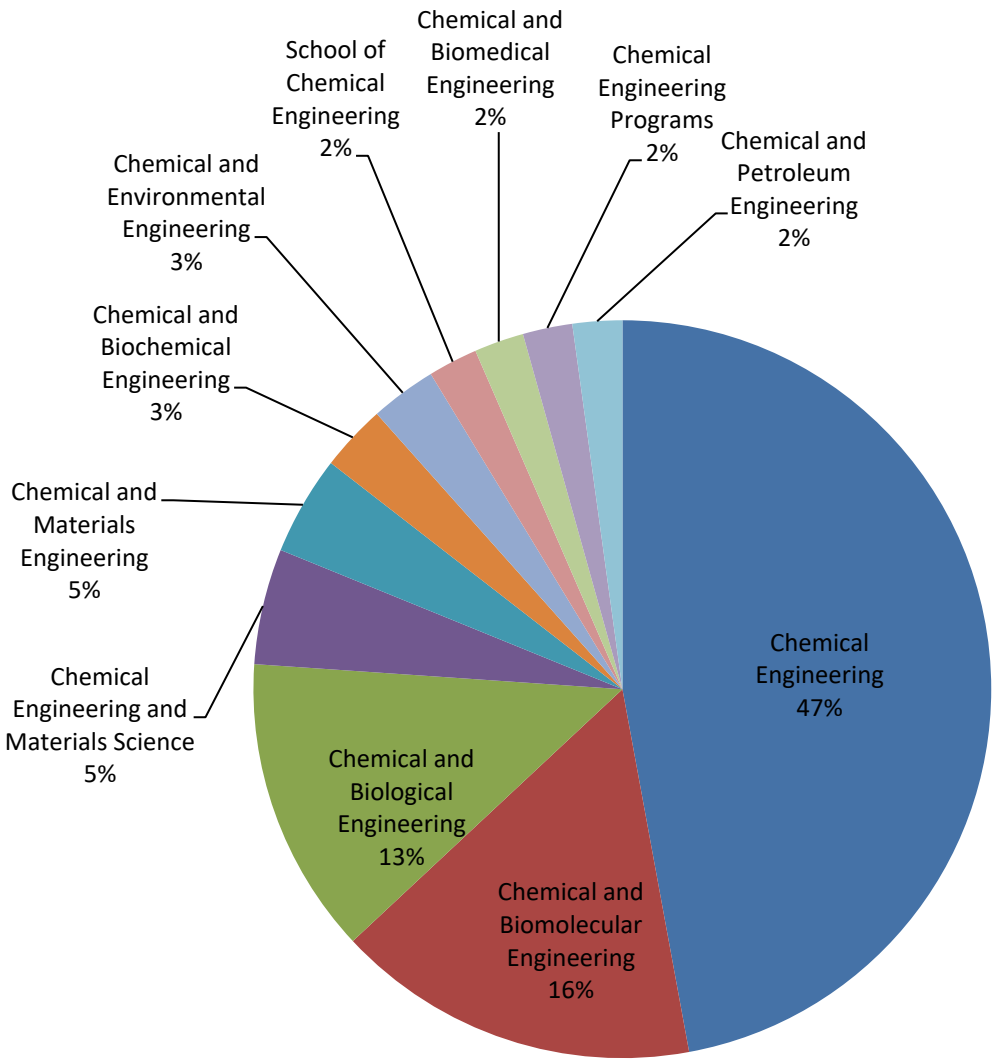
Summary Statistics	
Programs in Survey	159
Programs in USA [a,b]	159
Percent Surveyed	100
States in Survey [a]	52
States with Programs	49
States without Programs	3
Percent of States Surveyed	100

[a] Includes Puerto Rico and the District of Columbia
[b] ABET lists 160 programs.

All programs are different and each is designed for the constituency of the program.

Program Benchmarking

What do department call themselves?



Summary Stats	
Programs in Survey:	159
Programs in USA[a,b]	159
% Surveyed:	100
States[a] in Survey:	52
States[a] w/ Programs:	49
States[a] w/o Programs:	3
% States Surveyed:	100

[a]Includes DC & Puerto Rico

[b]160 programs are listed in ABET

ChemE "National" Curriculum

Course / Content	National, 1994[a]	National, 2012	USMA
Design	4.9	5.7	3.5
Laboratory	3.7	4.1	3.5
Reactor Design	1.9	3.1	3.5
Separations	3.2	3.0	3.5
Control	2.3	3.0	3.0
Material & Energy Balances	3.6	3.6	3.5
Transport Phenomena	11.7	6.3	7.0
Chemical Engineering Thermodynamics	4.2	4.8	3.5
Chemistry (excl. Phys. Chem.)	19.0	14.7	10.5
Physical Chemistry	6.4	3.0	3.5
Physics	7.7	7.7	7.0
Mathematics (through ODEs)	14.5	14.8	16.5
Computers / Programming	3.6	2.4	3.0
Statistics	3.0	1.0	3.0
Electrical Engineering	3.8	1.0	3.5
Civil Engineering	3.8	0.9	3.0

mode: 0.0 (47)

[a] Ronald N. Occhiogrosso and Banita Rana, *J. Chem. Eng. Ed.,* 184-187 (Summer 1996)

Cadet Enrollment in USMA Academic Majors

ABET Departments Only, Class of 2016, as of January 2014

Major	Number
Mechanical Engineering	117
Systems Engineering	79
Computer Science	64
Civil Engineering	38
Life Science	35
Systems Design and Management	32
Chemical Engineering	**30**
Electrical Engineering	28
Environmental Engineering	26
Engineering Management (GE)	24
Human Geography	23
Physics	22
Environmental Science	16
Kinesiology	16
Nuclear Engineering	14
Information Technology	13
Geospatial Information Science	12
Chemistry	7
Engineering Management (CE)	7
Engineering Management (ENV)	7
Engineering Management (ME)	6
Interdisciplinary Science	5
Elec & Info Tech Sys	4
Environmental Geography	4
Engineering Management (EE)	2
Engineering Management (NE)	1

ABET Criteria

1. STUDENTS
2. PROGRAM EDUCATIONAL OBJECTIVES
3. PROGRAM OUTCOMES
4. CONTINUOUS IMPROVEMENT
5. CURRICULUM
6. FACULTY
7. FACILITIES
8. SUPPORT
9. PROGRAM CRITERIA

(ABET EAC Criteria)

Definitions

Program Educational Objectives

Program educational objectives are broad statements that describe what graduates are expected to attain within a few years of graduation.

Student Outcomes

Student outcomes describe what students are expected to know and be able to do by the time of graduation (skills, knowledge, and behaviors).

(ABET EAC Criteria)

Outcomes

- Program outcomes are ABET a-k outcomes plus any additional outcomes articulated by the program

- Program must have assessment and evaluation process that periodically demonstrates and documents the degree to which outcomes are attained

(ABET EAC Criteria)

End of Section 5 (Supplements)

Revised

Chemical Engineering

Advisory Board Meeting

8 April 2016

6. Old Supplemental Slides

United States Military Academy
Department of Chemistry and Life Science

ABET Table 5-1

Semester	Course Number and Descritption	Category (Credit Hours) Math and Basic	Engineering Check if contains		General Educatio	Other
1	MA103 Math Modeling/Intro Calculus	4.0		( )		
	CH101 General Chemistry I	3.5		( )		
	EN101 Composition			( )		3.0
	HI10x History			( )		3.0
	PL100 General Psychology			( )		3.0
	PE11x Combatives/Boxing/Movement			( )		0.5
	MD101 4th Class Military Perf I			( )		
2	MA104 Calculus I	4.5		( )		
	CH102 General Chemistry II	3.5		( )		
	EN102 Literature			( )		3.0
	HI10x History			( )		3.0
	IT105 Intro to Computing and IT		0.5	( )		2.5
	MS100 Introduction to Warfighting			( )		1.5
	MD102 4th Class Military Perf II			( )		
3	MA205 Calculus II	4.5		( )		
	PH201 Physics I	3.5		( )		
	Lx203 Foreign Language I			( )		3.5
	SS201 Economics			( )		3.5
	PY201 Philosophy			( )		3.0
	PE215 Fundamentals/Personal			( )		1.5
	MS200 Fundamentals: Army			( )		1.5
	MD201 3rd Class Military Perf I			( )		
4	MA366 Appl. Engineering	2.0	1.0	( )		
	CH362 Mass & Energy Balances		3.5	( )		
	PH202 Physics II	3.5		( )		
	Lx204 Foreign Language II			( )		3.5
	SS202 American Politics			( )		3.5
	EV203 Physical Geography	2.5		( )		0.5
	PE2xx Lifetime Physical Activity			( )		0.5
	MD202 3rd Class Military Perform. II			( )		
5	CH363 Separation Processes		3.5	(√)		
	EE301 Fund of Electrical Engineering		3.5	( )		
	CH383 Organic Chemistry I	3.5		( )		
	MC311 Thermal-Fluid Systems I		3.5	(√)		
	MA206 Probability and Statistics	2.5	0.5	( )		
	PL300 Military Leadership			( )		3.0
	PE320 Survival Swimming			( )		0.5
	MS300 Platoon Operations			( )		1.5
	MD301 2nd Class Military Perf I					
6	CH364 Chemical Reaction		3.5	(√)		
	XE472 Dynamic Modeling & Control		3.0	( )		
	Engineering Elective 1		3.0	( )		
	MC312 Thermal-Fluid Systems II		3.0	( )		
	MC300 Fund of Engr Mech & Dsn		3.0	(√)		
	EN302 Advanced Composition			( )		3.0
	PE360 Combat Applications			( )		0.5
	MD302 2nd Class Military Perf II					
7	CH459 Chem Engr Laboratory		3.5	(√)		
	CH481 Physical Chemistry I	3.5		(√)		
	Engineering Elective 2		3.0	( )		
	CH485 Heat and Mass Transfer		3.5	( )		
	HI301 Military History I			( )		3.0
	PE450 Army Fitness Development			( )		1.5
	MX400 Officership			( )		2.0
	MD401 1st Class Military Perf I					
8	CH402 Chem Eng Process Design		3.5	(√)		
	CH400 Chem Eng Professional		1.0	( )		
	Engineering Elective 3		3.0	( )		
	SS307 International Relations			( )		3.5
	HI302 Military History II			( )		3.0
	LW403 Constitutional/Military Law			( )		3.5
	MD402 1st Class Military Perf II			( )		
Totals - ABET Basic Level Requirements:		32.0	48.0		0.0	65.5
	Total Credit Hours:	41.0	49.0		Min. if all 3.0 electives	
	155.5					
	Percent of Total:	26.4%	31.5%		0.0%	42.1%
Values must satisfy one set	Minumum Credit Hours	32 Hours	48 Hours			
	Percent of Total:	25.0%	37.5%			

Shoring up engineering credits

- adding CH365
- increasing CH400 to 1.5 credits
- extensive internal review

ABET-Proofing our Split Credit Courses

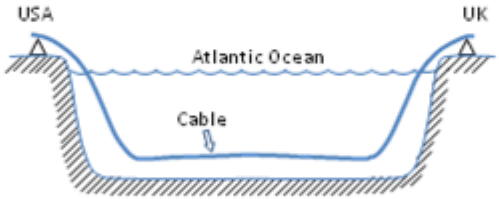
Fundamental Question – Are These Safe?

- Program evaluator (PEV) will see us at 49.0 versus 48.0 ET.
- Split-credit courses are an ABET red flag issue. MA366, MA206, and IT105 are all at risk.
- Pool of ABET PEVs is diverse (education, employment, background, etc.)
    - Can we model the evaluation process using the advisory board?
- Design a method for quantifying the risk.
- Summer ET-credit test survey.

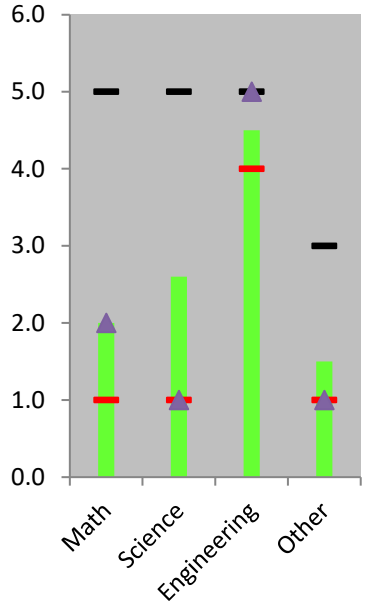
Assessing Engineering Content

Instructions for Part 2: This survey contains several problems. Your job is to assess whether the primary theme of the problem is mathematics, basic science, or engineering. Following each problem is a short survey. For each problem, read the problem and then complete the survey. Darken the box under the term that most accurately describes your opinion regarding that response. Use your best judgment in making the assessment. There are absolutely no right or wrong answers.

1. An insulated cable placed in the Atlantic Ocean connecting the United States to the United Kingdom is used for telecommunications. Symptoms develop in the operation of the cable indicating the possibility that a hole may have formed in the insulation. Discuss possible methods for finding (i) whether or not a hole has in fact formed, and (ii) the location of the hole, if it exists.



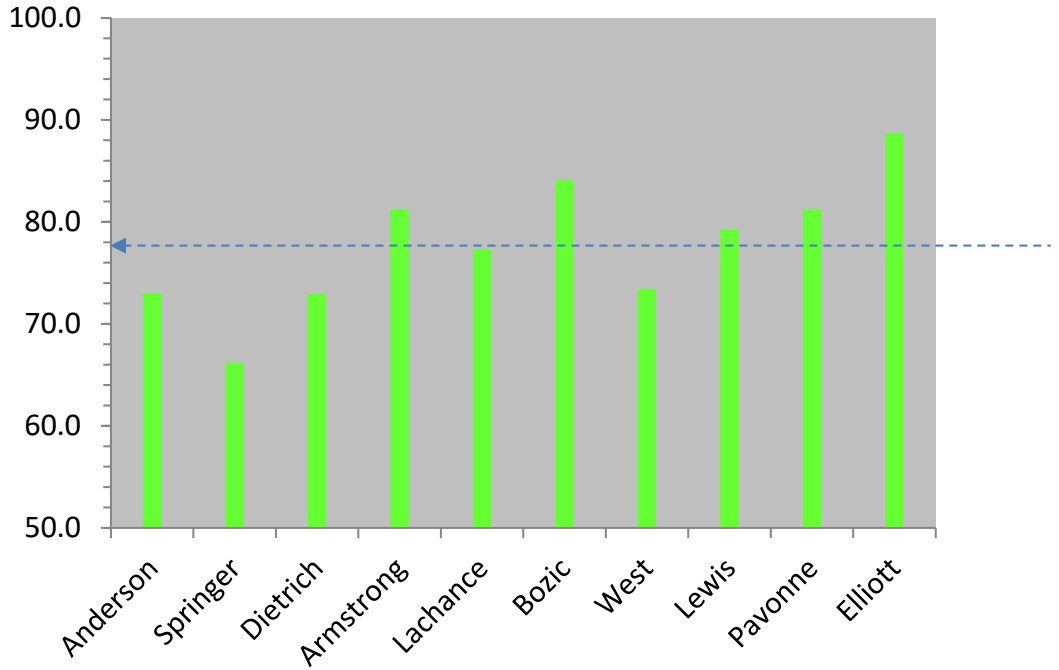
	Great extent		Moderate		Not at all
To what extent is this a mathematics problem?	☐	☐	☐	☐	☐
To what extent is this a basic science problem?	☐	☐	☐	☐	☐
To what extent is an engineering problem?	☐	☐	☐	☐	☐
To what extent is this some other type of problems?	☐	☐	☐	☐	☐



5=great extent

Comparing the Assessments

Author's intention versus reader's perception



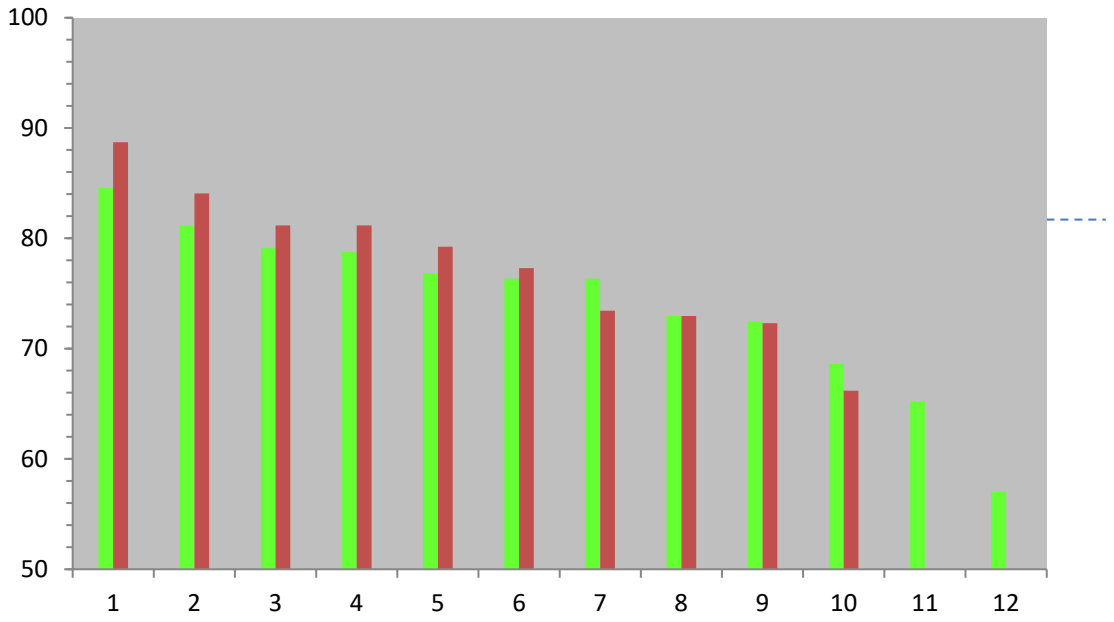
-1 for each 1-point deviation from instructor's answer.

For example, if the instructor answered 5 and you answered 4, 1 pt. was deducted for that response.

Total points determined from total possible cuts.

Comparing the Assessments

Author's intention versus reader's perception



-1 for each 1-point deviation from instructor's answer.

For example, if the instructor answered 5 and you answered 4, 1 pt. was deducted for that response.

Total points determined from total possible cuts.

ABET-Proofing our Split Credit Courses

Conclusions

•A good program evaluator (PEV) will examine book and background of faculty in addition to course content.

•At this time, USMA process (ABET Committee) involves course content only.

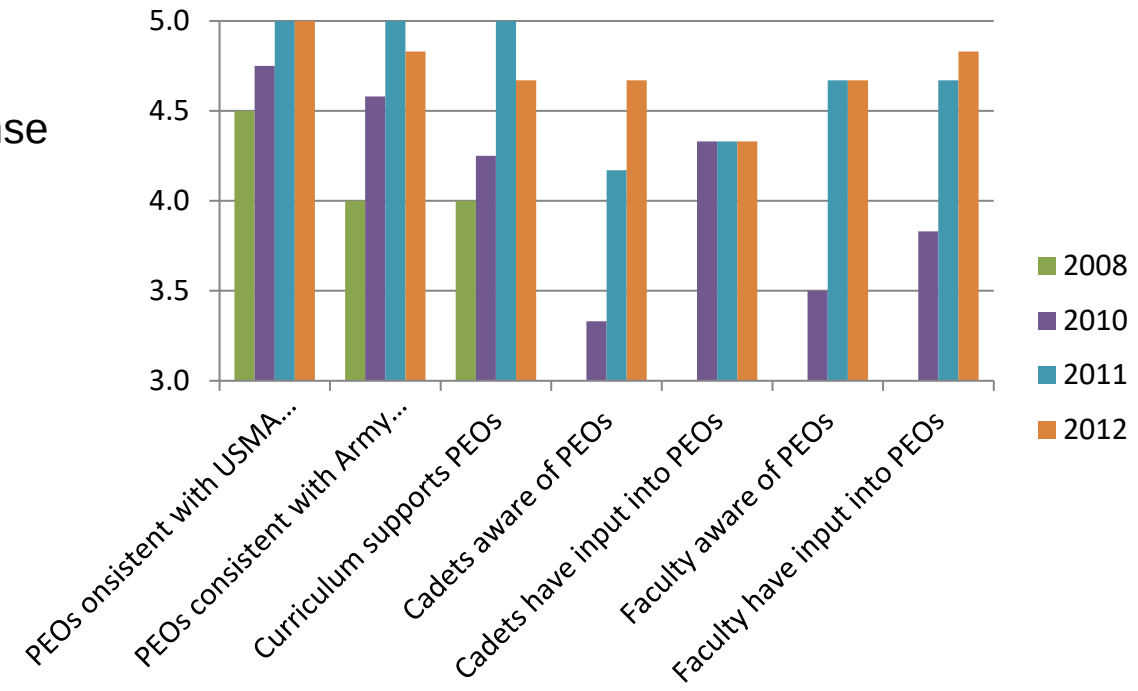
•Interest in continuing this study, imperfect as it is? If so, need volunteers to examine MA366.

•Long-term fix is to not use split credit hours (challenging with 26 core courses).

How Faculty View the PEO Process?

Faculty are another key constituency.

Faculty Response



Funding Pipeline

	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14
R&U	$4,291.7	$3,431.0	$5,808.7	$4,521.3	$1,453.1	$1,188.0
S&M	$809.5	$931.0	$810.5	$965.6	$945.4	$889.8
OPS	$404.9	$316.9	$297.2	$267.5	$238.7	$289.8

Challenge 1 - ABET Bean Counting

ABET Self Study Table 5-1

Course	Required, Elective or Selected Elective (R, E or an SE)	*Subject Area (Credit Hours)*				Last Two Terms the Course was Offered	Maximum Section Enrollment for the Last Two Terms the Course was Offered[2]
		Math & Basic Sciences	Engineering Topics	General Education	Other		
Term 1 (Semester 1):							
MA103 Math Modeling/Intro Calculus	R	4.0				14-1, 14-2	19
CH101 General Chemistry I	R	3.5				14-1,14-2	20
EN101 Composition	R				3.0	14-1,14-2	18
HI10x History	R				3.0	14-1,14-2	18
PL100 General Psychology	R				3.0	14-1,14-2	19
PE11x Combatives/Boxing/Movement	R				0.5	14-1,14-2	44
IT105 Introduction to Computing & IT	R		0.5		2.5	14-1,14-2	18
MA366 Applied Engineering Math	R	2.0	1.0			13-2,14-2	18
MA206 Probability and Statistics	R	2.5	0.5			14-1,14-2	19
TOTALS-ABET BASIC-LEVEL REQUIREMENTS		41.0	49.5		66.5		
OVERALL TOTAL CREDIT HOURS	156.0						
PERCENT OF TOTAL		26.0	31.4		42.5		
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

52.5 in AY16

Career Counseling

Engineer

Year Group 2014

INTELLIGENCES: Interpersonal, Logical-Mathematical, Spatial

SKILLS: Engineer officers must possess an innate ability to evaluate and assess problems, the resident knowledge to brainstorm possibilities, and then quickly implement solutions to solve problems facing our maneuver commanders. This requires a design mindset – the ability to develop tasks and work processes for teams and motivate those teams to reach harmoniously, efficiently, and effectively desired outcomes. Officers must thrive in the world of abstract concepts and data-based reasoning, be able to discriminate and filter information of importance, and be capable of rapid visualization; all while skillfully possessing the ability to communicate concepts verbally or in writing. Collectively, these skills make Engineer officers superb problem solvers and invaluable to our Army and Nation.

KNOWLEDGE: The Engineer branch strongly desires officers with academic backgrounds in the domain-specific disciplines listed below, with particular emphasis on degrees that are accredited by the Accreditation Board for Engineering and Technology (ABET). These disciplines provide officers with a foundation in the scientific method that enhances their ability to become expert problem solvers.

- **RELEVANT EDUCATION PRIORITY 1:** ABET Engineering Majors (Civil, Mechanical, Electrical, Systems, Environmental, Chemical, Nuclear, Engineering Management, Computer Science, Information Technology).
- **RELEVANT EDUCATION PRIORITY 2:** Non-ABET Engineering; Science, Technology, and Mathematics (STEM) disciplines.
- **RELEVANT EDUCATION PRIORITY 3:** All other disciplines.
- **RELEVANT TRAINING/EXPERIENCE:** Cadet Troop Leading Time / Leader Development Time (CTLT / CLDT) with Engineer Unit or Academic Enrichment Program in engineering or related activity (not all inclusive).

BEHAVIORS: (In addition to foundational)

- **ADAPTABLE**
- **AMBITIOUS**
- **CHARISMATIC**
- **COMMITTED**
- **DEPENDABLE**
- **DETAIL FOCUSED**
- **DILIGENT**
- **EXPERT**
- **INNOVATIVE**
- **INSPIRING**
- **INTELLECTUALLY CURIOUS**
- **PERCEPTIVE**
- **PROACTIVE**
- **PROBLEM SOLVING**
- **TENACIOUS**
- **VISIONARY**

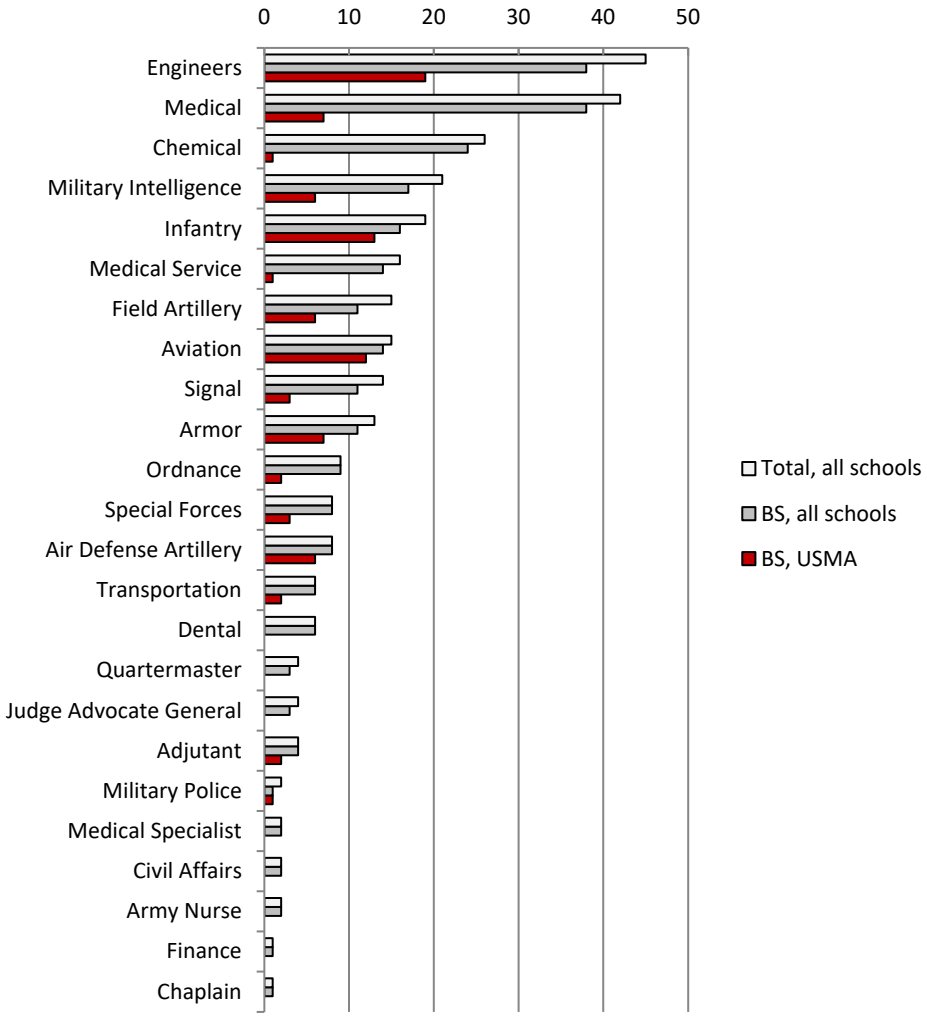
TALENT PRIORITIES:

1. **DOMAIN-SPECIFIC EDUCATION:** Possessing an engineering degree (ABET-preferred), high performers in science, technology, engineering, and math (STEM) disciplines.
2. **PROJECT MANAGER:** Able to determine requirements, develop work processes, delegate responsibilities, and lead teams to desired outcomes.
3. **PROBLEM SOLVER:** Able to choose between best practices and unorthodox approaches to reach a solution. Accomplishes the task.
4. **INSPIRATIONAL LEADER:** Motivates teams to work harmoniously and productively towards a common goal.
5. **SPATIALLY INTELLIGENT:** Easily perceives, understands, and operates within the multi-dimensional world.

Approved by Branch Commandants, Certified by CAC Commander, Distributed by DCS-G1 DMPM, April 2013

Branch Distribution of Chemical Engineers

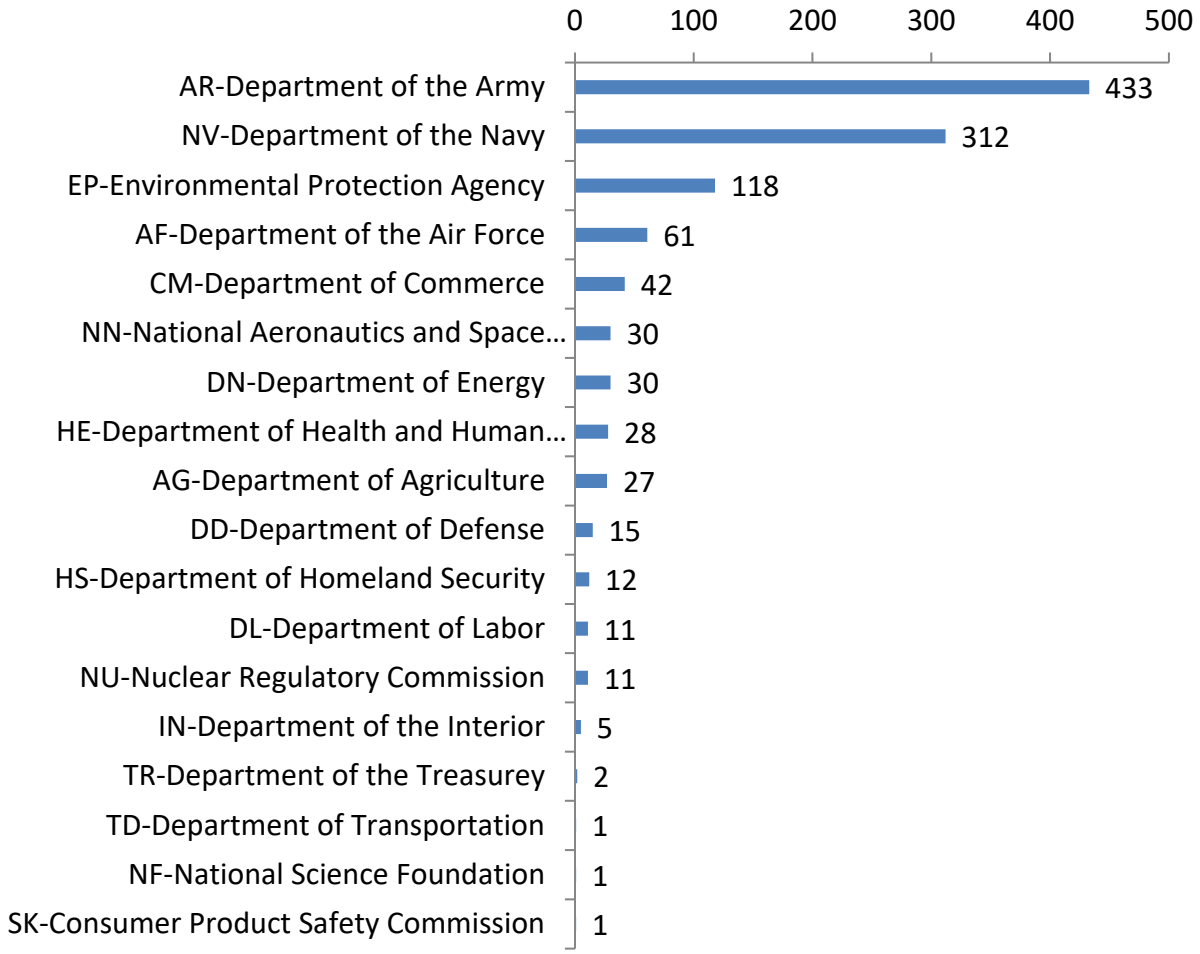
Where our graduates are currently serving



All USMA “green-suiter” graduates as of July 2013

Government Employment of Chemical Engineers

As of July 2013

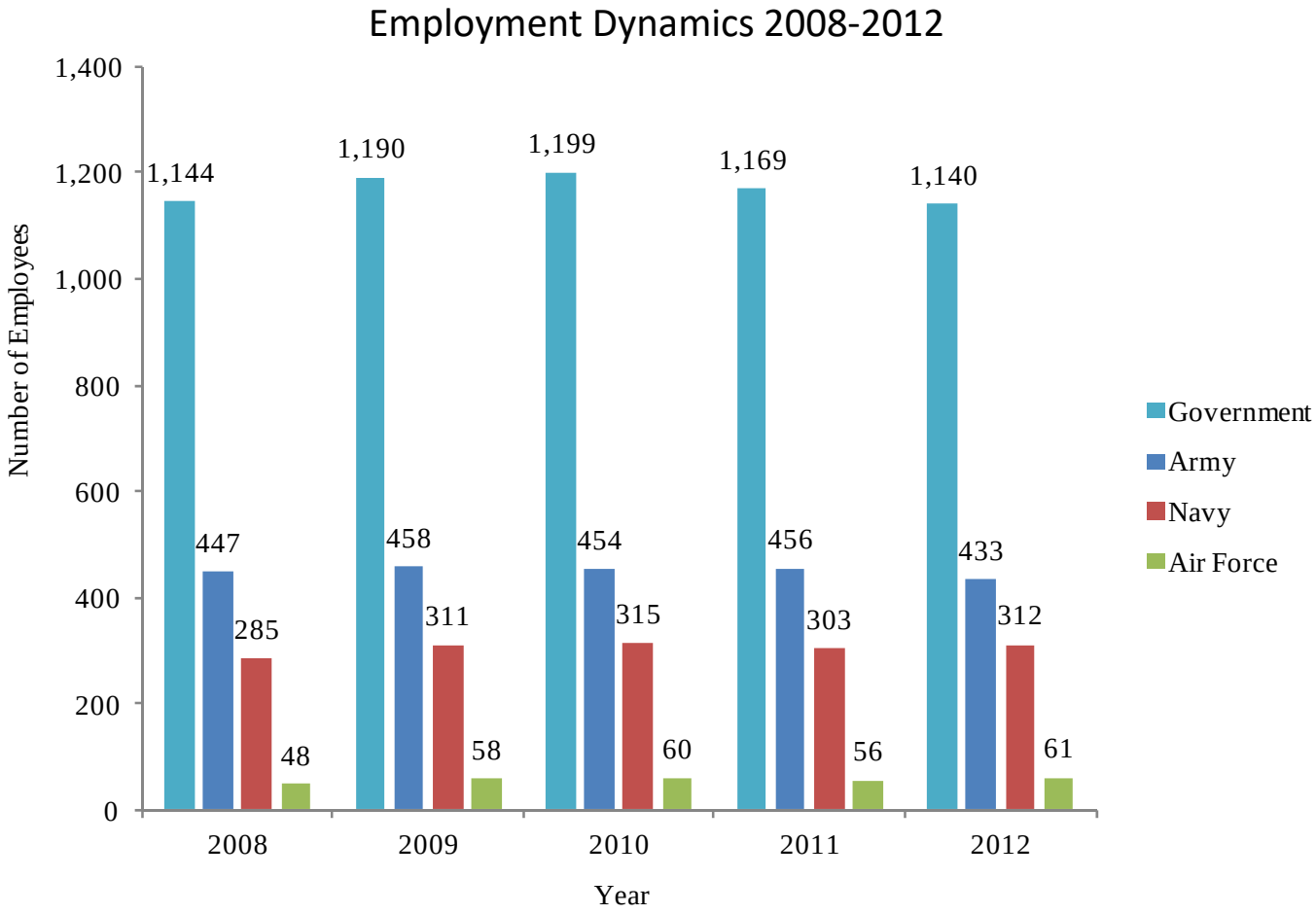


Government Employment of Chemical Engineers

As of July 2013

Government Employment of Chemical Engineers

Labor Market Survey



Chemical Engineering Salary Survey

Occupation: Chemical Engineers (SOC code 172041) Period: May 2012		
Industry (NAICS Code)	**Employment(1)**	**Annual mean wage(2)**
Professional Scientific and Technical Services (541000)	10170	$104,840
Chemical Manufacturing (325000)	9850	$99,440
Petroleum and Coal Products Manufacturing (324000)	1890	$109,280
Management of Companies and Enterprises (551000)	1250	$142,790
Plastics and Rubber Products Manufacturing (326000)	960	$81,410
Educational Services (611000)	780	$74,080
Computer and Electronic Product Manufacturing (334000)	720	$95,280
Merchant Wholesalers Nondurable Goods (424000)	690	$89,160
Oil and Gas Extraction (211000)	580	$133,870
Utilities (221000)	550	$118,150
Paper Manufacturing (322000)	480	$91,360
Wholesale Electronic Markets and Agents and Brokers (425000)	410	$91,160
Machinery Manufacturing (333000)	380	$85,860
Mining (except Oil and Gas) (212000)	40	$106,280
Beverage and Tobacco Product Manufacturing (312000)	40	$91,150
Textile Mills (313000)	40	$79,770
Government	1140	$104,210
Department of the Army	433	$101,757
Department of the Navy	312	$98,270
Department of the Air Force	61	$99,423
Departent of Defense	15	$99,423

Footnotes:
(1) Estimates for detailed occupations do not sum to the totals because the totals include occupations not shown separately. Estimates do not include self-employed workers.
(2) Annual wages have been calculated by multiplying the hourly mean wage by 2080 hours; where an hourly mean wage is not published the annual wage has been directly calculated from the reported survey data.
(8) Estimate not released.

SOC code: Standard Occupational Classification code -- see http://www.bls.gov/soc/home.htm
NAICS code: North American Industry Classification System code -- see http://www.bls.gov/bls/naics.htm

Data extracted on June 21 2013

Topical (Criterion "9") Outcomes Evaluation

FE Exam Pass Rates for USMA Engineers in the Graduating Class of 2012

Discipline-Specific Results Reported by the National Council for Engineering Education

Fundamentals of Engineering Exam 6 April 2013

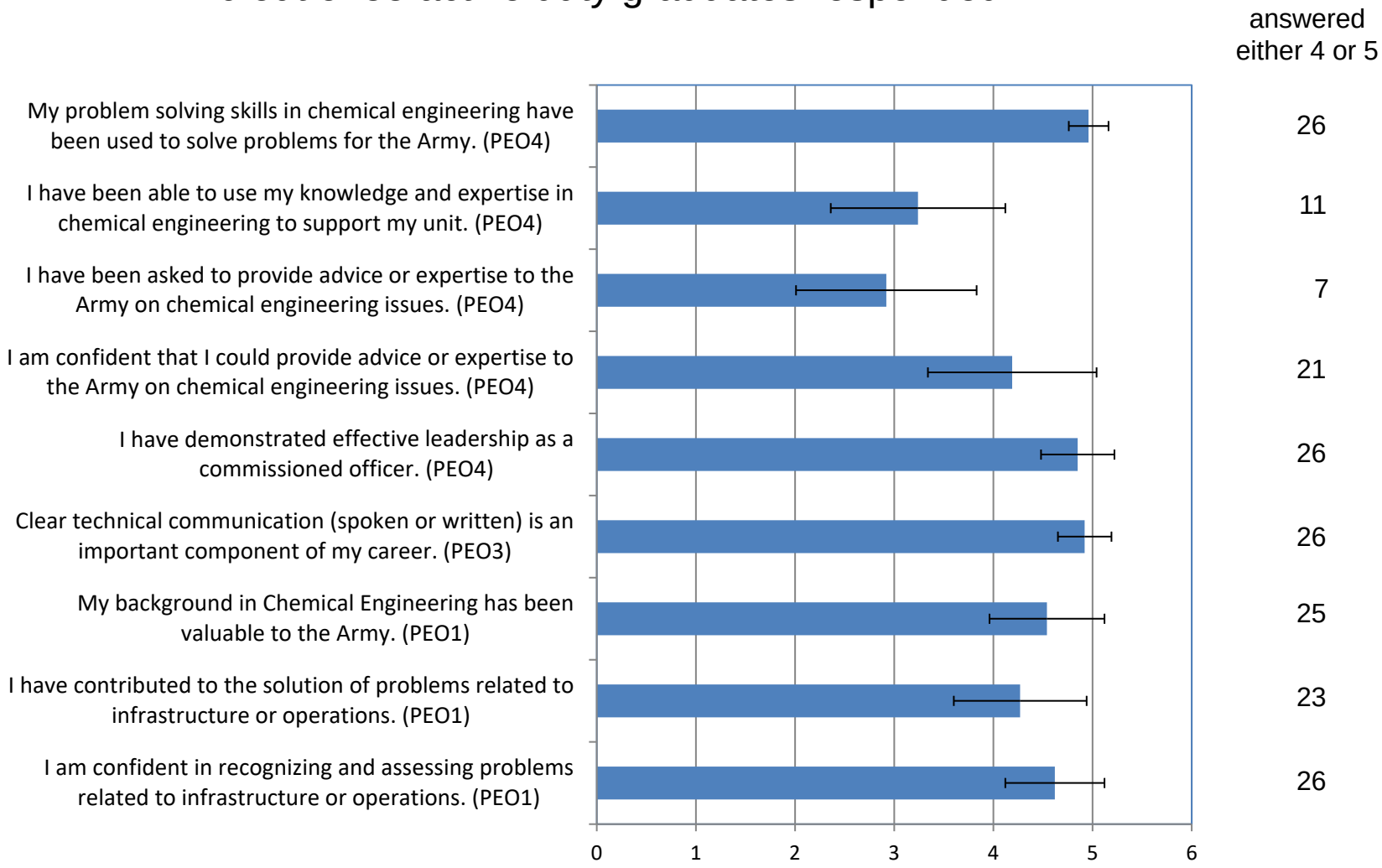
	USMA			National		
Major	**Took**	**Passed**	**Percent**	**Took**	**Passed**	**Percent**
Mechanical	66	54	82%	5406	4468	83%
Civil	44	42	95%	5312	6638	80%
Electrical	25	22	88%	1060	1472	72%
Eng. Management	43	27	63%	53	33	62%
Systems	47	39	83%	53	43	81%
Chemical	***12***	***11***	***92%***	***1507***	***1301***	***86%***
Environmental	17	17	100%	629	551	88%
Nuclear[a]	14	12	86%	18	16	89%

[a] No discipline-specific exam offered.

USMA engineers scored at or above the national average in all disciplines.

Program Graduates Survey Results

26 out of 55 active duty graduates responded.

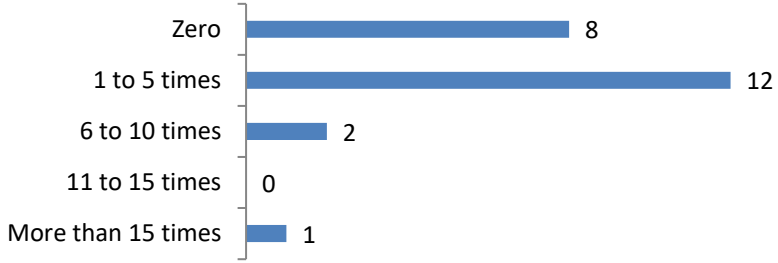


(error bars are standard deviations)

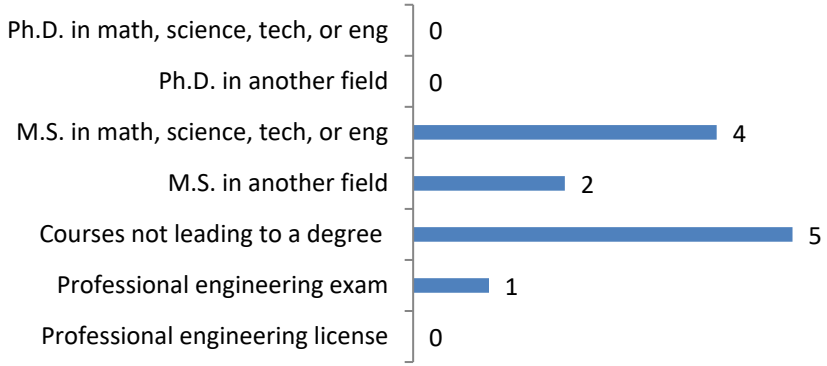
Program Graduates Survey Results

26 out of 55 active duty graduates responded.

How many times have you been called upon to use your chemical engineering expertise in the last year?

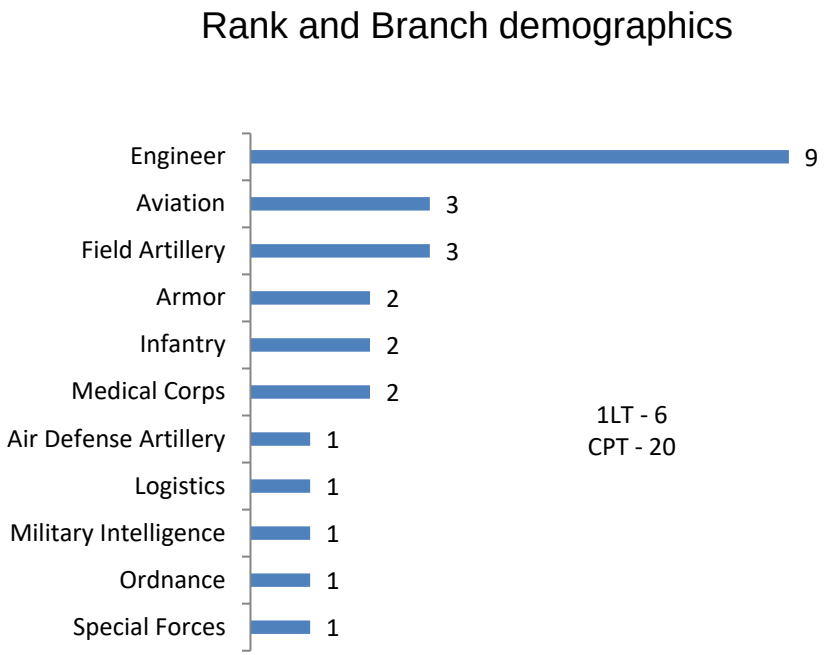


Continuing education activities



Program Graduates Survey Results

26 out of 55 active duty graduates responded.



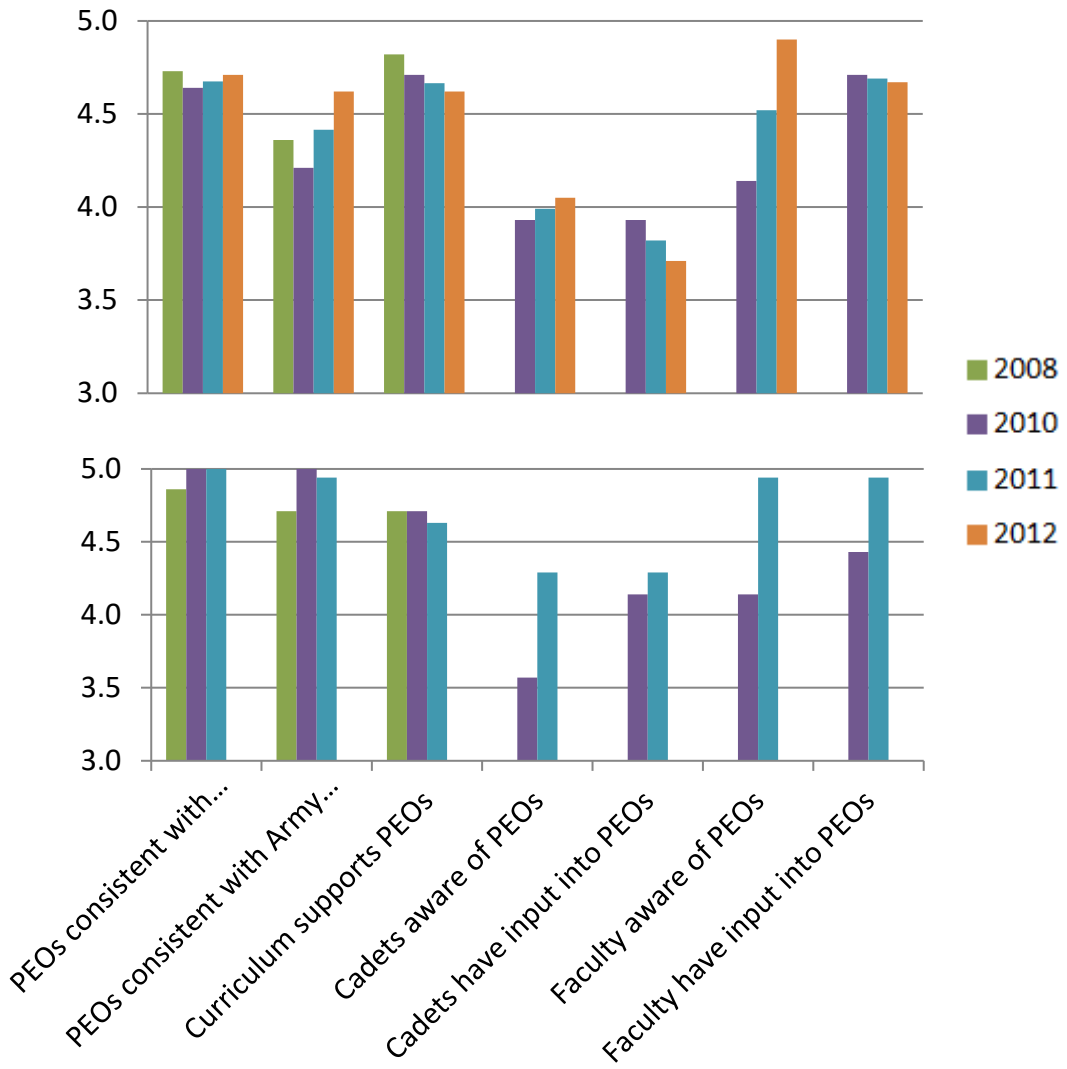
Delete

How Cadets View the PEO Process

Cadets are a key constituency

Cadet Response

Advisory Board



Faculty responses are in the supplemental slides.

End of Section 6 (Old Supplements)