Chemical Engineering

Advisory Board Meeting

November 14, 2014

United States Military Academy
Department of Chemistry and Life Science

Thank You! Advisory Board 2014-2015

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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

Advisory Board Meeting Agenda

November 14, 2014

Introductory remarks and orientation

Program assessment

Cadet Discussions

Future Challenges

Facilities and construction

Wrap-up

Chemical Engineering

Advisory Board Meeting

November 14, 2014

1. Introductory Remarks

United States Military Academy
Department of Chemistry and Life Science

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.

"Inspired to serve."

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.

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

ACCREDITATION BOARD FOR ENGINEERING AND TECHNOLOGY

Visit – 28-30 September 2014

Why ABET Accreditation?

- An external certification of quality
- Keeps us in touch with the engineering and computing professions
- Helps USMA recruiting
- Provides important opportunities for graduates
- Allows USMA engineering majors to take the Fundamentals of Engineering Examination
- Almost everything that ABET expects us to do is something we should be doing anyway ...

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
- 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 seeking first-time accreditation in 2014
  - Chemical Engineering

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

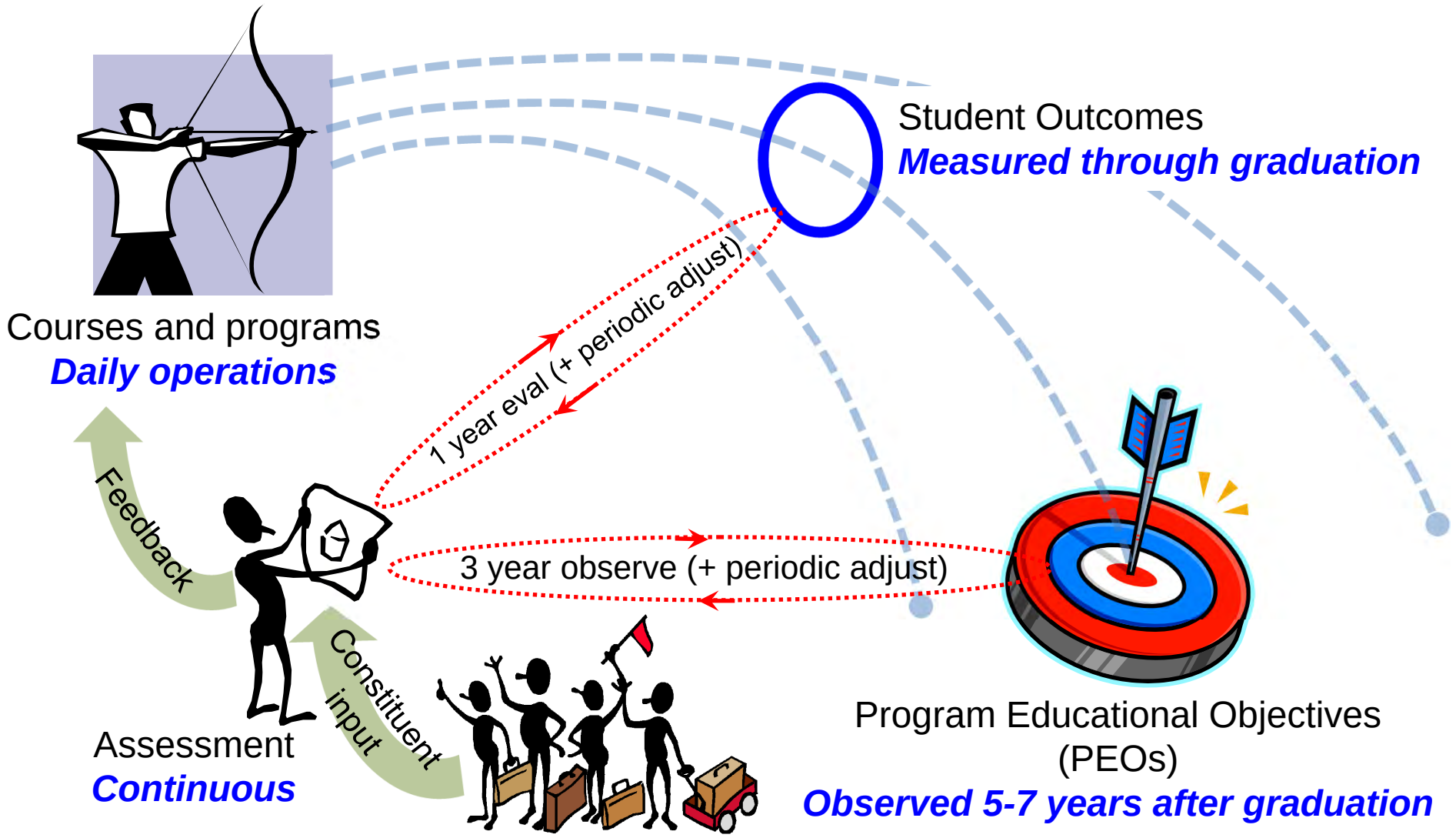
Harmonized Criteria

Terms You Should Know

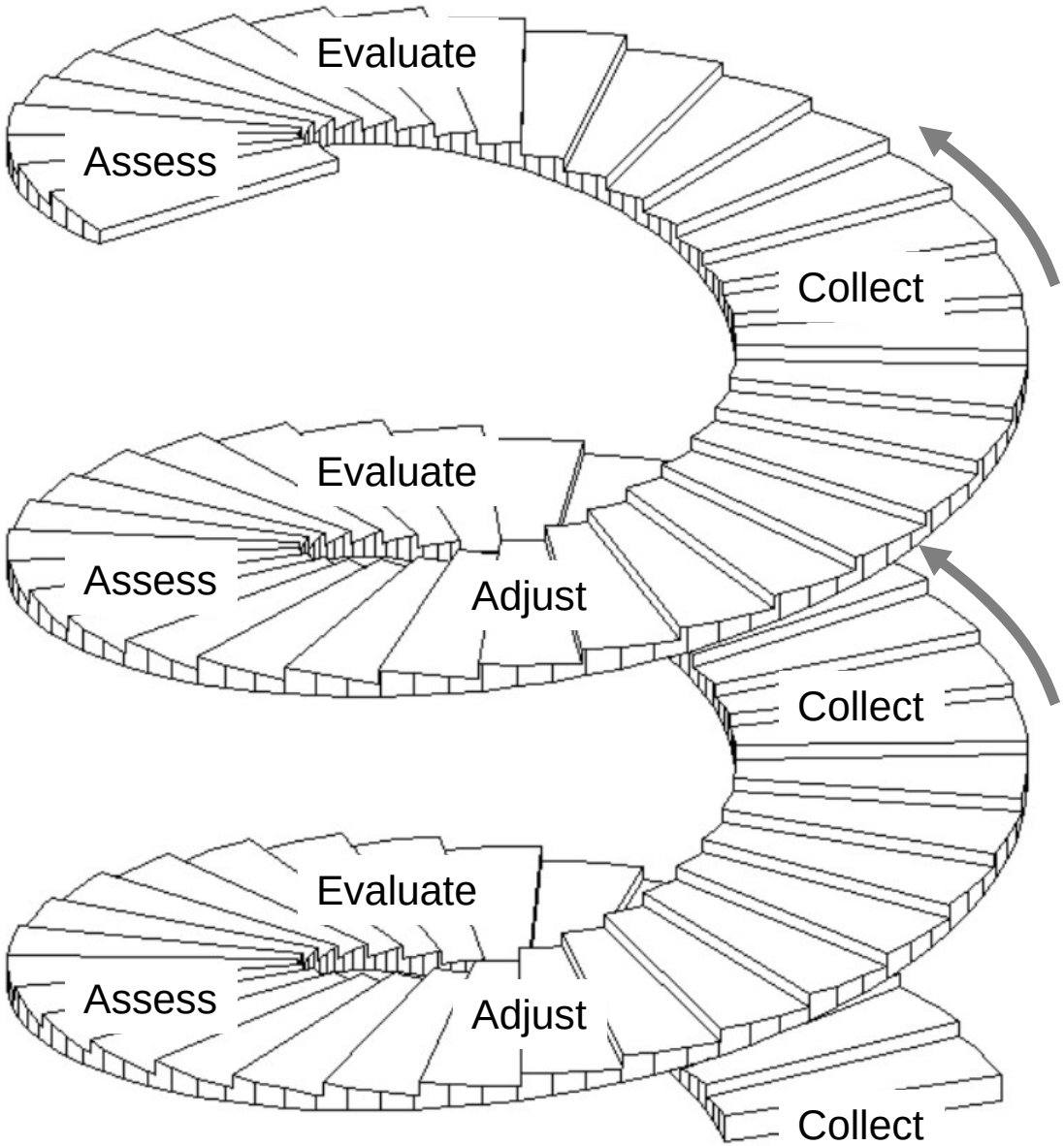
- **Program Educational Objectives (PEOs)**
  - Gleaned by asking *program constituents*
    - For us: Army, profession, graduate schools, other
  - Our external ***Advisory Board*** a key resource.
  - Desired professional accomplishments of graduates **5-7 years after graduation**
  - Adjust every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



Fall 2014 ABET Visit

VISIT DATES: 28 – 30 September 2014

TYPICAL AGENDA

- **SAT:** Team Members Arrive (17)
- **SUN:** ABET Team Meeting
  Laboratory & Facility Tours
  Review Program Documentation
- **MON:** Meet with Dean/Staff/Program Directors/Dept Heads
  Individual Meetings with Superintendent & Staff (chair)
  USMA Staff/Dean's Staff/Library/Math/Science (chair)
  Program Review/Faculty/Students (evaluators)
  Hosted Lunch with faculty, students and advisory board members (chair & evaluators)
  Closed Evaluator Team Meeting/Dinner
- **TUE:** Visit Facilities & Interview Faculty/Staff/Students
  Brief Dean (team chair) & Heads (evaluator) on findings
  Private Lunch
  Exit Interview with Superintendent/Dean/Heads
  Departure

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

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 very careful in deciding on new initiatives

Advisory Board Findings

Excerpts from Minutes of 6-7 March 2014

•Curriculum was previously thin on on engineering credit hours. This problem has been well identified and rectified.

•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 student outcomes.

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

•The USMA ChE program and faculty are highly praised by the students.

•Students feel that they must work considerably harder than other cadets.

•Students feel that they are isolated (from commercial ChE practice).

End of Section 1

Chemical Engineering

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2. Outcomes 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

The program provides the graduate with a thorough grounding and working knowledge of the chemical sciences, including:
12. General, organic, and physical chemistry.
13. Material and energy balances on chemical processes, including safety and environmental factors.
14. Thermodynamics of physical and chemical equilibria.
15. Heat, mass, and momentum transfer.
16. Chemical reaction engineering.
17. Continuous and staged separation operations.
18. Process dynamics and control.
19. Modern experimental and computing techniques.
20. Process design.

Required Courses	
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
ME311	Thermal-Fluid Systems I
ME312	Thermal-Fluid Systems II
EE301	Fundamentals of Electrical Engineering
CE300	Fundamentals of Engineering Mechanics & Design (Statics & Dynamics)
CH481	Physical Chemistry (Chemical Engineering Thermodynamics in Fall 2015)
CH383	Organic Chemistry

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

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

Assessment

CHEME Coursework Embedded Indicators

MECHE Coursework Embedded Indicators

Fundamentals of Engineering Exam Topics

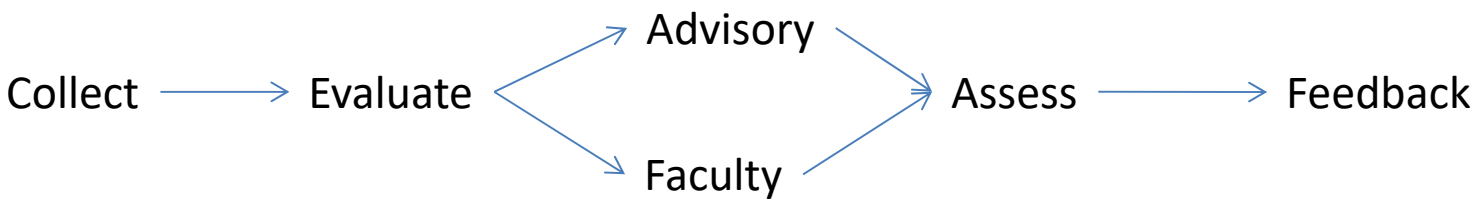
Participation in FE Exam (not pass rate)

Student end of semester surveys

Student CHEME Program Exit Surveys

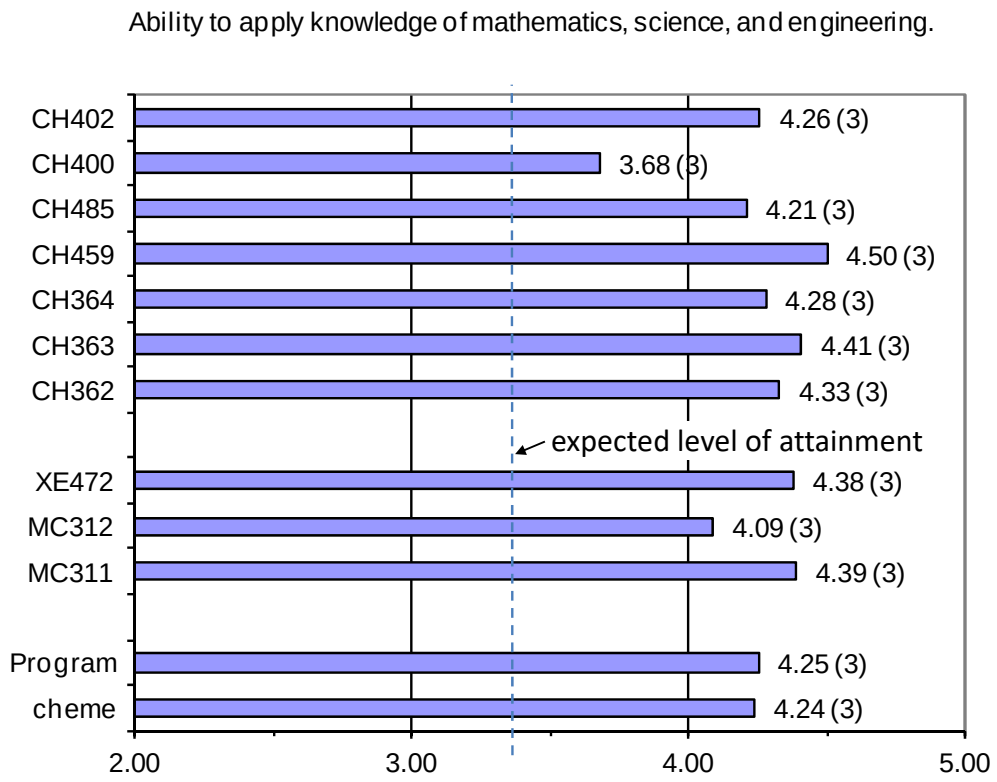
Course Grades

Process



Coursework Embedded Indicators

Example Results - coursework graded events – Student Outcome 1

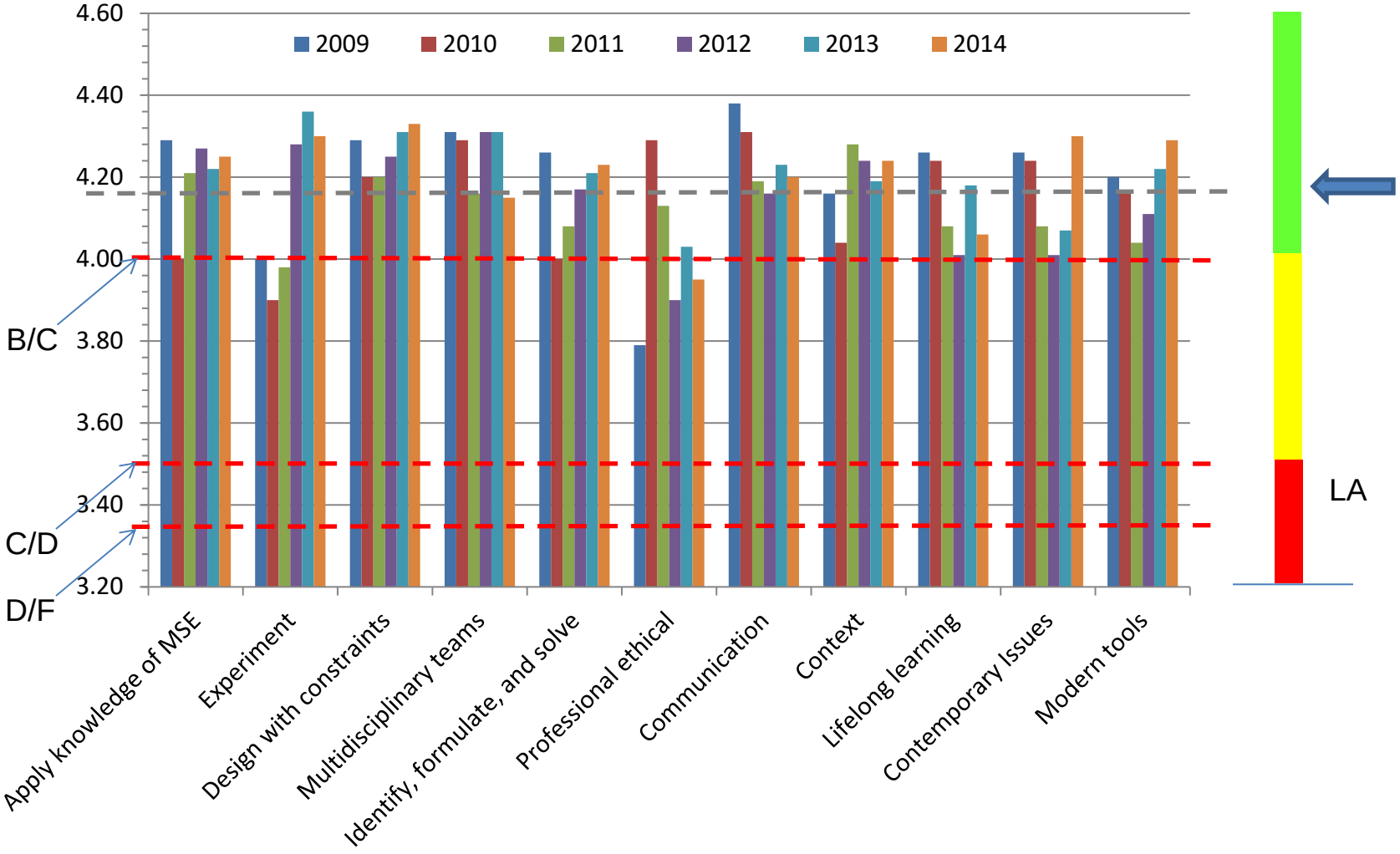


Values in parentheses are coverage ratings from Table 5-3 in the Self Study, page 5-9

Data shown here is for Class of 2014
Similar data is collected for all 11 ABET outcomes

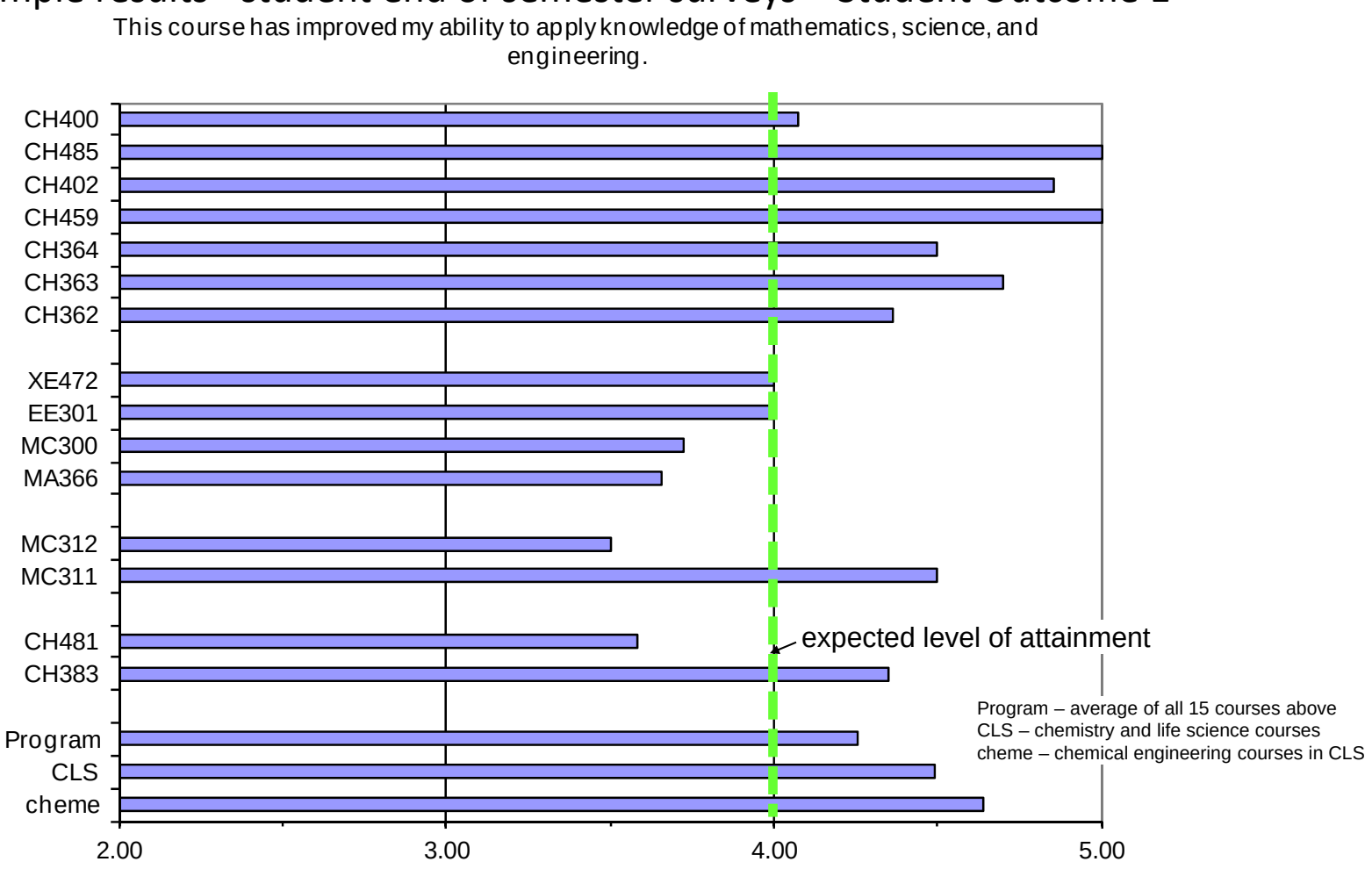
Performance on Embedded Indicators

Program Averages AY2009 to AY2014



End-of-Semester Surveys

Example results - student end of semester surveys – Student Outcome 1



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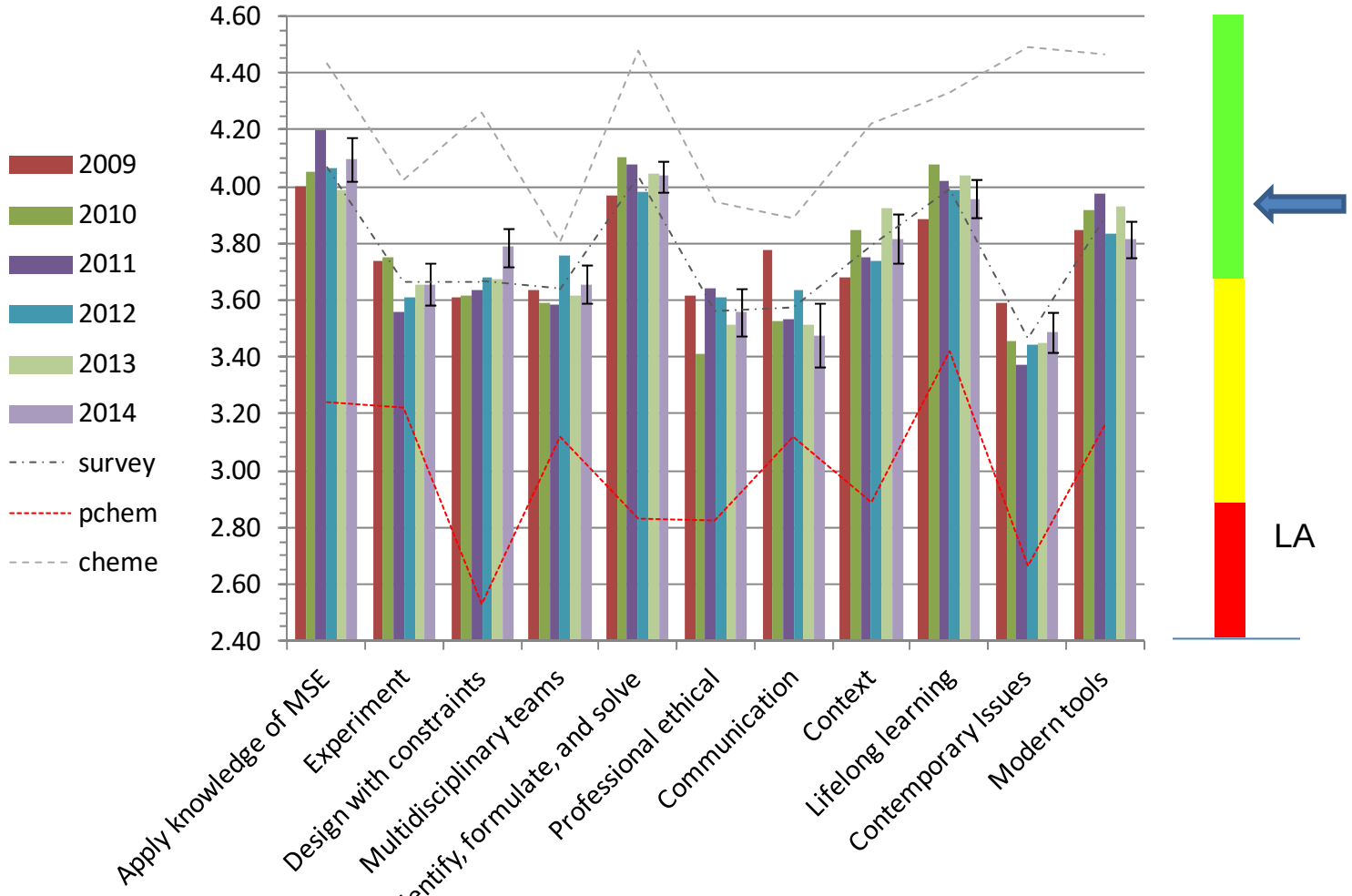
End-of-Semester Surveys

Program Averages from AY2009 to AY2014



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

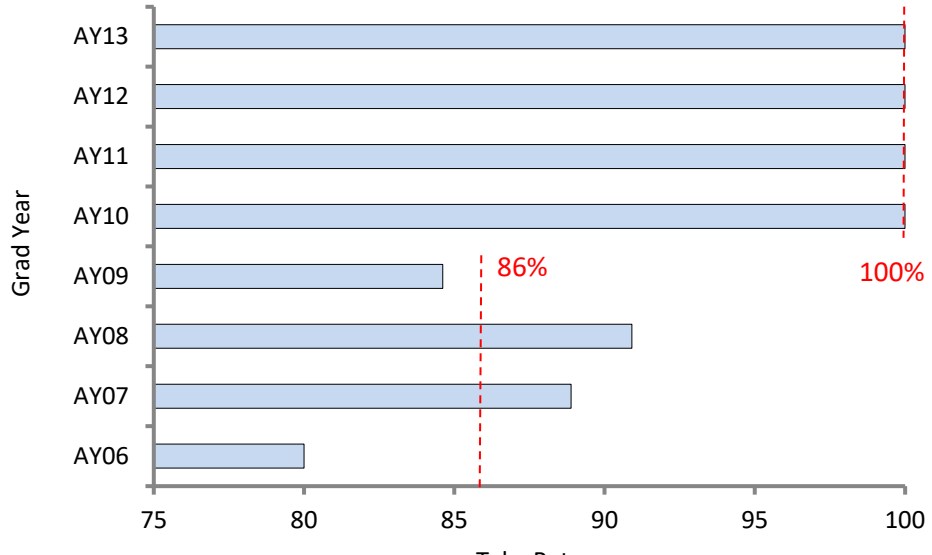
	USMA			National		
Major	**Took**	**Passed**	**Percent**	**Took**	**Passed**	**Percent**
Mechanical	66	54	82%	5406	4468	83%
Civil	44	42	95%	5312	6638	80%
Electrical	25	22	88%	1060	1472	72%
Eng. Management	43	27	63%	53	33	62%
Systems	47	39	83%	53	43	81%
Chemical	***12***	***11***	***92%***	***1507***	***1301***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

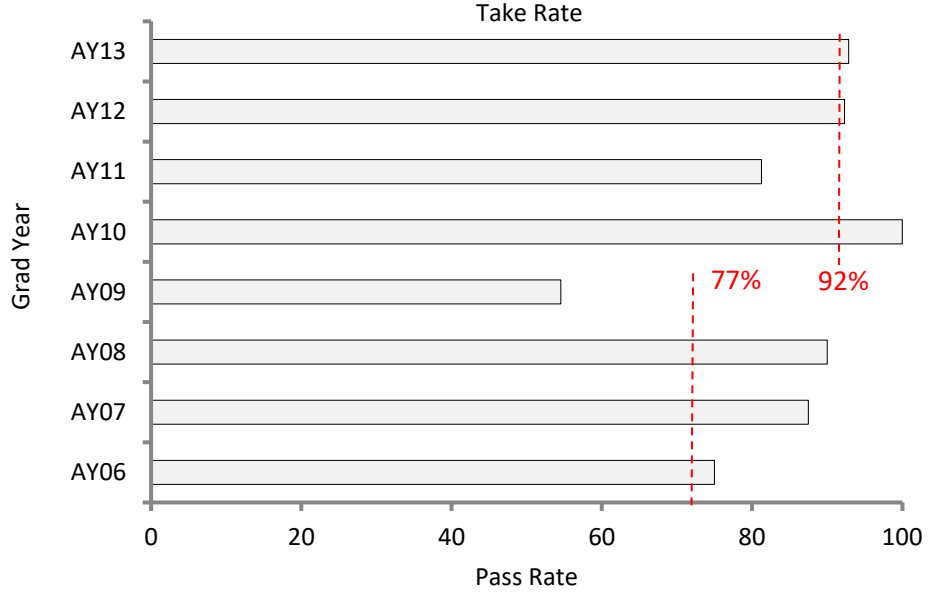
[a] No discipline-specific exam offered.

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

Performance on Fund. of Engineering Exam

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

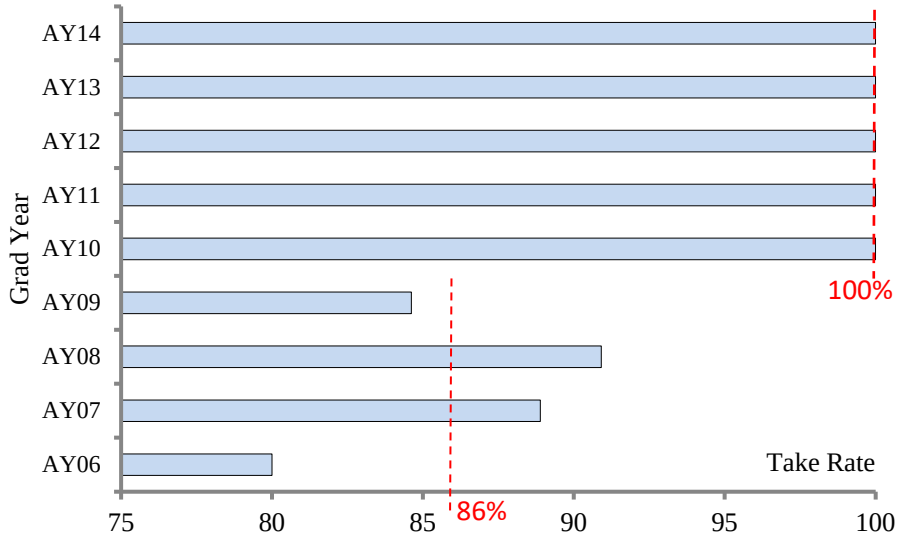


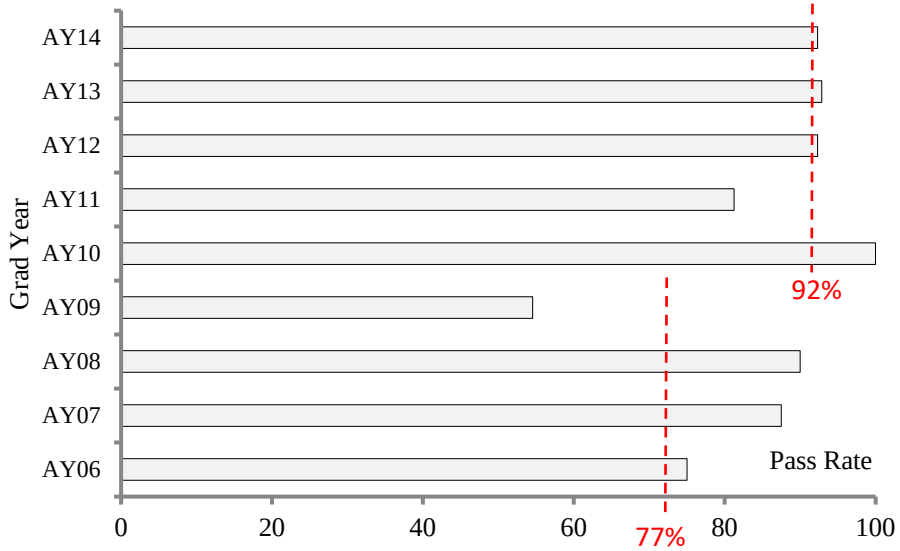


CH400 Initiated

Performance on Fund. of Engineering Exam

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

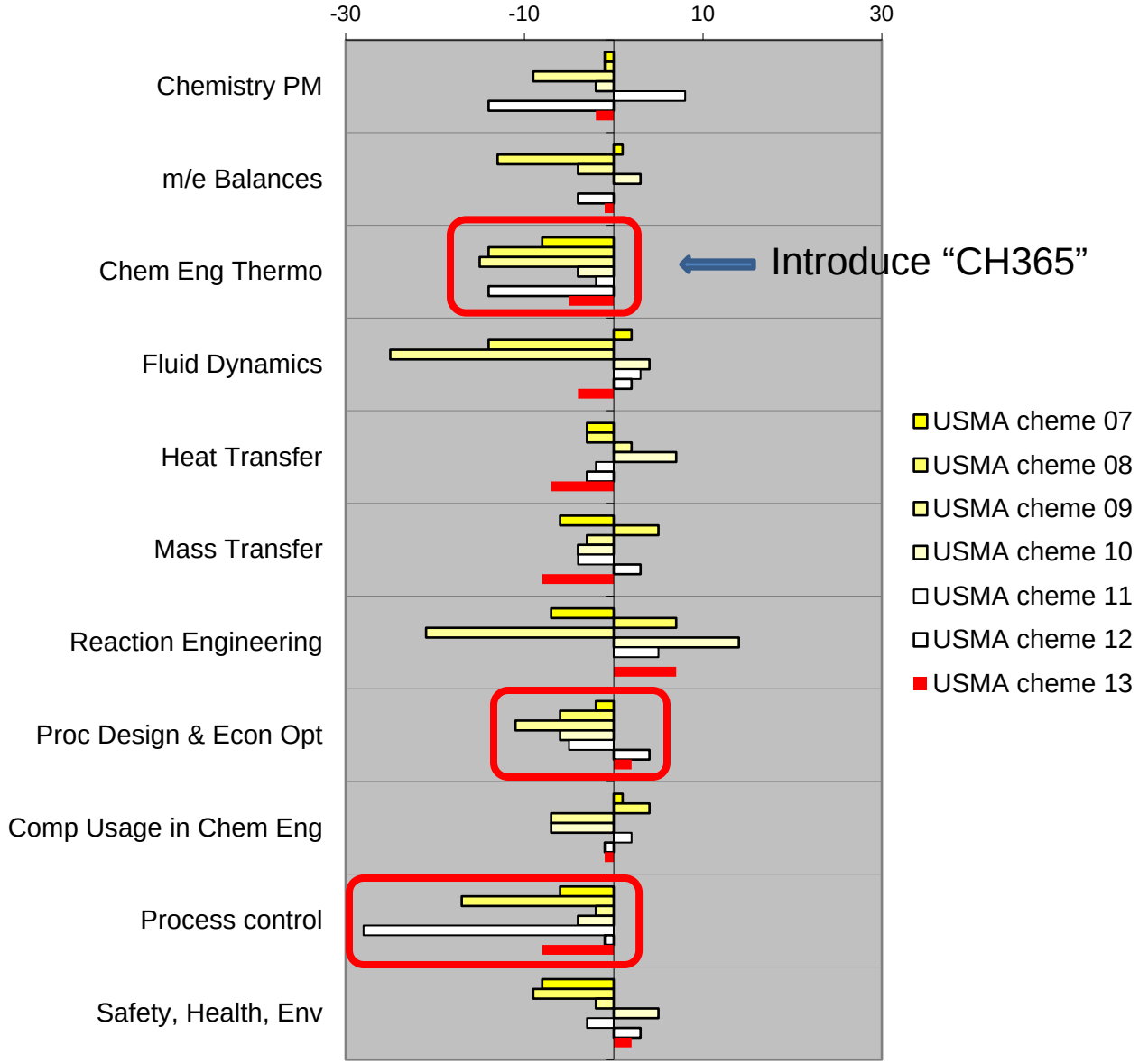




CH400 Initiated

Topical (Criterion 9) Outcomes Evaluation

PM exam score deviations from national average, AY07 to AY13



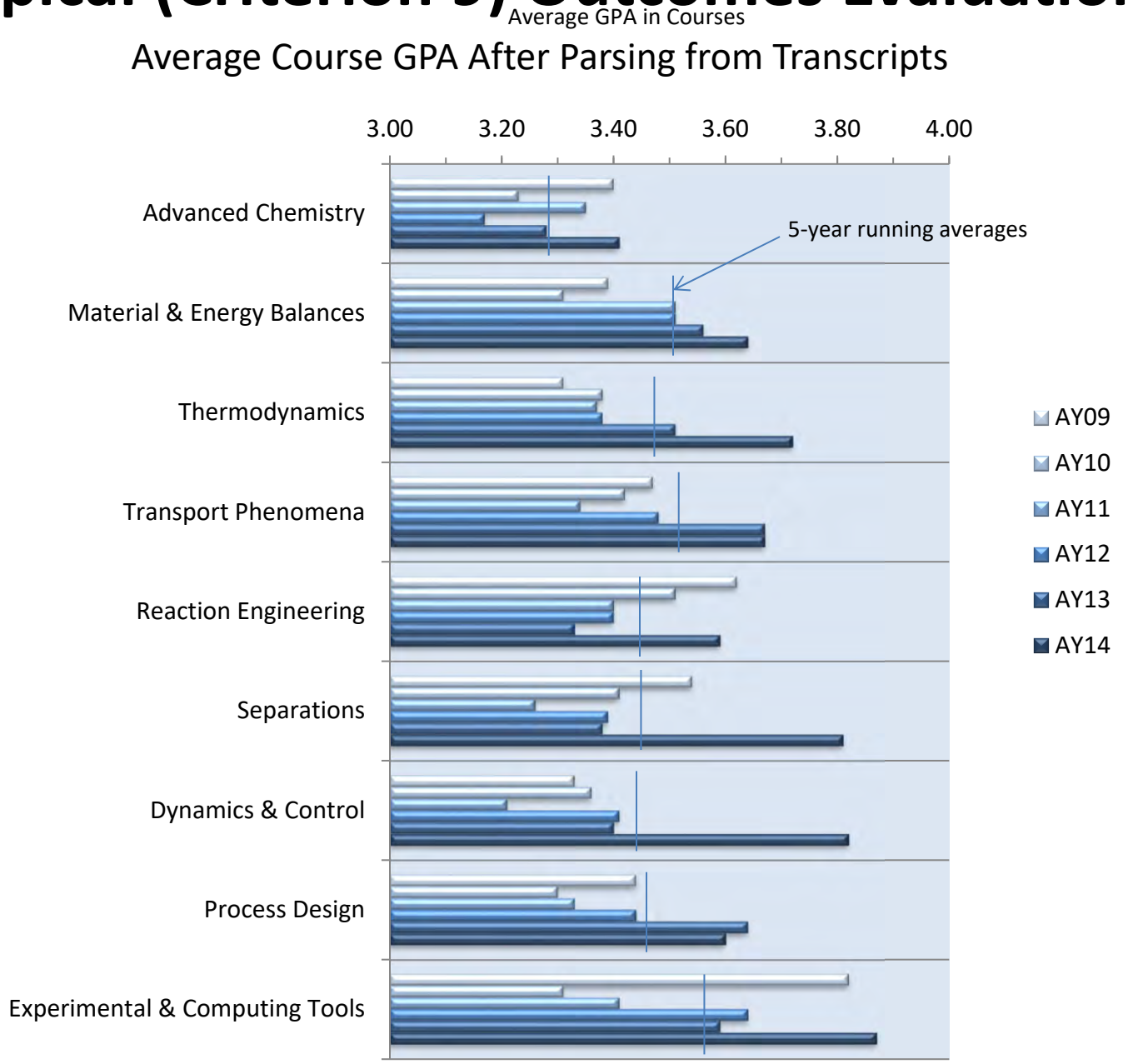
Program Outcomes 12-20

Analysis of Transcripts (Course Grades for Chemical Engineers)

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

Topical (Criterion 9) Outcomes Evaluation



End of Section 2

(Advisory Board Completes Survey Part 1)

Chemical Engineering

Advisory Board Meeting

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3. Assessment (Program Objectives)

United States Military Academy
Department of Chemistry and Life Science

Lunch – Cadet Mess

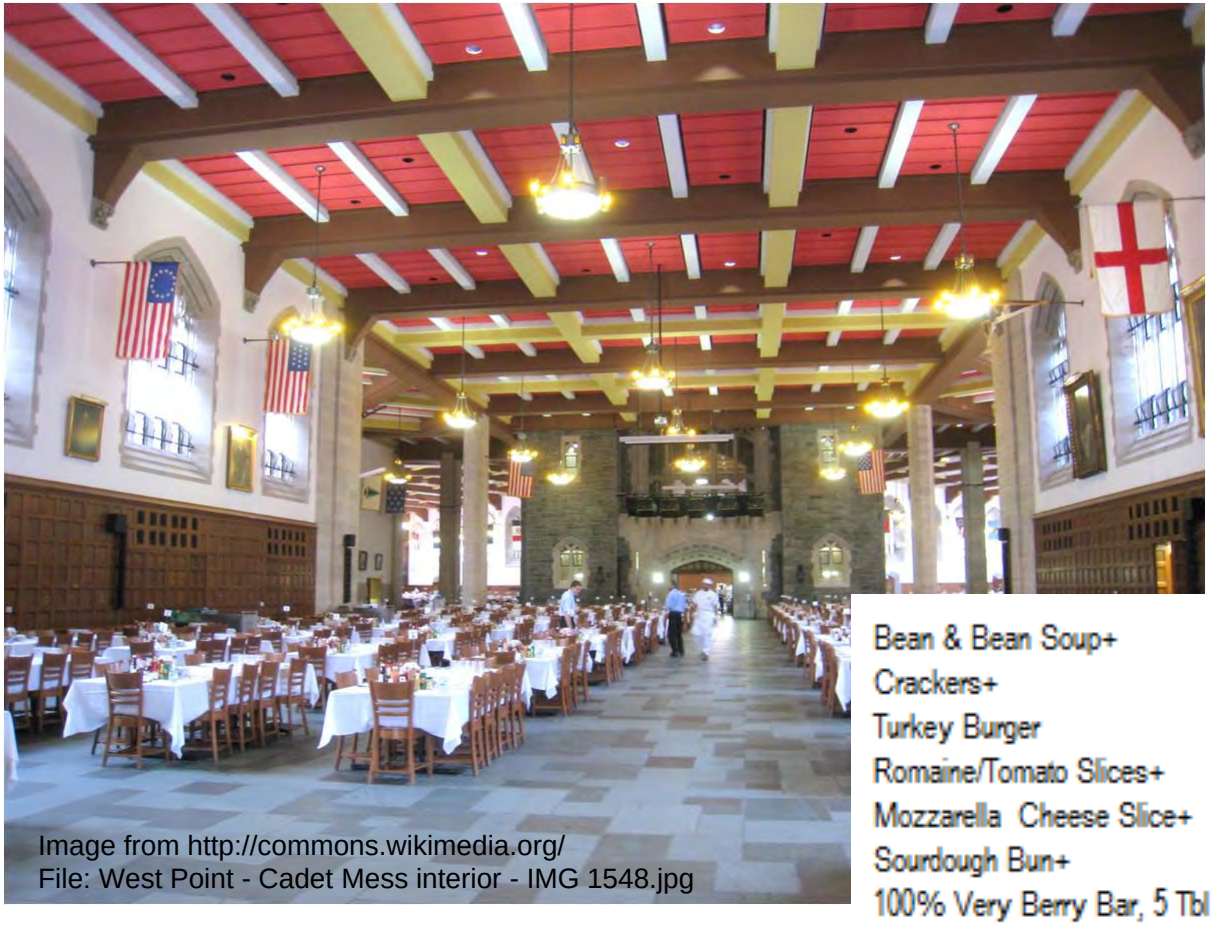


Image from http://commons.wikimedia.org/
File: West Point - Cadet Mess interior - IMG 1548.jpg

Bean & Bean Soup+	1C	200c
Crackers+	1pkt	25c
Turkey Burger	1ea	228c
Romaine/Tomato Slices+	½ C	25c
Mozzarella Cheese Slice+	1sl	70c
Sourdough Bun+	1ea	140c
100% Very Berry Bar, 5 Tbl	2oz	80c
Sea Salt Baked Chips, 5Tbl	1oz	110c
Fresh Fruit Bar	1ea	125c
Sports Beverage	8oz	50c
Skim/Low Fat Milk	8oz	80c/100c

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)

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.

(ABET EAC Criteria)

Program Objectives

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

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

1. Demonstrate effective leadership and chemical engineering expertise. [formerly #4]

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 Recommendation from October 2012

Assessment Instruments for Objectives

Program Surveys

Program Advisory Board Surveys
Program Faculty Surveys
Program Cadet Surveys
Program Graduate Surveys (??)

Strategy going forward:

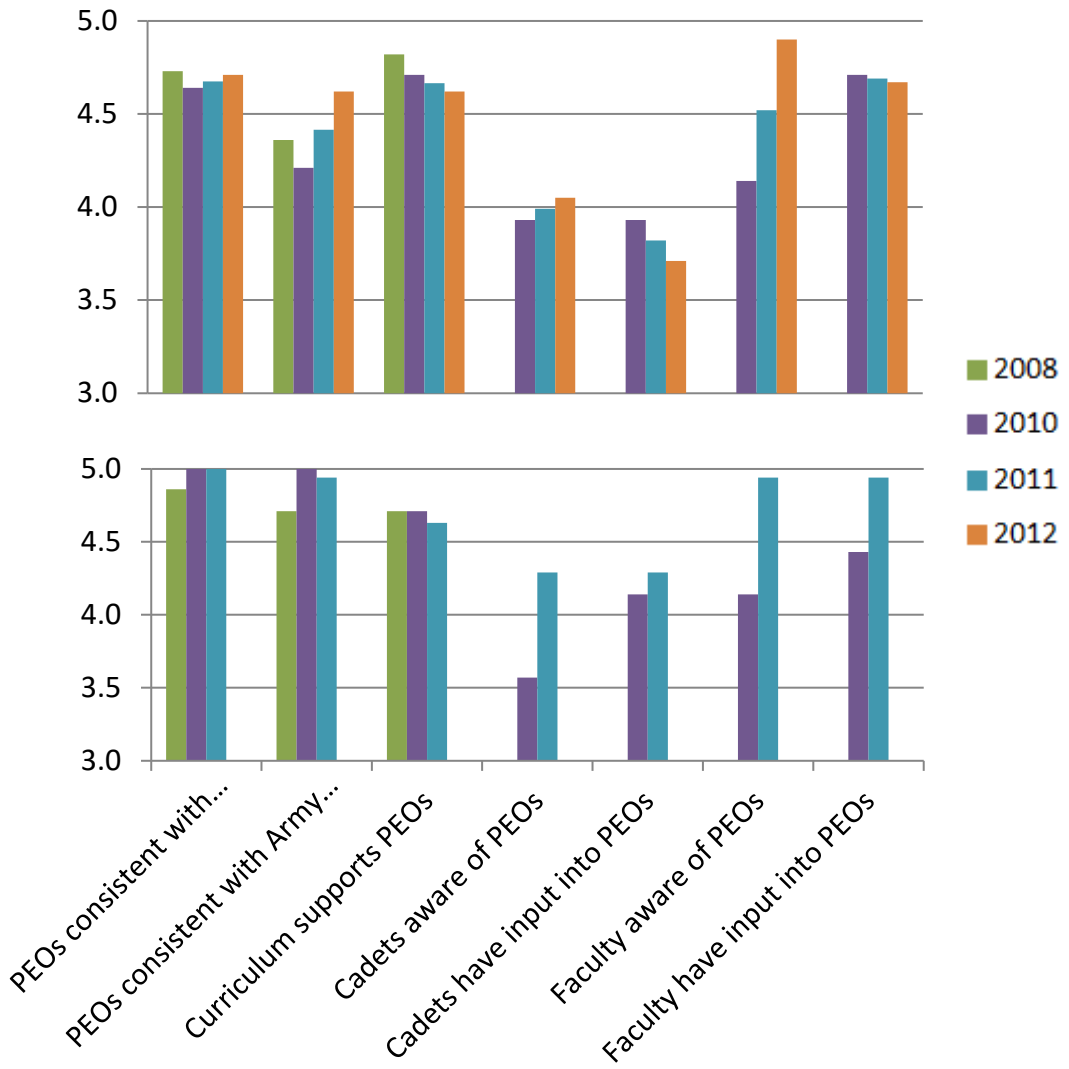
Assess consistency with the mission of the institution and the needs of the constituencies improve objectives.

How Cadets View the PEO Process

Cadets are a key constituency

Cadet Response

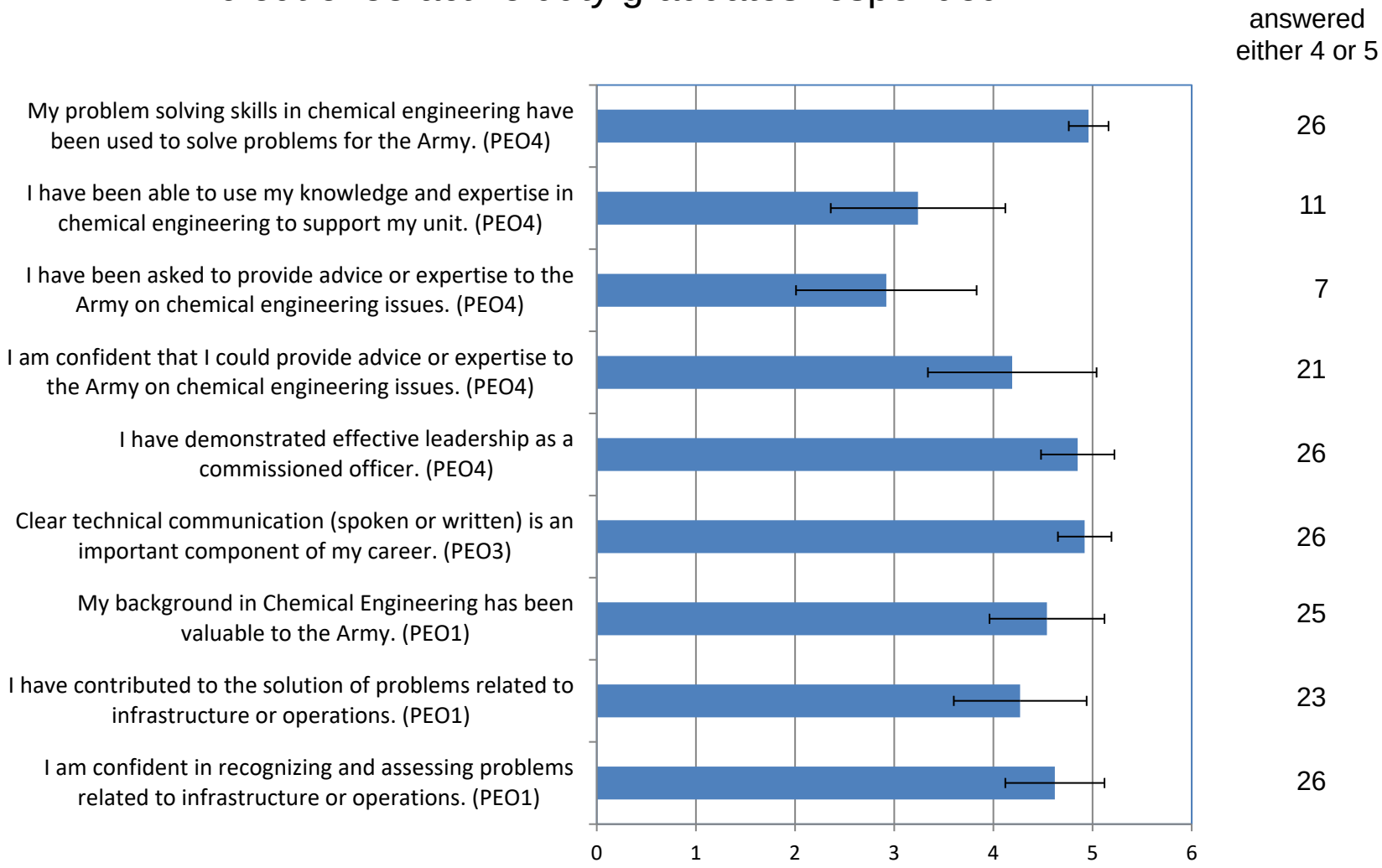
Advisory Board



Faculty responses are in the supplemental slides.

Program Graduates Survey Results

26 out of 55 active duty graduates responded.

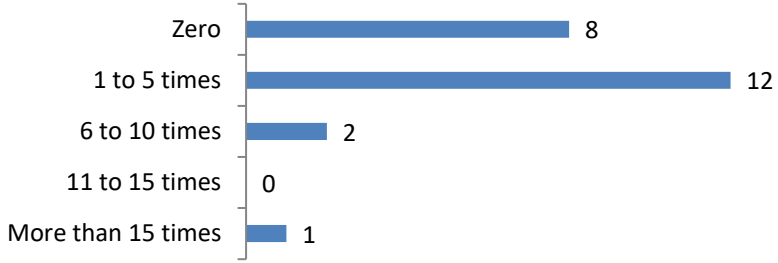


(error bars are standard deviations)

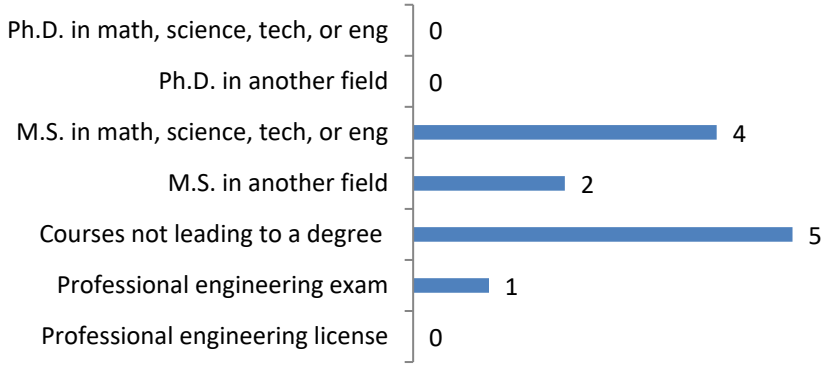
Program Graduates Survey Results

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



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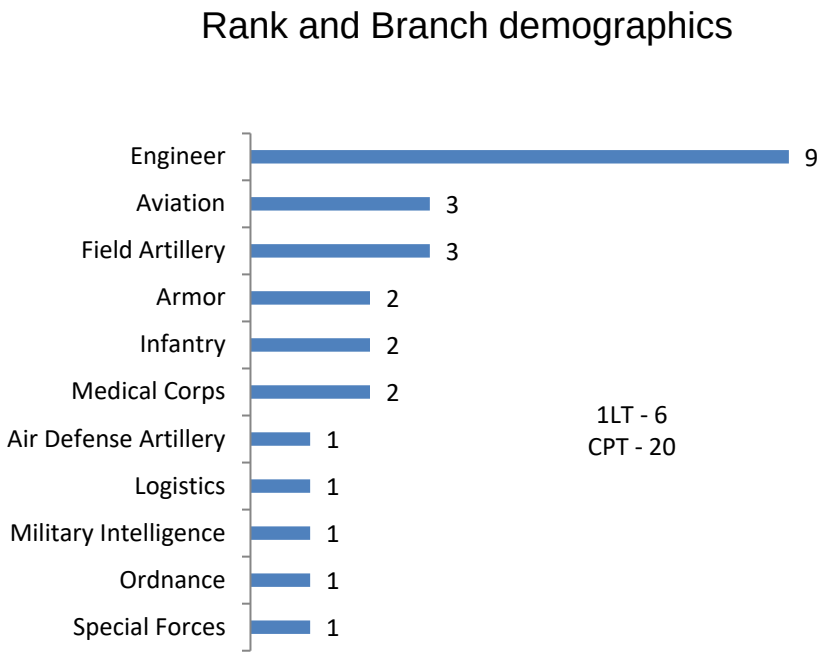
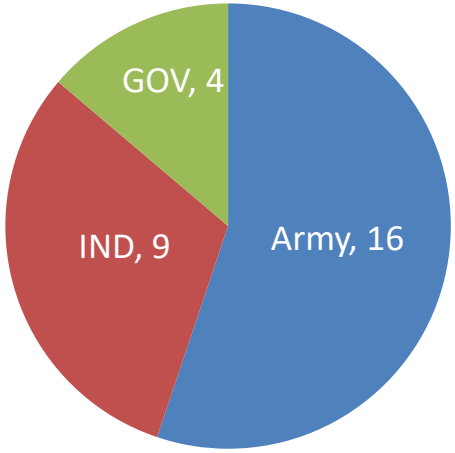


Enrichment Opportunities

Advanced Individual Academic Development (AIAD)

- Lawrence Livermore National Lab
- Army Research Labs
- Picatinny Arsenal
- BAE Systems
- Audia Group
- US Mint
- Renewal Energy Group
- US Department of Agriculture
- US Department of Homeland Security
- US Army Engineer Research Development Center
- Research, Development, and Engineering Command



29 fully funded internships

End of Section 3

(Advisory Board Completes Survey Part 2)

Chemical Engineering

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November 14, 2014

4. Future Challenges

United States Military Academy
Department of Chemistry and Life Science

Strategic Influence

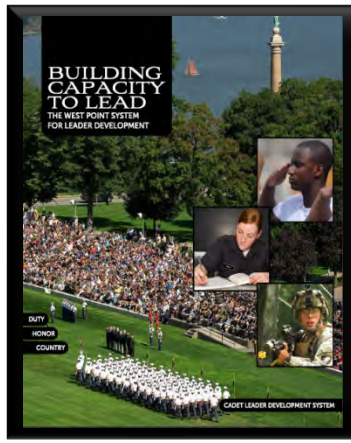
Governmental Strategic Guidance
- President
- Congress
- Department of Defense
- Government Agencies (e.g., NSA, FBI, CIA, …)

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

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

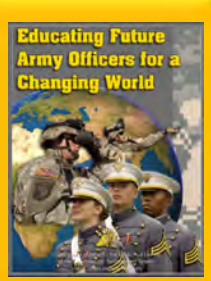
West Point Mission and Strategic Plan

Academic Program Vision and Strategic Plan



West Point Leader Development System

Academic Program Goals



- Core Courses
- Academic Majors
- Enrichment Experiences

Academic Excellence

#1 Most Accessible Professors

#6 Best College Library

#10 Best Athletic Facilities

#11 Best Classroom Experience

#1 Public College in the country

#1 Best Buy

#3 Liberal Arts College

#7 Overall College in the country

#2 Top Public Schools

#3 Best Undergrad Engineering Program

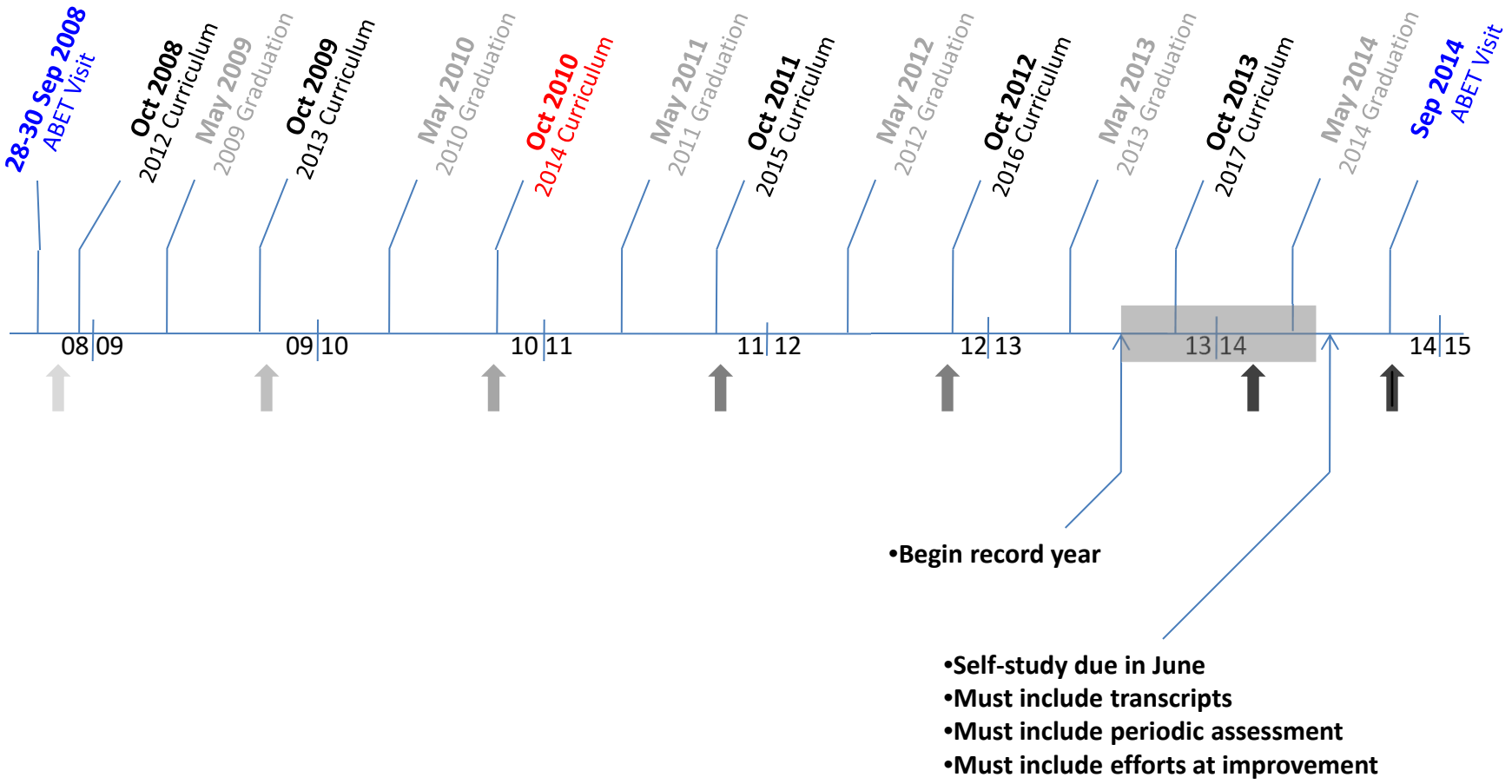
- #2 Civil Engineering Program
- #3 Mechanical Engineering Program
- #7 Electrical Engineering Program

#24 National Liberal Arts College

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

Timeline for Curricular Actions



Visit: 14-16 September (Proposed)

Challenge 1 - ABET Bean Counting

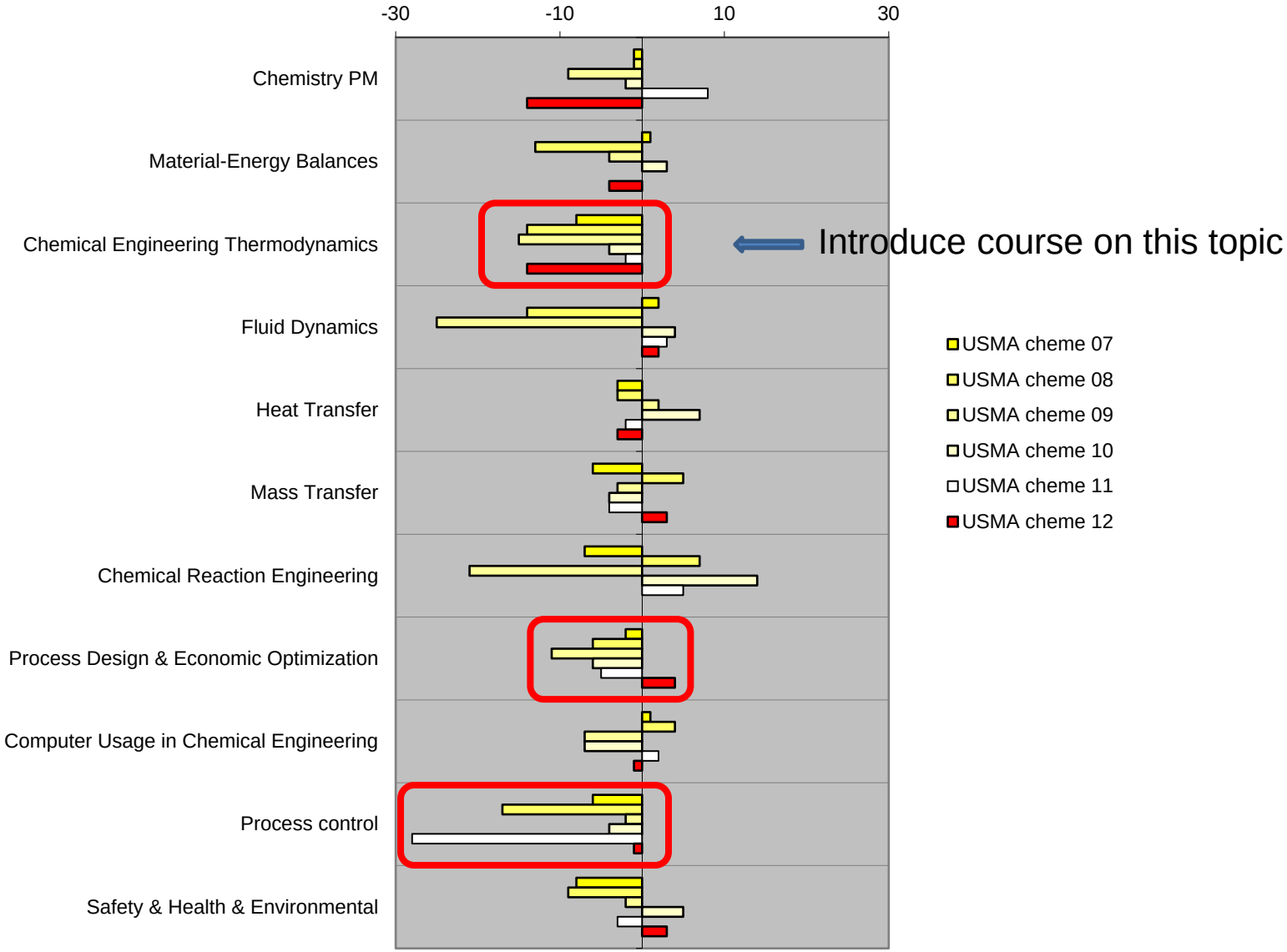
ABET Self Study Table 5-1

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

Survey of Chemical Engineering Curricula

PM exam score deviations from national average



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**

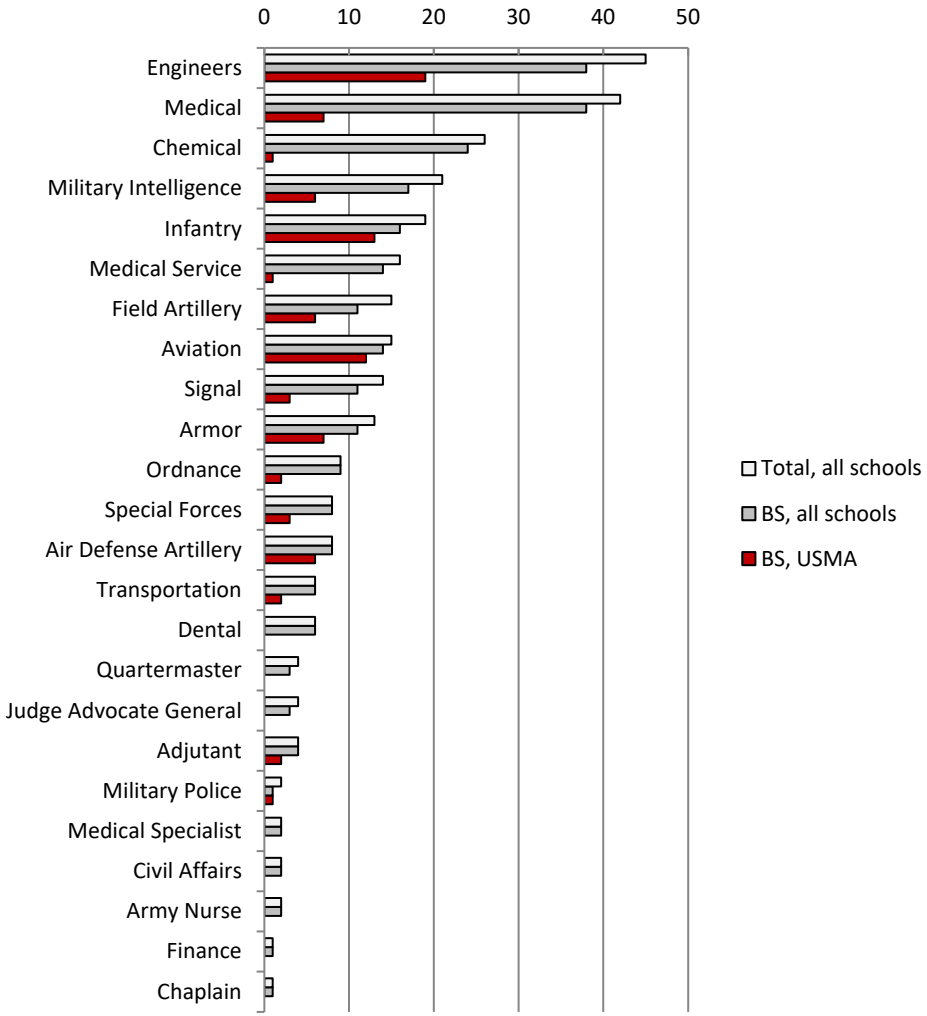
TALENT PRIORITIES:

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

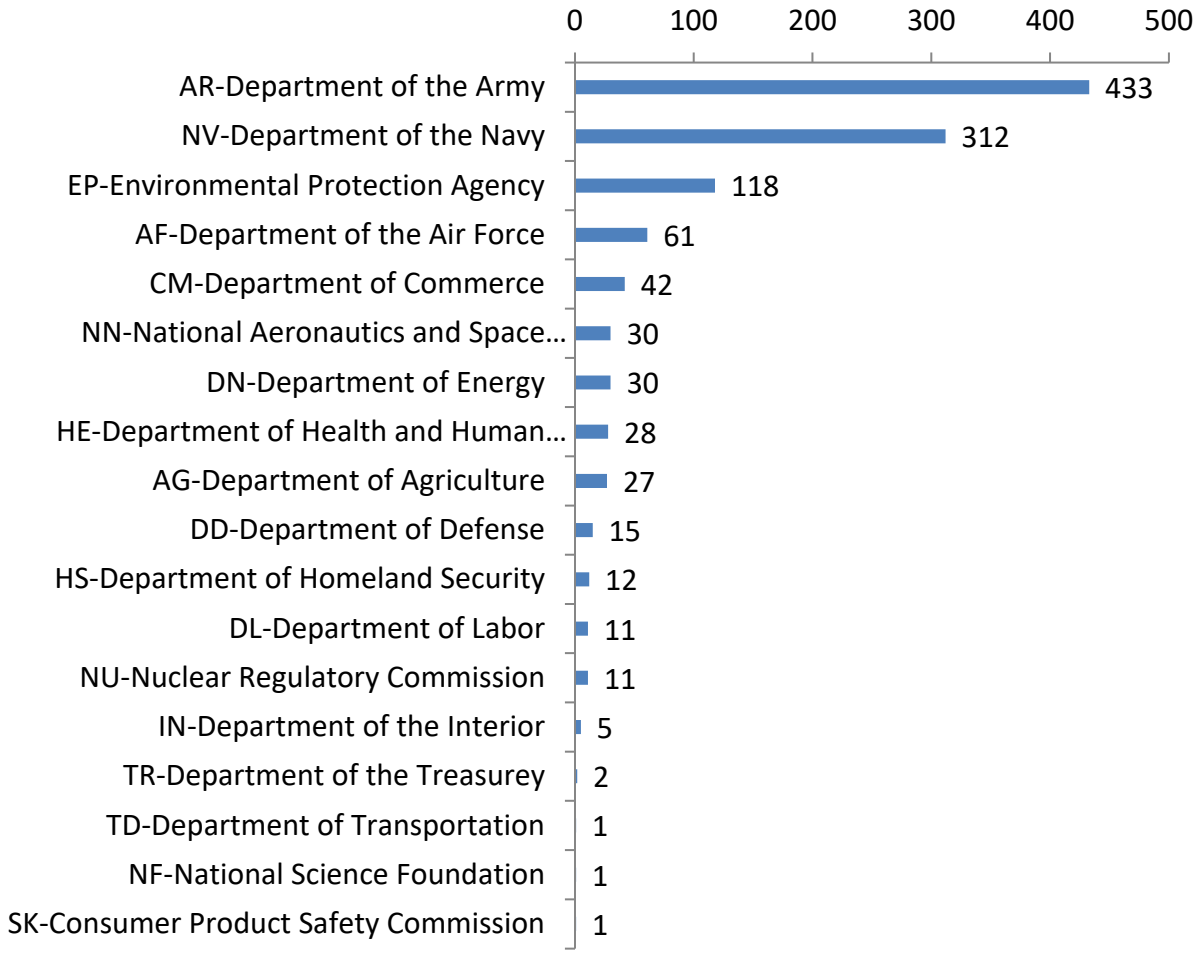
Where our graduates are currently serving



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

Government Employment of Chemical Engineers

As of July 2013

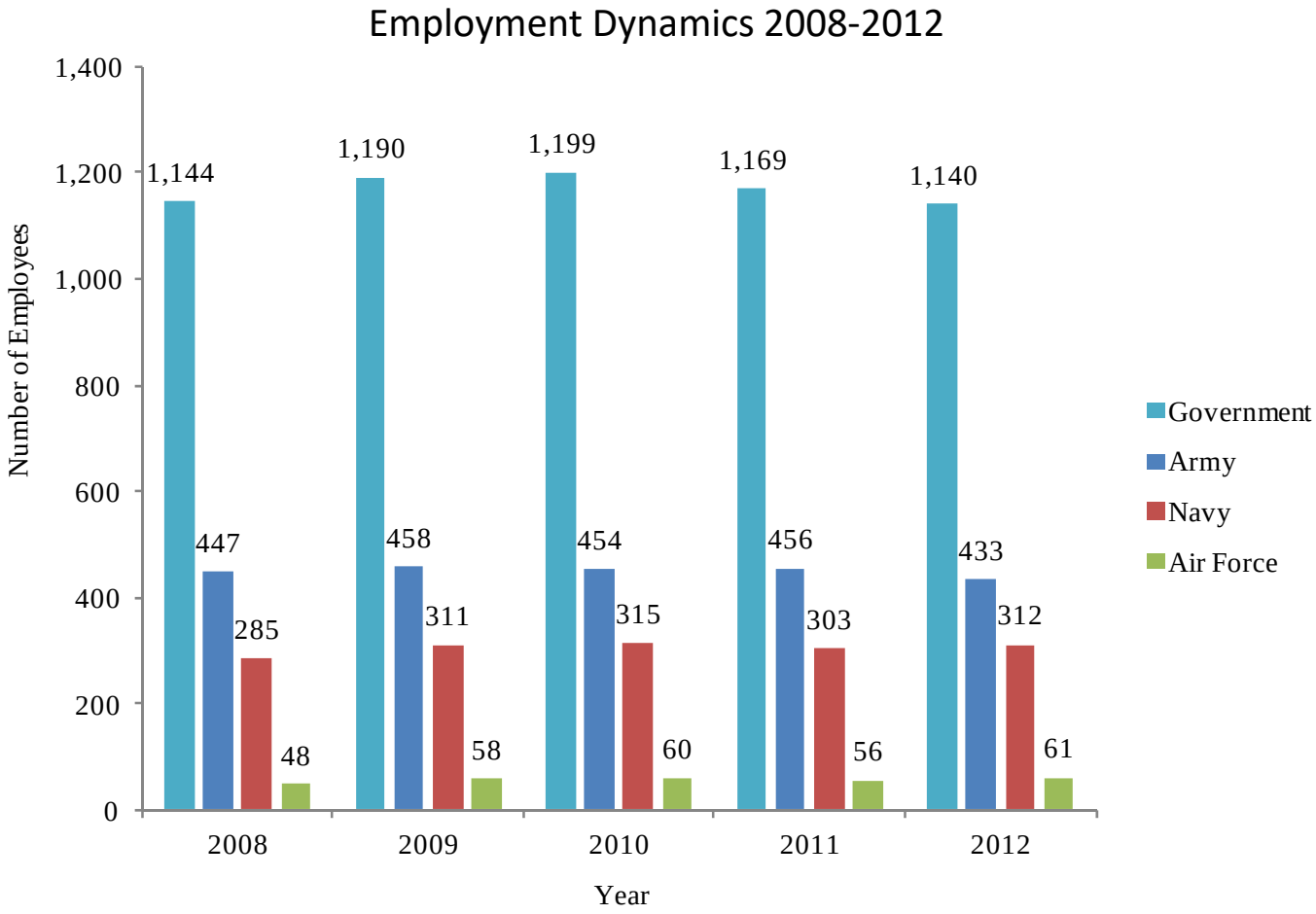


Government Employment of Chemical Engineers

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

Chemical Engineering Faculty

Can we support critical courses?

	AY14	AY15	AY16	AY17	AY18	AY19
Biaglow	X	X	X	X	X	X
Lachance	X	a	a	?	?	?
Woodka	X	X				
Gerfen	X	X	X			
Winter		X	X	?		
Belanger		X	X	?		
Bull		X	X			
Kalainoff		X	X	X	X	X
Armstrong				X	X	X
White				X	X	X
Onwuanumkpe				X	X	X
Pfluger					X	X
James					X	X
Totals		8	7	5	7	7

a – available to teach; currently in registrar's office

End of Section 4

Chemical Engineering

Advisory Board Meeting

November 14, 2014

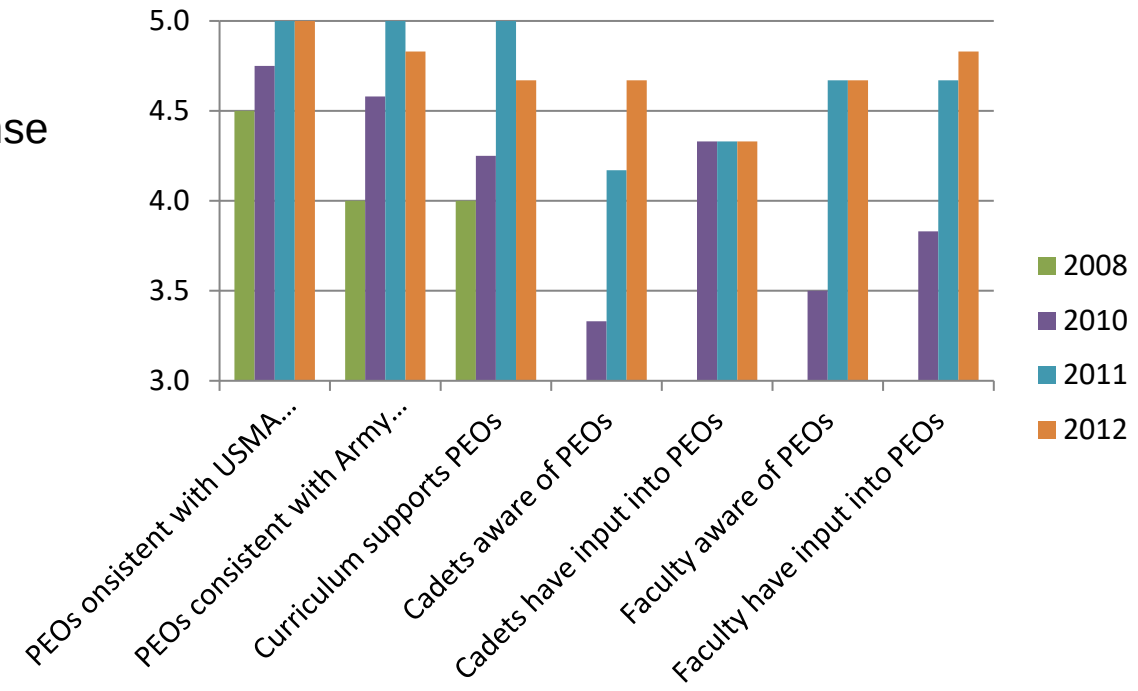
Supplemental Slides

United States Military Academy
Department of Chemistry and Life Science

How Faculty View the PEO Process?

Faculty are another key constituency.

Faculty Response



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

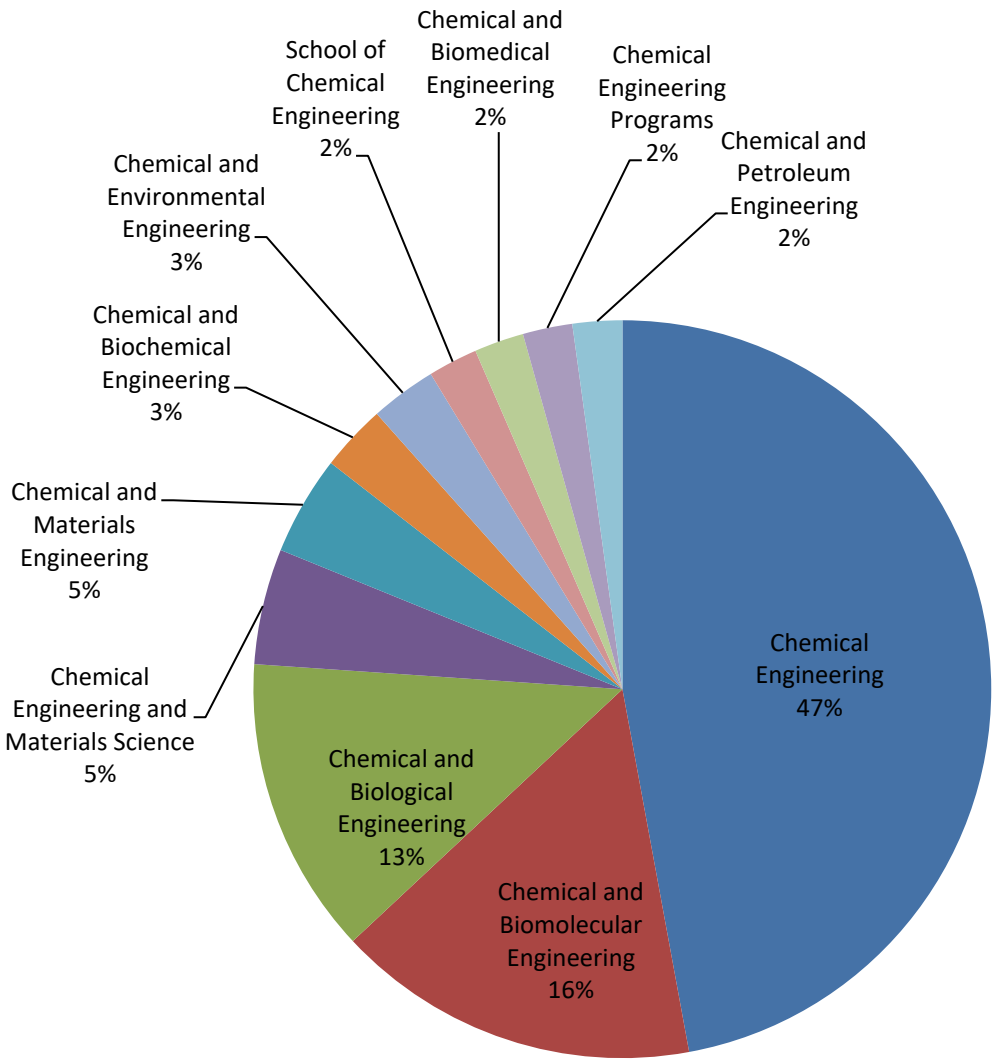
[a] Includes Puerto Rico and the District of Columbia

[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

Proposed Change 1

Change CH400 Chemical Engineering Professional Practice

Currently 1.0 credit hours in AY2013 - change to 1.5 ASAP

Reason - bolster the USMA chemical engineering credit hour count

We would go from 49 to 49.5 credit hours

Precedent - Parity with other USMA courses currently 2.0 credit hours

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

Proposed Change 2

Add CH365 Chemical Engineering Thermodynamics

Currently covered in physical chemistry

Reason - bolster the USMA chemical engineering credit hour count

We would go from 49 to 52 credit hours (52.5 w/ both changes)

Precedent - Parity with other chemical engineering programs

Assessment based. Intimately connected with assessment. Having collected data over a long period of time, response to data is critical.

Proposed Change 2

CH365 Chemical Engineering Thermodynamics

•Key potential shortcoming in response to assessment of chemical engineering thermodynamics 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). It does demonstrate we are responding to the data.

•Bolstering the USMA chemical engineering credit hour count will reduce the probability of failing ABET Criterion 5 (go from 49 to 52.5 credit hours in ET and 41 to 37.5 in BS).

•Loss of Physical Chemistry is a concern.

ABET Table 5-1

Semester	Course Number and Description	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

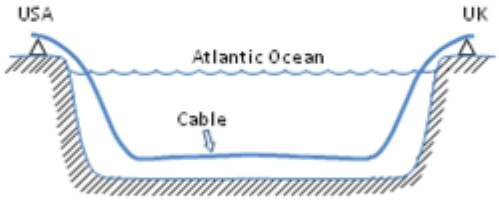
Fundamental Question – Are These Safe?

- 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.

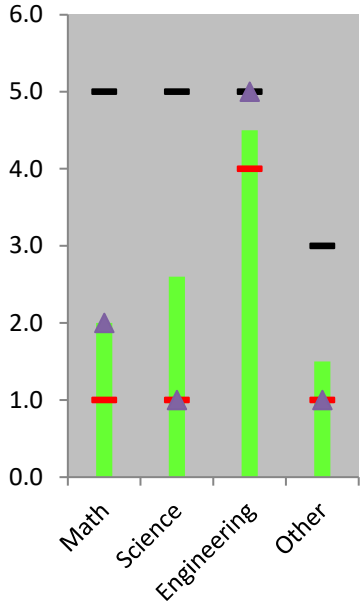
Assessing Engineering Content

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.



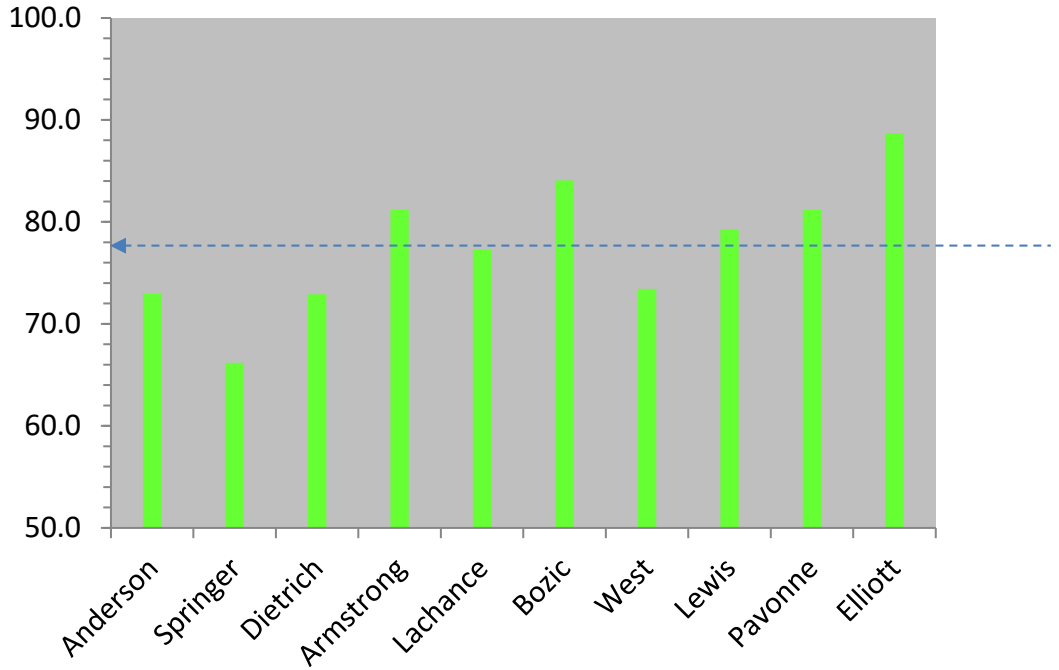
	Great extent		Moderate		Not at all
To what extent is this a mathematics problem?	☐	☐	☐	☐	☐
To what extent is this a basic science problem?	☐	☐	☐	☐	☐
To what extent is an engineering problem?	☐	☐	☐	☐	☐
To what extent is this some other type of problems?	☐	☐	☐	☐	☐



5=great extent

Comparing the Assessments

Author's intention versus reader's perception



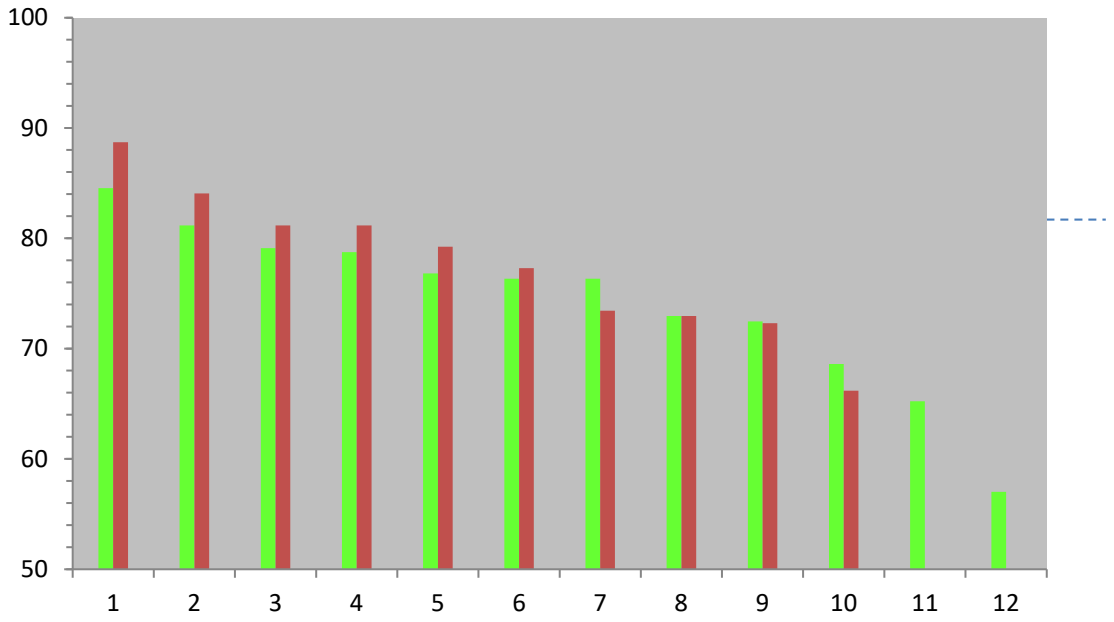
-1 for each 1-point deviation from instructor's answer.

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).

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)