# Chemical Engineering

Advisory Board Meeting

April 8, 2016

United States Military Academy
Department of Chemistry and Life Science

# Thank You! Advisory Board 2014-2015 Needs Revision

| | | |
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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

Needs Revision

# Advisory Board Meeting Agenda

**April 8, 2016**

Introductory remarks and orientation

Program assessment

Cadet Discussions

Future Challenges

Facilities and construction

Wrap-up

# Chemical Engineering

Advisory Board Meeting

April 8, 2016

## 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 | Engineering Technology Accreditation Commission

Revised


Visit – 28-30 September 2014

Program Report Received – September 30, 2015

Accredited October 1, 2012 to present

Revised

# Why ABET Accreditation?

- An external certification of quality
- Keeps us in touch with the engineering profession
- Helps USMA recruiting
- 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.

# The ABET Process

- It's what we should do anyway. A reservoir 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 profession:
  - A natural way to benchmark with others
  - Helps articulate educational standards to the Army

# About ABET

- 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 3,569 programs in 40 disciplines at more than 714 colleges and universities in 29 countries
- There are more than 2,200 program evaluators and other volunteers

Revised

# 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 2009
  - Information Technology
  - Nuclear Engineering
- One program initially accredited in 2015
  - 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

Governs the curriculum – Basic Math and Science; design, analysis and control; hazards associated with processes

Harmonized Criteria

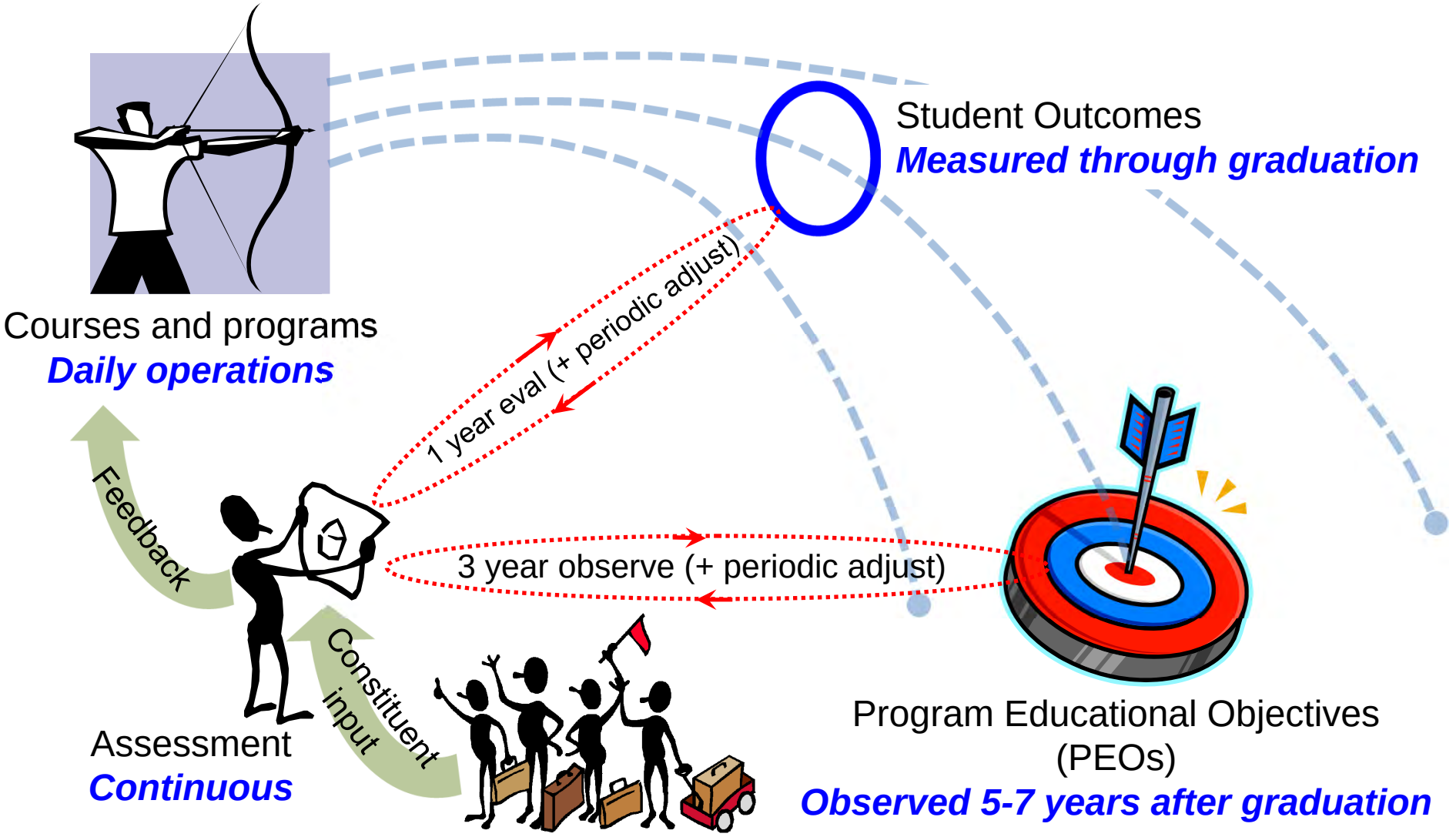
# Terms You Should Know

- **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…

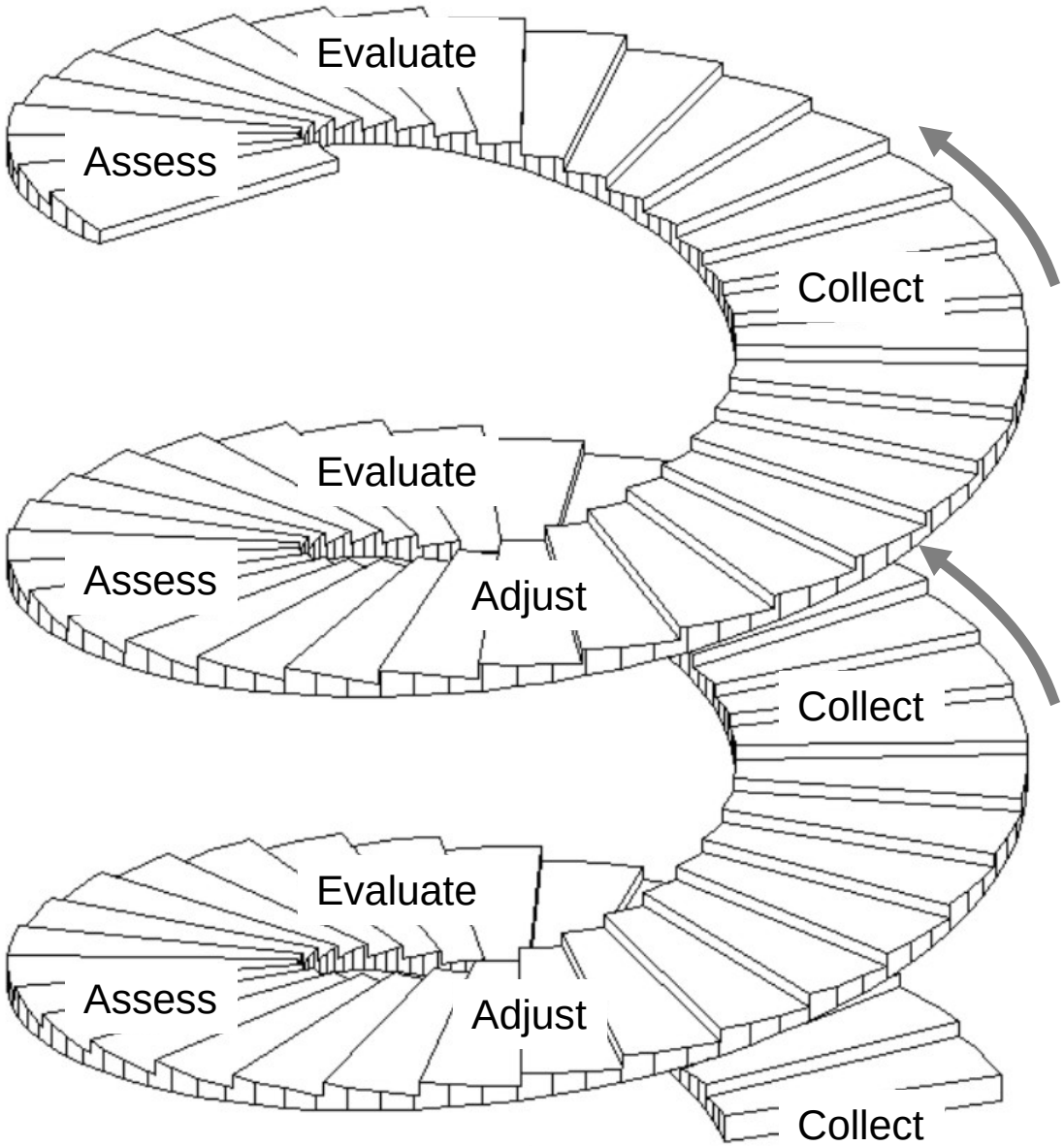
- **Student Outcomes**
  - What students should be able to do **at graduation**
  - Must be **measurable**
  - Designed to lead naturally to the PEOs
  - Assess/evaluate some fraction yearly.
- **Assessment → Continuous improvement**
  - Collect meaningful data to evaluate performance indicators (PIs)
  - 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 Student Outcomes and relevance of PEOs

Needs Revision – Delete?

# Assessment → Improvement



# Assessment Cycle



Needs Revision - Delete

# Accreditation AAR

- Self-study review and Q&A 15 June to 27 September 2014.
- Site visit 28-30 September 2014
  - Document auditing and verification of self-study
  - Tour of facilities
  - Interviews with students and faculty
- 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 1, 2012
- Initial PEV feedback was that we should streamline our student outcomes

Important Slide - Revised

# 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

Needs Revision

# 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

Advisory Board Meeting

April 8, 2016

## 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

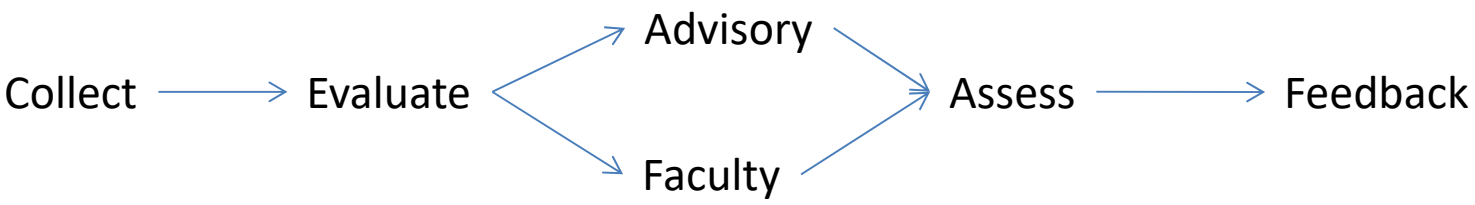
Participation in FE Exam (not pass rate)

Student end of semester surveys

Student CHEME Program Exit Surveys

Course Grades

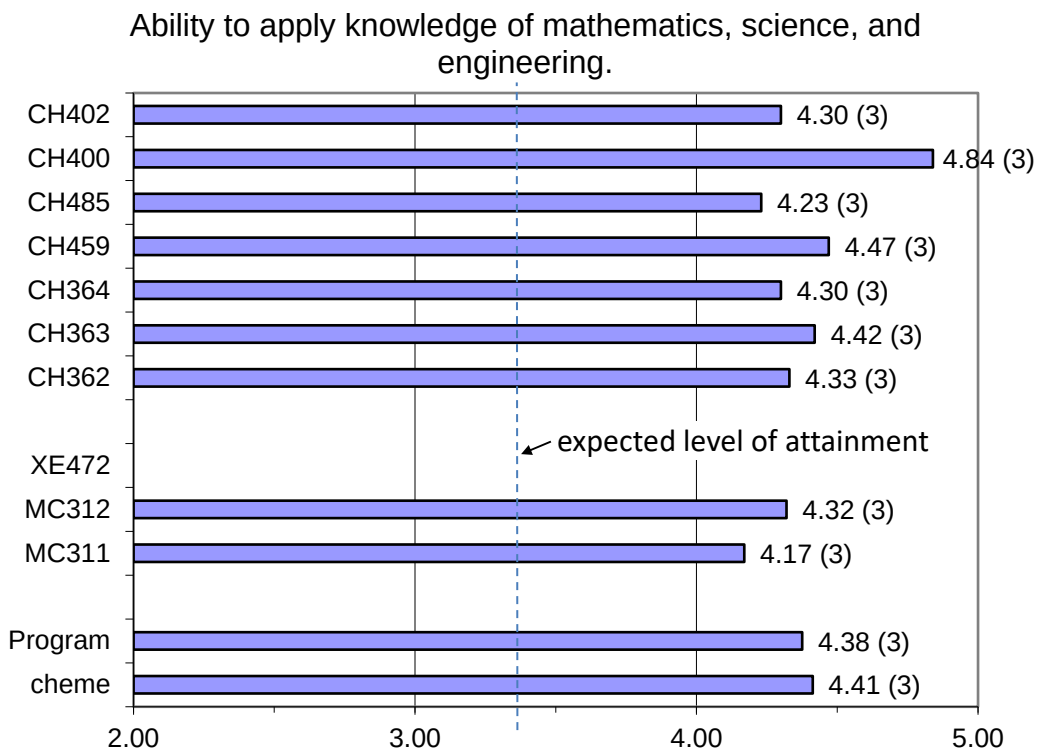
## Process



# Example Data: Coursework Embedded Indicators

Revised

Student Outcome 1



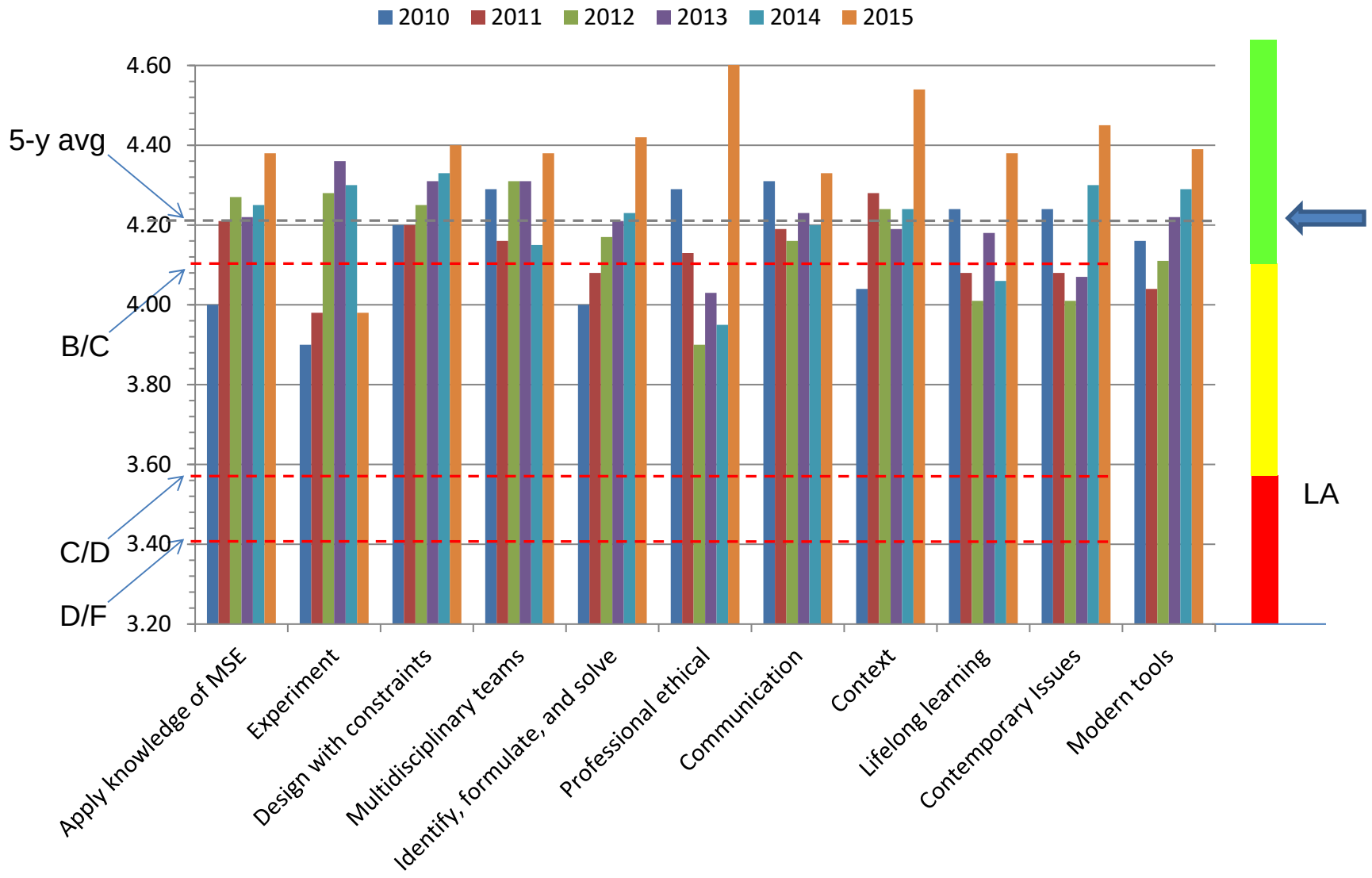

Values in parentheses are coverage ratings from Table 5-3 in the Self Study, page 5-9

Data shown here is for Class of 2015
Similar data is collected for all 11 ABET outcomes

Revised

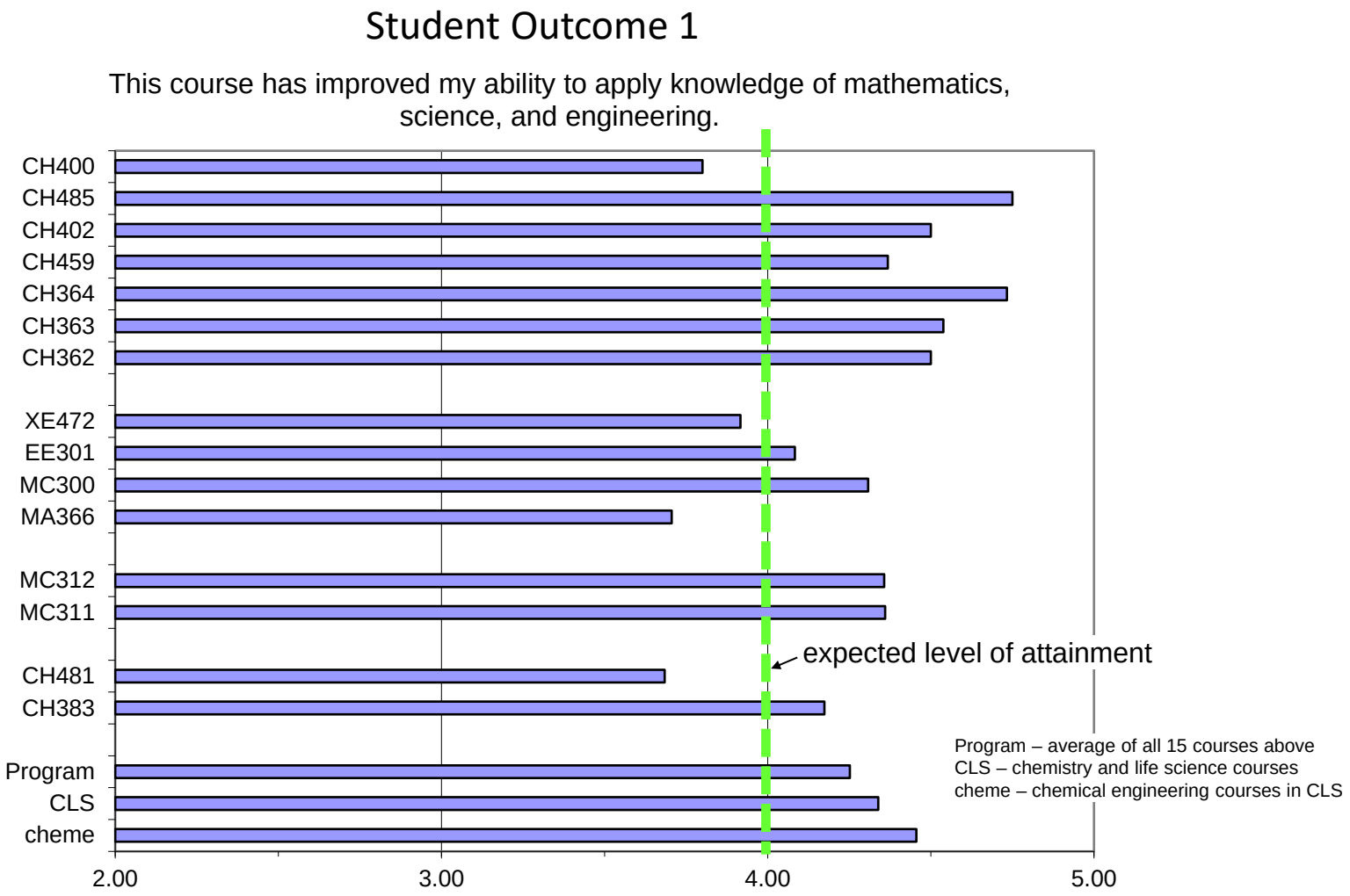
# Performance on Embedded Indicators

## Program Averages AY2009 to AY2014



# Example Data: End-of-Semester Surveys

Revised



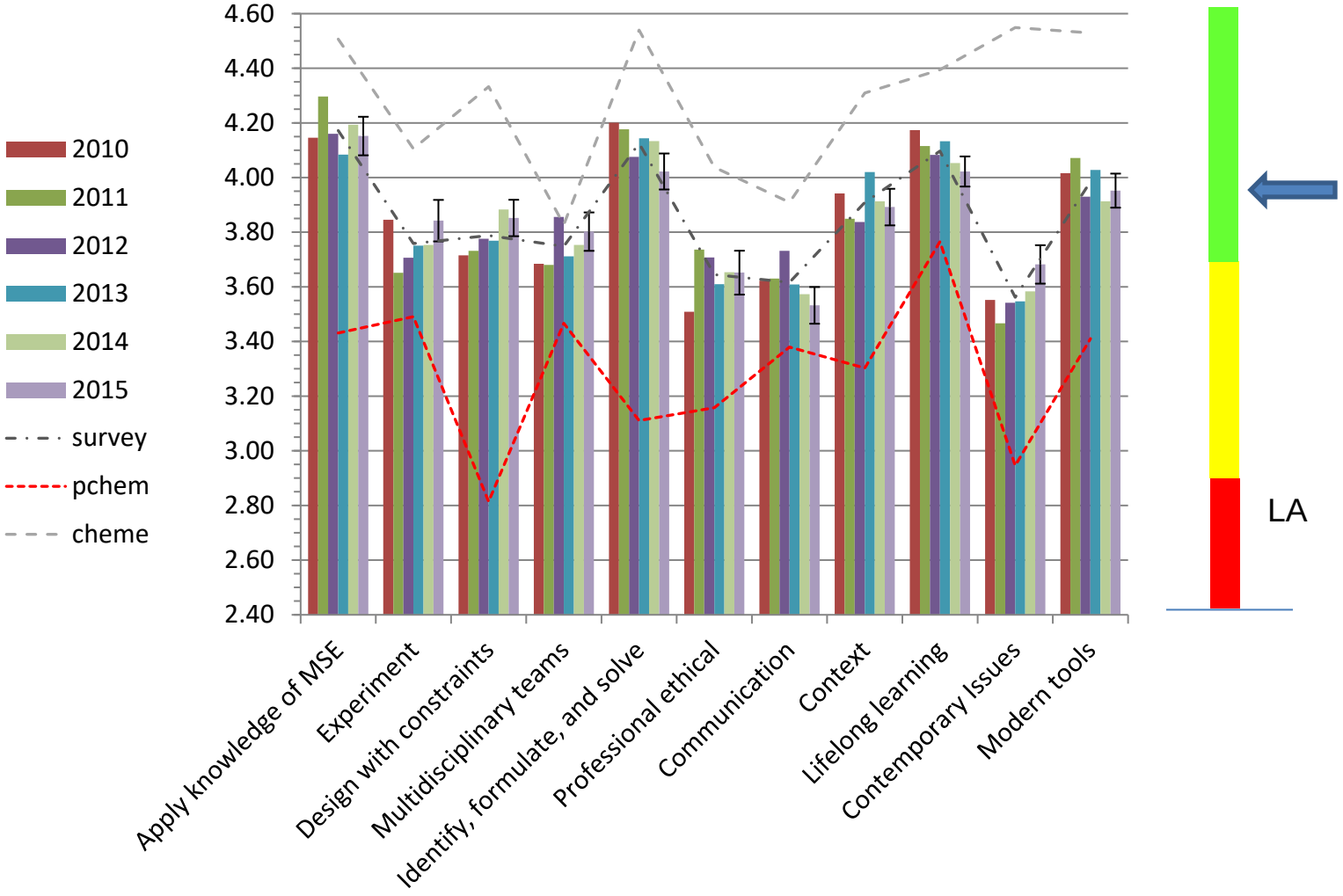

Data shown here is for Class of 2015

Similar data is collected for all 11 ABET outcomes

Revised

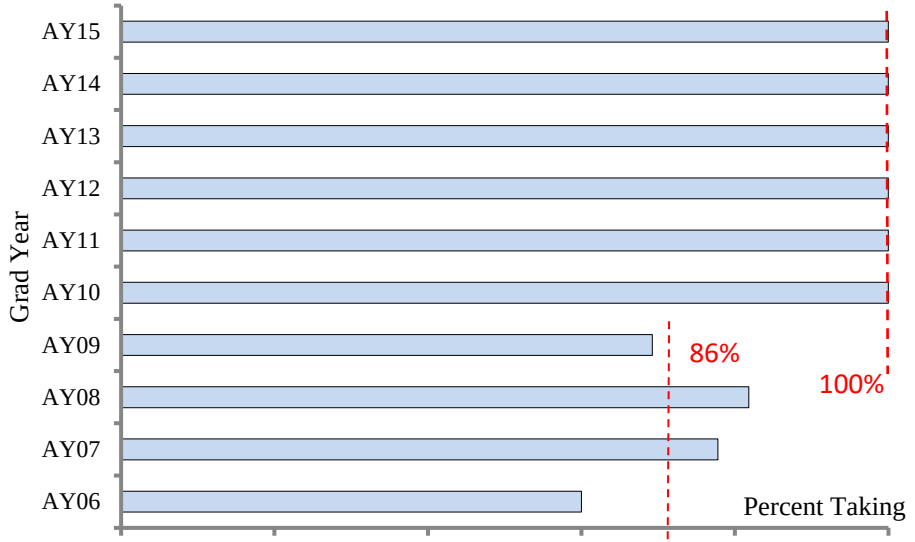
# End-of-Semester Surveys

## Normalized Program Averages from AY10-15



# Performance on Fund. of Engineering Exam

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

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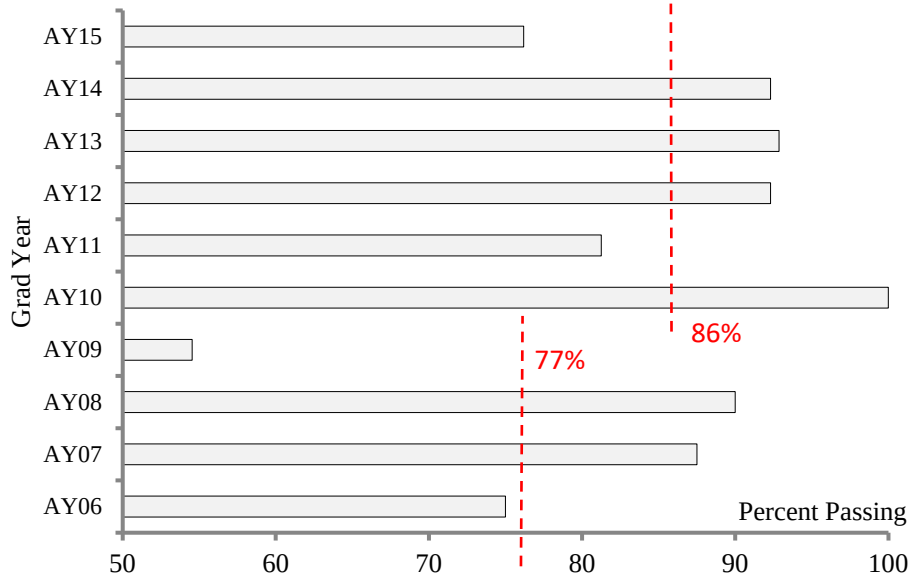
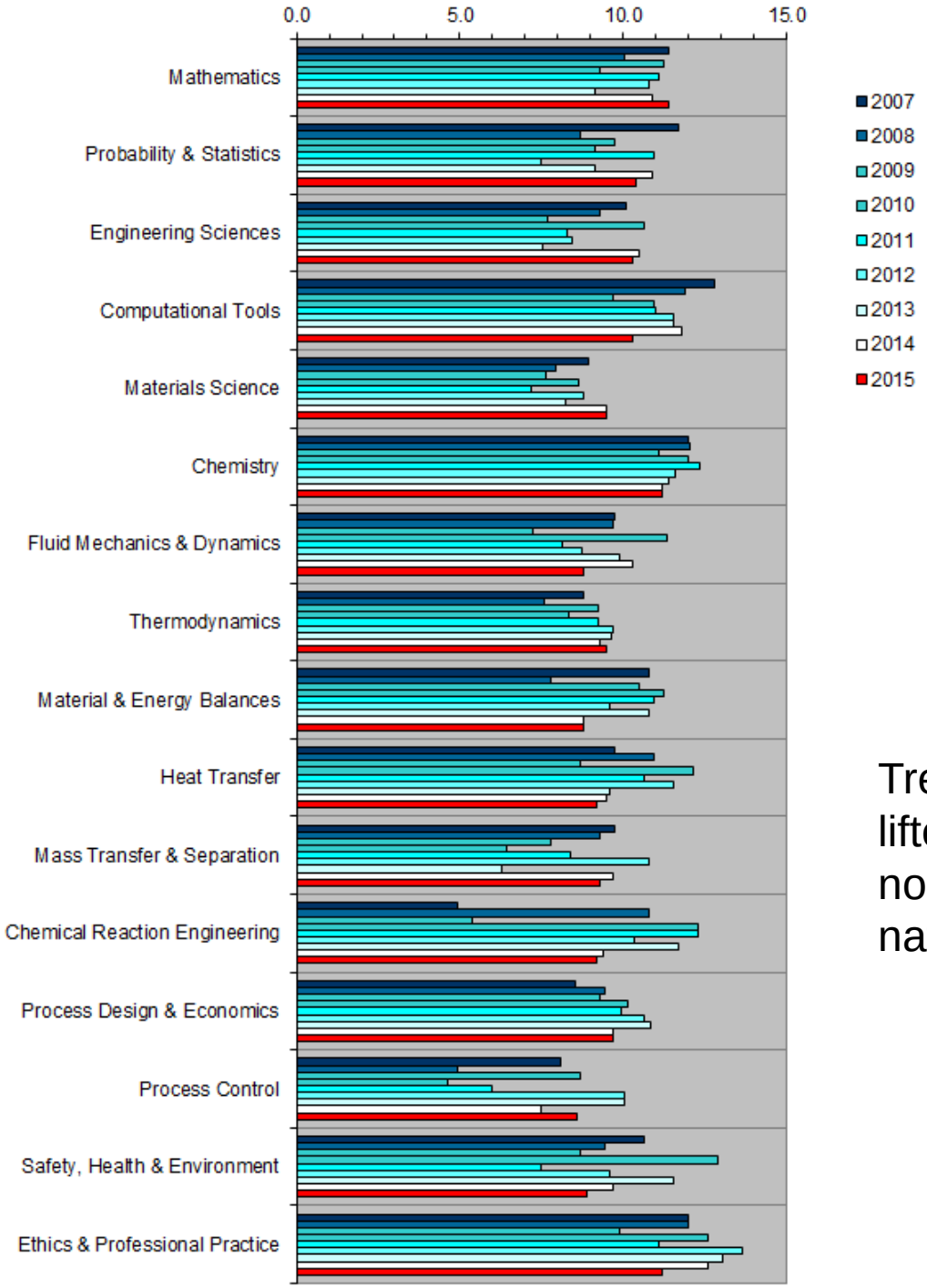



CH400 Initiated

# Program Outcome Evaluation

Performance Indicators AY07 to AY15

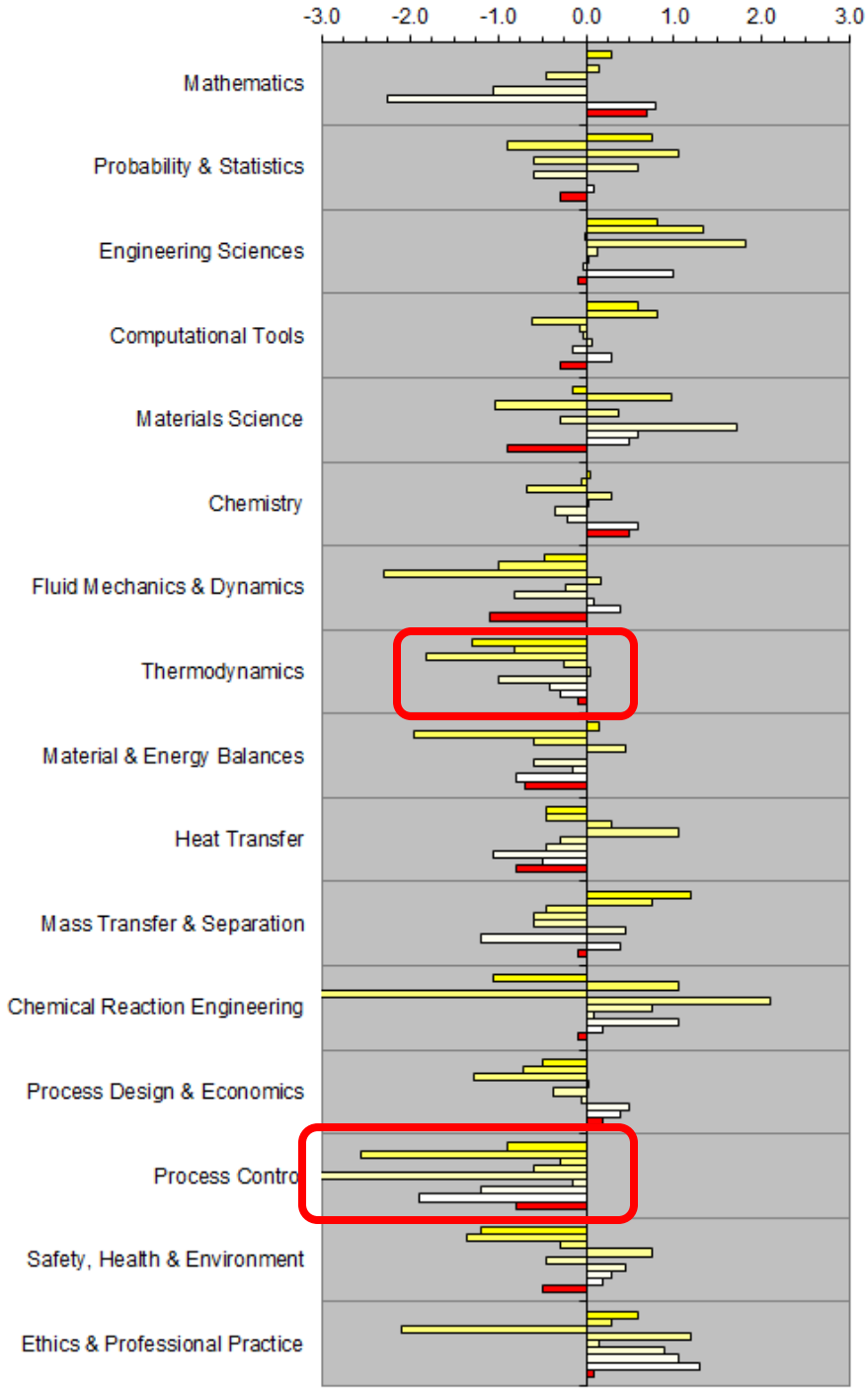



New Slide

Trends need to be lifted out so data is normalized against national average

# Topical Outcomes Evaluation

Deviations from National Averages AY07 to AY15



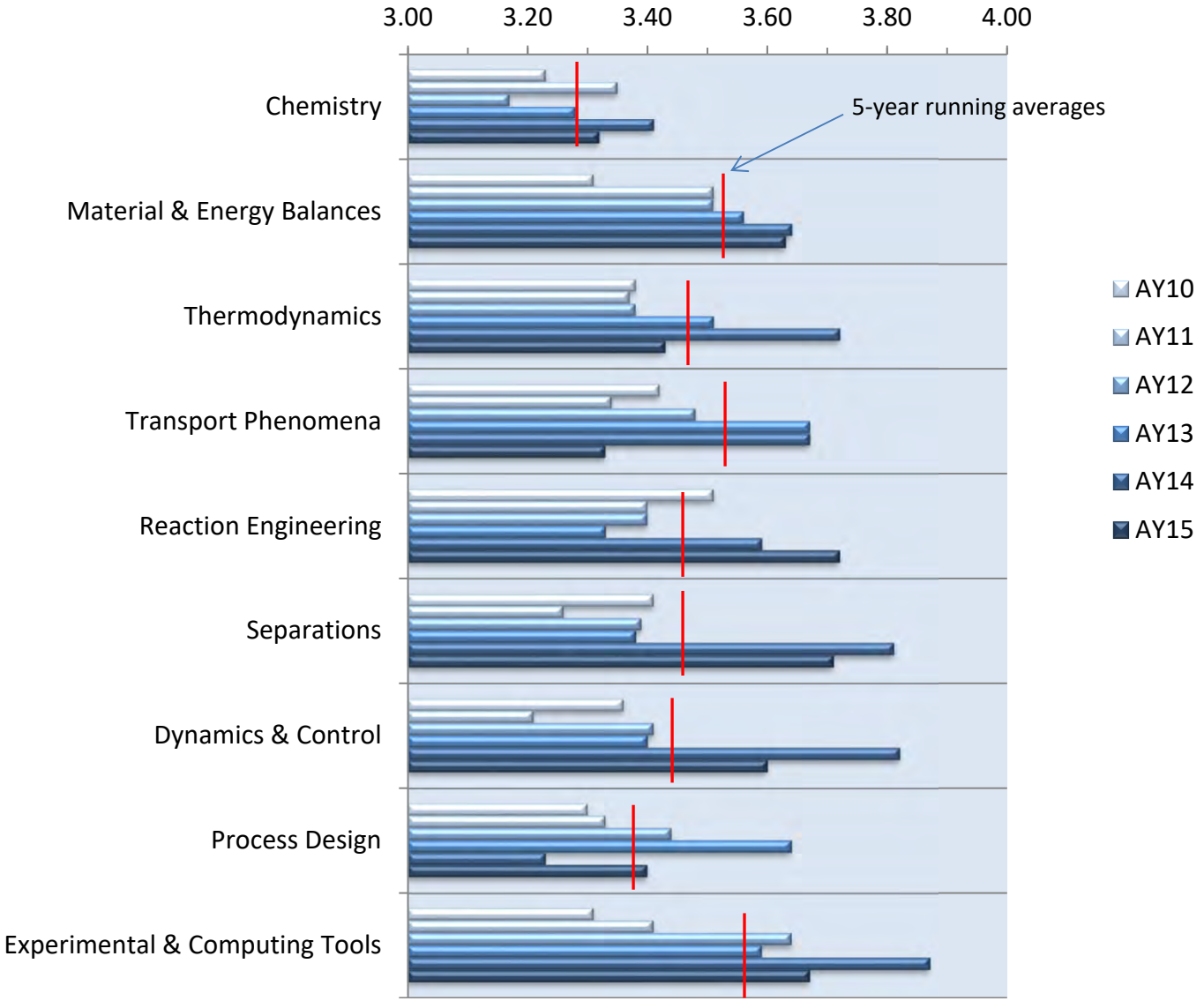

Revised

Intervention accomplished - introduced "CH365"

Intervention Suggested

# Topical Outcomes Evaluation

Average Course GPA After Parsing from Transcripts



# End of Section 2

(Advisory Board Completes Survey Part 1)

Revised

# Chemical Engineering

Advisory Board Meeting

March 8, 2016

## 3. Assessment (Program Objectives)

United States Military Academy
Department of Chemistry and Life Science

# Lunch – Cadet Mess

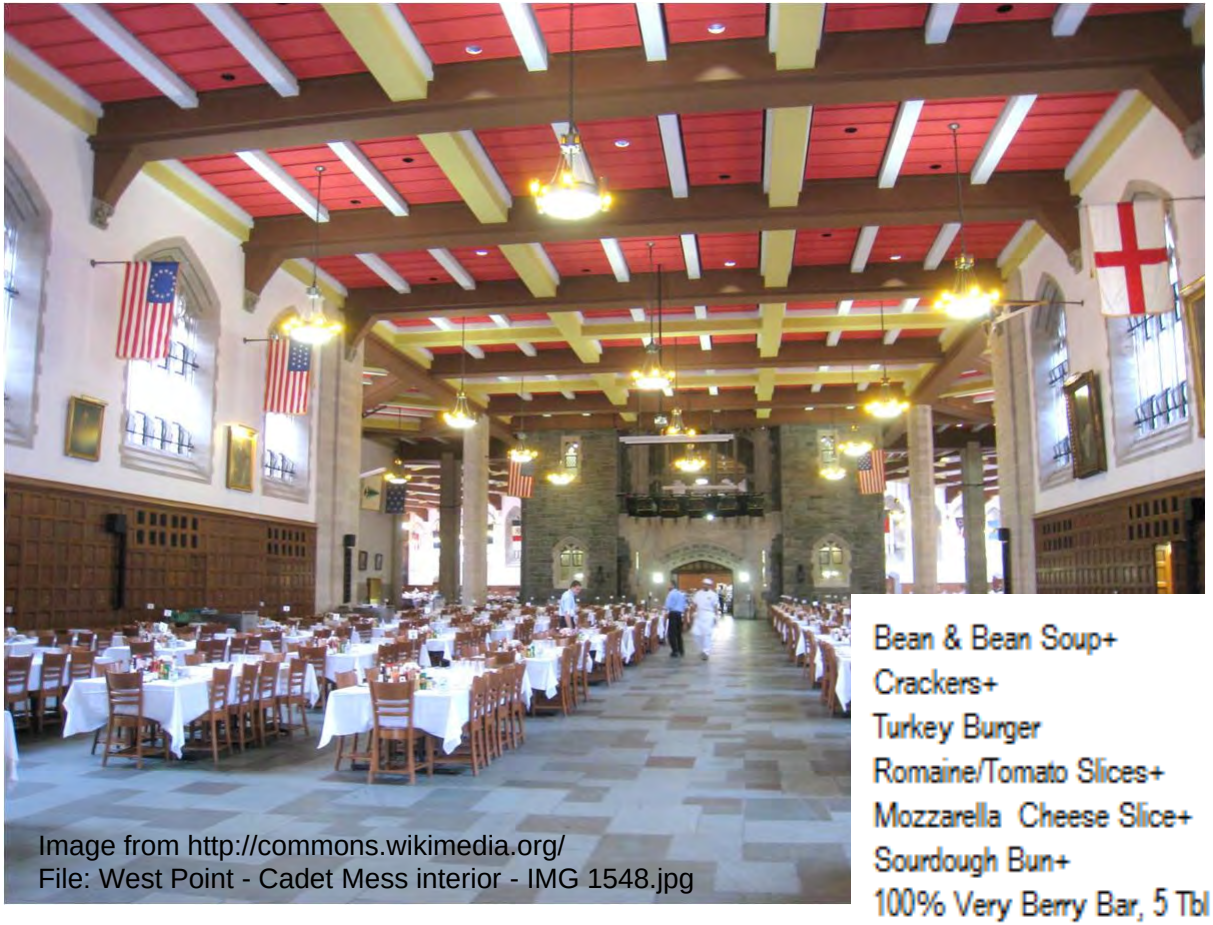


Image from http://commons.wikimedia.org/
File: West Point - Cadet Mess interior - IMG 1548.jpg

| | | |
|---|---|---|
| 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.

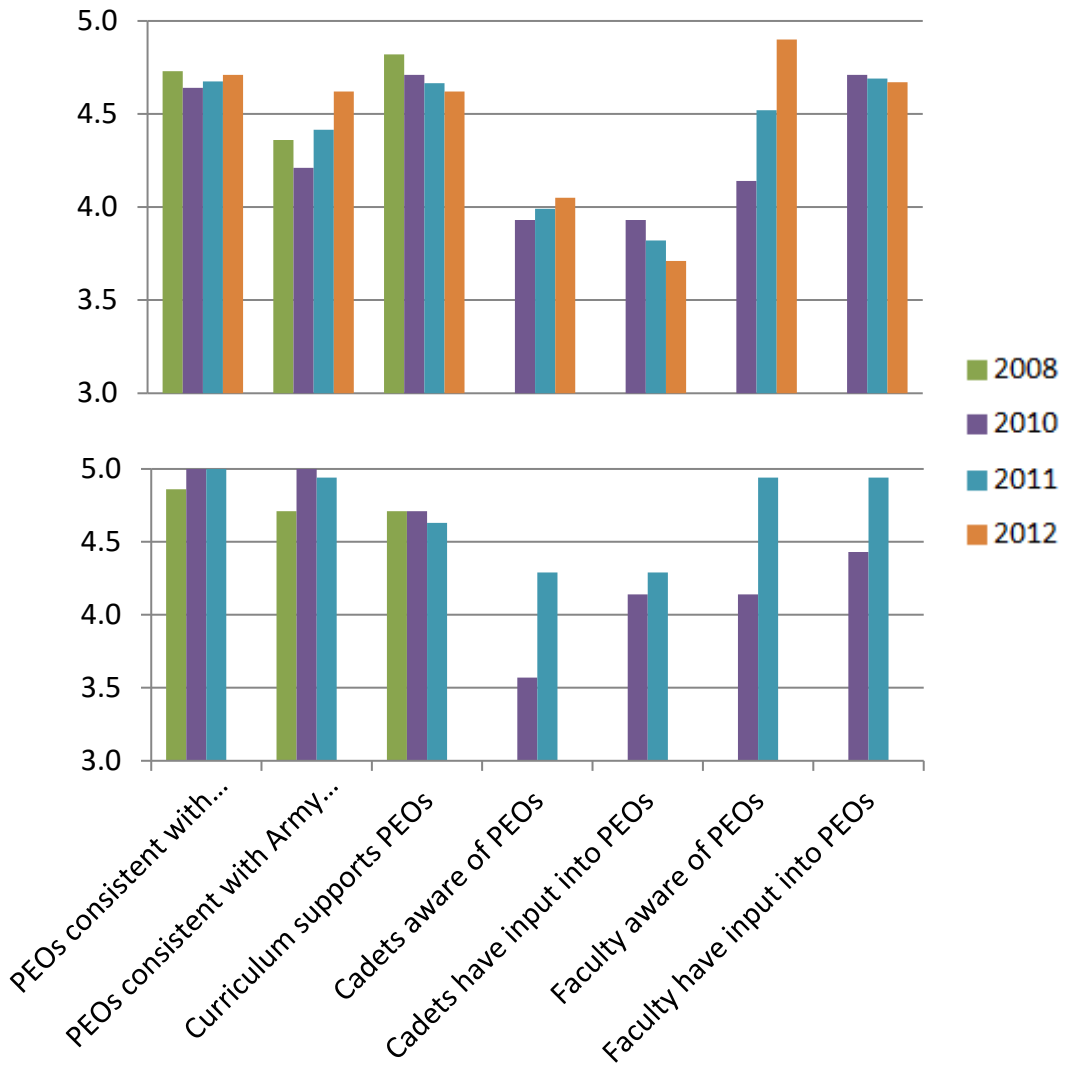
Delete

# How Cadets View the PEO Process

Cadets are a key constituency

Cadet Response

Advisory Board

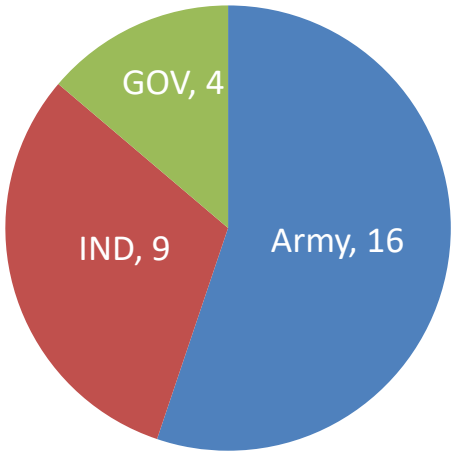



Faculty responses are in the supplemental slides.

# 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

Advisory Board Meeting

April 8, 2016

## 4. Future Challenges

United States Military Academy
Department of Chemistry and Life Science

# 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

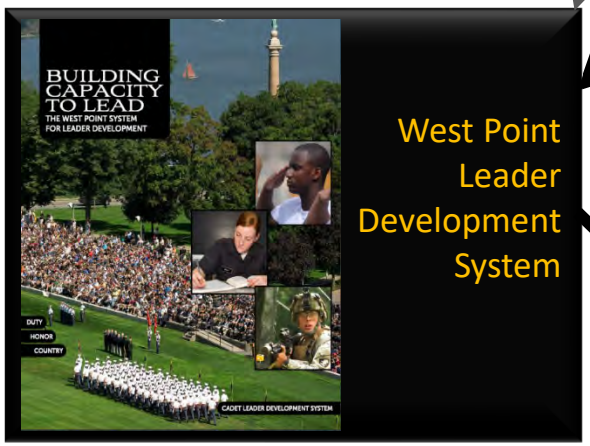
# Strategic Influence

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

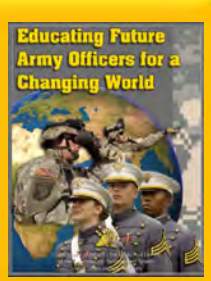
West Point Mission and Strategic Plan




West Point Leader Development System

Academic Program Vision and Strategic Plan

**Academic Program Goals**




- Core Courses
- Academic Majors
- Enrichment Experiences

# Proposed Change 1

## 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 Change 2

## CH366 Chemical Engineering Process Control

•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.

# Proposed Change 3

# CH300 Technical Writing

•Response to curriculum changes.

•Perceived shortcoming in cadet writing ability across the core

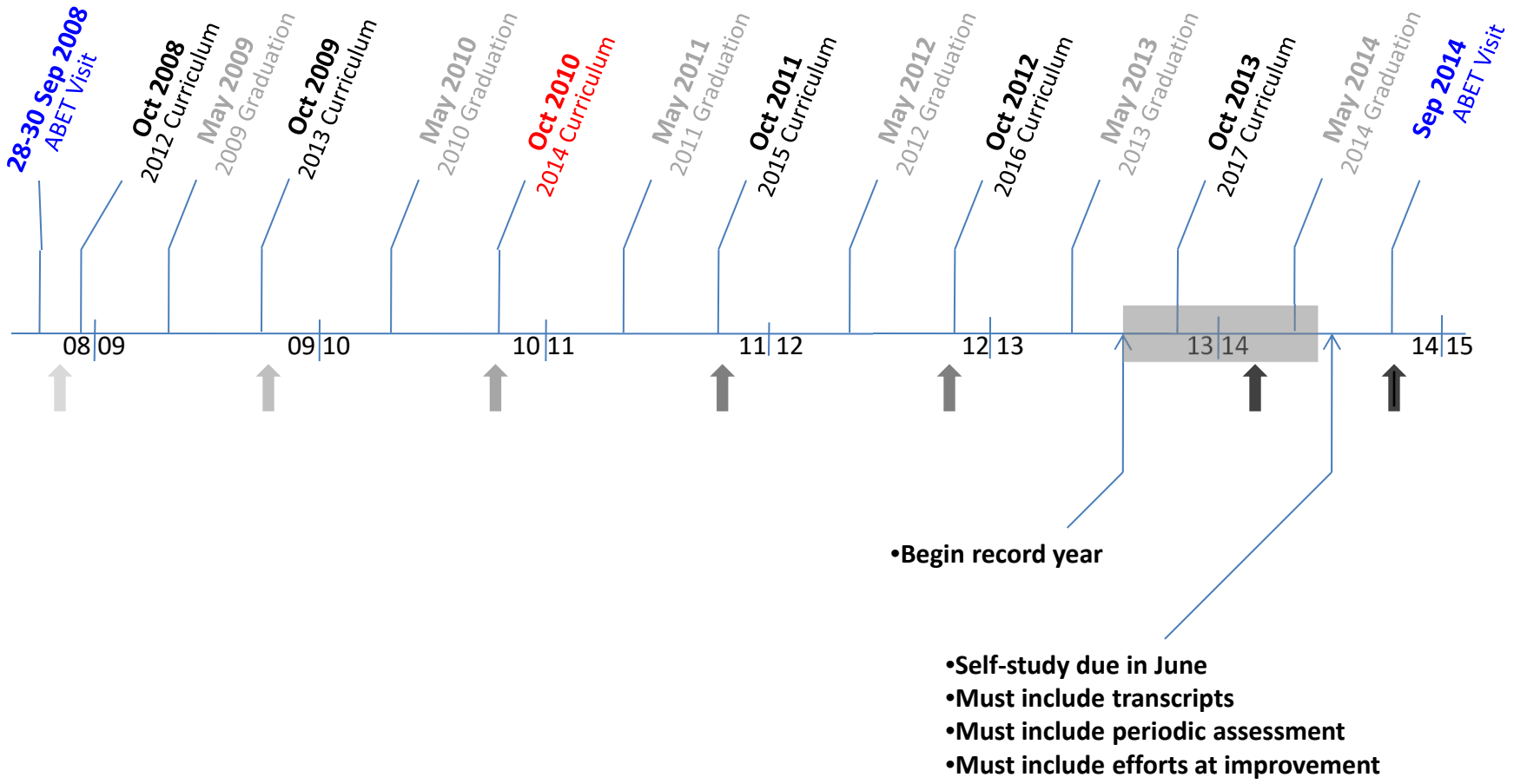
•Dean is currently requiring us to sacrifice technical content from one of our courses to address perceived shortcoming.

•Opportunity for us to engage in engineering-specific communication skills

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

Needs Revision

# Timeline for Curricular Actions




Visit: 14-16 September (Proposed)

# Chemical Engineering Faculty

Needs Revision

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

Revised

# Chemical Engineering

Advisory Board Meeting

April 8, 2016

Supplemental Slides

United States Military Academy
Department of Chemistry and Life Science

# 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 |

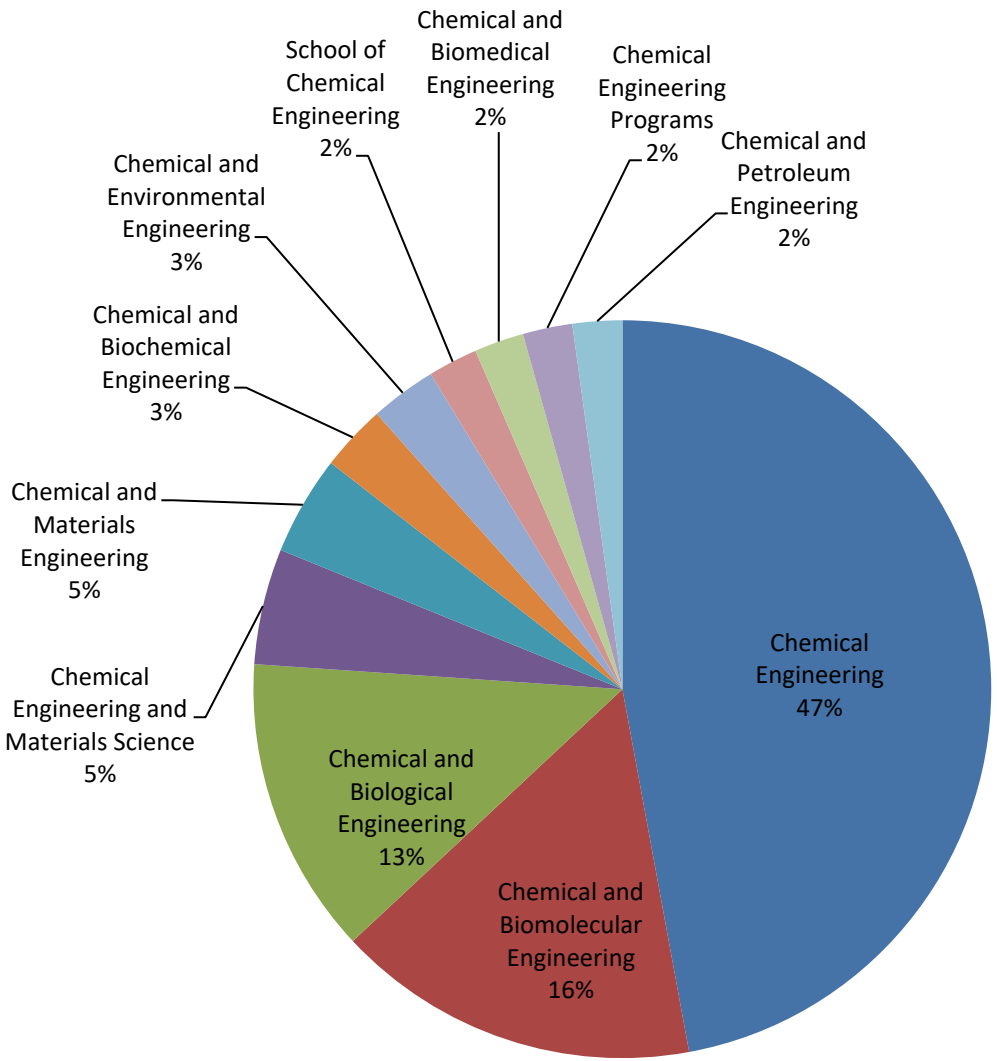
[a] Includes Puerto Rico and the District of Columbia

[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 |
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| % 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

April 8, 2016

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

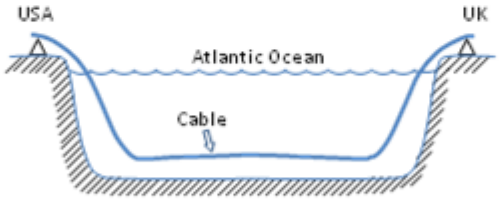
## Fundamental Question – Are These Safe?

- 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.

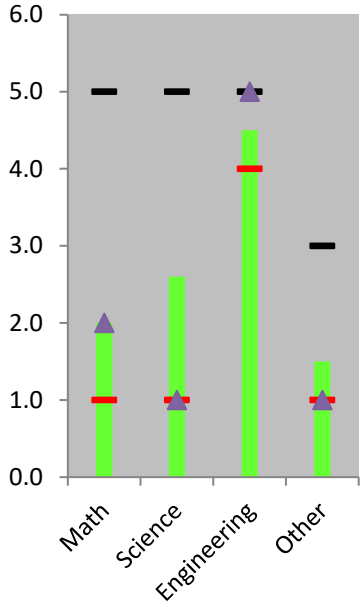
# Assessing Engineering Content

**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.



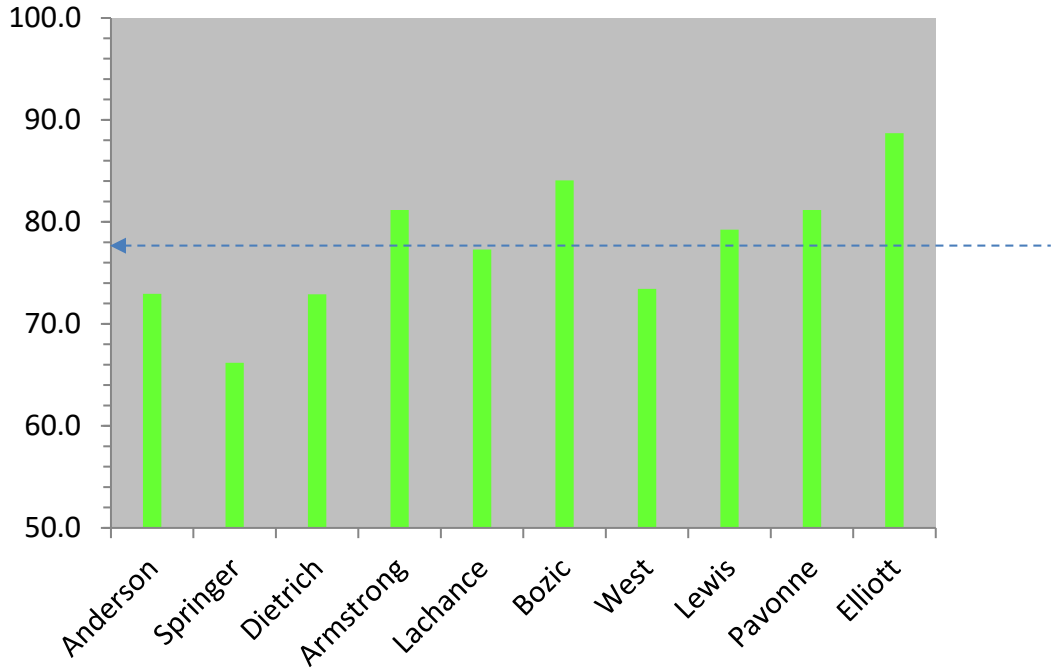

| | Great extent | | Moderate | | Not at all |
|---|---|---|---|---|---|
| To what extent is this a mathematics problem? | ☐ | ☐ | ☐ | ☐ | ☐ |
| To what extent is this a basic science problem? | ☐ | ☐ | ☐ | ☐ | ☐ |
| To what extent is an engineering problem? | ☐ | ☐ | ☐ | ☐ | ☐ |
| To what extent is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




5=great extent

# Comparing the Assessments

Author's intention versus reader's perception



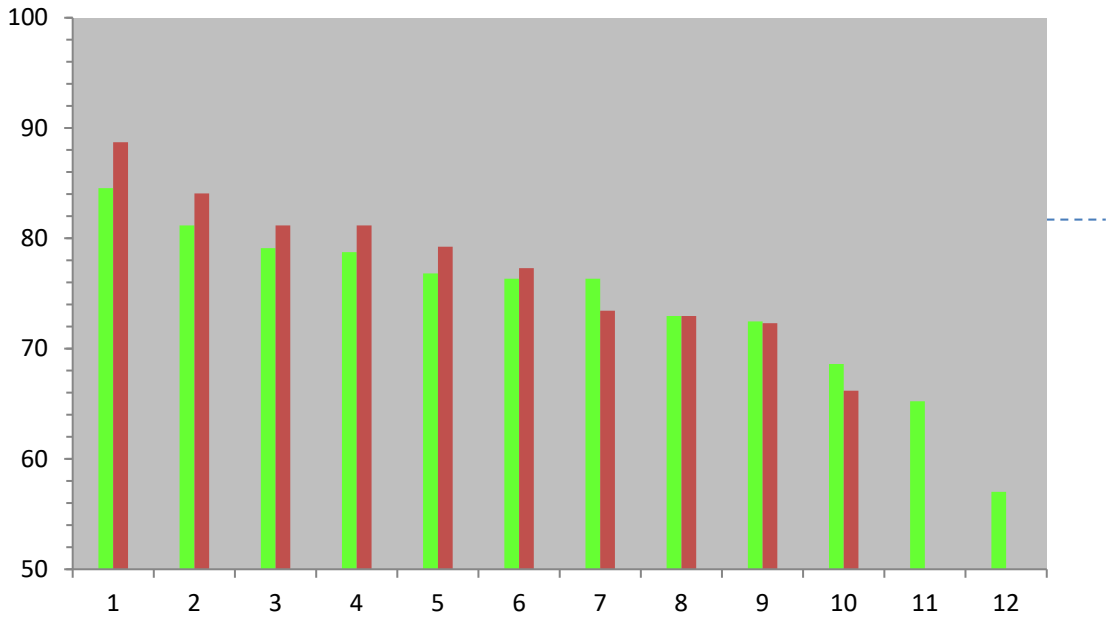

-1 for each 1-point deviation from instructor's answer.

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.

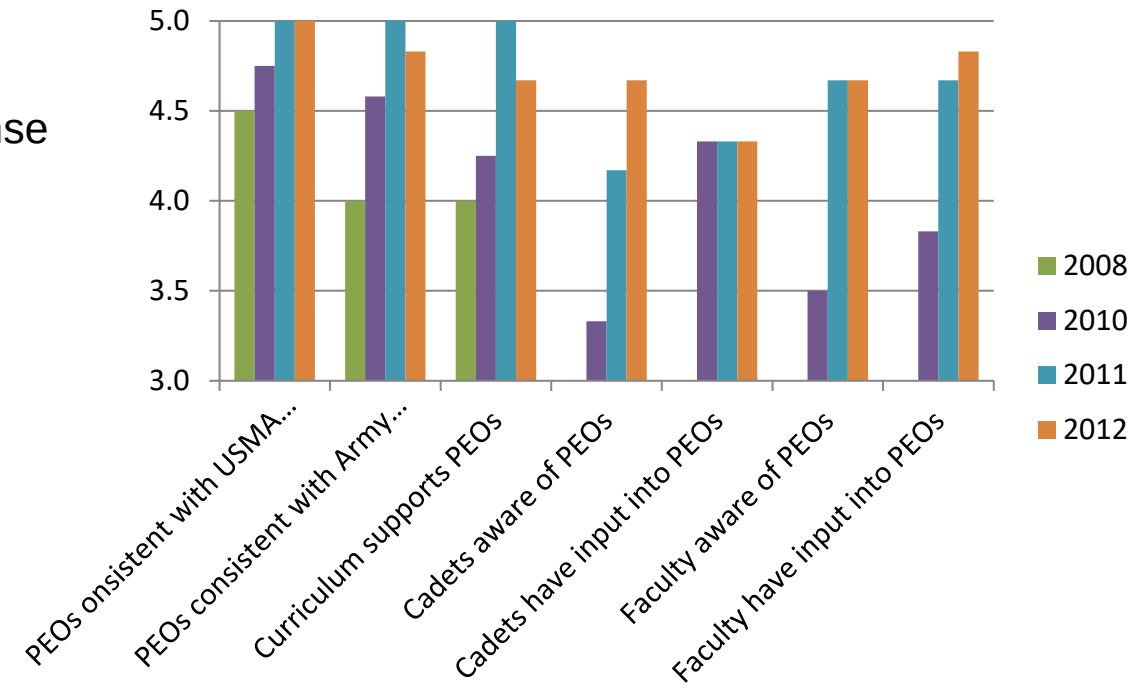
•Interest in continuing this study, imperfect as it is? If so, need volunteers to examine MA366.

•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**

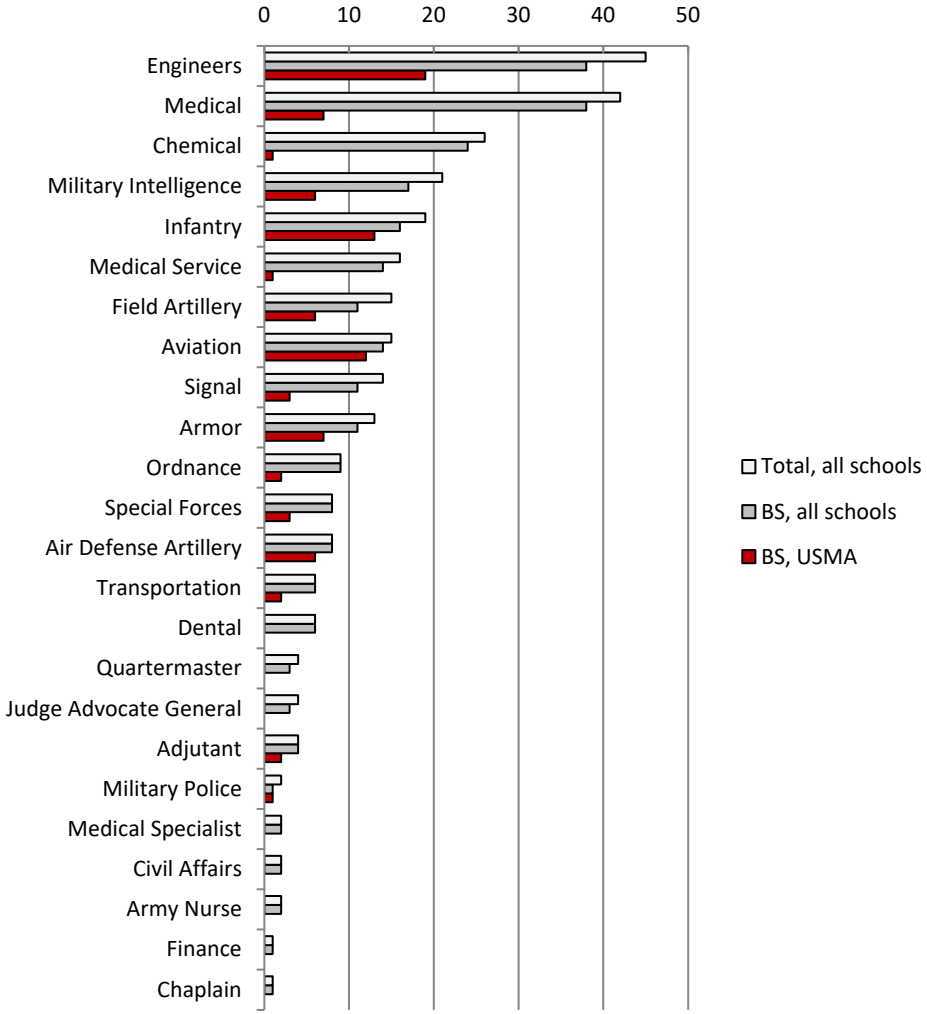
**TALENT PRIORITIES:**

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

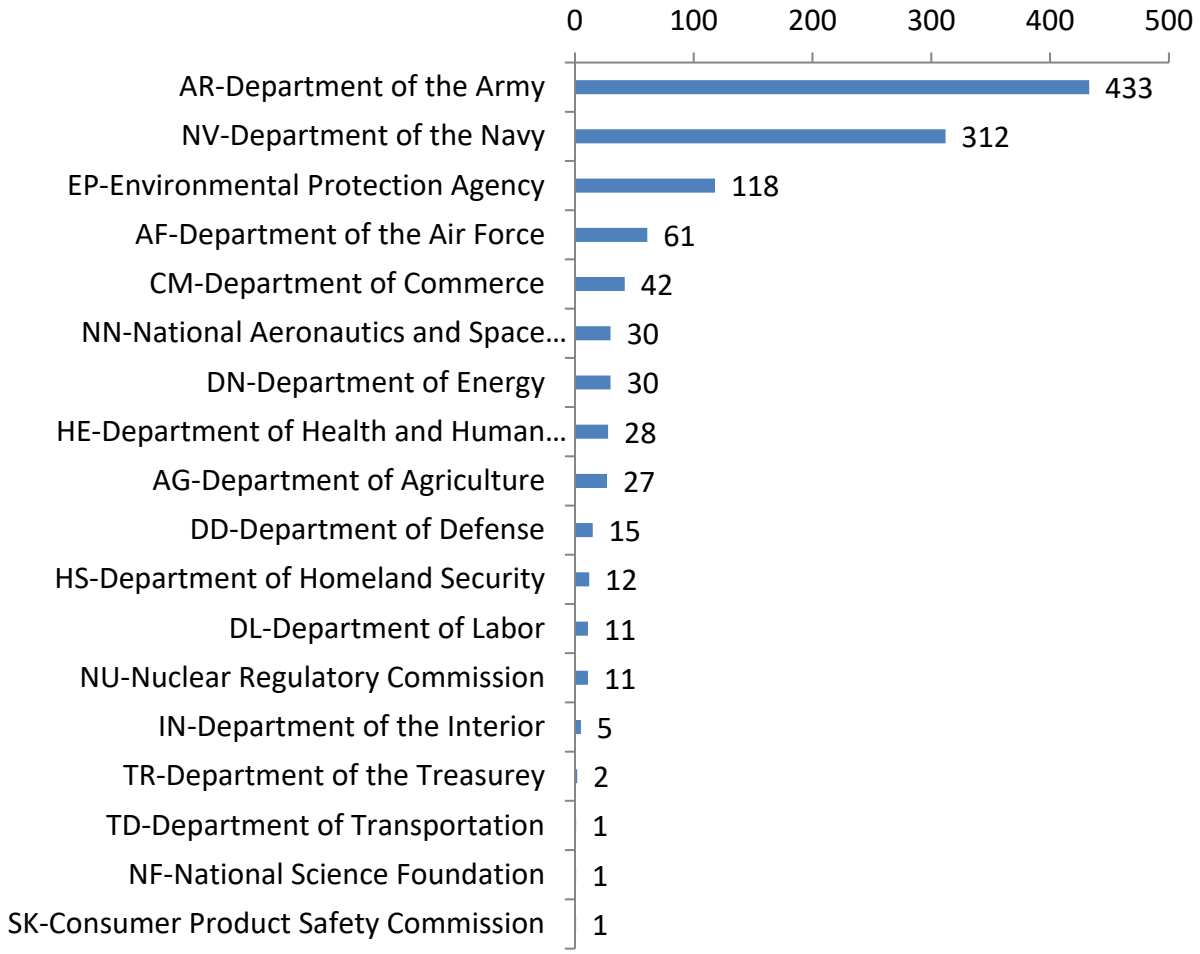
Where our graduates are currently serving




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

# Government Employment of Chemical Engineers

As of July 2013

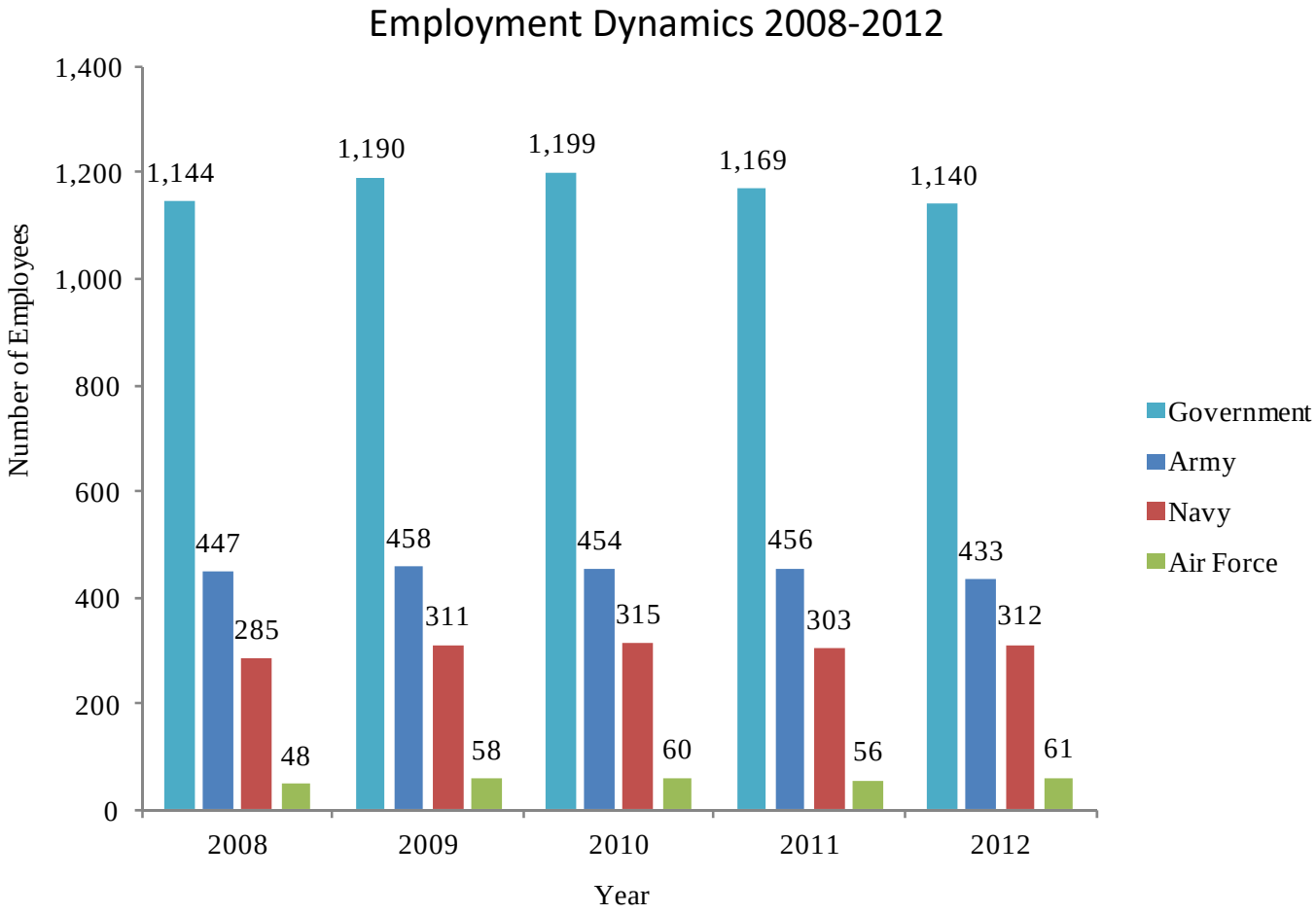


# Government Employment of Chemical Engineers

As of July 2013

# Government Employment of Chemical Engineers

Labor Market Survey



# Chemical Engineering Salary Survey

| Occupation: Chemical Engineers (SOC code 172041)<br>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% |

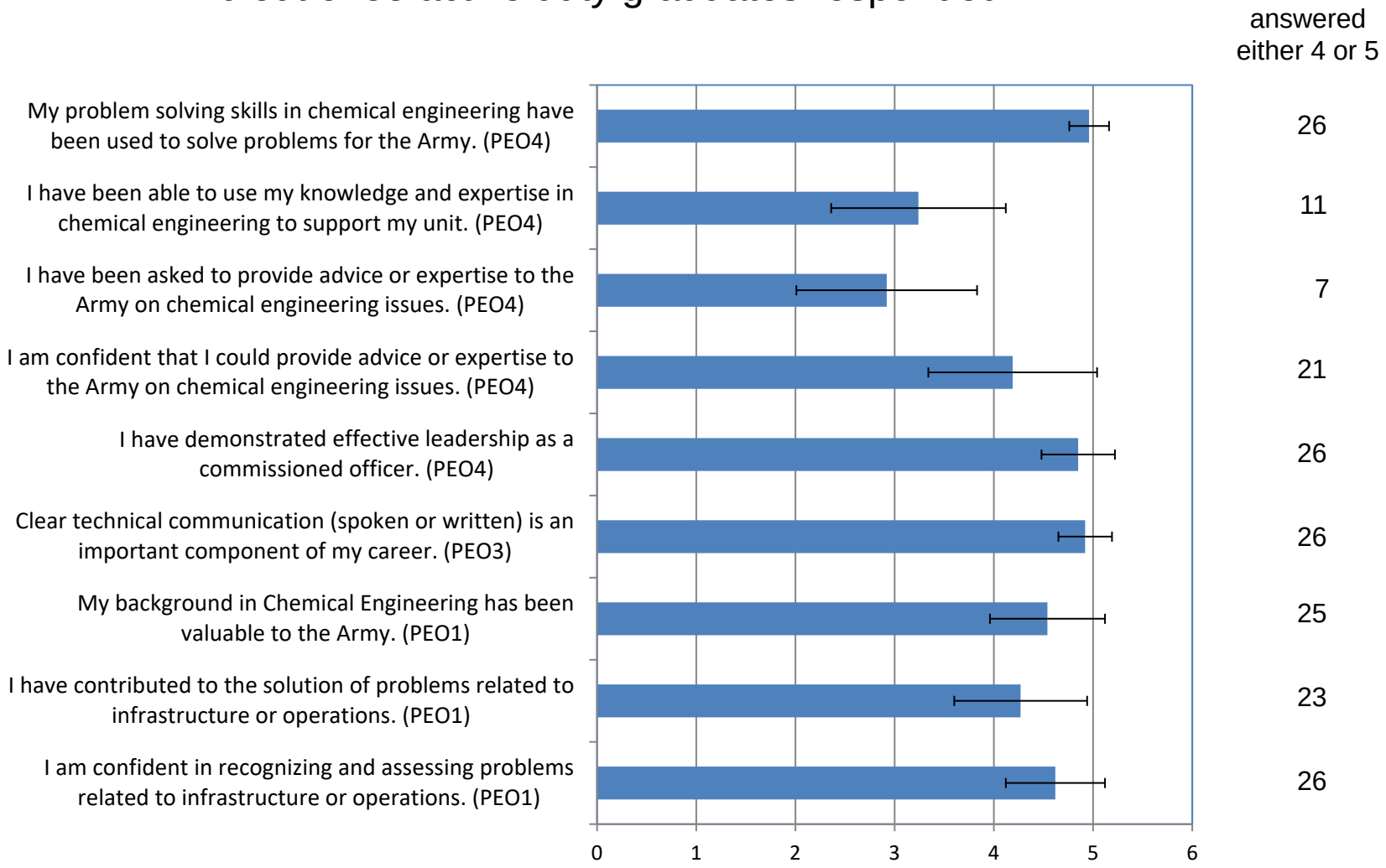
[a] No discipline-specific exam offered.

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

Delete

# Program Graduates Survey Results

26 out of 55 active duty graduates responded.




(error bars are standard deviations)

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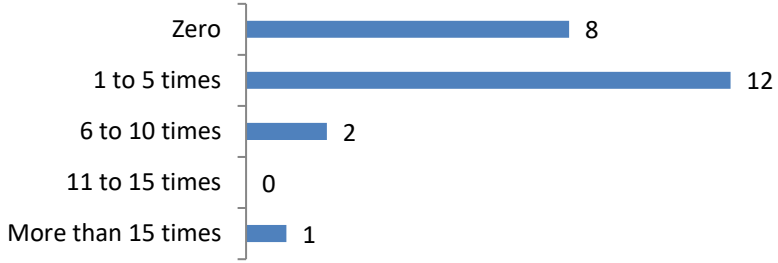
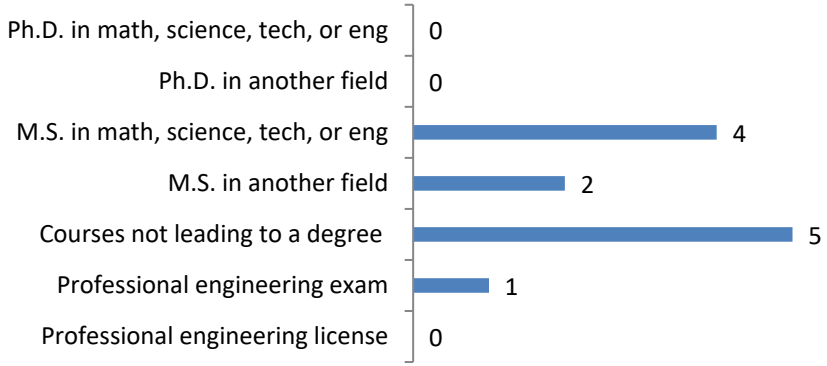
# Program Graduates Survey Results

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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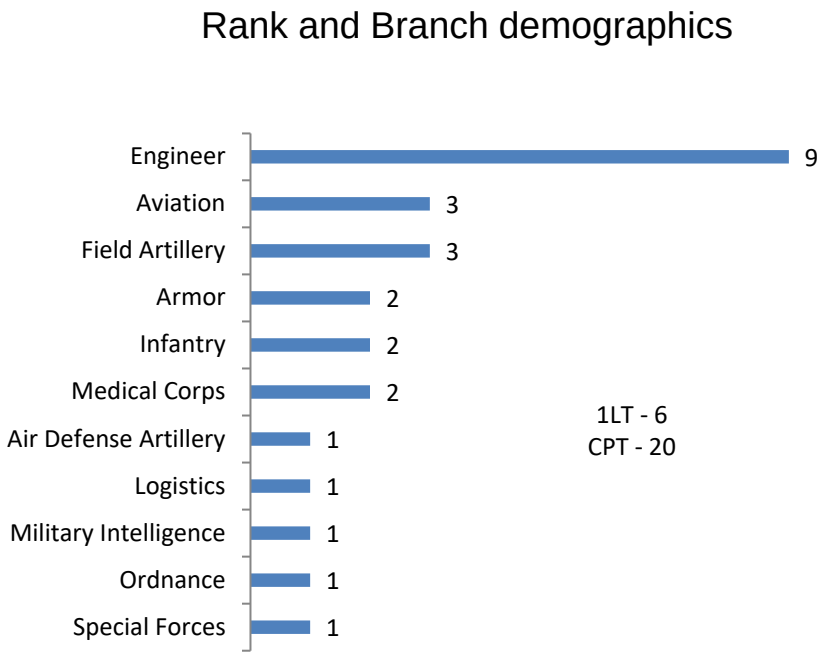
# Program Graduates Survey Results

26 out of 55 active duty graduates responded.



**End of Section 6 (Old Supplements)**