

Chemical Engineering

Advisory Board Meeting

14 April 2017

United States Military Academy
Department of Chemistry and Life Science

Advisory Board Meeting Agenda

14 April 2017

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

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1. Introductory Remarks

United States Military Academy
Department of Chemistry and Life Science

Thank You! Advisory Board 2016-2017

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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



USMA MISSION

To *educate, train, and inspire*
the Corps of Cadets so that each graduate
is a commissioned *leader of character*
committed to the values of
Duty, Honor, Country
and prepared for a career of professional
excellence and service to the Nation as
an officer in the United States Army.

USMA VISION

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

“Inspired to serve.”

PROGRAM VISION

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

PROGRAM MISSION

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



Engineering Technology Accreditation Commission



Accredited 1 October 2012 to present

Next Record Year: [AY2019-2020](#)

Next ABET Visit: [Fall 2020](#)

Why ABET Accreditation?

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

Thoughts to Consider

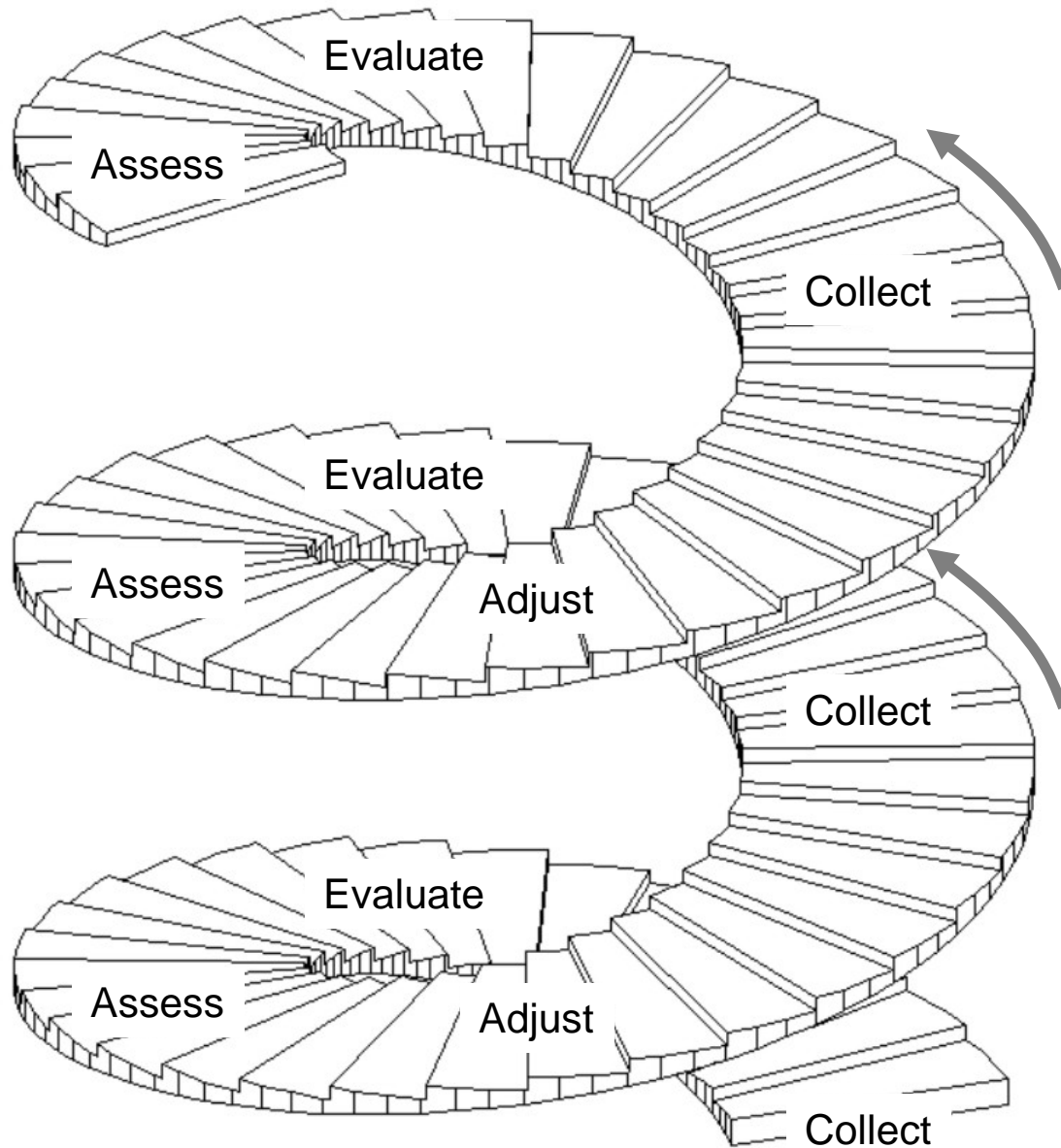
- The ABET process is expensive in terms of faculty time
 - USMA is a small undergraduate college with limited human resources (faculty) and high faculty turnover
- The ABET accreditation is important to the institution and to the Army (so we tend to do it well)
- The only way we can be successful with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

Terms You Should Know

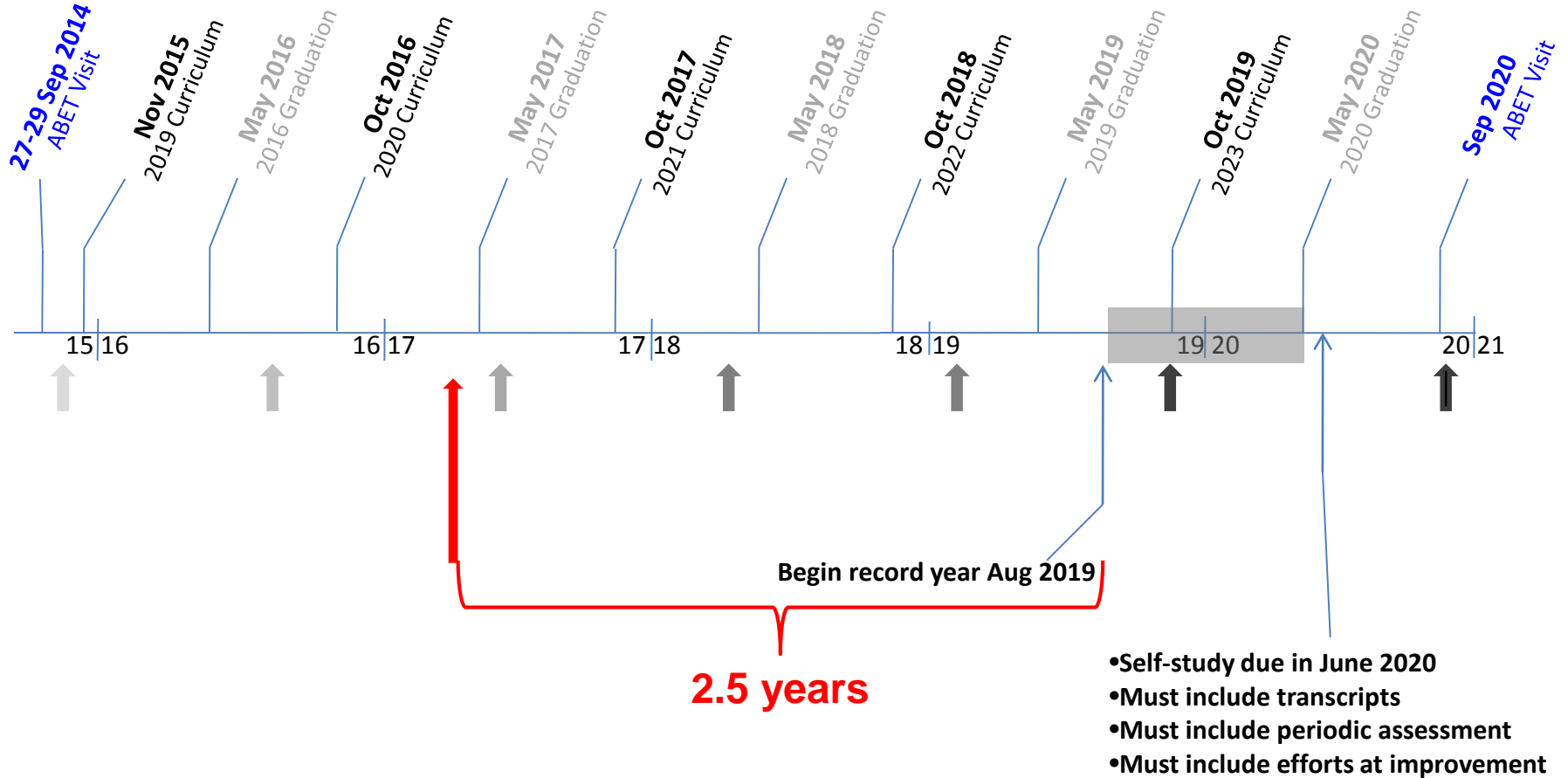
- **Program Educational Objectives (PEOs)**
 - Gleaned by asking *program constituents*
 - For us: Army, profession, graduate schools, other
 - **Our external Advisory Board a key resource.**
 - Desired professional accomplishments of graduates **5-7 years after graduation**
 - Adjust every 3 years or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



Timeline for Curricular Actions



Advisory Board Findings

Excerpts from Minutes of 8 April 2016

- The USMA program satisfies ABET requirements while meeting the mission and vision of both the Army and the Academy.
- ChE courses required at USMA cover the spectrum of topics relevant to ChE practice, both within the Army and in the private sector.
- The USMA cadets interviewed are the finest group of young people the Board members individually and collectively have been privileged to meet.
- The Chemistry and Life Sciences department has been diligent in assessing conformance to objectives, and has a demonstrated track record in continuously improving the program.
- The enrichment opportunities afforded by summer internships are outstanding.

Advisory Board Opportunities for Improvements

Excerpts from Minutes of 8 April 2016

- There are problems in the course content and applications in the process controls course. Cadets report a perception of the course being too theoretical, inadequate in practical applications, and focused on mechanical controls and robotics, rather than process industry controls
- More effective technical communication training should be provided. Consideration of a technical writing course (CH300) would improve the program, and should also cover the effective visual display of technical information (Edward Tufte program).
- The proposed bioengineering concentration is important, and should incorporate topics that other schools have determined to be important in their bioengineering concentrations that were established years ago.

End of Section 1

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2. Program Assessment

United States Military Academy
Department of Chemistry and Life Science

Student Outcomes

Identical to ABET a-k as described on slide 11

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

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

Student Outcomes

Additional outcomes articulated by the program as described on slide 11

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

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

Required Courses * (for classes 2017, 2018, 2019)

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

***Not including prerequisites**

Required Courses * (for classes 2020+)

MA366/MA365 Engineering Mathematics with Applications

CH362 Mass & Energy Balances

CH363 Separation Processes

CH364 Chemical Reaction Engineering

~~XE472 Dynamic Modeling & Control~~ **CH367 Introduction to Automatic Process Control**

CH485 Heat & Mass Transfer

CH459 Chemical Engineering Laboratory

CH402 Chemical Engineering Process Design

CH400 Professional Practice

MC311 Thermal-Fluid Systems I

MC312 Thermal-Fluid Systems II

EE301 Fundamentals of Electrical Engineering

MC300 Fundamentals of Engineering Mechanics & Design (Statics & Dynamics)

CH365 Chemical Engineering Thermodynamics

CH383 Organic Chemistry 1

***Not including prerequisites**

Assessment

CHEME Coursework Embedded Indicators

MECHE Coursework Embedded Indicators

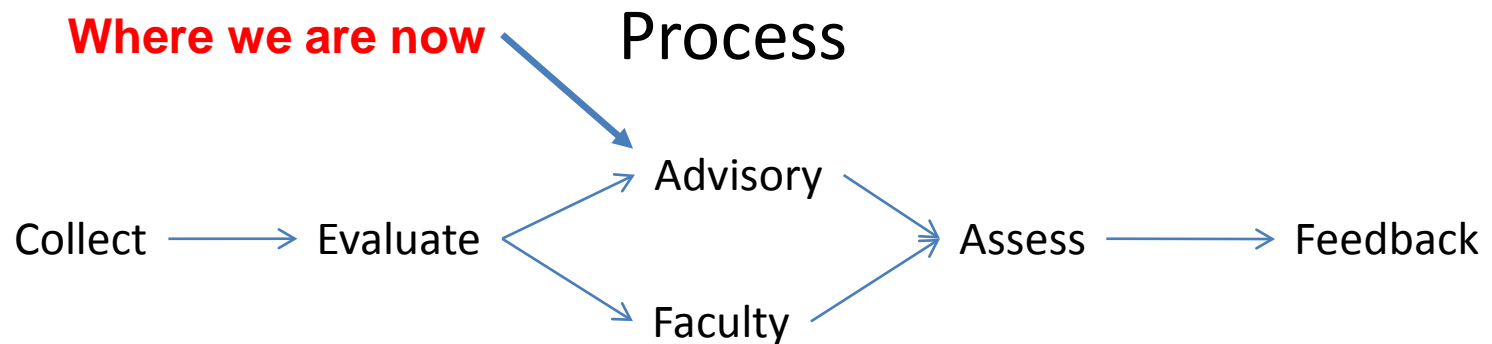
Fundamentals of Engineering Exam Topics

Participation in FE Exam (not pass rate)

Student end of semester surveys

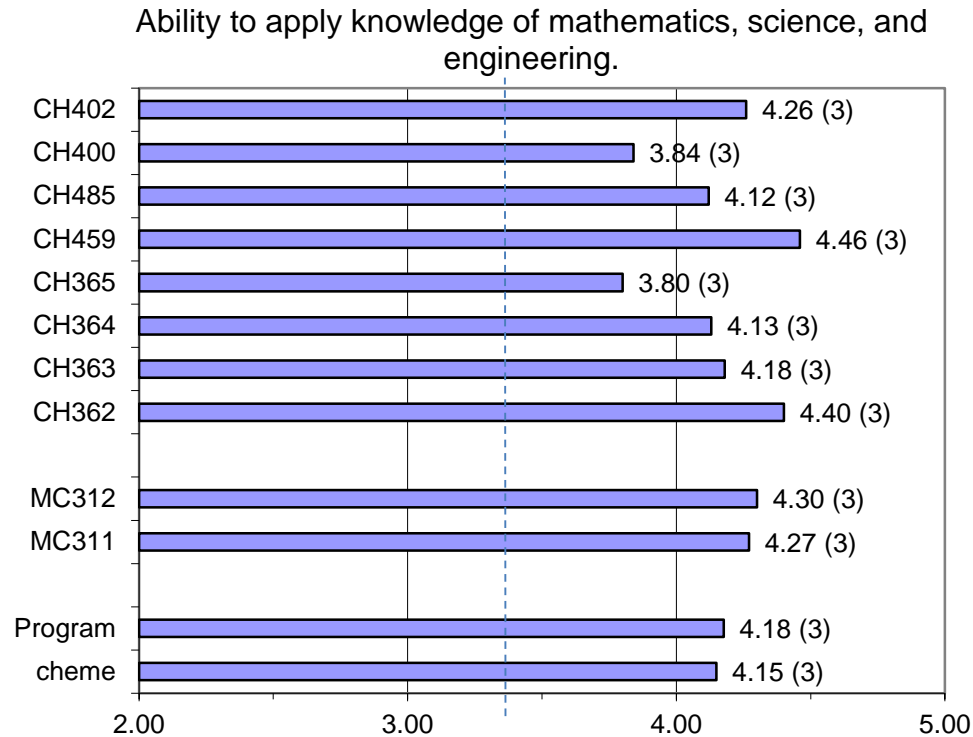
Student CHEME Program Exit Surveys

Course Grades



Example Data: Coursework Embedded Indicators

Student Outcome 1

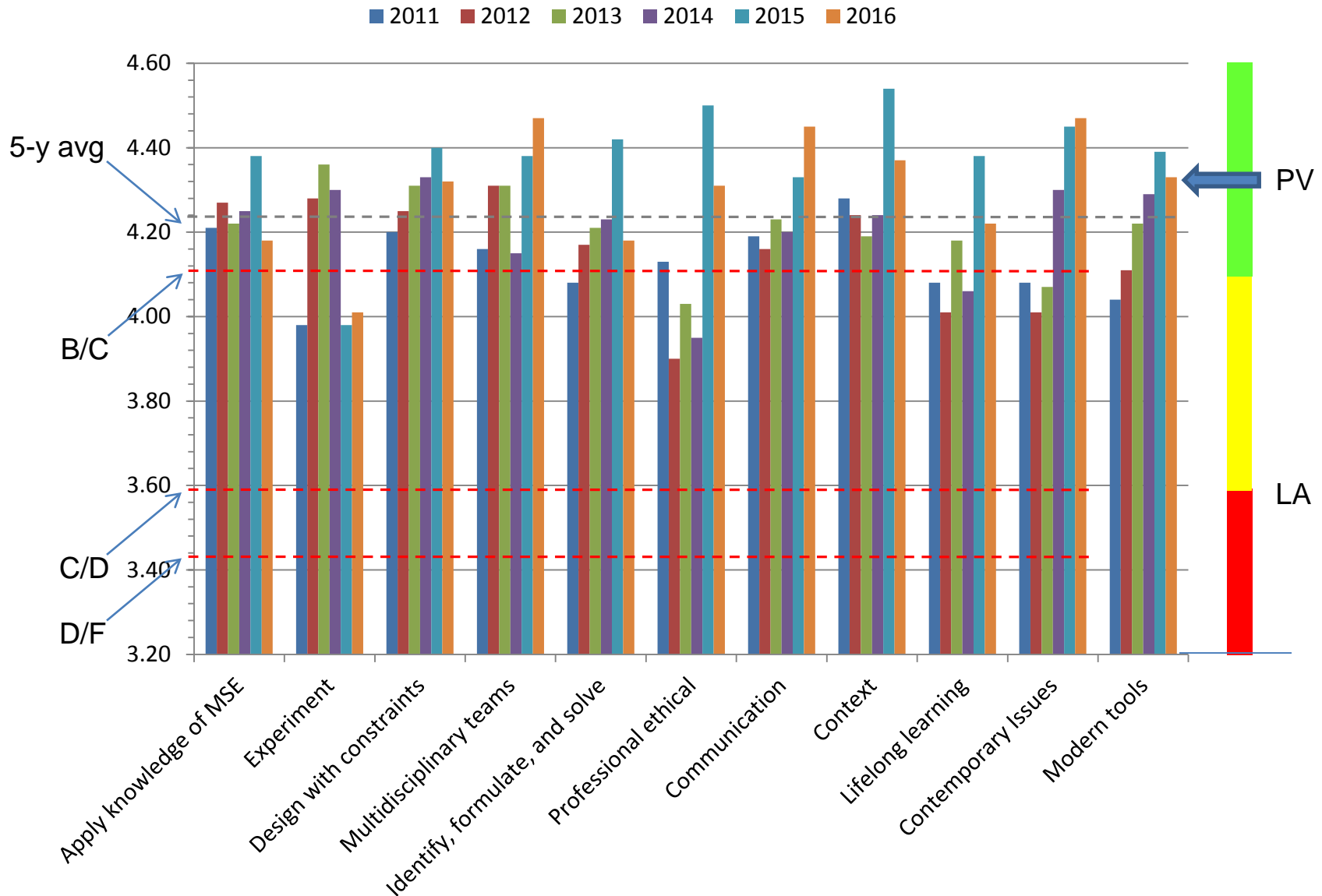


Values in parentheses are coverage ratings from Table 5-3 in the Self Study, page 5-9

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

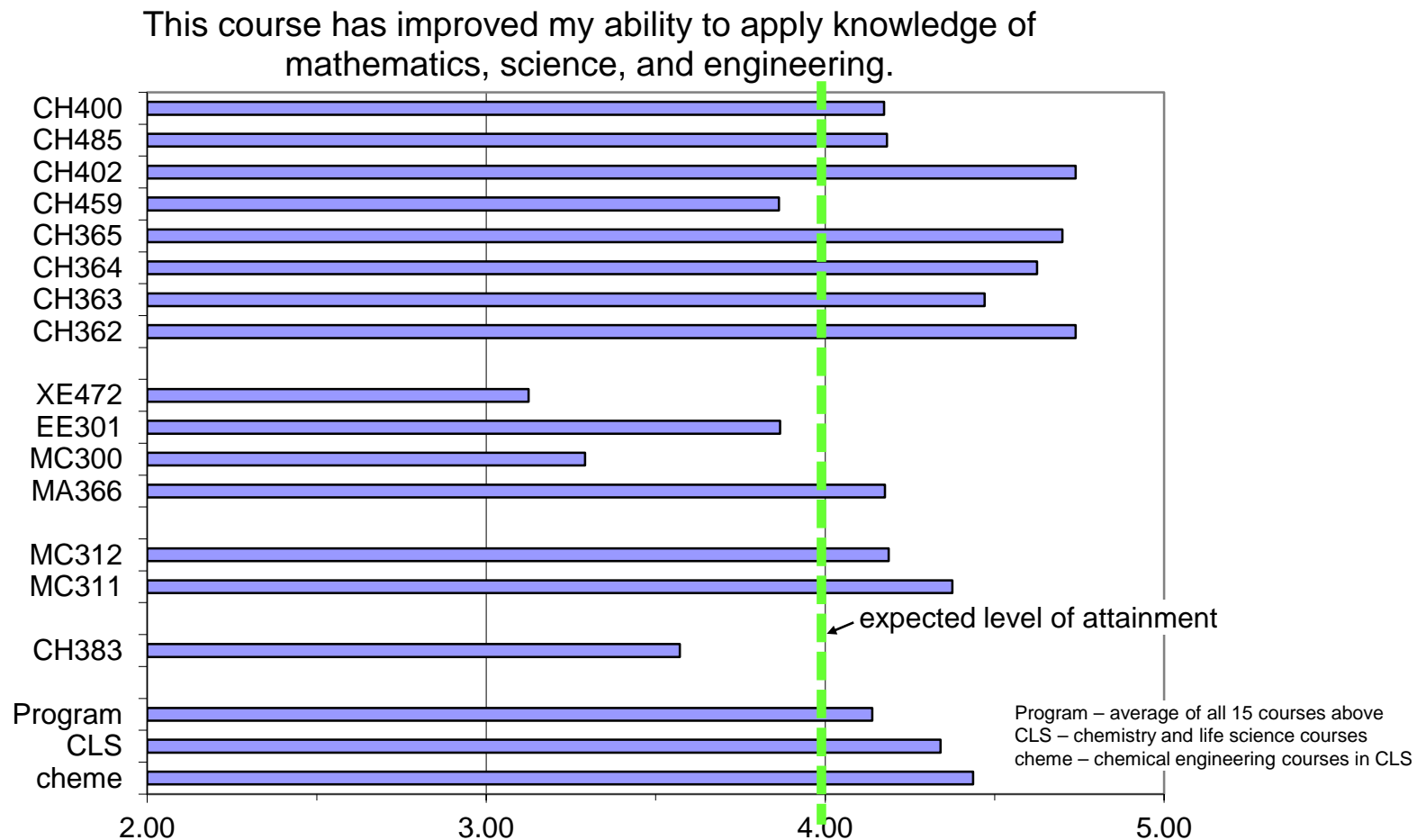
Performance on Embedded Indicators

Program Averages AY2011 to AY2016



Example Data: End-of-Semester Surveys

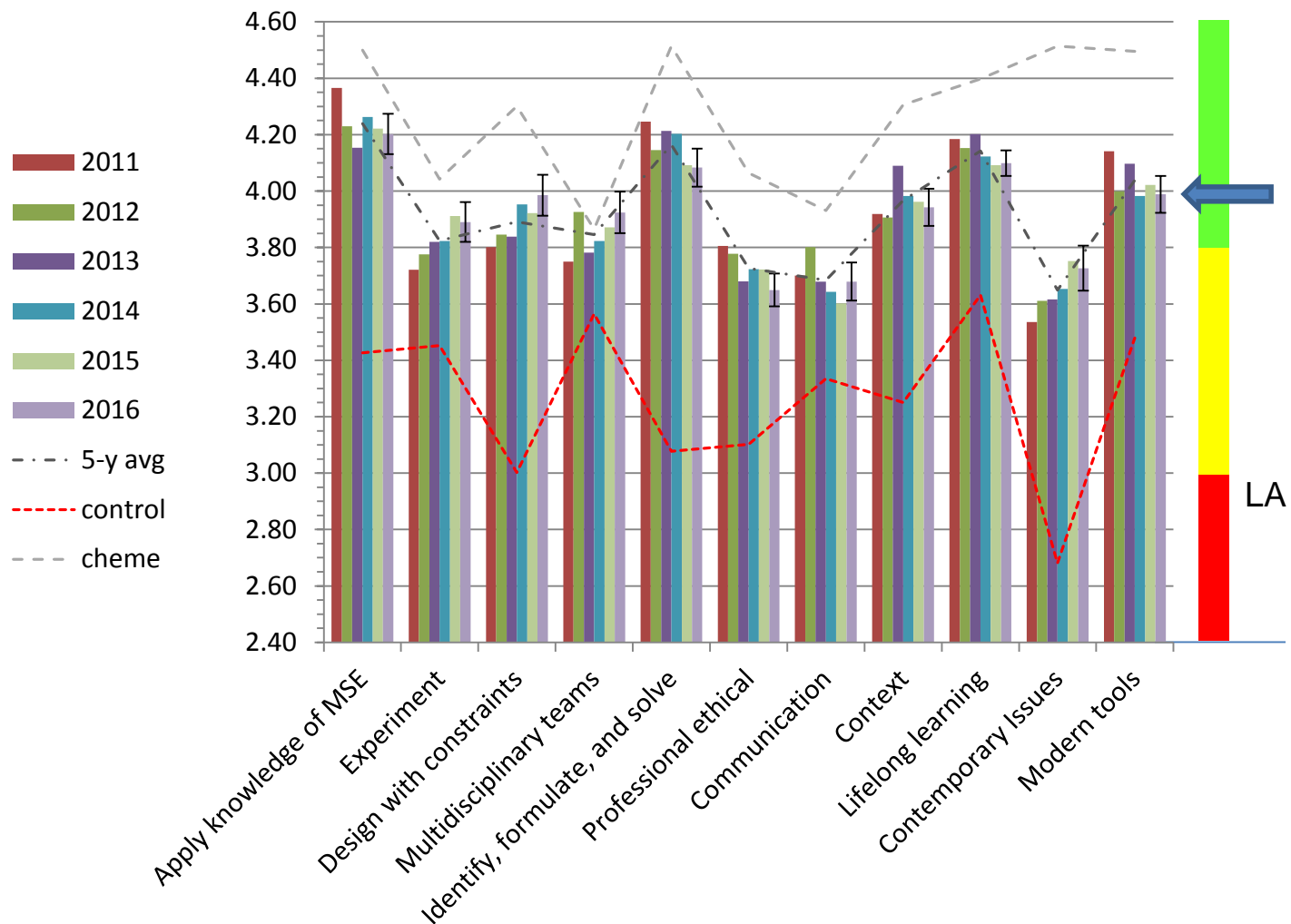
Student Outcome 1



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

End-of-Semester Surveys

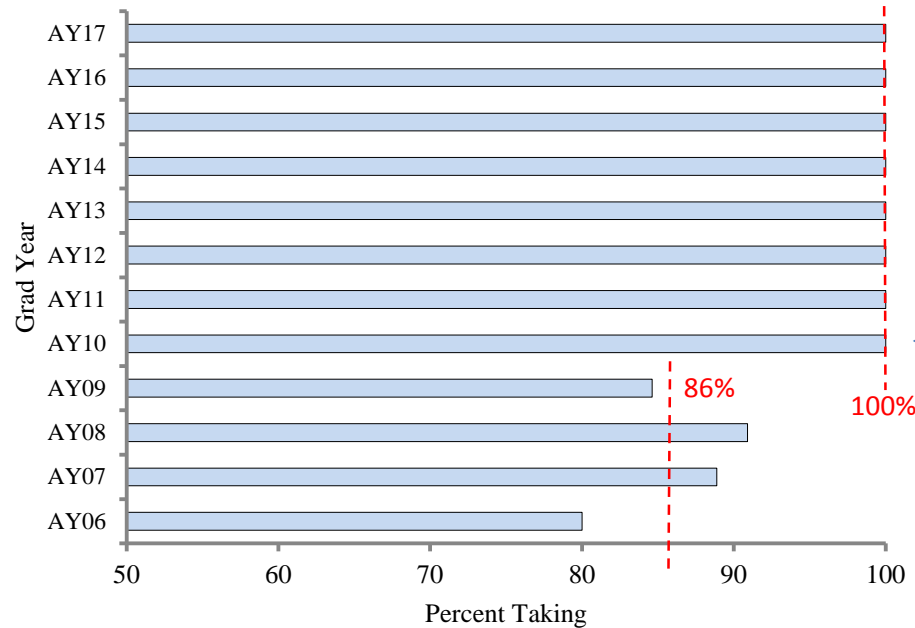
Normalized Program Averages from AY11-16



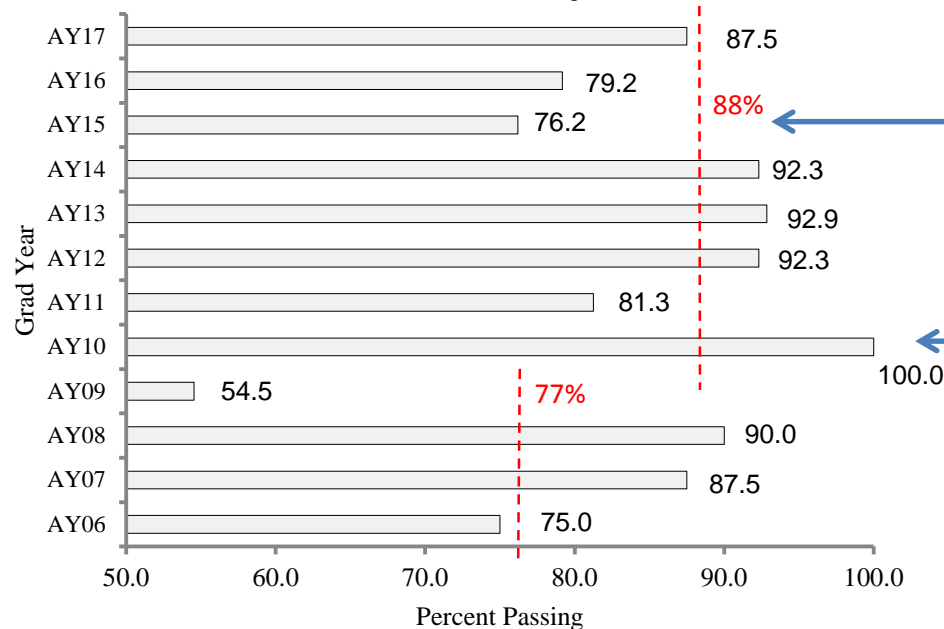
Fundamentals of Engineering Exam

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

Percent taking



Percent passing



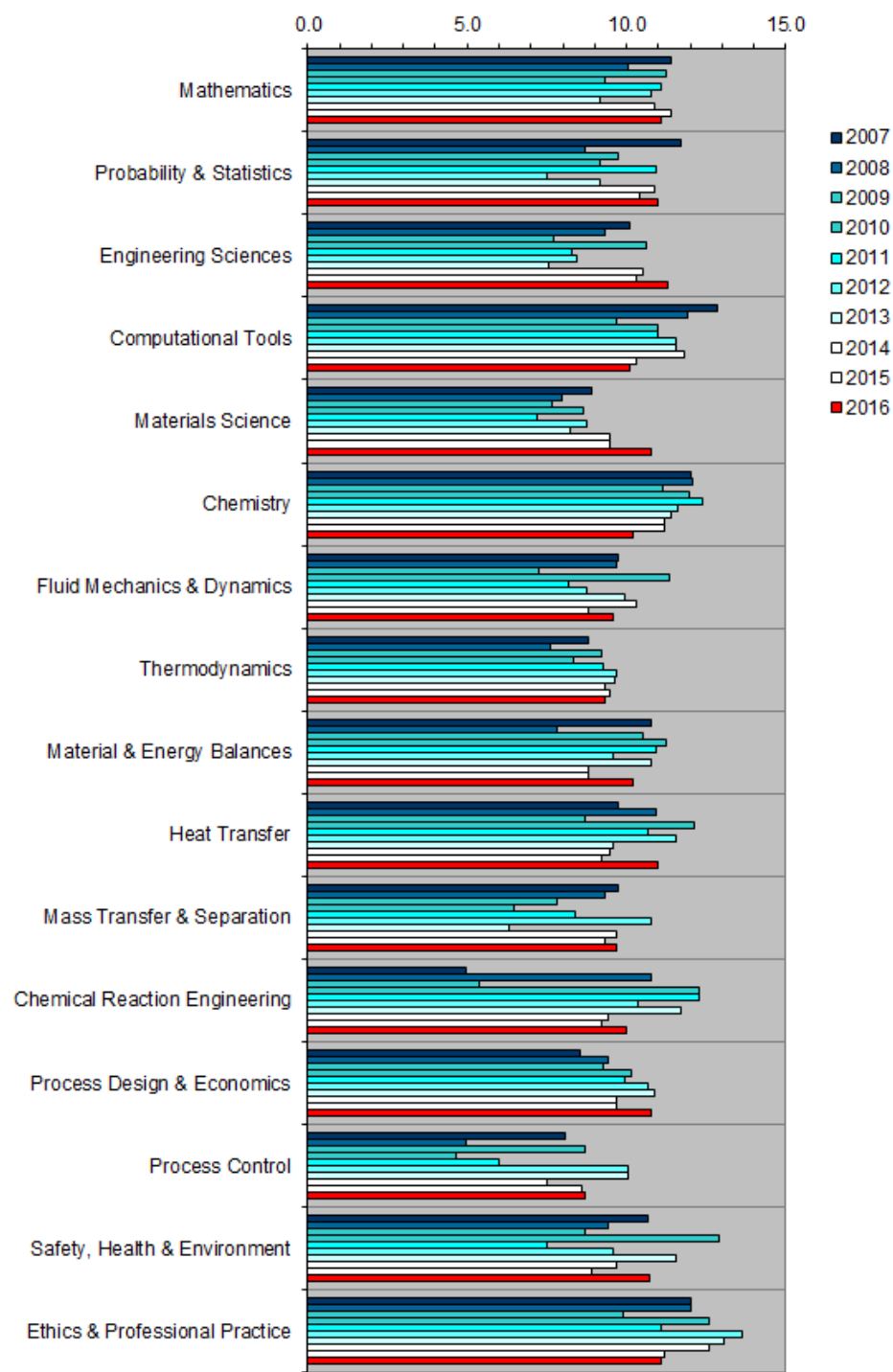
National, (+/- ~1%):

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

Outcome 12 Evaluation

Performance
Indicators
AY07 to AY16

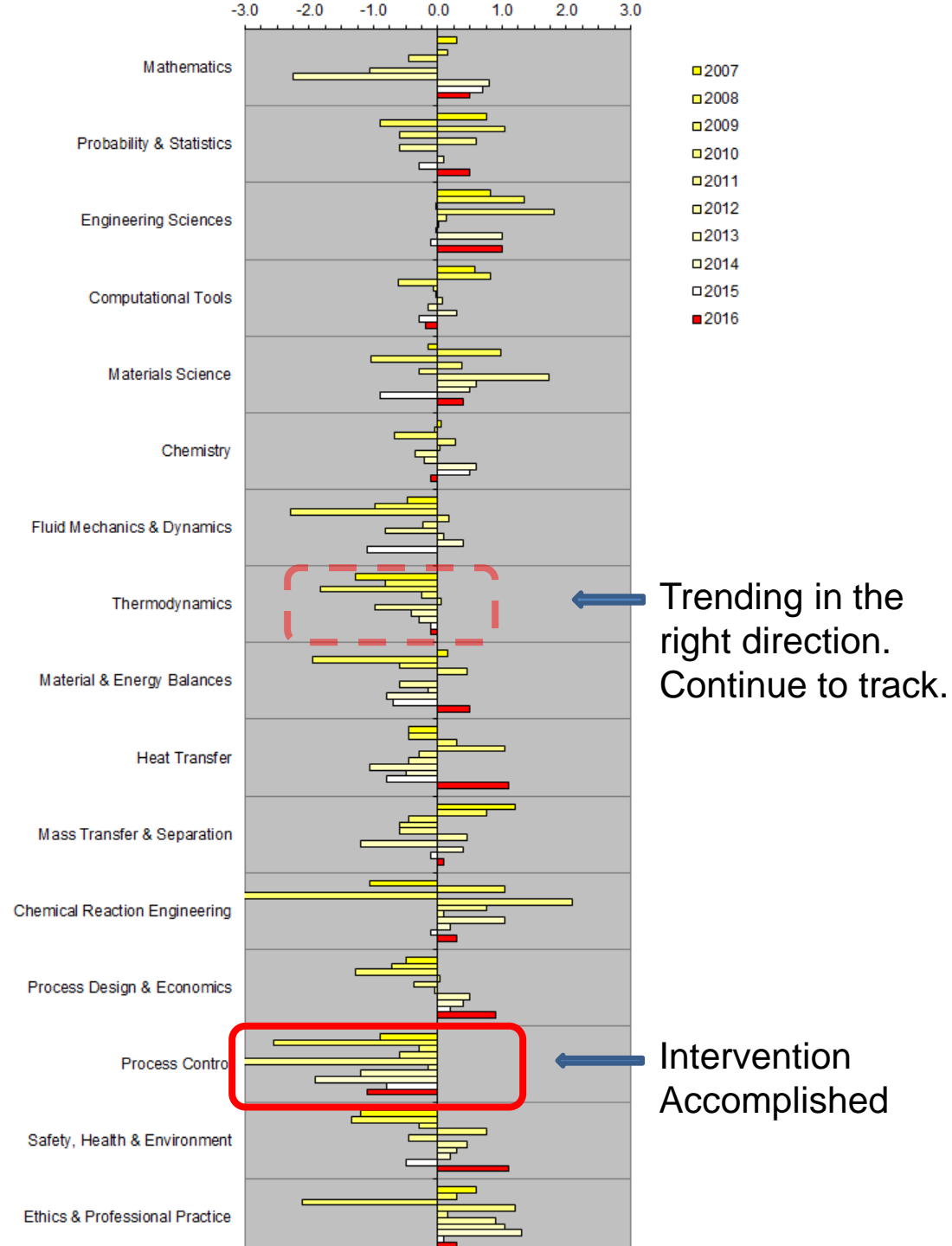
FEE Results



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

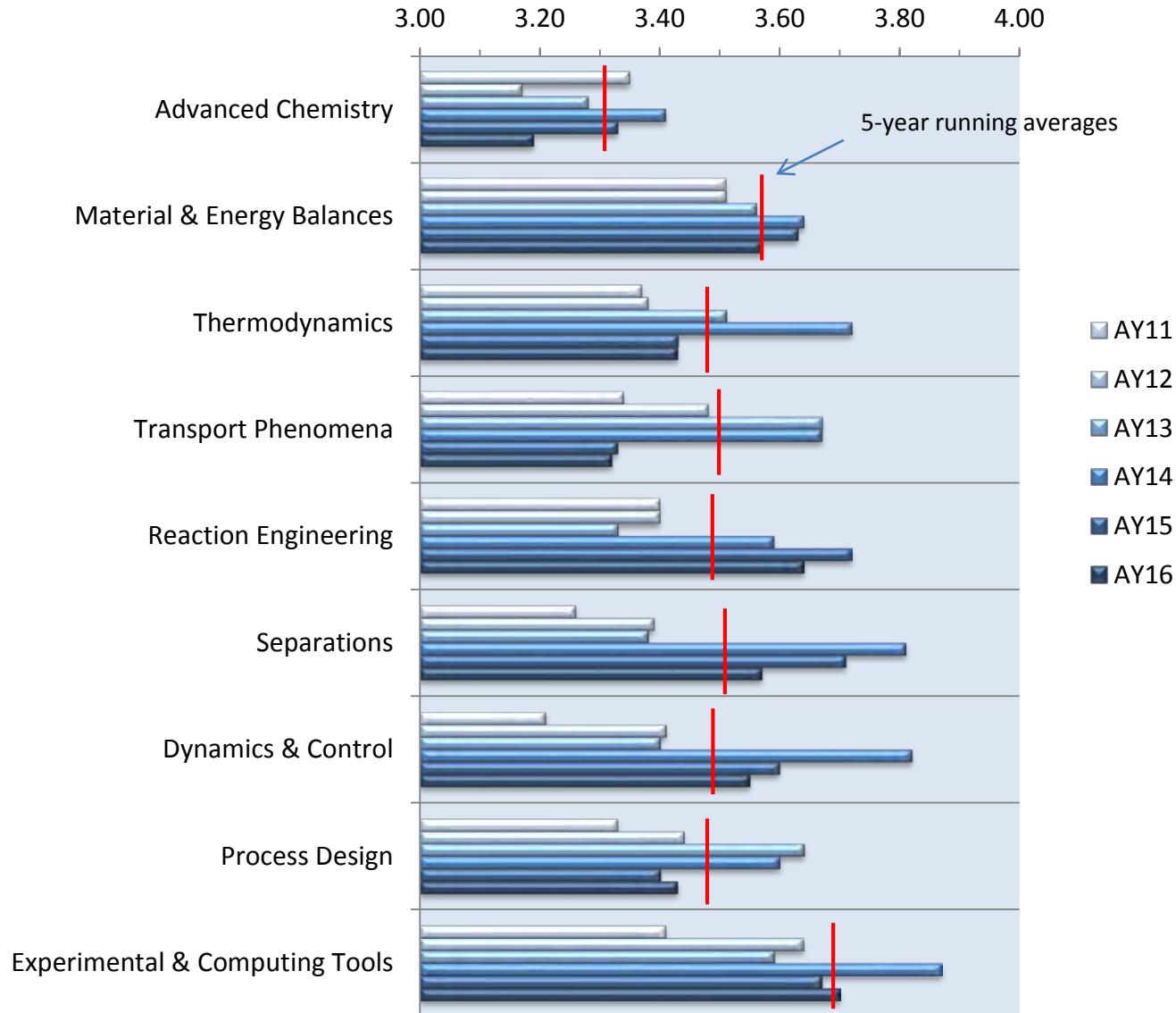
Topical Outcomes Evaluation

Deviations from
National Averages
AY07 to AY16



Topical Outcomes Evaluation

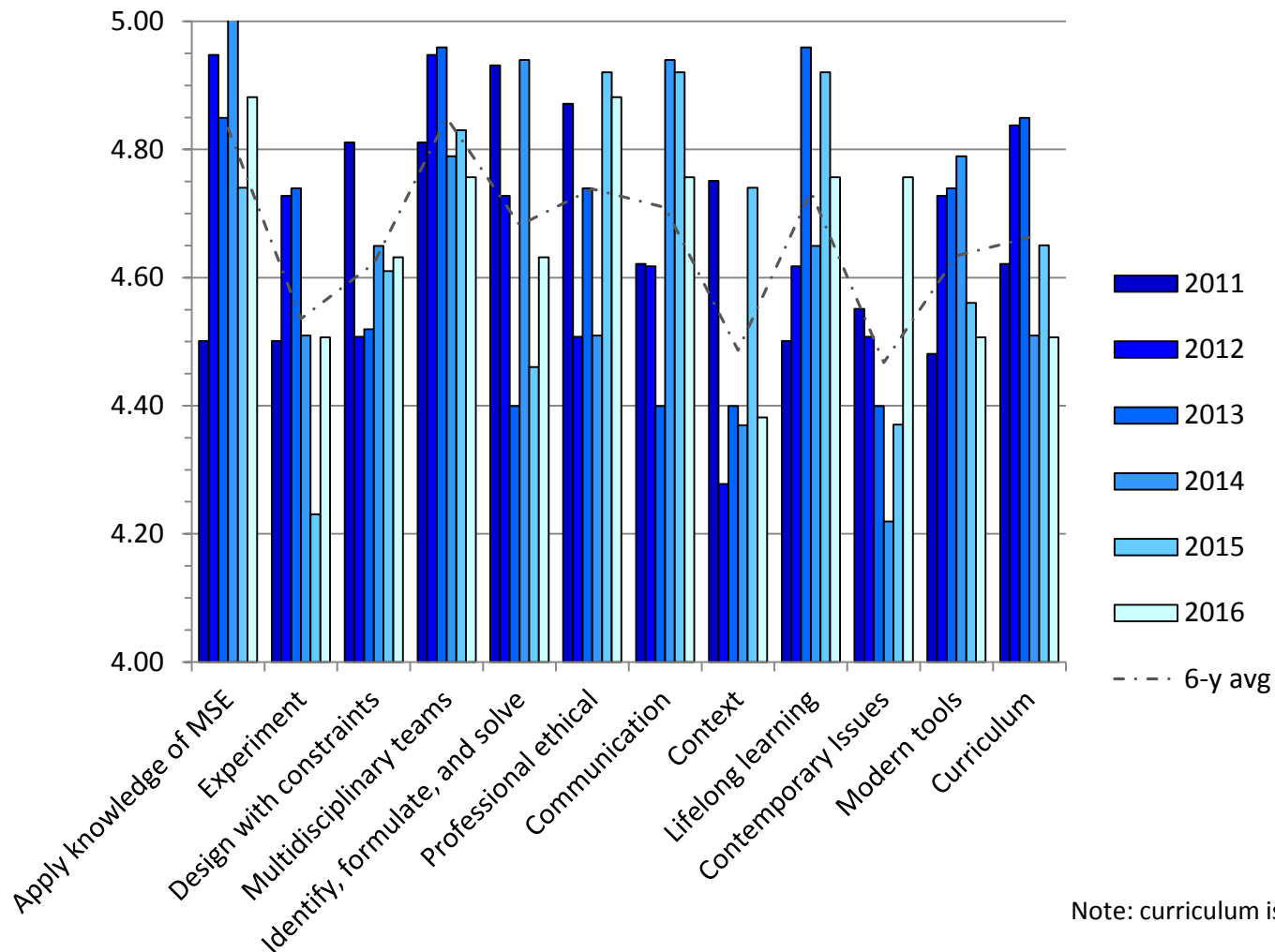
Average Course GPA from Transcripts, AY2011 to AY2016



Advisory Board Student Outcomes Surveys

Normalized Program Averages from AY10-16

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

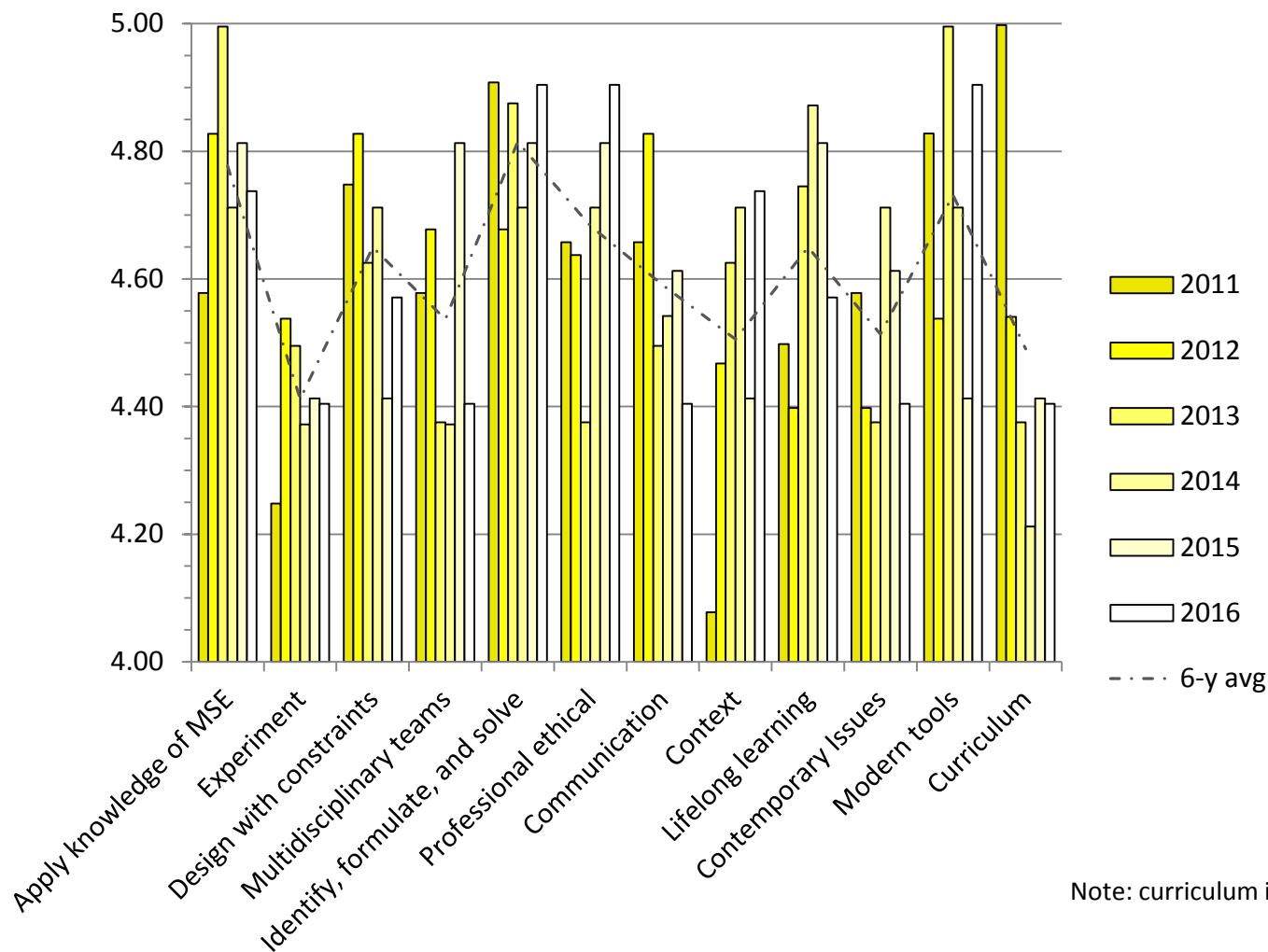


Note: curriculum is outcome 12

Faculty Student Outcomes Surveys

Normalized Program Averages from AY10-16

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



Advisory Board Completes Survey Part 1

ABET Criterion 2: Objectives

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

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

Program Objectives (Current Redbook)

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

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

Advisory Board Recommended: October 2012

Assessment Instruments for Objectives

Program Surveys

Program Advisory Board Surveys

Program Faculty Surveys

Program Cadet Surveys

Strategy going forward:

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

Enrichment Opportunities

Advanced Individual Academic Development (AIAD)

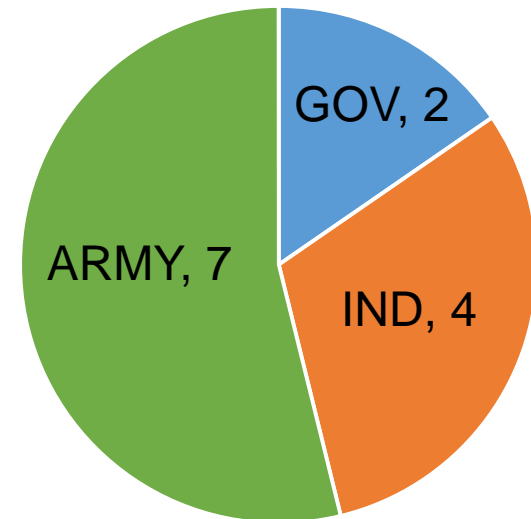
Goal: Faculty Collaboration

Cadet Mentoring/Research

Cadet AIAD

Cadet Mentoring/Research

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



13 fully funded internships
16+ available

Advisory Board Completes Survey Part 2

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3. Introduction to Automatic Process Control

United States Military Academy
Department of Chemistry and Life Science

Former Proposed Change 1

CH367 Introduction to Automatic Process Control

~~CH366~~ Chemical Engineering Process Control

- 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.

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4. Future Challenges

United States Military Academy
Department of Chemistry and Life Science

Academic Excellence



- #1 Most Accessible Professors**
- #2 Best College Library**

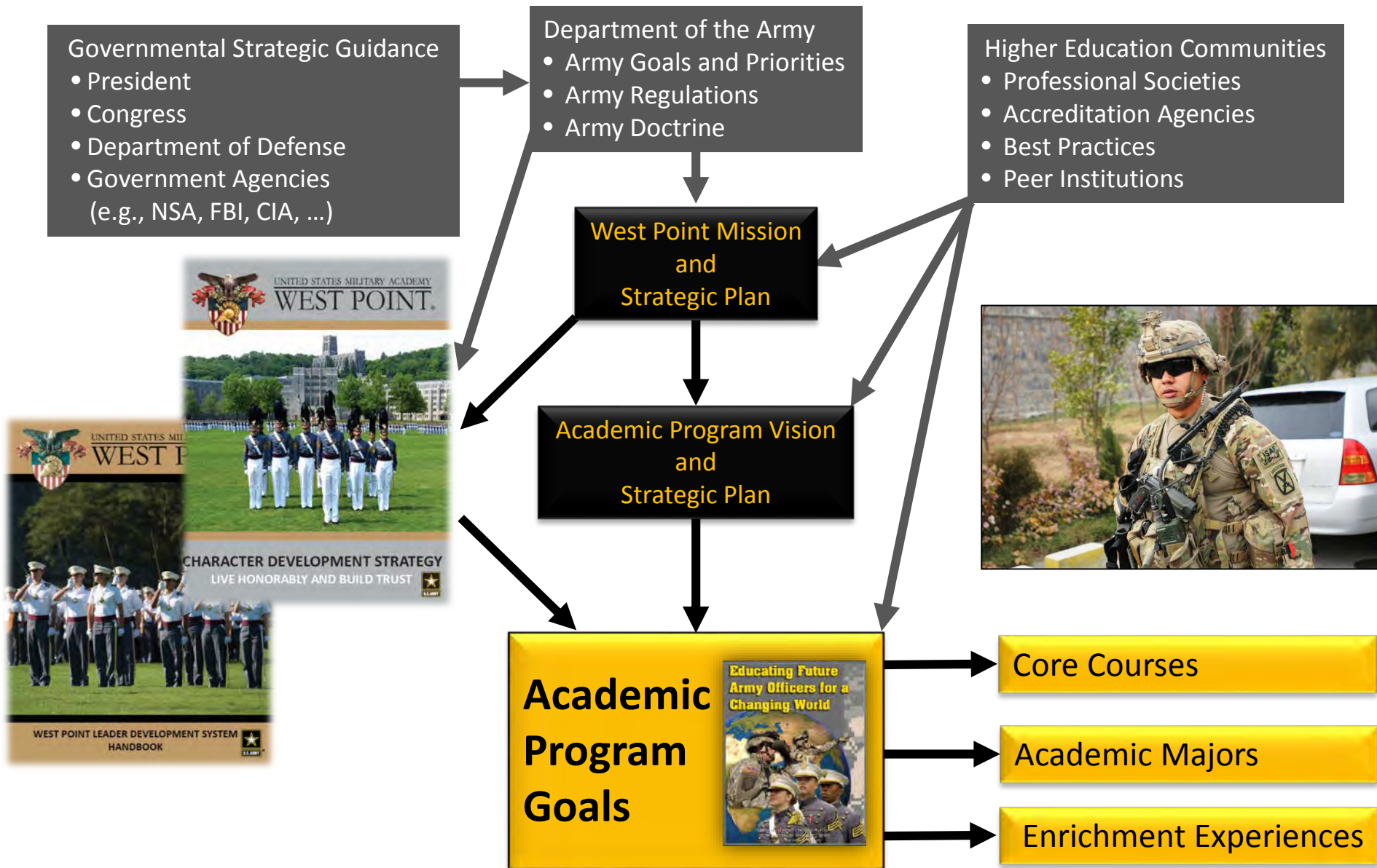


- #1 Public College in the country**
- #6 Liberal Arts Universities**
- #11 In the Northeast**
- #14 Overall College in the country**



- #2 Top Public Schools (Liberal Arts)**
- #3 Best Undergrad Engineering Program**
- #4 Civil Engineering Program**
- #7 Mechanical Engineering Program**
- #19 National Liberal Arts College**

Strategic Influence



Chemical Engineering Faculty

Can we support critical courses?

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

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

b – available to teach; currently acting department deputy

? – uncertain status

Current Curriculum

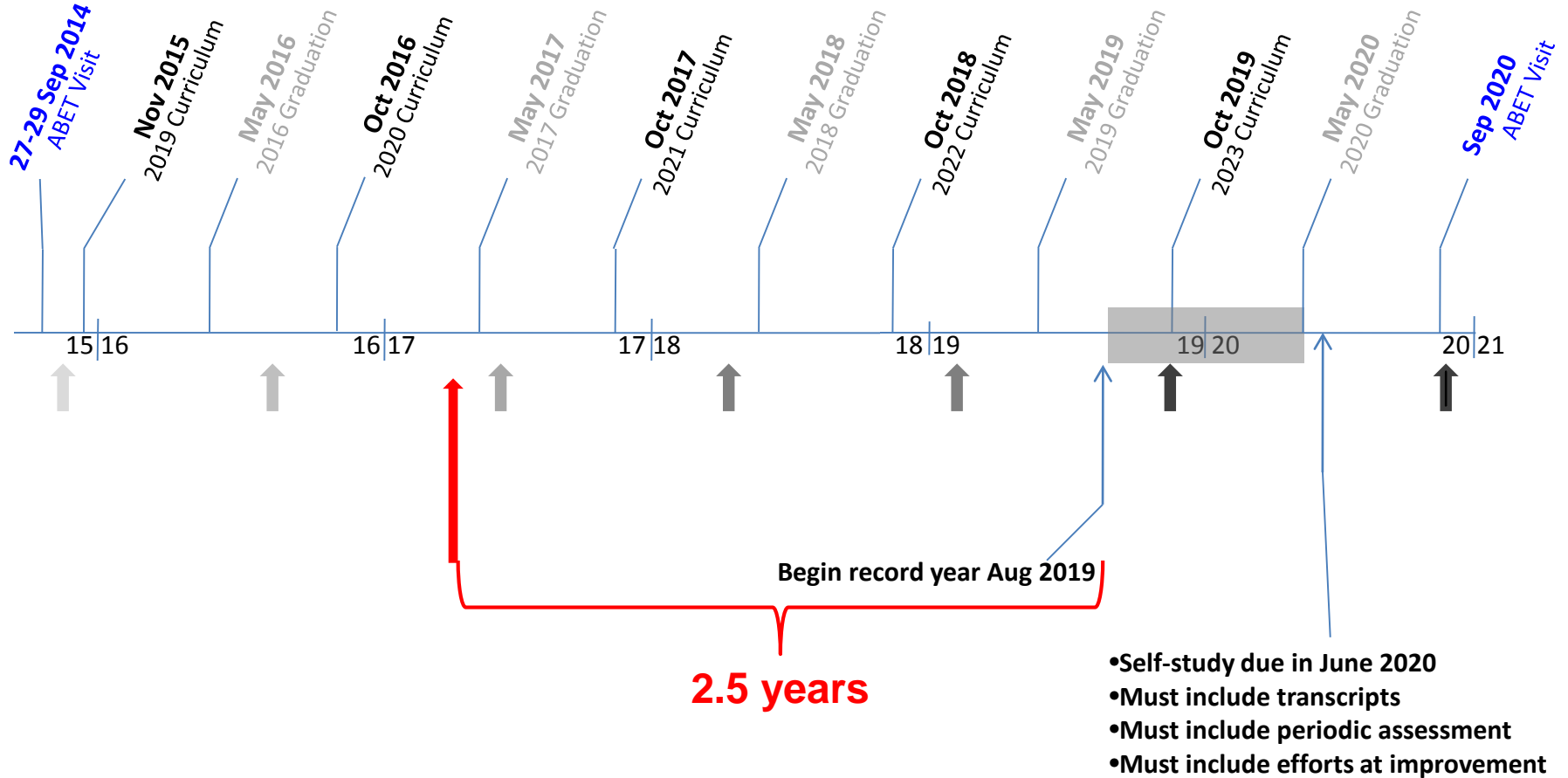
CEN1 - Class of 2020

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

Recent Curriculum Changes and Ongoing Impact

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

Timeline for Curricular Actions



Proposed Curriculum Change 1

CH300 Technical Writing

- Response to curriculum changes.
- Perceived shortcoming in cadet writing ability across the Corps
- Dean is currently requiring us to sacrifice technical content from one of our courses to address perceived shortcoming.
- Opportunity for us to engage in engineering-specific communication skills
 - USMA objective
 - ABET Criterion
 - PROGRAM Objective (advisory board)

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

Proposed Curriculum Change 2

Addition of CH401 Chemical Engineering Design Principles

Assign 3.0 credit hours in AY2019

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

Precedent - Parity with other USMA programs

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

Proposed Curriculum Change 3

CH359 Engineering Measurements

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

Electives Proposals

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

Engineering Concentrations

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

Materials Engineering

MC364 Mechanics of Materials
MC380 Engineering Materials
Open Elective

Nuclear Engineering

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

Decision Analysis

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

Advanced Control Systems

EE360 Digital Computer Logic
EM484 Dynamic Systems Analysis
XE475 Mechatronics

Energy Conversion Systems

EE377 Electrical Power Generation
ME472 Energy Conversion Systems
ME480 Heat Transfer

Power Systems

ME306 Dynamics
ME491 Mechanical Power Plants
EE377 Electrical Power Generation

XE442 Alternative Energy Engineering

Industrial Engineering

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

Other Advanced Engineering Electives

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

Proposed Bioengineering Electives

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

Other Electives

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

Proposal

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

Some Administrative

- Travel Paperwork
- Tour of Unit Operations Lab – now operational

End of Section 4