



Chemical Engineering

United States Military Academy



Advisory Board Meeting

4 May 2018

United States Military Academy
Department of Chemistry and Life Science

Advisory Board Meeting Agenda

4 May 2018

Time	Event	Location
0730-0745	Shuttle at 5-Star Parking Lot	5-Star
0745-0800	Arrival – Light Breakfast	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 Update	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



Chemical Engineering

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4 May 2018

1. Introductory Remarks

United States Military Academy
Department of Chemistry and Life Science

Thank You! Advisory Board 2017-2018

Kevin Shipe ✓ Automation Innovation Engineer NALCO Champion 7705 Hwy 90A, Sugarland, TX 77498 281-263-7335 kevin.a.shipe@gmail.com	Lucy Hair ✓ EleCent Team Leader CPOIS Program Lawrence Livermore National Lab 925-423-8545 hair1@llnl.gov	COL (Ret) Paul Dietrich ✓ 3855 Victory Blvd Staten Island, NY 10314-6716 718-698-8526 paul@the-dietrichs.com
LTC Andrew Pfluger ✓ US Army Student Detachment Colorado School of Mines 845-545-2235 andrew.r.pfluger.mil@mail.mil	Kisondra Waters ✓ Principal Analyst, Competitive Cost & Margin Analytics, HIS Chemical 1 N Lexington Ave, 17th Floor, White Plains NY 10601, 650-714-1751 kisondra@gmail.com	Anthony Hatfield ✓ Eli Lilly and Company Consultant Engineer Indianapolis Parenteral Manufacturing Cartridge Facility 317-655-0429 hatfieldan@lilly.com
Donald C. Glaser ✓ President, Simulation Solutions, Inc. 179 Avenue at the Common Shrewsbury, NJ 07702 732-389-5400 dglaser@simulation-solutions.com	Matt Garvey ✓ Simulation Solutions, Inc. Shrewsbury, NJ mgarvey@simulation-solutions.com	
COL (Ret) Vance P. (Phil) Visser 2925 Thomas Smith Lane, Williamsburg, VA 23185 philvisser@yahoo.com 757-254-3017	COL (Ret) Dwight Springer Former Deputy Head Chemistry and Life Science US Military Academy 817-431-5331 dss5456@verizon.net	Anthony Pavone Process Economics Program HIS Chemicals (650) 384-4311 tonypavone@ihs.com

Thank you!

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





USMA MISSION



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



USMA VISION

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

"Inspired to serve."



PROGRAM VISION

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



PROGRAM MISSION

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



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, 30+ plebes, 2021 - 26; 100 total – a new high)
- 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

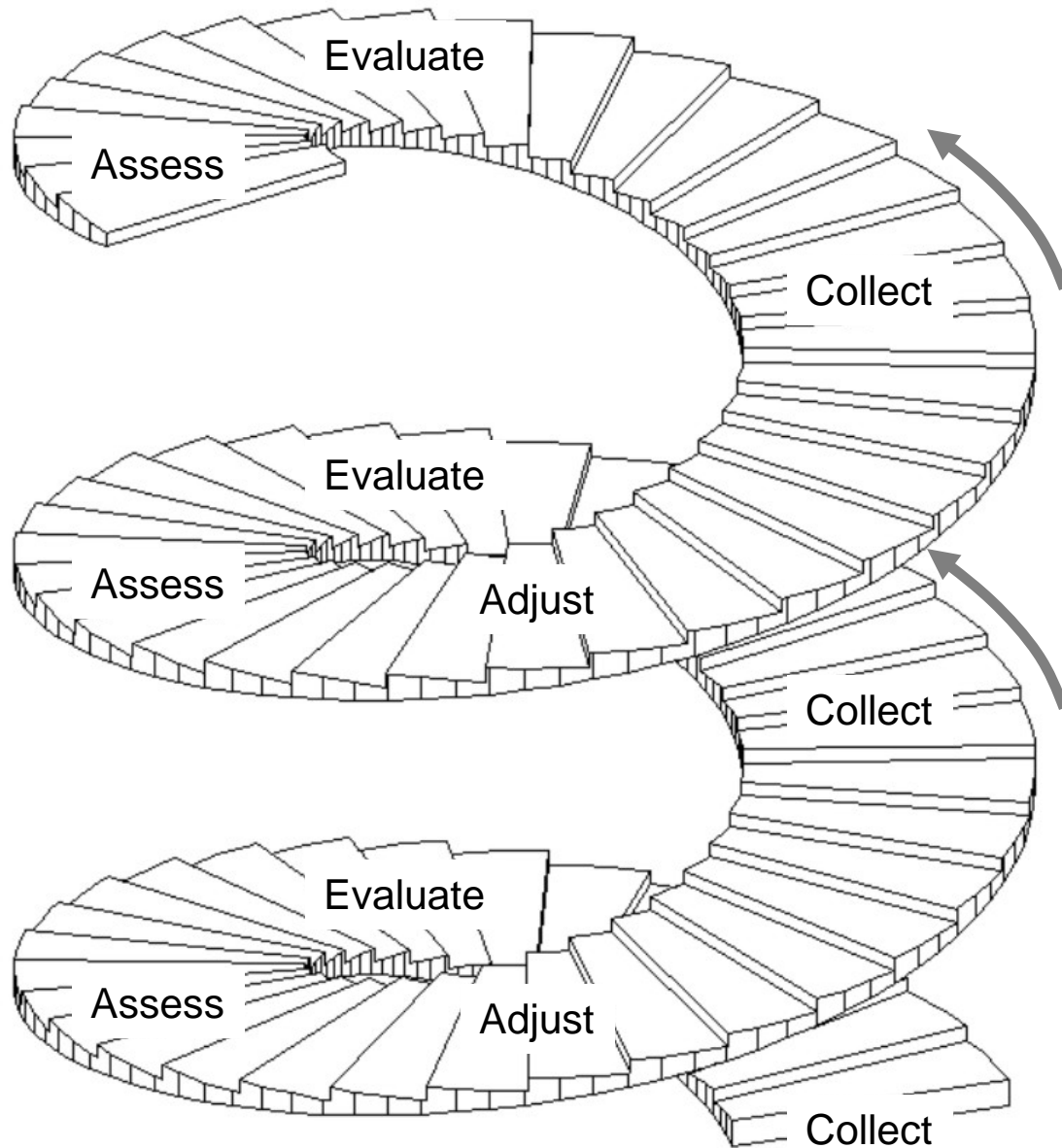
- The ABET process is expensive in terms of faculty time
 - USMA is a small undergraduate college with limited human resources (faculty) and high faculty turnover
- The ABET accreditation is important to the institution and to the Army (so we tend to do it well)
- The only way we can be successful with 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

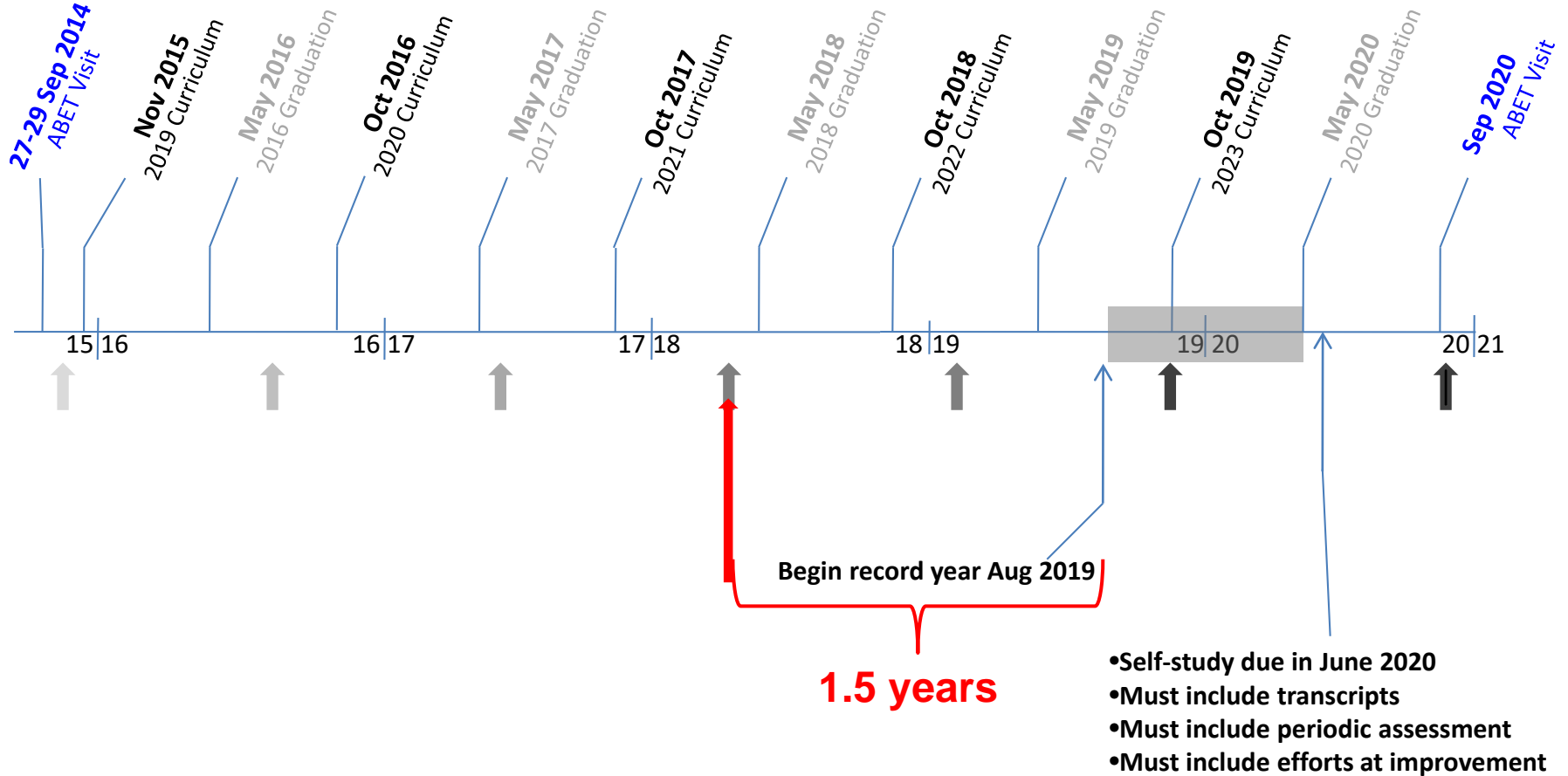
- **Program Educational Objectives (PEOs)**
 - Gleaned by asking *program constituents*
 - For us: Army, profession, graduate schools, other
 - **Our external Advisory Board a key resource.**
 - Desired professional accomplishments of graduates **5-7 years after graduation**
 - Adjust every 3 years or 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 14 April 2017

- 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 inclusion of more time with cadets via the resume/interview session was unanimously viewed as positive.
- The initial direction for the new CH367 appears appropriate. Suggestions were provided for potential topics to be included.

Advisory Board Opportunities for Improvements

Excerpts from Minutes of 14 April 2017

- Cadet feedback indicated continued support for elective courses within the chemical engineering program and the chemistry department more generally.
- 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).



End of Section 1



Chemical Engineering

United States Military Academy



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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+)

MA364/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

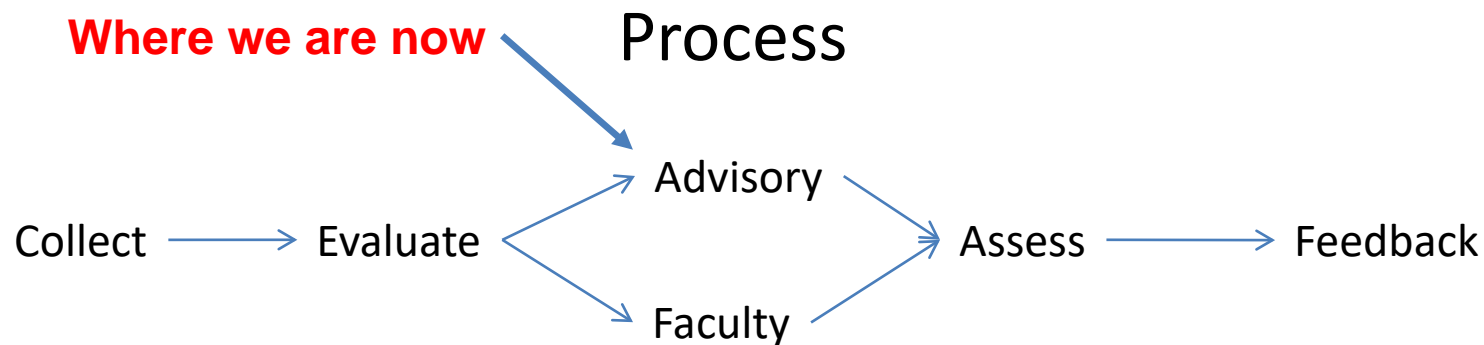
Fundamentals of Engineering Exam Topics

Participation in FE Exam (not pass rate)

Student end of semester surveys

Student CHEME Program Exit Surveys

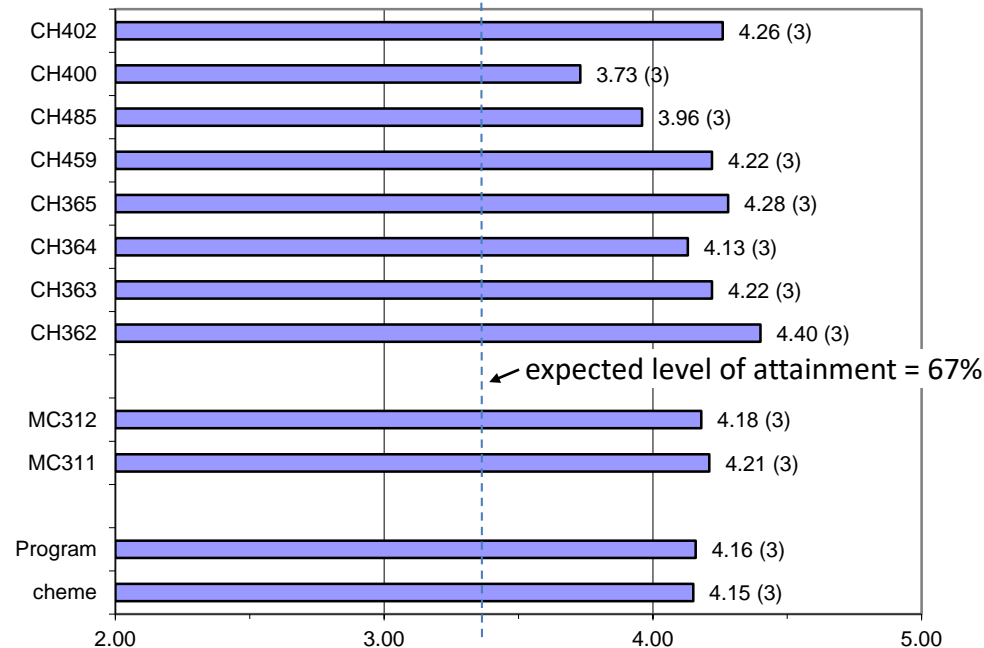
Course Grades



Example Data: Coursework Embedded Indicators

Student Outcome 1

Ability to apply knowledge of mathematics, science, and engineering.

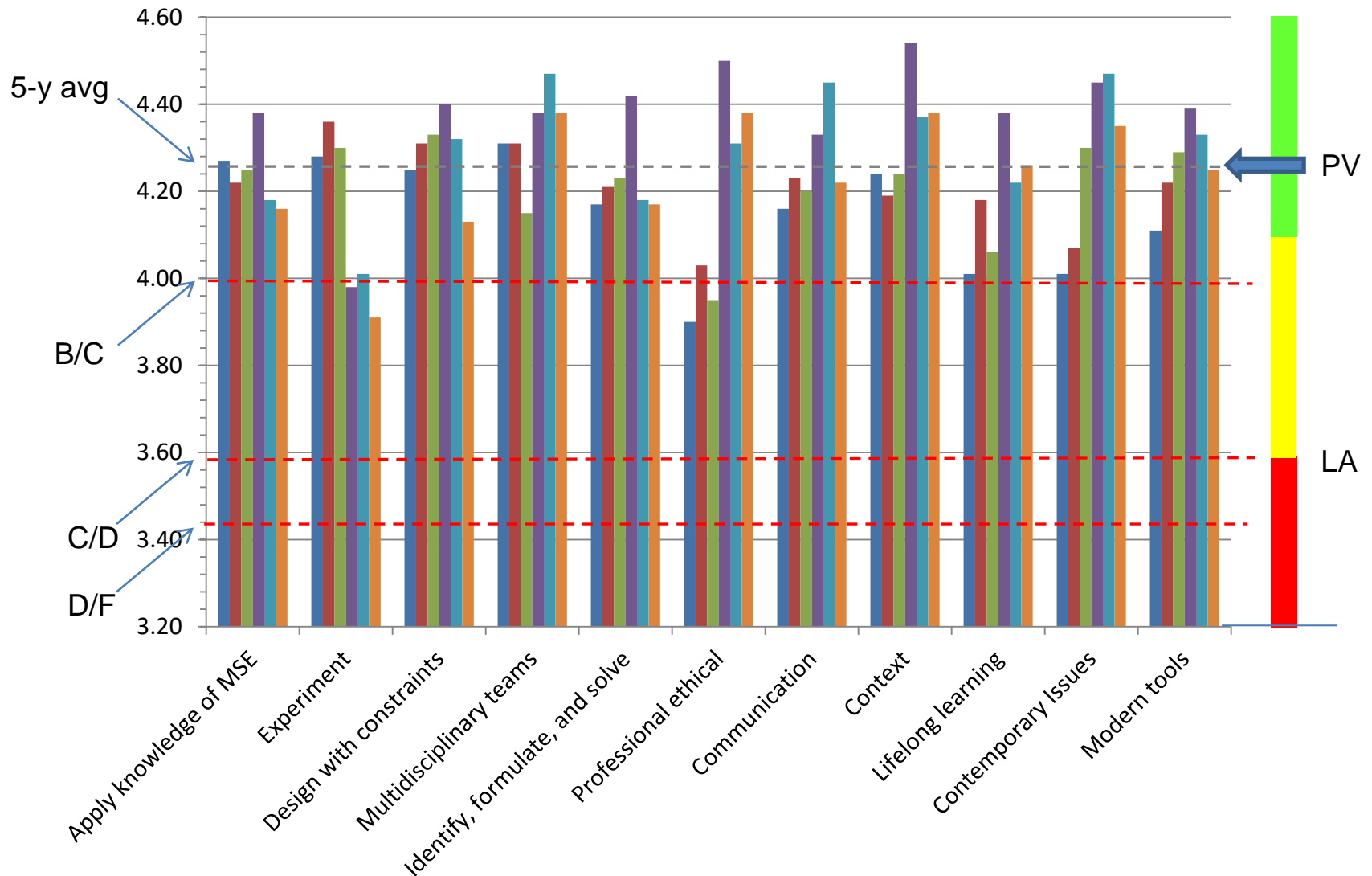


Data shown here is for Class of 2017
 Similar data is collected for all 11 ABET outcomes
 Summary of all data is shown on next slide
 (AY17 is assessed using old outcomes)

Performance on Embedded Indicators

Program Averages AY2012 to AY2017

■ 2012 ■ 2013 ■ 2014 ■ 2015 ■ 2016 ■ 2017

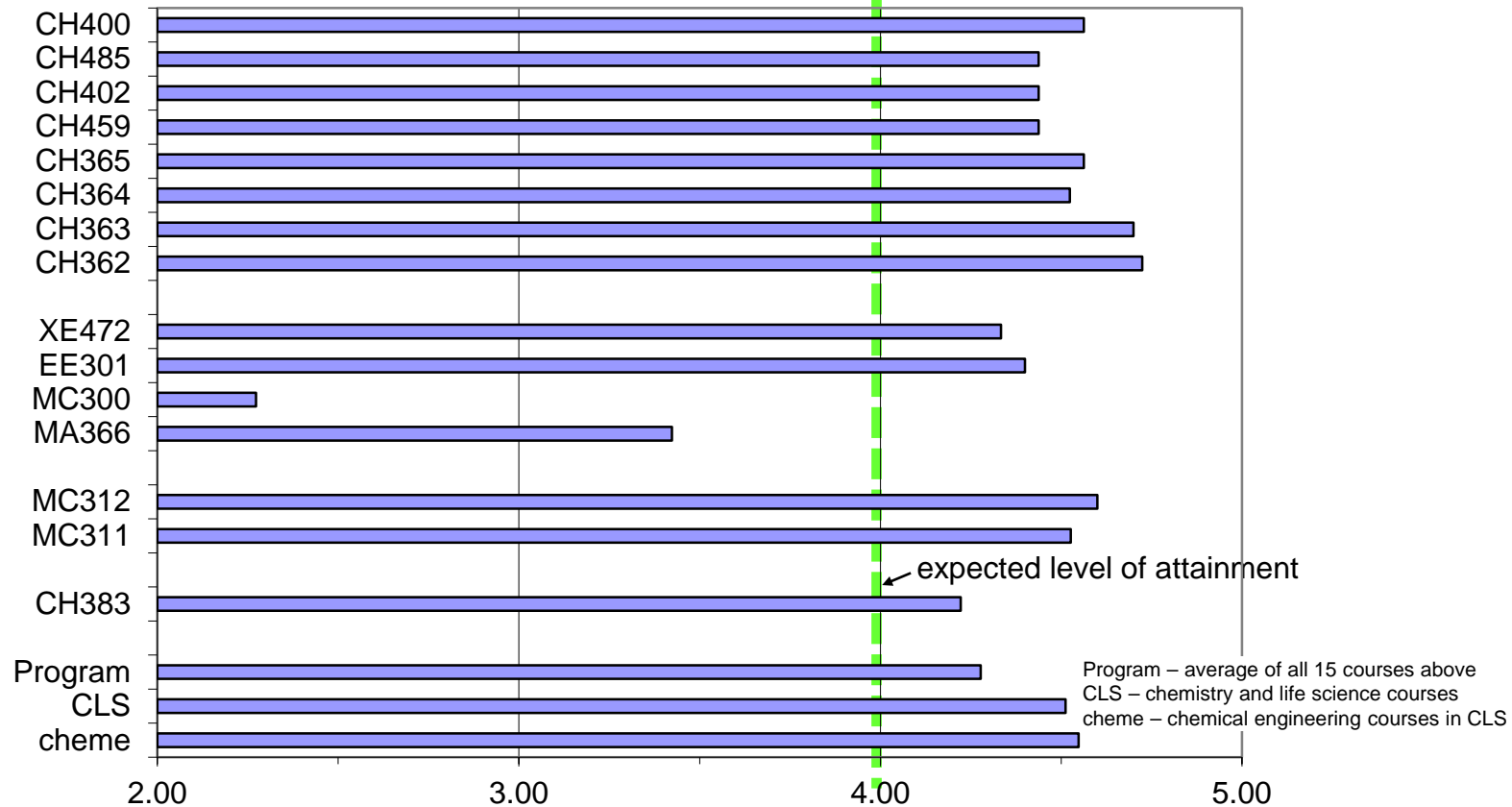


expected level of attainment is the 5-year average (PV)

Example Data: End-of-Semester Surveys

Student Outcome 1

This course has improved my ability to apply knowledge of mathematics, science, and engineering.



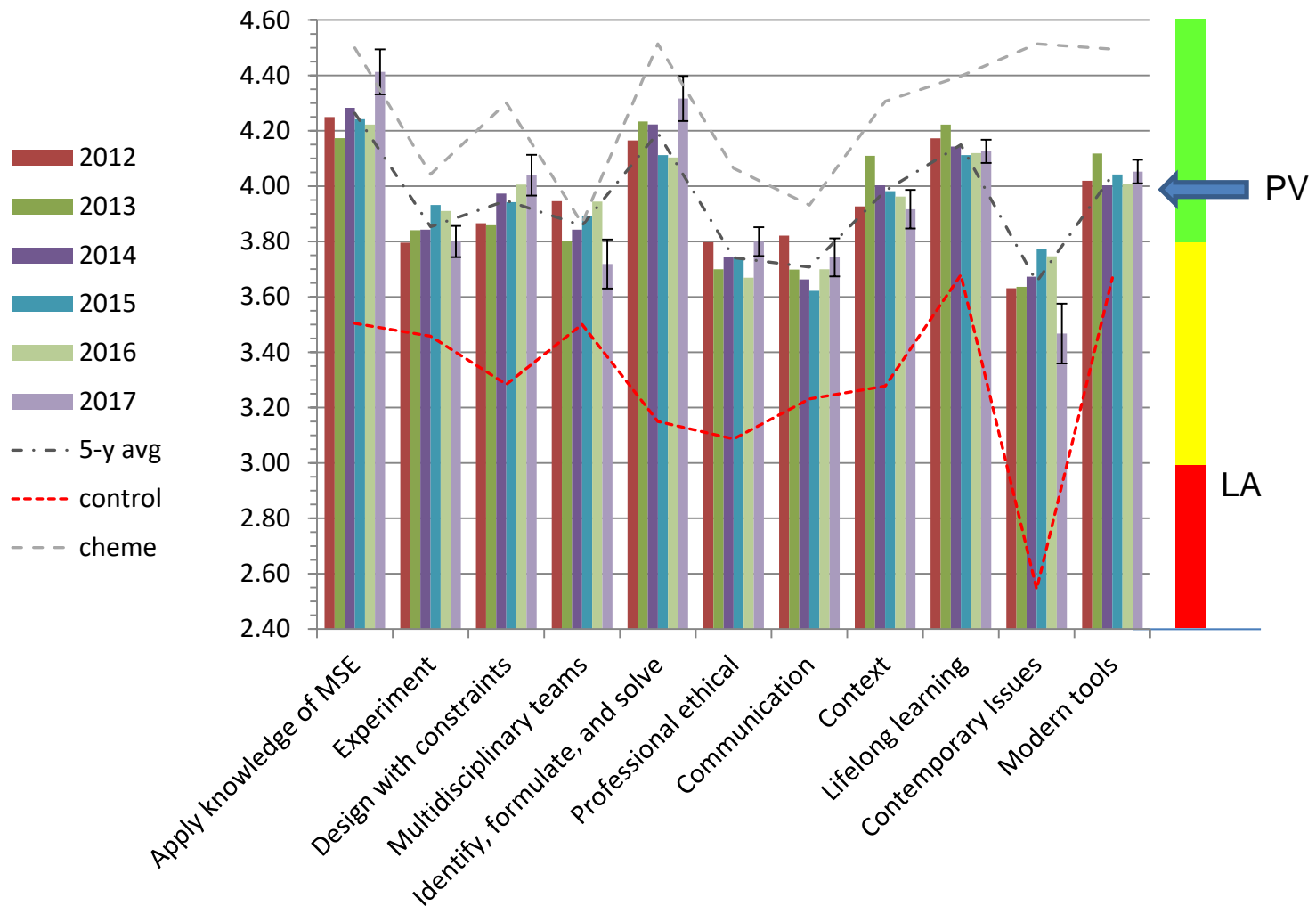
Data shown here is for Class of 2017

Similar data is collected for all 11 ABET outcomes (old)

Summary of all data is shown on next slide

End-of-Semester Surveys

Normalized Program Averages from AY12-17

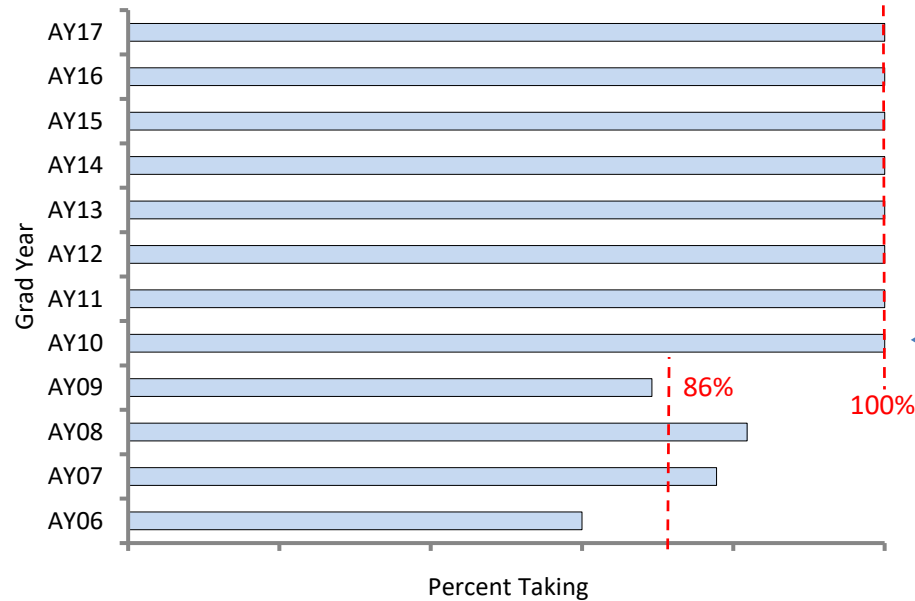


expected level of attainment is the 5-year average (PV)

Fundamentals of Engineering Exam

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

Percent taking

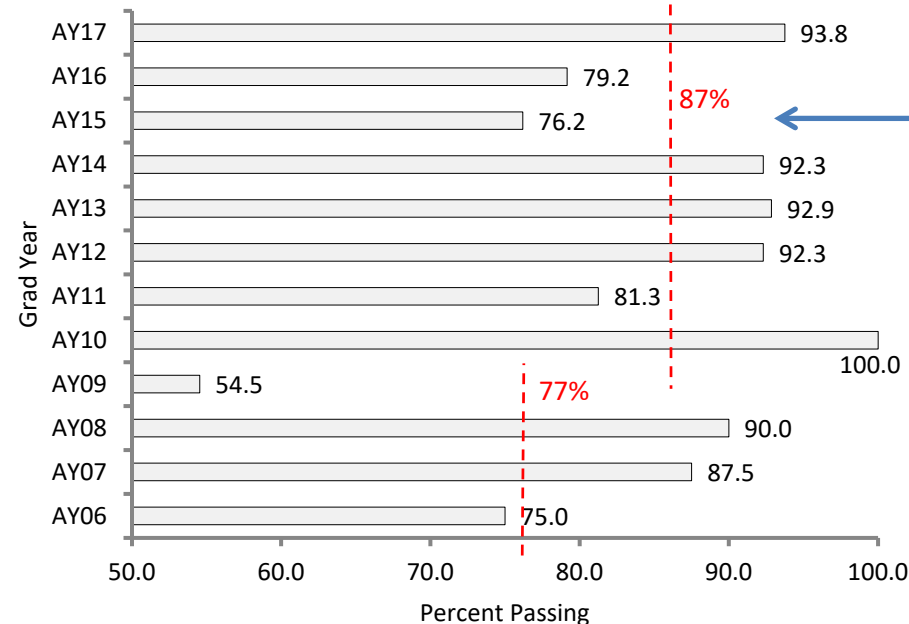


CH400 Initiated

Percent passing

National, (+/- ~1%):

2017	74.0%
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%

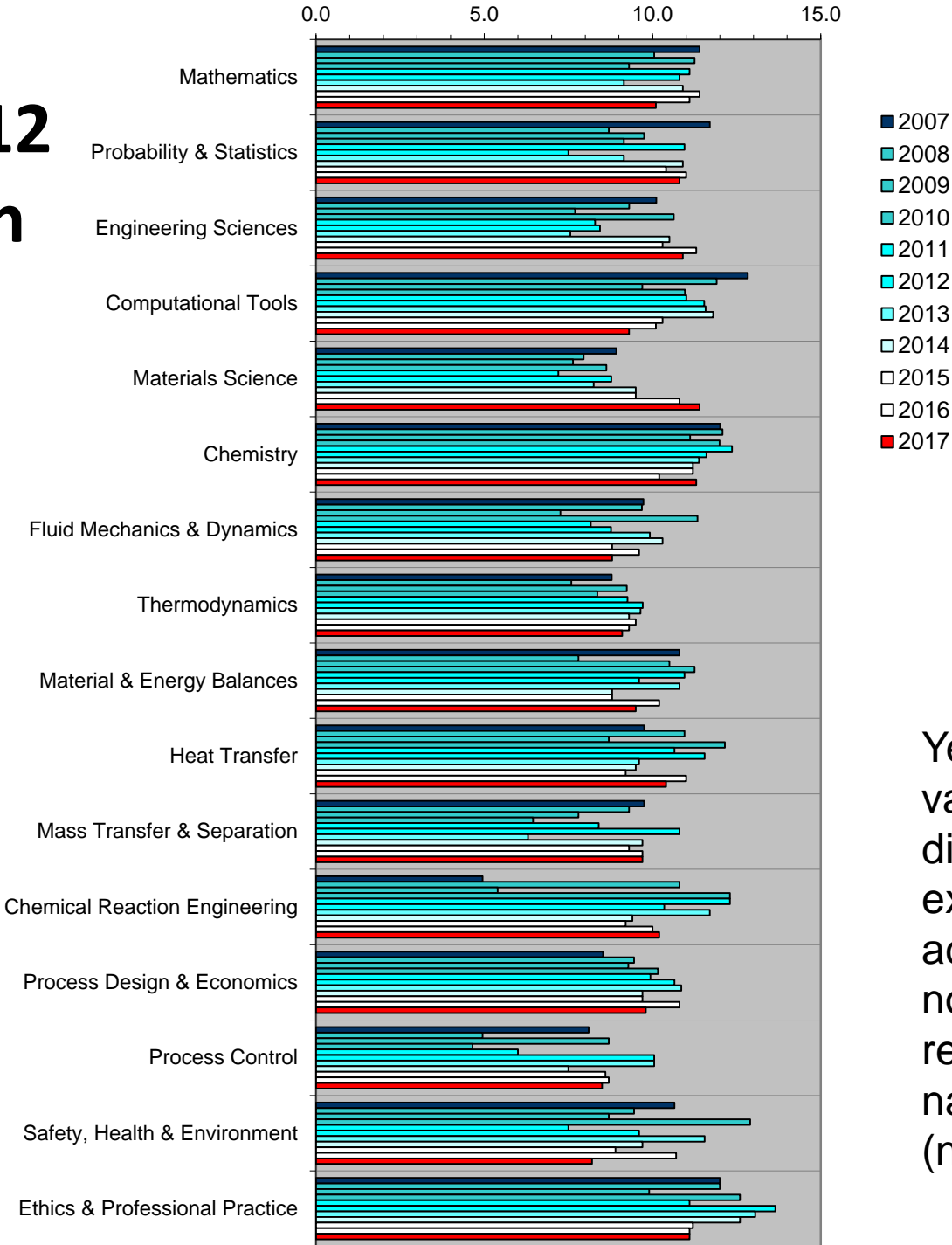


Electronic Testing

Outcome 12 Evaluation

FEE Results

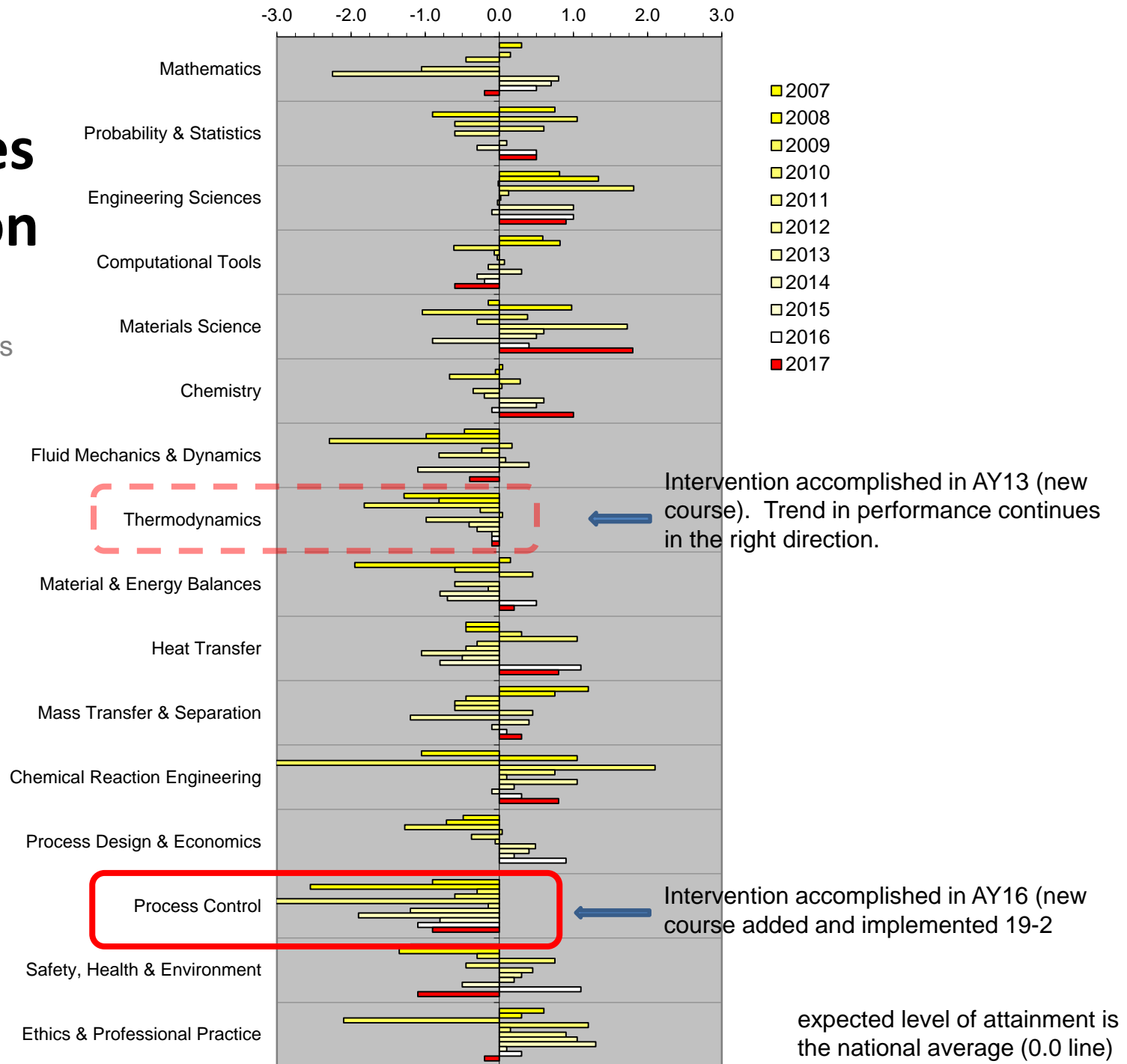
Performance
Indicators
AY07 to AY17



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

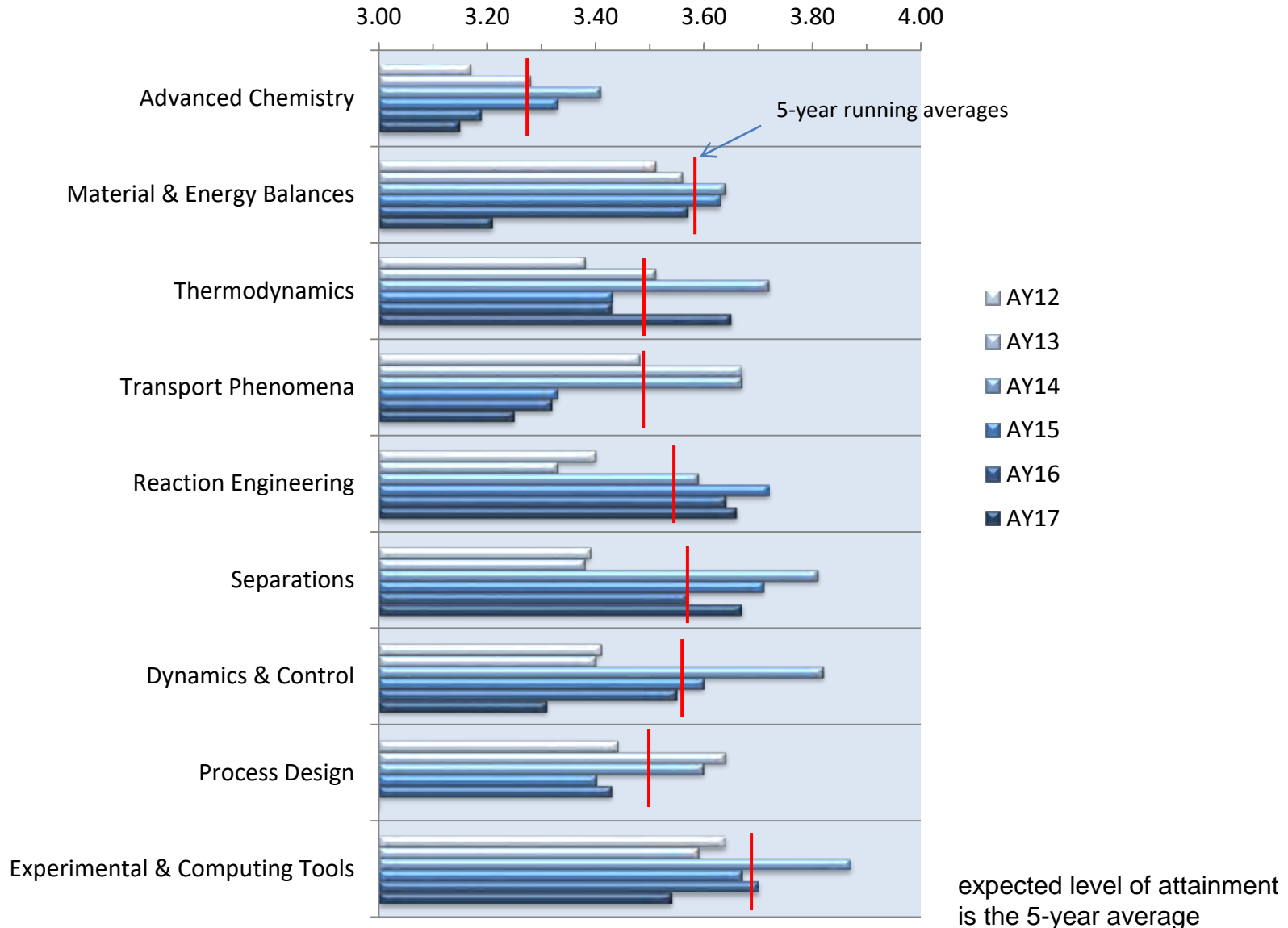
Topical Outcomes Evaluation

Deviations from
National Averages
AY07 to AY17



Topical Outcomes Evaluation

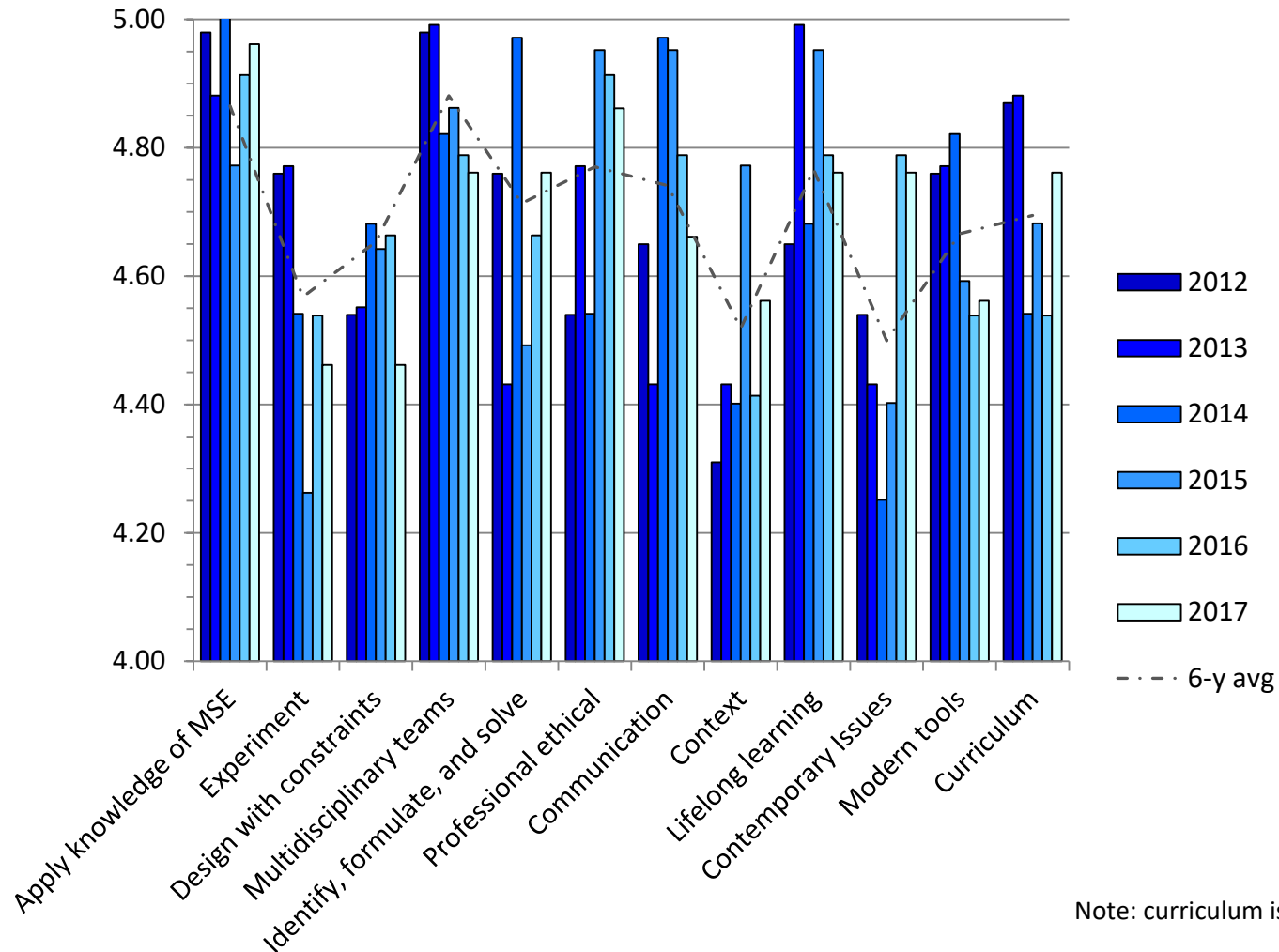
Average Course GPA from Transcripts, AY2012 to AY2017



Advisory Board Student Outcomes Surveys

Normalized Program Averages from AY12-17

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

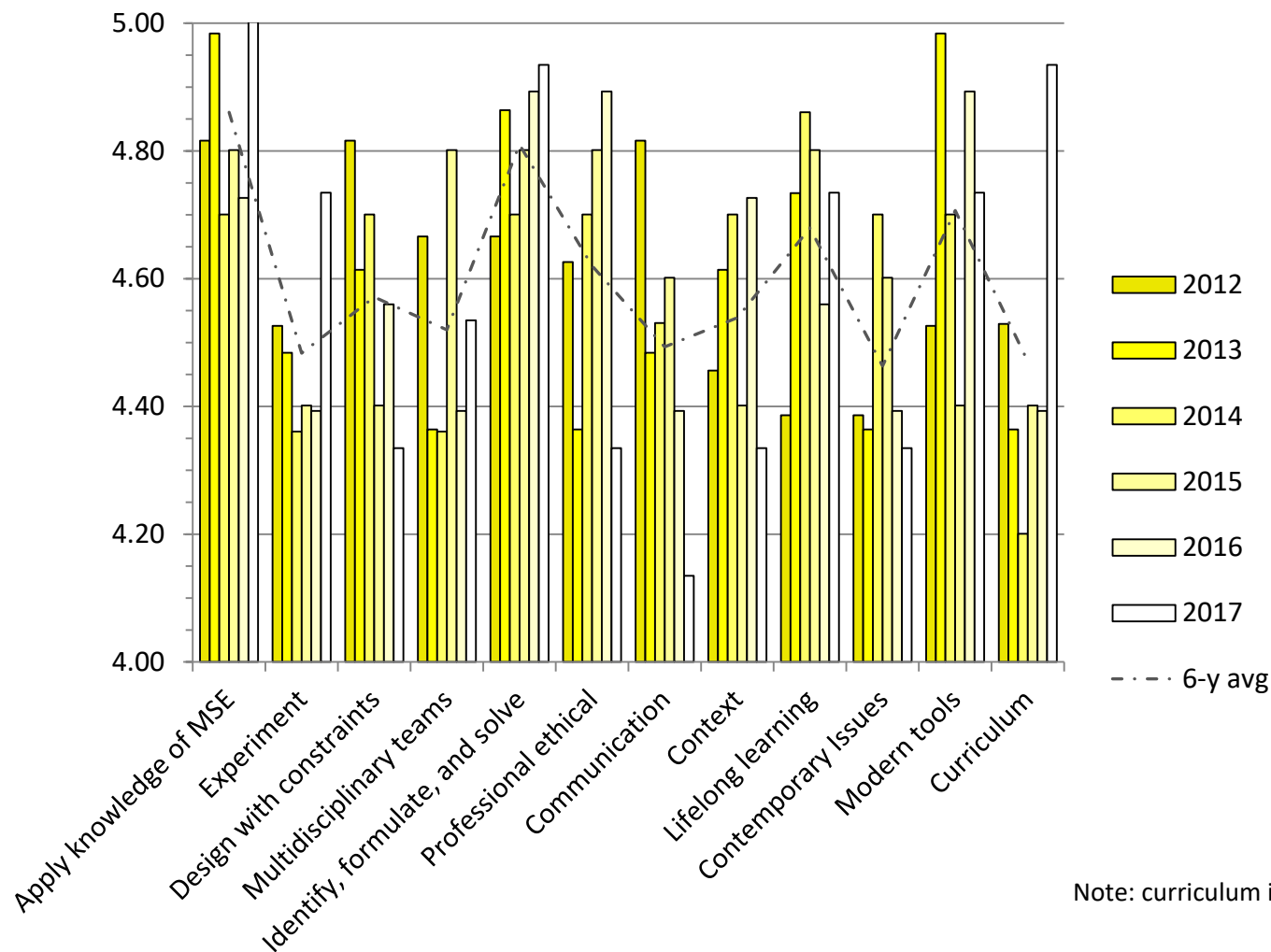


Note: curriculum is outcome 12

Faculty Student Outcomes Surveys

Normalized Program Averages from AY12-17

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:

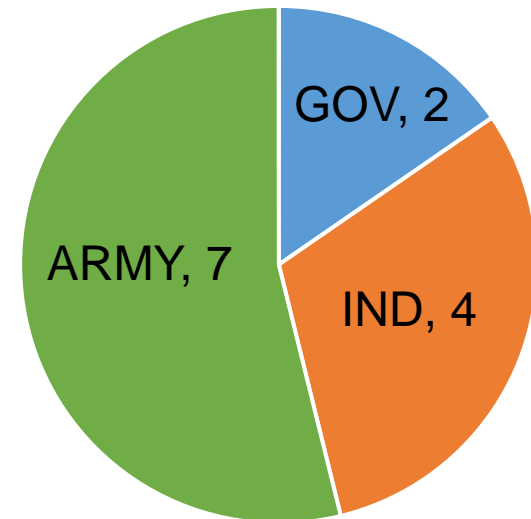
Assess consistency with the mission of the institution and the needs of the constituencies improve objectives.

Enrichment Opportunities

Advanced Individual Academic Development (AIAD)



- 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



Chemical Engineering

United States Military Academy



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3. Introduction to Automatic Process Control

United States Military Academy
Department of Chemistry and Life Science

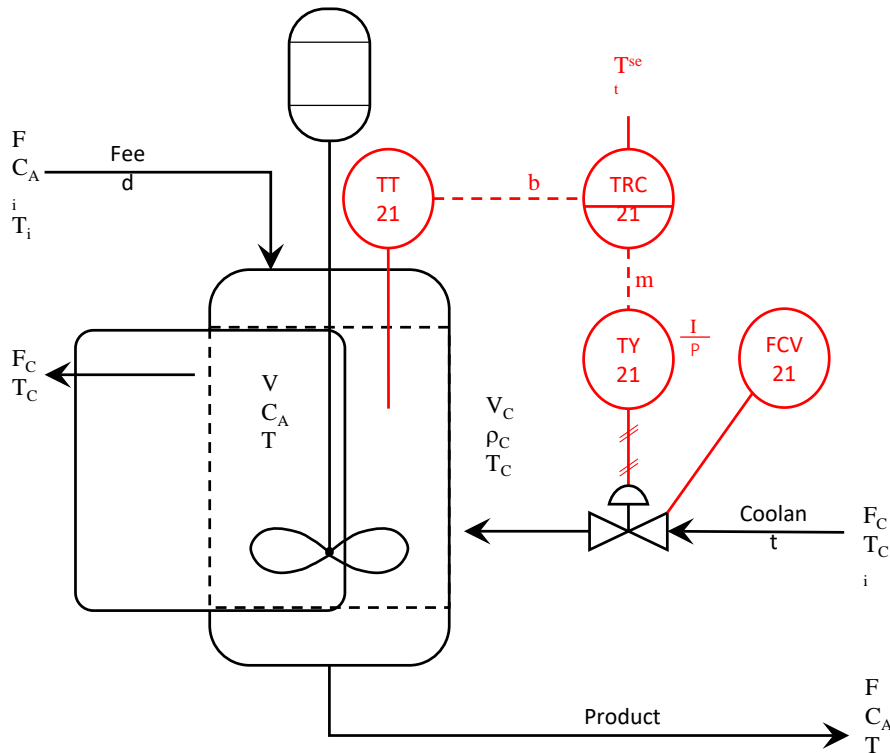
CH367

Introduction to Automatic Process Control

First iteration: AY 2019-2 (Spring 2019) for class of 2020

Proposed Text: Process Dynamics and Control, Seborg, et al.

CH367 Capstone



Objectives

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



Board – Cadet Discussions



Concept (flexible) of discussions

- ~ 1000-1045 Board ask questions of cadets
- ~ 1045-1140 Cadets ask questions of board



Lunch – West Point Club



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



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4. Future Challenges

United States Military Academy
Department of Chemistry and Life Science



ABET Criteria



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

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

1. identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. to communicate effectively with a range of audiences
4. recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. acquire and apply new knowledge as needed, using appropriate learning strategies.

Chemical Engineering Faculty

Can we support critical courses?

	AY18	AY19	AY20	AY21	AY22	AY23
Biaglow	X	X	X	X	X	X
Lachance	a	a	?	?	?	?
Bull	X	X	X			
Kalainoff	b	b	?	?	?	
Armstrong	X	X	X	X		
Nagelli	X	X	X	X	X	X
James	X	X	X	X	X	X
Miller, A.	X	X	X			
Pfluger		X	X	X		
Corrigan		X	X	X		
Chin				X	X	X
Yi				X	X	X
Totals	6+	8+	8+	8+	5+	3+

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

b – available to teach; currently acting department deputy

? – uncertain availability



Chemical Engineering



United States Military Academy



Example Schedule for Chemical Engineering, Classes of 2021 and Beyond

Fall Term	Course	Credit Hours	Spring Term	Course	Credit Hours
4th CLASS					
MA103	Math. Modeling & Intro. Calculus	4.5	MA104	Calculus I	4.5
CH101	General Chemistry I	4.0	CH102	General Chemistry II	4.0
EN101	Composition	3.0	EN102	Literature	3.0
HI107	Western Civilization	3.0	HI108	Regional Studies in World History	3.0
IT105	Introduction to Computing & IT	3.0	PL100	General Psychology	3.0
PE11x	Combatives / Boxing / Movement	0.5	MS100	Introduction to Warfighting	1.5
			PE150	Fundamentals/Personal Fitness	1.5
3rd CLASS	Total	18.0		Total	20.5
MA205	Calculus II	4.0	CH362	Mass and Energy Balances	3.5
PH205	Physics I	4.0	MA364/5	Engineering Mathematics	3.0
Lx203	Foreign Language	4.0	PH206	Physics II	4.0
SS201	Economics	3.0	Lx204	Foreign Language	4.0
PY201	Philosophy	3.0	SS202	American Politics	3.0
MS200	Fundamentals: Army Operations	1.5	EV203	Physical Geography	3.0
			PE 2xx	Lifetime Physical Activity	0.5
2nd CLASS	Total	19.5		Total	21.0
CH363	Separation Processes	3.5	CH364	Chemical Reaction Engineering	3.5
EE301	Fundamentals of Electrical Engineering	3.5	CH367	Introduction to Automatic Process Control	3.0
CH383	Organic Chemistry I	3.5	MC312	Thermal-Fluid Systems 2	3.0
MC311	Thermal-Fluid Systems 1	3.5	MC300	Fundamentals of Eng. Mech. & Design	3.0
PL300	Military Leadership	3.0	SS307	International Relations	3.0
MA206	Probability and Statistics	3.0	MS300	Platoon Operations	1.5
PE32x	Survival Swimming	0.5	PE360	Combat Applications	1.5
1st CLASS	Total	20.5		Total	18.5
CH459	Chemical Engineering Laboratory	3.5	CH402	Chemical Engineering Process Design	3.5
CH365	Chemical Engineering Thermodynamics	3.0	CH400	Chemical Engineering Prof. Practice	1.5
CH485	Heat & Mass Transfer	3.5	Elective	Engineering Elective 3	3.0
Elective	Engineering Elective 1	3.0	HI302	History of the Military Art	3.0
Elective	Engineering Elective 2	3.0	LW403	Constitutional & Military Law	3.0
PE450	Army Fitness Development	1.5	MX400	Officership	3.0
	Total	17.5		Total	17.0

Current Curriculum

CEN1 - Class of 2021

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	MA364/5 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

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

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

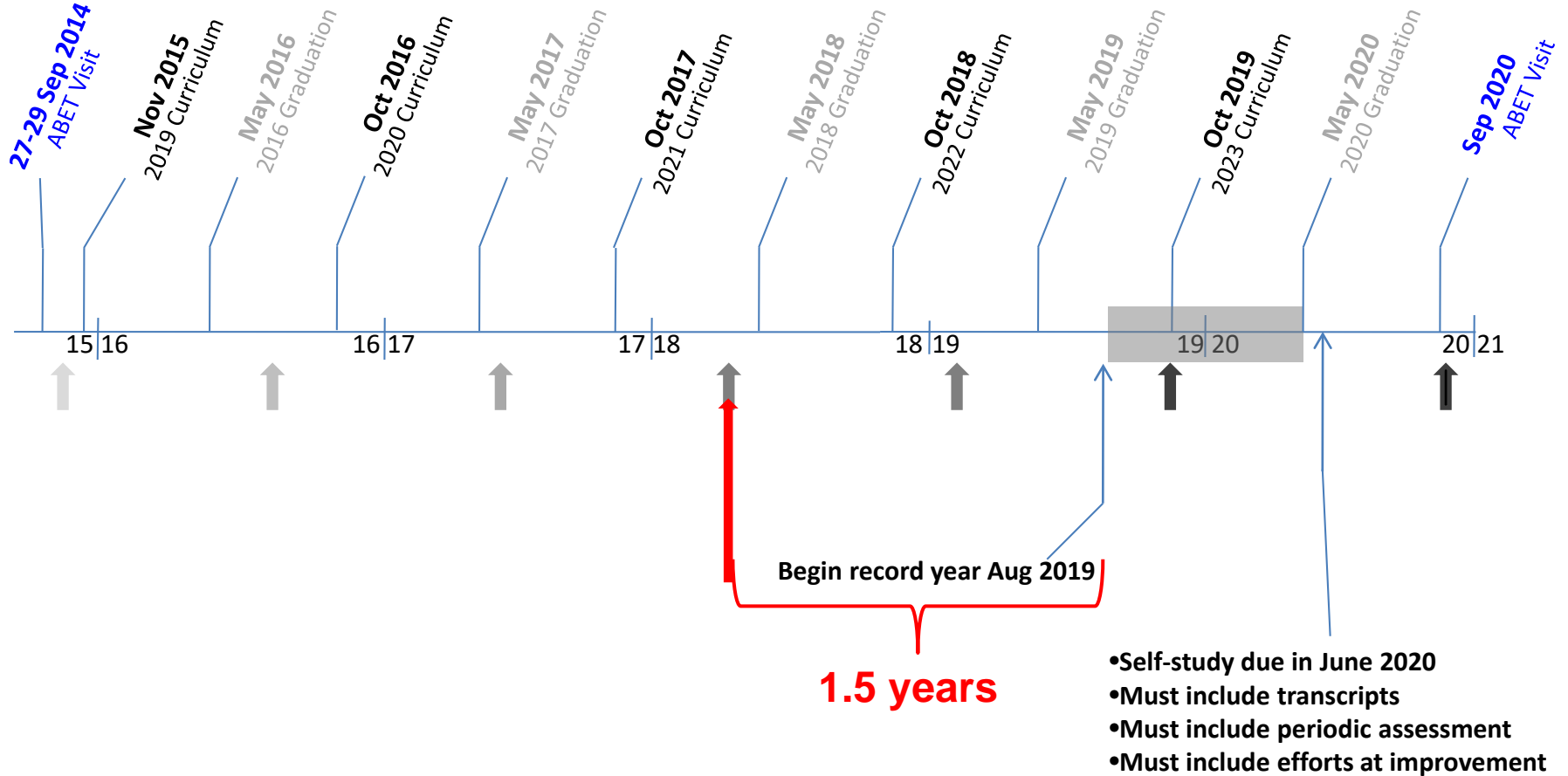
Recent Curriculum Changes and Ongoing Impact

- 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

Implementing Schedule Change

- AY 19-1 the Academy's 1-day/2-day schedule will change
 - Now 40 1-days and 30 2-days
 - **Some courses must shift to a 30-lesson sequence (CH363)**
- The additional 10 2-days are now 'Study Days'
- Biggest impact on Chemical Engineering is CH459 (ChemE Laboratory)
 - Back-to-back sections: experiment reset time?
- Major impacts to core classes, CH101/102
 - Full impact on base knowledge and understanding uncertain

Timeline for Curricular Actions





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



Electives Proposals



- Cadets have expressed ongoing interest in more chemical engineering electives
- Currently have 3 engineering electives in our major (to meet ABET requirements; 9 credit hours)
- ABET change lowered the required number of strictly engineering credit hours to 45
 - Options: retain engineering elective (at least in short term, will do so)? Chemistry elective? MSE at large? Others?



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)
 - Biomedical Engineering (Fundamentals)
 - Bioprocess Engineering (Fundamentals)
 - Biological Systems Design



Other Electives / Thoughts

- 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
- Thoughts on “Research” courses as electives and/or efficacy for “teaching”?



Some Administrative

- Next Advisory Board on-site
 - Late April/Early May 2019
 - Coincide with USMA Projects Day – invite 1-2 board members to come a day early and participate as a judge.
- Travel Paperwork
- Tour of Unit Operations Lab