Inclusive Learning Communities across the Foundation Coalition

Jeff Froyd, Texas A&M University

Southern Illinois University-Edwardsville, 27 October 2001, Edwardsville, IL

Introduction

Part I

Tenets of Learning

- **Each learner needs learning goals**
- **Each learner relates incoming information to his/her existing cognitive network**
- **Sharing insights with others and listening to their insights help improve your understanding of workshop content**
- **Effective workshops are partnerships between facilitators and participants.**
  - Effective workshops do not occur when participants expect the facilitators to do all the cognitive work
  - Effective workshops do not occur when facilitators expect that participants will be able to "just make sense" out of a large set of informative slides
- **Each participant brings many mental models to learning and change experiences.**

Mental Models – Ladder of Inference

Observable data → Choice of action

1. Observable data
2. People select the data they will use and ignore the rest.
3. People use their personal and cultural beliefs to construct meaning for the data.
4. People make assumptions using the added meaning.
5. People draw conclusions from the assumptions and selected data.
6. People use the conclusions to adopt personal beliefs to use in the future.
7. Finally, people select an action based on their beliefs.

Take action based on personal beliefs	I can't count on John
Adopt personal beliefs to be used in the future	John always comes in late
Draw conclusions	
Make assumptions using the added meaning	John knew when the lab started and was deliberately late
Use personal and cultural beliefs to add meaning	
Select the data	John entered lab 30 minutes late
Observable data	

Engage Participant Resistance

- **Learning is change; change is learning.**
- **Possible sources of participant resistance**
  - You are unsure about who we are and why we might be qualified.
  - You are unsure about whether inclusive learning communities are appropriate for your campus.
  - You are unsure about how the workshop material will be relevant to your work and the challenges you face.

Introduction: Basic Guidelines

- **Will operate in a team-based mode**
  - The group knows more than any one person
- **Interrupt frequently**
  - No pre-defined set of material that "must" be covered in this workshop
- **When looking at inclusive learning communities, we will focus on**
  - Alternative structures
  - Lower division curricula

Introduction: Team Formation

- **Self-Organize into four-person groups**
  - Want to emphasize both departmental diversity
    - Try to organize so that you have no more than one departmental representative per team
  - Introduce yourselves (name & institution) within the group

Background

- **Alexander Meiklejohn, Experimental College, University of Wisconsin, 1927-1932**
  - Two-year program of study, democracy in fifth century Athens, 19th and 20th century America
- **Joseph Tussman, University of California-Berkeley, 1965-1967**
  - Two-year program instead of a collection of courses

Building Connections Among Students

- **Common element – linked/clustered courses: students enroll in common sections for two or more courses**

- **Engineering projects help connect science, mathematics and engineering.**

- **Additional mechanisms are often used to develop community in an academic context.**

Building Connections Among Students

- **Alternative mechanisms**
  - – Coordinated/integrated syllabi
    - Syllabi linked in real-time or ahead of time
  - – Student advisors: Freshman Interest Groups (FIG)
    - Peer, undergraduate, graduate
    - Structured study times, study nights
  - – Common student teams across cluster
    - Team assignments, e.g., engineering projects
  - – Enrichment seminar: Federated Learning Community
    - May include a “master learner”

Why “Inclusive” in ILC?

- **Integrate mechanisms that allow participation of industry and/or other external constituencies**
  - Externally-sponsored projects
  - Industry-presented case studies
  - Industry nights
  - Industry-presented skills workshops, e.g., conflict resolution
- **Increase appreciation for diversity and its multiple values**
  - Team experiences
  - Diversity workshops, industry-sponsored diversity workshops

Introduction: Share information

- Within your group: discuss the following question among yourselves

What might be advantages of inclusive learning communities on your campuses?

What might be some barriers?

Describe how this workshop *should* inform your decisions about inclusive learning communities.

Appoint a reporter to capture group results

Group Reports …

- **???**

Foundation Coalition Examples

Part II

FC Partner Institutions

- Arizona State University (ASU)
- Rose-Hulman Institute of Technology (RHIT)
- Texas A&M University (TAMU)
- University of Alabama (UA)
- University of Massachusetts-Dartmouth (UMD)
- University of Wisconsin-Madison (UW)

FC Core Competencies

- Active/Cooperative Learning
- **Students Teams in Engineering**
- Increasing Participation of Women and Underrepresented Minorities in Engineering
- **Technology-Enabled Learning**
- Curricular Integration
- **Continuous Improvement through Assessment and Evaluation**
- Managing Curricular Change

FC First-Year Curricula

- **ASU First-Year: EnGAGE**
- **RHIT First-Year: IFYCSEM**
  - Integrated, First-year Curriculum in Science, Engineering and Mathematics
- **TAMU First-Year: No name**
- **UA First-Year: TIDE**
  - Teaming, Integration, Design, Engineering
- **UMD First-Year: IMPULSE**
  - Integrated Mathematics, Physics, Undergraduate Laboratory Science, Engineering
- **UW First-Year: LINKS**

EnGAGE
ASU First-Year Cohorts

<table>
<tr><td rowspan="7">800 Entering Students</td><td rowspan="5"></td><td rowspan="2"></td><td rowspan="2">Calculus II+</td><td>Linked</td><td>10%</td></tr>
<tr><td>Independent</td><td>10%</td></tr>
<tr><td rowspan="3">Calculus I</td><td>Integrated</td><td>10%</td></tr>
<tr><td>Linked</td><td>20%</td></tr>
<tr><td>Independent</td><td>20%</td></tr>
<tr><td rowspan="2">Pre-calc, trig, alg</td><td colspan="2">Linked</td><td>20%</td></tr>
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</table>

Integrated – tightly interconnected section of Engineering, Calculus, Physics and English

Linked – students enroll in common sections of two or more of the following: Engineering, Calculus, Physics, English

Independent – independent sections of first-year courses

Freshman Integrated Program in Engineering (FIPE)

F ‘94 - S ‘97

- **English - 3 hrs F&S**
- **Physics - 4 hrs F&S**
- **Calculus - 4 hrs F&S**
- ***Engineering - 4 hrs F***
- **Chemistry - 4 hrs S**

15 hours/semester

F ‘97 - present

- **English - 3 hrs F&S**
- **Physics - 4 hrs F&S**
- **Calculus - 4 hrs F&S**
- ***Engineering - 2 hrs F&S***

13 hours/semester

Arizona State University

Sample

ASU

Classroom

Projects <---> Integration, Active Learning, Technology

Projects

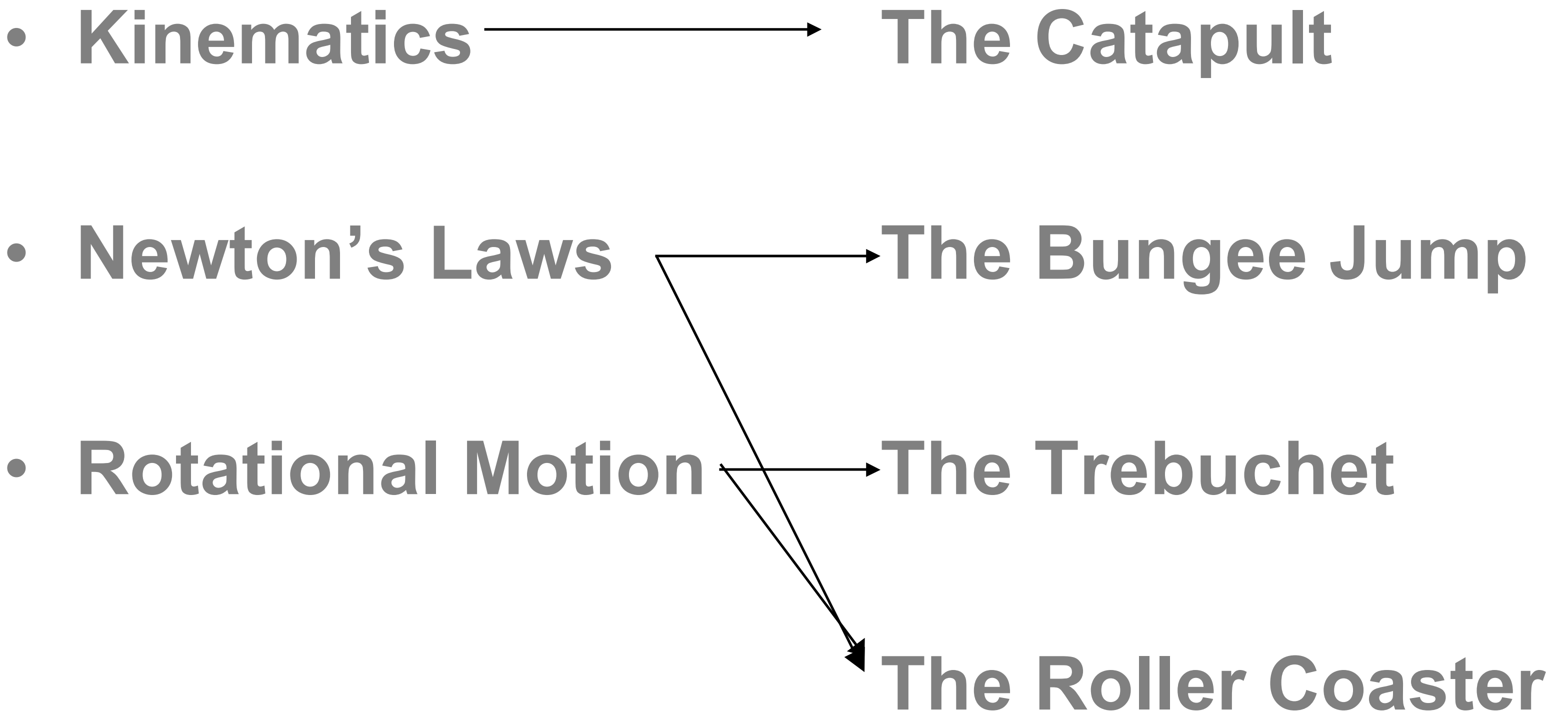
Engineering:
- Design Process
- Design Tools
- Teamwork

English:
- Rhetorical Skills
- Presentation Software
- Peer Review

Calculus:
- Math Skills
- Computer Algebra

Physics:
- Science Skills
- Data Capture
- Lab Technique

First Semester Projects



- Kinematics
- Newton's Laws
- Rotational Motion

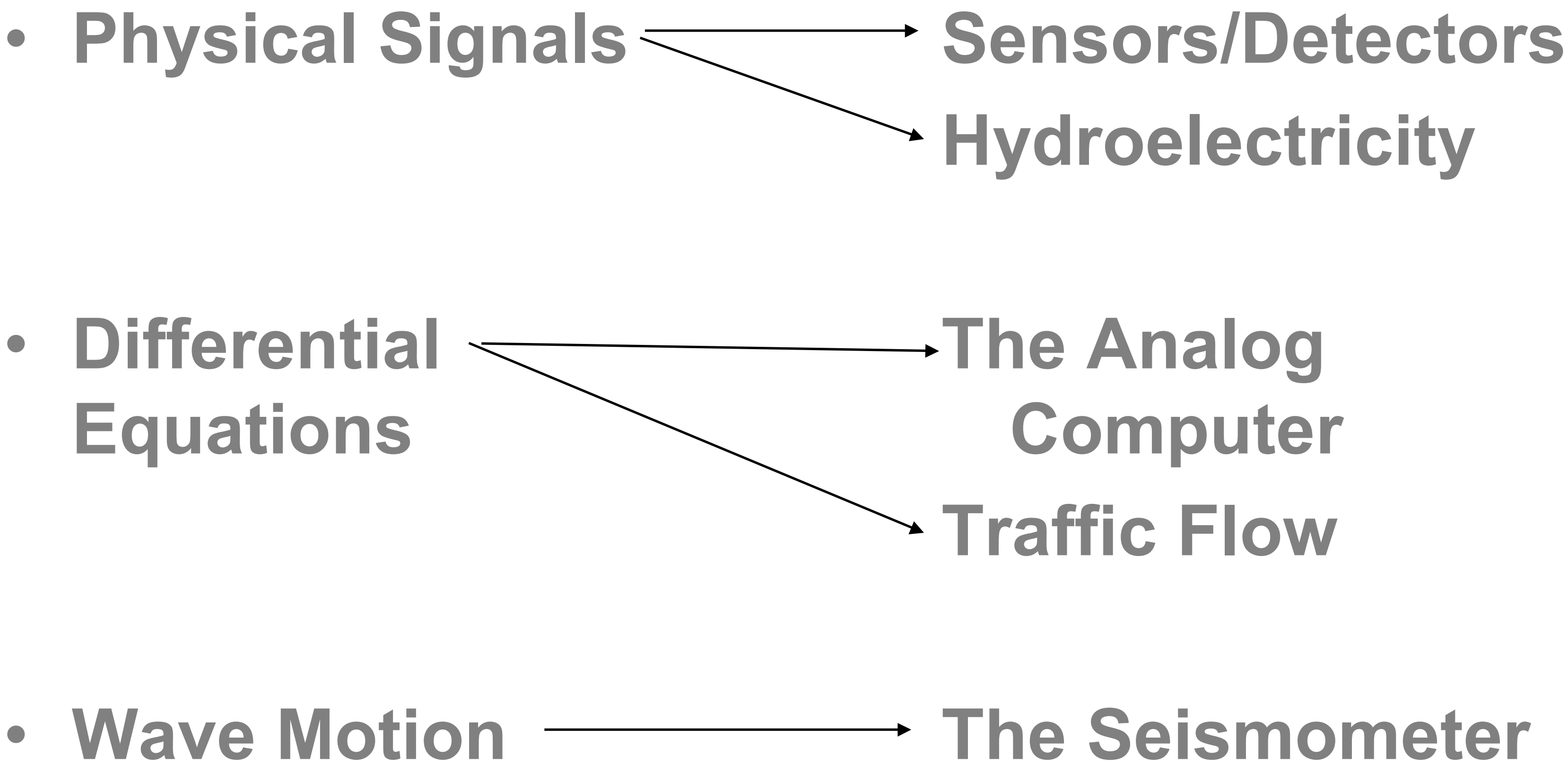
The Catapult

The Bungee Jump

The Trebuchet

The Roller Coaster

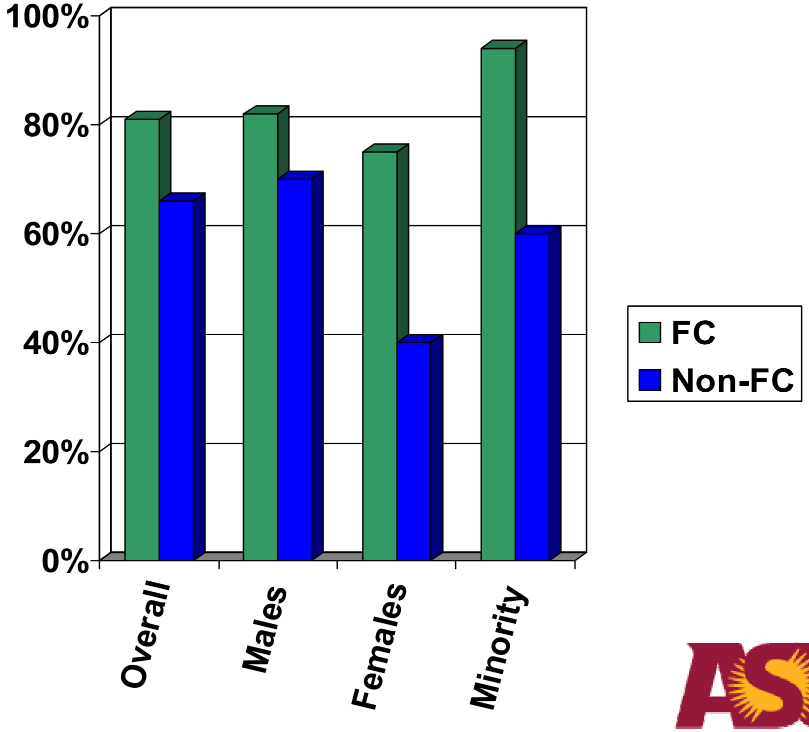
Second Semester Projects



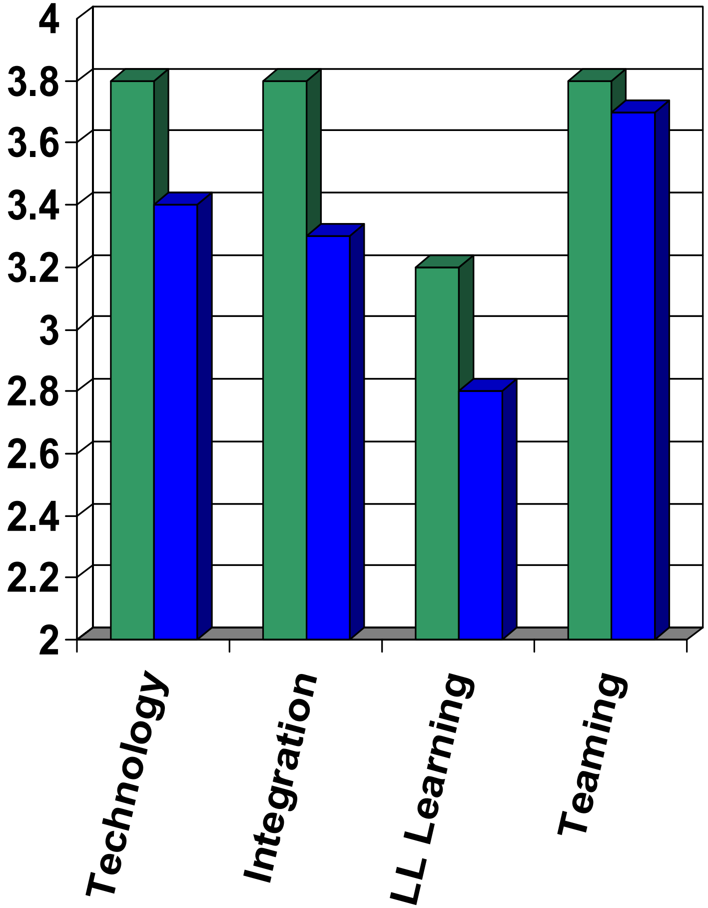
- Physical Signals → Sensors/Detectors
- Physical Signals → Hydroelectricity
- Differential Equations → The Analog Computer
- Differential Equations → Traffic Flow
- Wave Motion → The Seismometer

Impact

Retention



Attitudes toward FC core ideas



ARIZONA STATE UNIVERSITY

EnGAGE Program - Option 2

- **Three Course Groups - chosen from this list**
  - Engineering Design (4)
  - Chemistry (4)
    - Chemistry for Engineers or General Chemistry
  - English Composition (3)
  - Computer Programming (3)
    - Programming (C++) or Programming (Java) or Principles of Computing
  - University Physics (4)
  - Mathematics (3 or 4)
    - Precalculus or Calculus
  - Digital Design (3)

EnGAGE Program - Option 2

- Fall Semester only
- 12 combinations from list
- Student groups of 20-25
- Students expected to take at least one more course

Reflection

THINK-PAIR-SHARE (5 minutes)

- Write down 2-4 ideas that you have gained from conversation about inclusive learning communities at ASU.
- Write down 2-4 items about which you would like additional information

Reflection

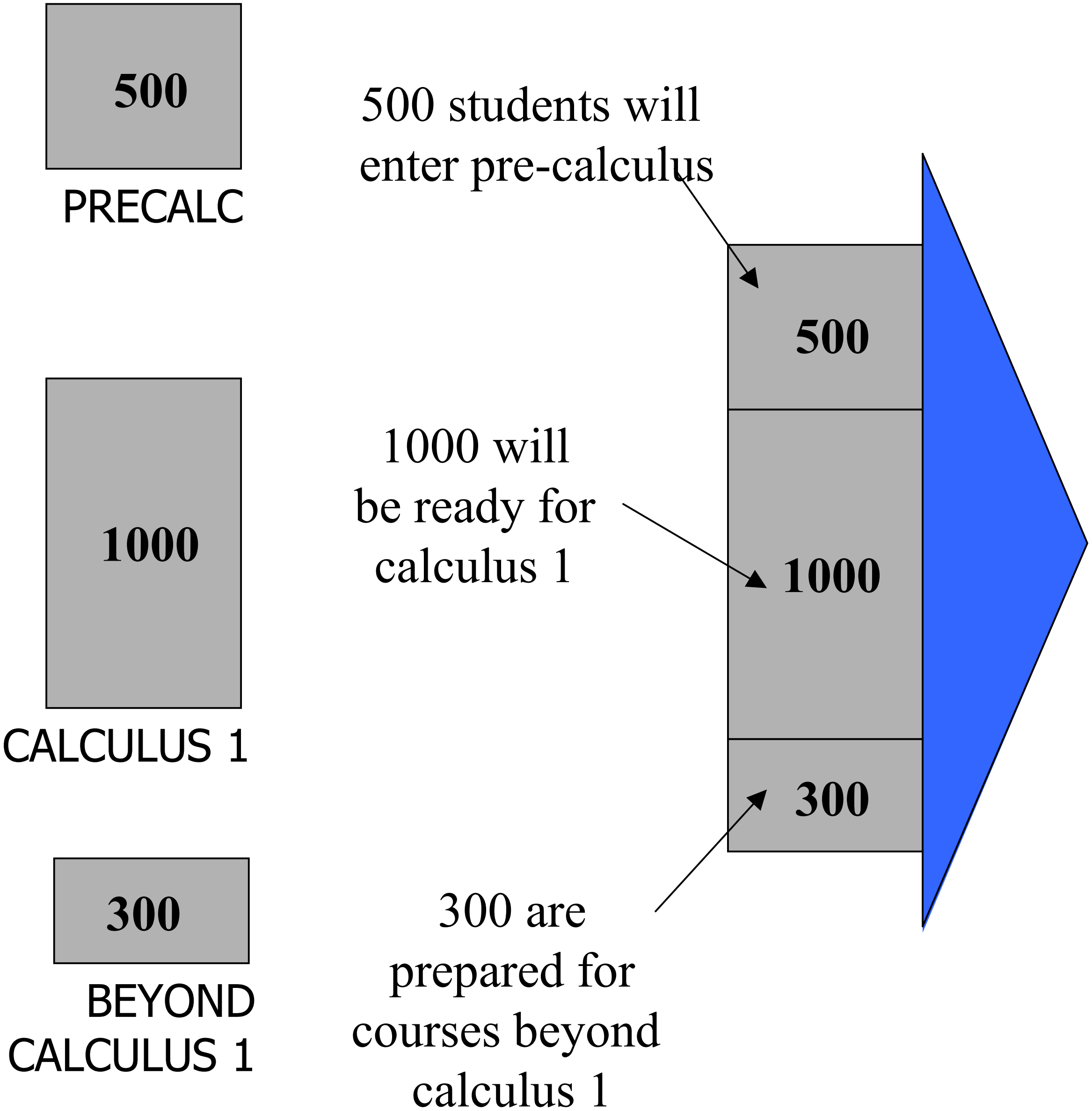
TAMU First-Year Cohorts

1800 Entering Students	Calculus II+	Linked	3%
		Independent	14%
	Calculus I	Linked	47%
		Independent	8%
	Pre-calc, trig, alg	Linked	17%
		Independent	11%

Linked – students enroll in common sections of two or more of the following: Engineering, Calculus, Physics, English

Independent – independent sections of first-year courses

CURRICULUM OPTIONS FOR STUDENTS



500

PRECALC

1000

CALCULUS 1

300

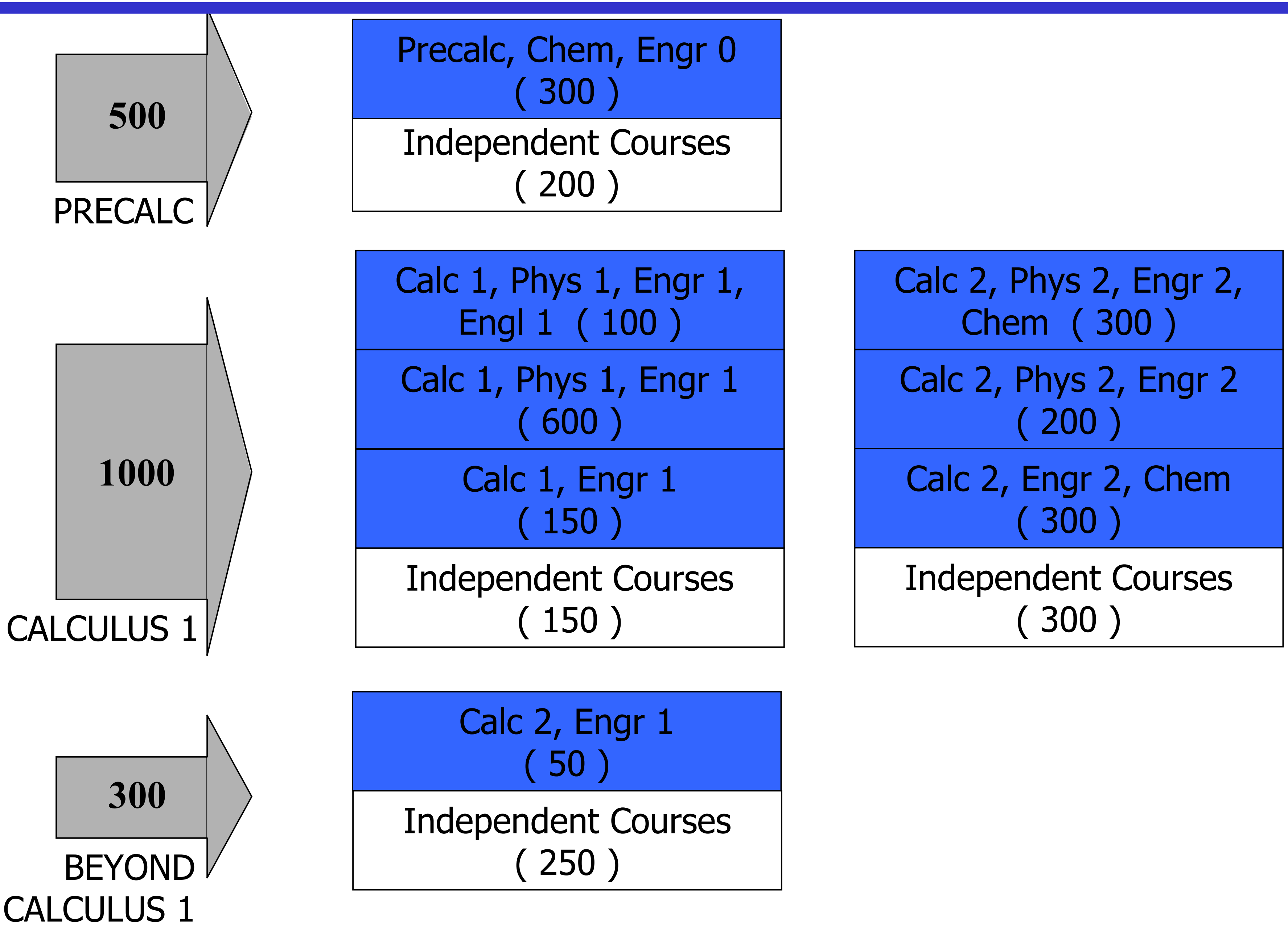
BEYOND CALCULUS 1

500 students will enter pre-calculus

1000 will be ready for calculus 1

300 are prepared for courses beyond calculus 1

First Year



500

PRECALC

Precalc, Chem, Engr 0
(300)

Independent Courses
(200)

1000

CALCULUS 1

Calc 1, Phys 1, Engr 1,
Engl 1 (100)

Calc 1, Phys 1, Engr 1
(600)

Calc 1, Engr 1
(150)

Independent Courses
(150)

Calc 2, Phys 2, Engr 2,
Chem (300)

Calc 2, Phys 2, Engr 2
(200)

Calc 2, Engr 2, Chem
(300)

Independent Courses
(300)

300

BEYOND
CALCULUS 1

Calc 2, Engr 1
(50)

Independent Courses
(250)

Integration of Courses

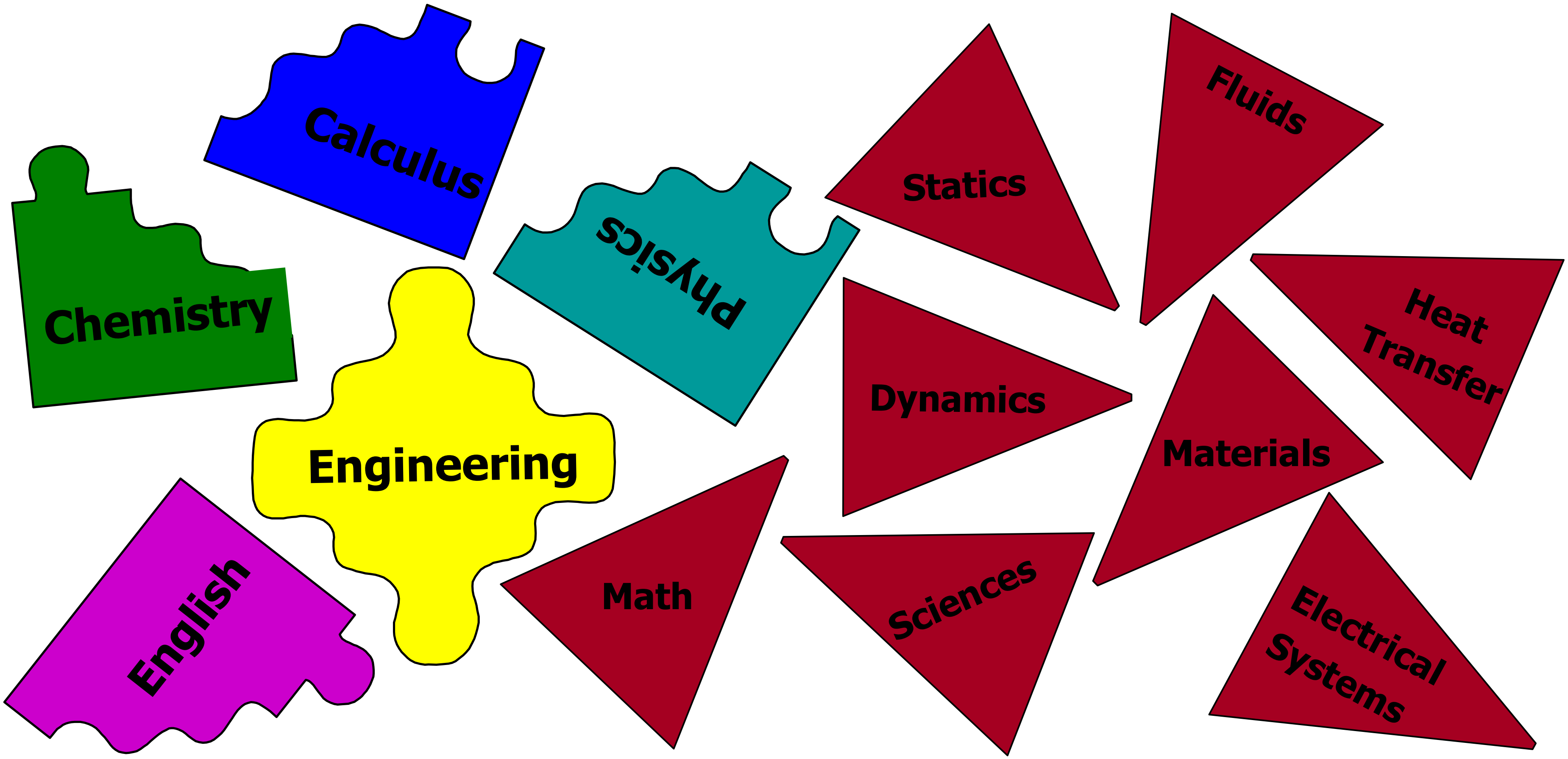
- **First Year**
  - Engineering
  - Physics
  - Chemistry
  - Calculus

- **Second Year**
  - Engineering Sciences
    - Materials
    - Thermodynamics
    - Statics/Dynamics
    - Mechanics
    - Circuits
  - Calculus
- **Upper Division**

In the old curriculum, students viewed the foundation courses as disjointed and unrelated.

FIRST YEAR

SECOND YEAR



Calculus

Chemistry

Physics

Engineering

English

Statics

Fluids

Dynamics

Heat Transfer

Materials

Math

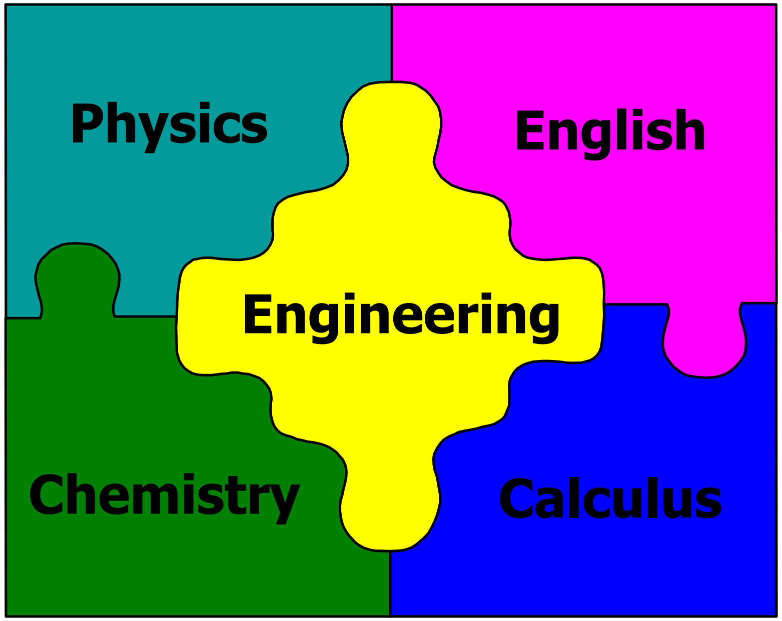
Sciences

Electrical Systems

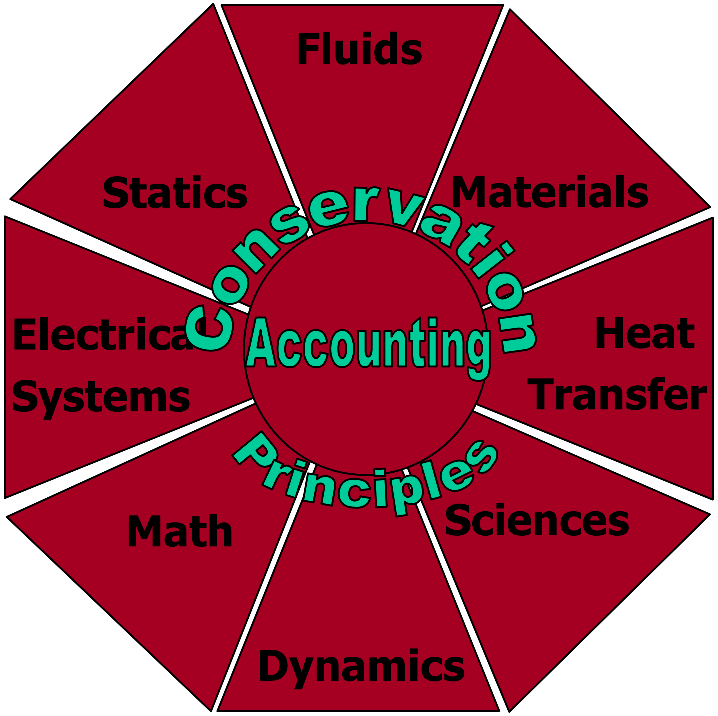
University Core Curriculum Requirements

In the integrated curriculum, course material clearly illustrates how these courses relate to the engineering field.

FIRST YEAR



SECOND YEAR



University Core Curriculum Requirements

CASE STUDY TOPICS

APPLIED MATERIALS - *Semiconductor Process Equipment-Cathode Base Field Failures*

COMPAQ - *Weighing Need to Differentiate VS. Benefits of Standardization*

DYNACON - *Launching Structures in the Offshore Marine Industry*

EXXON CHEMICAL - *Critical Care-A Case Study in Problem Solving and Team Work*

MOTOROLA - *Bringing Up a New FAB Plant*

TEXACO - #1*Getting Natural Gas to Market #2 Storage Tank Fire Investigation*

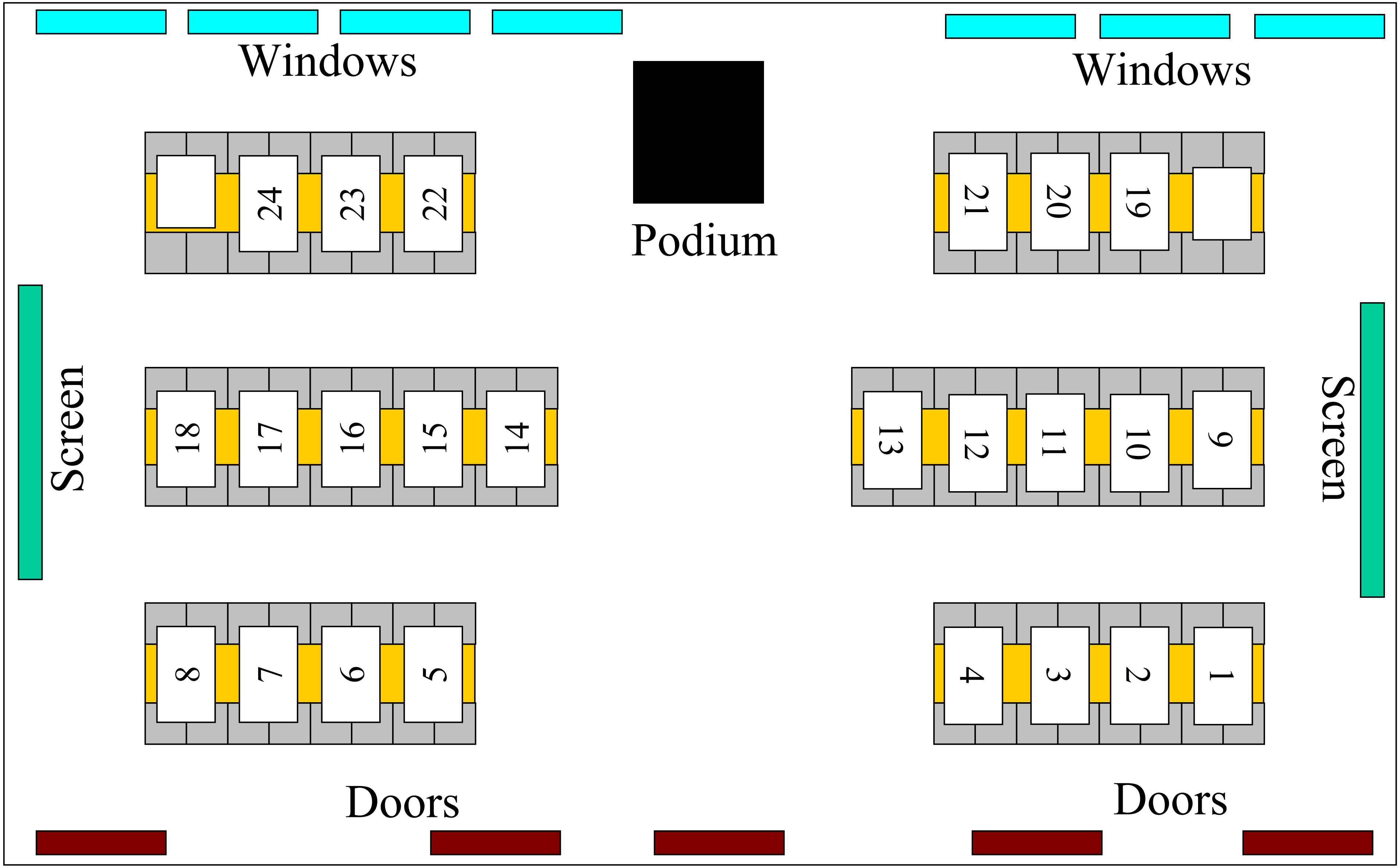
TU ELECTRIC - #1 *Over-speed of Auxiliary Turbines #2 Install COHPAC (Compact Hybrid Particulate Collector) at Big Brown Steam Electric Station*

LOCKHEED MARTIN - *Common Missile Warning System – Optical Sensor Placement*

Texas A&M University

- **Philosophy**
  - Classroom technology must be scalable for large classes (~100)
- **Classroom layout & equipment**
  - Remodeled about 10 classrooms for first-year and sophomore courses
  - One computer per two students
  - Departments have constructed their own classrooms, more are planned
- **Software & Applications**
  - Microsoft Office, Maple, AutoCAD, Eng. Equation Solver (EES), Internet
  - EE has students design, simulate, construct, measure and compare behavior of circuits. Class uses NI hardware and software.
- **Audience**
  - Freshman and sophomore engineering students
  - Specialized classes in specific disciplines

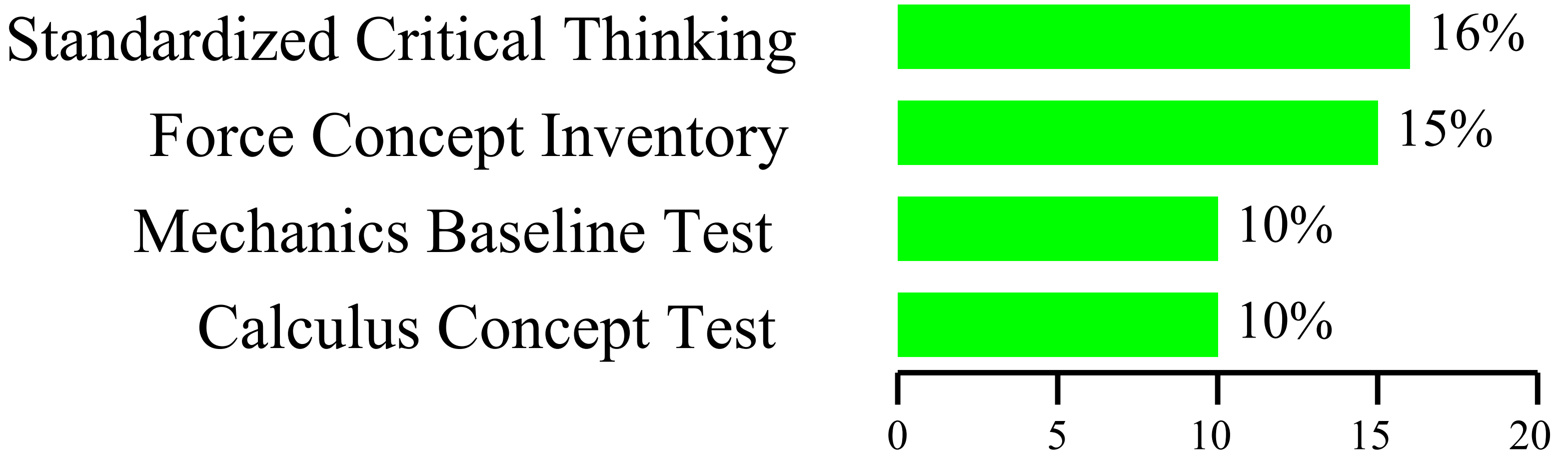
CVLB 319: ENGR 112 Team Layout
Sections 501 - 503



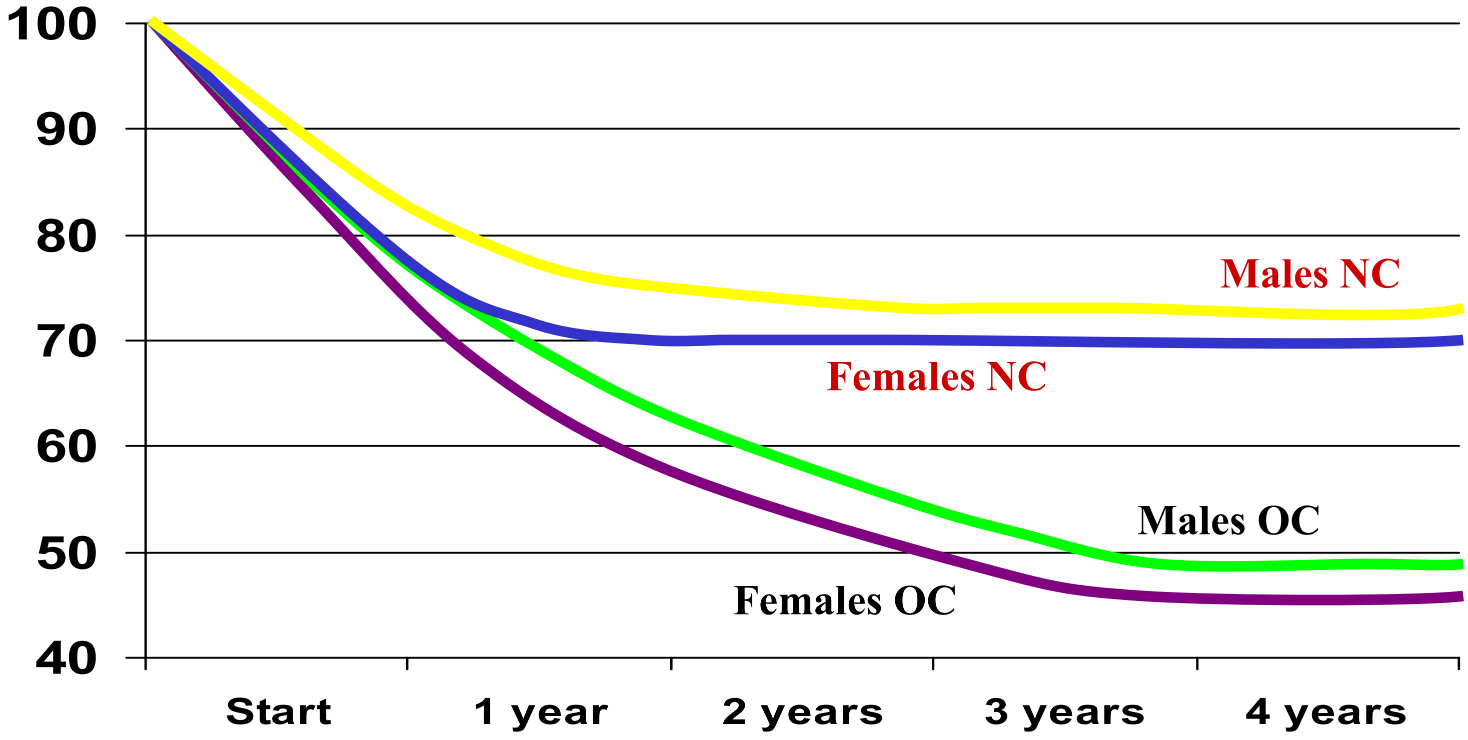
STUDENT PERFORMANCE ON STANDARDIZED TESTS

When compared to equivalent students in traditional engineering programs, after one year, students in the new curriculum perform better on standardized tests.

Test **% Gain Greater than Traditional**

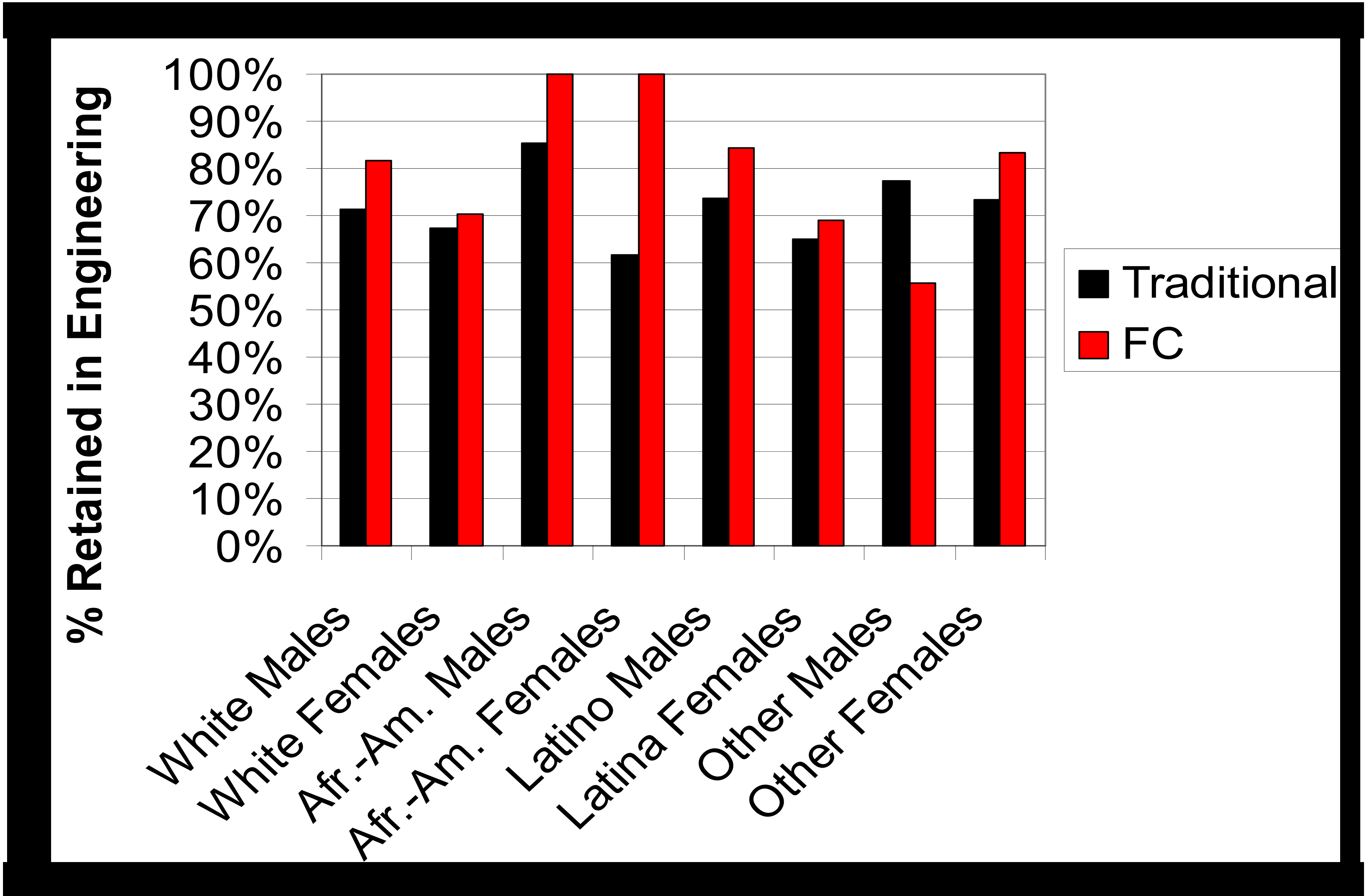


STUDENT RETENTION IN ENGINEERING AT TEXAS A&M

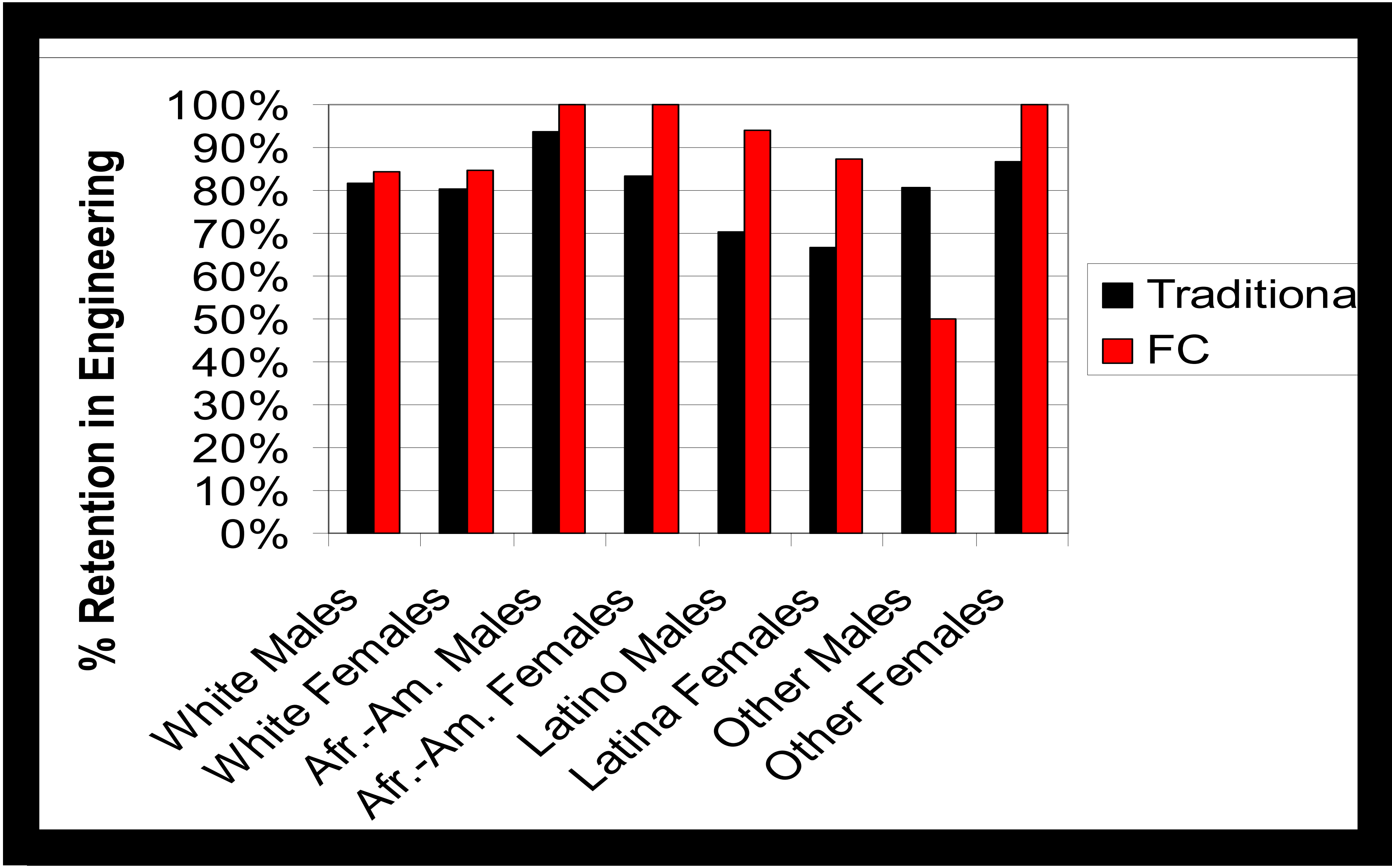


OC = Old Curriculum **NC = New Curriculum**

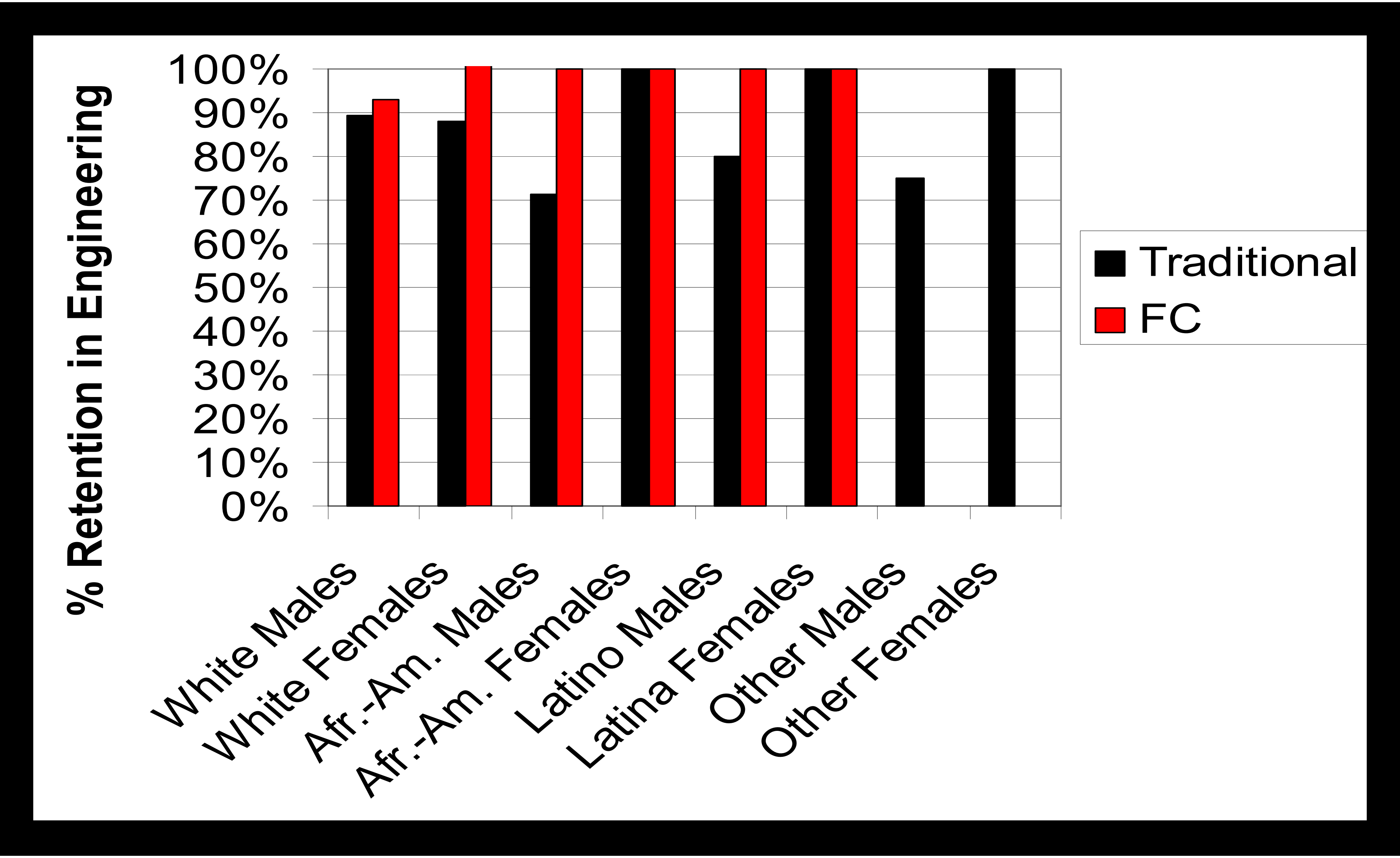
RETENTION THROUGH FIRST YEAR AT TAMU



RETENTION DURING 2nd YR AT TAMU



RETENTION DURING 3rd YR AT TAMU



REDUCED AVERAGE TIME TO GRADUATION

- Students in the new curriculum show a significant reduction in class repetition (fewer Ds, Fs, & Qs)
- These students complete foundation course work and graduate a semester sooner (on average) than students who are not involved in the new curriculum

Reflection

THINK-PAIR-SHARE (5 minutes)

- Write down 2-4 ideas that you have gained from conversation about inclusive learning communities at TAMU.
- Write down 2-4 items about which you would like additional information

Reflection

TIDE
UA First-Year Cohorts

<table>
<tr><td rowspan="9">400
Entering Students</td><td rowspan="7"></td><td rowspan="5"></td><td rowspan="2"></td><td rowspan="2">Calculus II+</td><td>Linked</td><td>5%</td></tr>
<tr><td>Independent</td><td>1%</td></tr>
<tr><td rowspan="3">Calculus I</td><td>Integrated</td><td>40%</td></tr>
<tr><td>Linked</td><td>2%</td></tr>
<tr><td>Independent</td><td>1%</td></tr>
<tr><td rowspan="2">Pre-calc algebra & trig.</td><td>Linked</td><td>20%</td></tr>
<tr><td>Independent</td><td>1%</td></tr>
<tr><td rowspan="2">Pre-calc algebra</td><td>Linked</td><td>25%</td></tr>
<tr><td>Independent</td><td>1%</td></tr>
</table>

Integrated – tightly interconnected sections of Engineering, Calculus, Physics and English

Linked – students enroll in common sections of two or more of the following: Engineering, Calculus, Physics, English

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TIDE – How are math and physics different?

Traditional Math	TIDE Math
• 4 lectures/week, no recitation • No graded homework • Computers not used	• **3 lectures/week, one 2-hr weekly recitation** • **Homework is graded** • **Computer software used in class and recitation** –Maple, Matlab
Traditional Physics	**TIDE Physics**
• Computers not used • Topics not linked to other classes	• **Computer software used in lecture and lab** –Excel, Maple, Interactive Physics • **Some integration with Math & Engineering** • **Studio Physics - Spring 2002**

TIDE – How is engineering different?

Traditional Engineering (Fall)	TIDE Engineering (Fall)
• Traditional board drafting (~1.5 hr) • AutoCAD (~1.5 hr)	• **Sketching (~0.5 hr)** • **Intro to engineering and disciplines, problem solving and computer “tools” (~1 hr)** • **Design projects (~1½ hr)** – Reports, presentations – Teaming skills
Trad. Engineering (Spring)	**TIDE Engineering (Spring)**
• Fortran programming (~3 hr)	• **MATLAB programming (~1½ hr)** • **Design projects (~1½ hr)** –Reports, presentations –Teaming skills

University of Alabama

- **Philosophy**
  - Technology in classrooms, classrooms convenient to students (one new classroom in “engineering dorm”)
- **Classroom layout & equipment**
  - Remodeled six different classrooms
  - Tables for four, one computer per two students
  - Departments constructing their own classrooms
- **Software & Applications**
  - Microsoft Office, compilers, MATLAB, Maple
- **Audience**
  - Freshman engineering students
  - All students in introductory computing sequence

Alabama Classroom Layout

- **Several classroom formats exist**
  - All have computers at student desks, instructor console, projection system
  - Primarily used for lower-division classes

IMPULSE
UMD First-Year Cohorts

<table>
<tr><td rowspan="6">250 Entering Students</td><td rowspan="4"></td><td rowspan="2"></td><td rowspan="2">Calculus II+</td><td colspan="3">Integrated</td><td>5%</td></tr>
<tr><td colspan="3">Independent</td><td>5%</td></tr>
<tr><td rowspan="2">Calculus I</td><td colspan="3">Integrated</td><td>40%</td></tr>
<tr><td colspan="3">Independent</td><td>15%</td></tr>
<tr><td rowspan="2">Pre-calc, trig, alg</td><td colspan="3">Linked</td><td>25%</td></tr>
<tr><td colspan="3">Independent</td><td>10%</td></tr>
</table>

Integrated – tightly interconnected section of Engineering, Calculus, Physics and English

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IMPULSE First-Year Curriculum

Courses	**Fall**	**Spring**
Physics for Sci. & Engr. I, II	4	4
Principles of Modern Chem. I, II	3	3
Intro. to Applied Chem. II	0	1
Critical Writing and Reading I	3	0
Intro. to Applied Sci. & Engr. I, II	3	2
Calc. for Applied Sci. & Engr. I, II	4	4
IMPULSE Total Credits	**17**	**14**
Program Specific (not IMPULSE)	**0**	**3**
Total Credits	**17**	**17**

University of Massachusetts-Dartmouth

- **Classroom layout & equipment**
  - – Remodeled three classrooms with tables that seat four students and have two computers (48 seats)
- **Software & Applications**
  - – Maple and Excel
  - – Based on Studio Physics model (RPI), students perform physics and chemistry experiments in the classroom, acquire, display and analyze data
- **Audience**
  - – Freshman & sophomore engineering majors

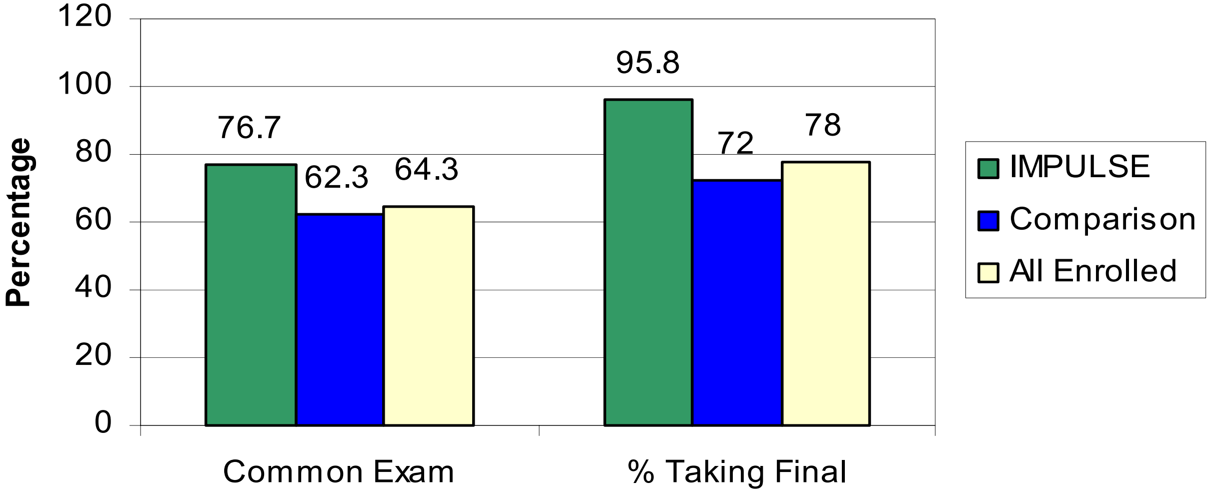
University of Massachusetts-Dartmouth

IMPULSE

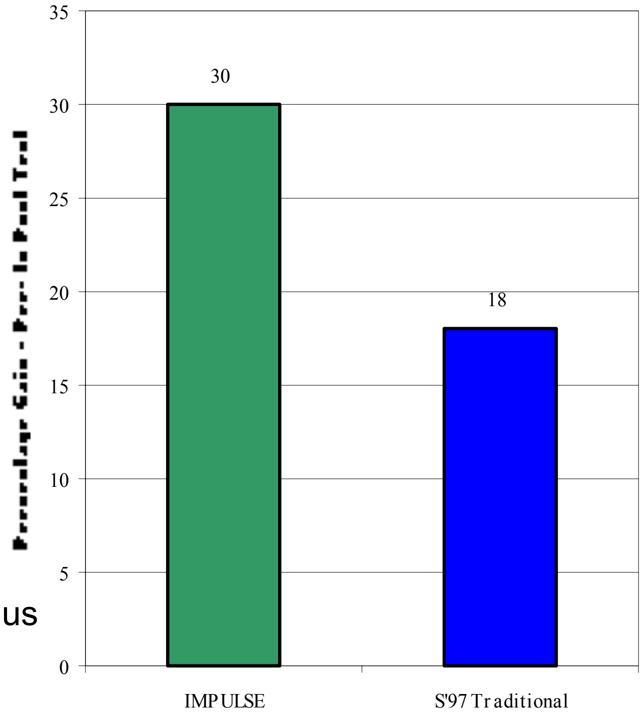
Classroom

Freshman Performance at UMass-Dartmouth Calculus and Physics

Performance in Calculus (Fall Quarter 1998)



Performance on the Force Concept Inventory



IMPULSE - Integration of Math, Physics, Undergraduate Laboratory Science, English, and Engineering - Curriculum.

- Students in the IMPULSE have a higher average (77) on a common calculus exam than the average (62) students in the 19998 comparison group.
- A higher percentage of students (96%) in the IMPULSE program are still enrolled in calculus at the final exam when compared to the percentage of students (72%) in a comparison group.
- Students in the IMPULSE program demonstrated a larger gain on the Force Concepts Inventory (FCI), a national normed physics tests, than students in the 1997 traditional curriculum.

LINKS
UW First-Year Cohorts

700 Entering Students			Calculus II+	Linked	3%
				Independent	30%
		Calculus I	Linked	6%	
			Independent	44%	
	Pre-calc, trig, alg	Linked	5%		
		Independent	12%		

Linked – students enrolled in LINKS, common sections of pairs of the following courses: Engineering and Technical Communication, Calculus and Chemistry. UW students have many other opportunities to participate in learning communities

Independent – independent sections of first-year courses

Roles of Student Teams

- **Students work to improve their team skills**
- **Students work on team assignments, including one or more projects**
- **Student teams provide interpersonal support for students when they are struggling**
- **Student teams provide nuclei for larger communities across cluster**

Industry Participation - Ideas

- Adoption of a team (of 4 students) or an entire cluster (of 96 students)
- Industry teams would visit their team/cluster 3-6 times a semester
- Industry would develop team projects for a 3-4 week duration based on “real world” problems and the student’s skill level
- Industry would help in the introduction and evaluation of projects
- Industry would serve as e-mail consultants to team/clusters
- Deliver course lectures on subjects such as ethics, design process, documentation, teaming, and/or communications
- Host cluster for a field trip to industry
- Develop a case study to be presented by engineers in the classroom
- Send new hires back to the classroom to discuss perceptions and realizations of the workplace
- Send an experienced engineering to talk to the class about their projects
- Conduct industry training like teaming, conflict management, communications, etc.
- Industry do mock interviews, resume writing, dinner with discussion

Industry Participation - FC

- **Host cluster for a field trip to industry**
  - UA Pilot Program
- **Develop a case study to be presented by engineers in the classroom**
  - TAMU First-Year Program
- **Conduct industry training like diversity, conflict management, communications**
  - TAMU First-Year: Industry-conducted workshops on diversity, conflict management

Role of First-Year Projects

- Provide students opportunities to apply an engineering design process
- Provide students opportunities to apply their teams skills to an extended project
- Provide students opportunities to connect their mathematics and science concepts to practice of engineering

Campus Transformation

Part III

Campus Transformation

- **As a team, design your “ideal” set of inclusive learning communities for the Fall of 2002**
  - Describe entering students and how cohorts will be formed
  - Describe addition mechanisms that you will use for strengthening connections within a cohort
  - Describe ways in which you will involve external constituencies in your communities
  - Describe the resources (besides $$$) that would be required to realize your visions
  - Select a different reporter from last time

Group reports…

- **Text goes here, fill in during workshop**

Wrap-up

- **How well did we achieve the desired results?**
- **Plus/Delta on the workshop**
  - One positive
  - One item for improvement

FC Publications on Inclusive Learning Communities

1. Morgan, J., J. Rinehart and J. Froyd, "Industry Case Studies at Texas A&M University", *Proceedings, 2001 ASEE Annual Conference*, ASEE, Albuquerque, NM, 24-28 June 2001
2. Malavé, C., et al., “Inclusive Learning Communities at Texas A&M University—A Unique Model for Engineering,” Proceedings of the First Conference on Creating and Sustaining Learning Communities: Connections, Collaboration, and Crossing Borders, Tampa, FL, March 10–13, 1999, Web Publication: http://www.usf.edu/~lc/conf
3. Richardson, Jim, Carlos Corleto, Jeff Froyd, P. K. Imbrie, Joey Parker and Ron Roedel, “Freshman Design Projects in the Foundation Coalition,” *Proceedings, 1998 Frontiers in Education Conference*, Tempe, AZ, November 1998, Web Publication: http://foundation.ua.edu/publications/fie98/1388.pdf
4. Learning Communities Annotated Bibliography, Web Publication: http://www.engr.wisc.edu/services/weel/coalition/bibliography.html

Learning Communities - Resources

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