Systemic Engineering Education Reform
~ The Path to Change ~

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Educational Reform
(What, How, Success, Challenges)

Single Institution: (the beginning)

Drexel University:
• Centered on first two years
• Primarily dealt with curriculum & student development
• Bridging across departments and Colleges within one University
• E⁴ which evolved into ‘tDEC’

Multiple Institutions:

Gateway Engineering Education Coalition
• Built on prior work and extended to all years
• Bridging across Universities
• A broader set of issues beyond curriculum alone
  ✓ Curriculum (as a vehicle to address broader set of issues)
  ✓ Educational Methods
  ✓ Professional Development of Faculty and Students
  ✓ Technology as an educational vehicle
  ✓ Specific attention underrepresented minorities
  ✓ Assessment
Traditional U.S. Undergraduate Sequenced Curriculum
(From the early 1950’s to the mid-1980’s and beyond)

Sequential, layered, and segments often disconnected

Passing Through the Filters
Identified Needs: 1980’s and forward
(National Studies, Academia, Industry)

• Increase emphasis on synthesis and design
• Retain strong foundation in mathematics, natural sciences, engineering sciences, and fundamental concepts of analysis and design
• Strengthen emphasis on historical and societal Perspectives
• Develop management and communication skills
• Provide interdisciplinary exposure
• Prepare for career-long learning
• Develop greater independent thought and leadership
• Use technologies as a means to enhance the educational process
• Increase faculty investment in undergraduate engineering education
• Establish an engineering educational culture that is supportive of understanding the issues of:
  • Educational Pedagogy
  • How students learn, how we teach, as well as what we teach
  • The need to measure the effectiveness of our educational process
A vertically Integrated Continuum

- A Joint Initiative between engineering, science, math & humanities

Integrated and Interwoven Components:
- Engineering Up-Front and the Intellectual Centerpiece
- Math, Science, and Engineering in parallel and concurrently
- Extensive Experiential Learning
- Interdisciplinary Themes
- Concurrent integration of communication, organizational management, group dynamics, teamwork skills, and social responsibility

Results: Retention, GPA, Lessons Learned
~ Next Step ~
An Integrated Continuum Across Full Program

Integrated, Unified Science/Math

Basic Engineering up Front

Hands-on Lab, Design, Systems Methodologies

Inverted Curriculum

Year 1

Year 2

Year 3

Year 4

Research Experience

In-Depth Engineering Science

Capstone Engineering

K - 14 Interface

Baccalaureate Interface

BS/MS (Practice Oriented)

BS (Industry)

BS/PhD (Research Oriented)

In-Depth Disciplinary Engineering

Multidisciplinary Themes

Applied Liberal Arts

An Inverted Curriculum
Gateway Engineering Education Coalition
www.gatewaycoalition.org
GATEWAY STRATEGIES

Culture Change
- Curriculum
- Professional Development
- Underrepresented Populations
- Instructional Technologies
- Assessment
- Linking/Sharing (Partnerships)

Phase I
- Innovate
- Institutionalize
- Develop
- Product

Phase II
- Implement
- Process
Students Participating in Freshman Design

<table>
<thead>
<tr>
<th>Award Year</th>
<th>Number of Students</th>
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<tbody>
<tr>
<td>Year 0 (1992)</td>
<td>140</td>
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<td>Year 5 (1997)</td>
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<td>Year 7 (1999)</td>
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<td>Year 8 (2000)</td>
<td>3051</td>
</tr>
<tr>
<td>Year 10 (2002)</td>
<td>3898</td>
</tr>
</tbody>
</table>

Students Participating in Courses that Formally Integrate Communication Skills and Ethics

<table>
<thead>
<tr>
<th>Award Year</th>
<th>Communication</th>
<th>Ethics</th>
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<td>Year 8 (2000)</td>
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<td>3051</td>
</tr>
<tr>
<td>Year 10 (2002)</td>
<td>5000</td>
<td>3898</td>
</tr>
</tbody>
</table>
Underrepresented Student Graduation Rates (Percent Degrees Awarded)

- **1991/92**
  - Women: 13.6%
  - African American: 3.9%

- **1996/97**
  - Women: 15.7%
  - African American: 6.0%

- **2000/01**
  - Women: 19.5%
  - African American: 7.1%
Comparison of Gateway Coalition’s 1st to 2nd year Retention Rates against a National Sample

*National sample of 2002 STEM majors as collected by the Consortium for Student Retention Data Exchange (CSRDE):
www.occe.ou.edu/csrde
Structured Assessment Process

The process of identifying, defining, measuring, and analyzing institutional and educational outcomes is one of the drivers of culture change.
Courses with Documented Learning Objectives

- Year 10 (2002): 1605
- Year 8 (2000): 1391
- Year 7 (1999): 523
- Year 5 (1997): 82
- Year 0 (1992): 30

Students Participating in Outcome Assessment Processes

- Year 10 (2002): 9411
- Year 8 (2000): 5128
- Year 7 (1999): 4788
- Year 5 (1997): 1882
- Year 0 (1992): 430
Texts & Multimedia Products

Gateway Web Repository
http://www.gatewaycoalition.org
Gateway Engineering Education Coalition
Opening Doors to the Future

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Engineering the Educational Enterprise for the Future
Cross-Institutional Programs using Technology as a Bridge

- Concurrent Engineering
- SLA Network
- Rapid Prototype Design
Courses Using Cooperative Learning Methodologies

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Courses</th>
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<tbody>
<tr>
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<tr>
<td>2000</td>
<td>330</td>
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<tr>
<td>1999</td>
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<tr>
<td>1997</td>
<td>117</td>
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<tr>
<td>1992</td>
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Faculty Teaching Lower Div. Engineering Courses

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<td>99</td>
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<td>141</td>
<td>153</td>
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<td>180</td>
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<td>186</td>
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Engineering the Educational Enterprise for the Future
The Future?

Thank You

Access Slides on-line:
• http://www.gatewaycoalition.org
• Search
• UPADI