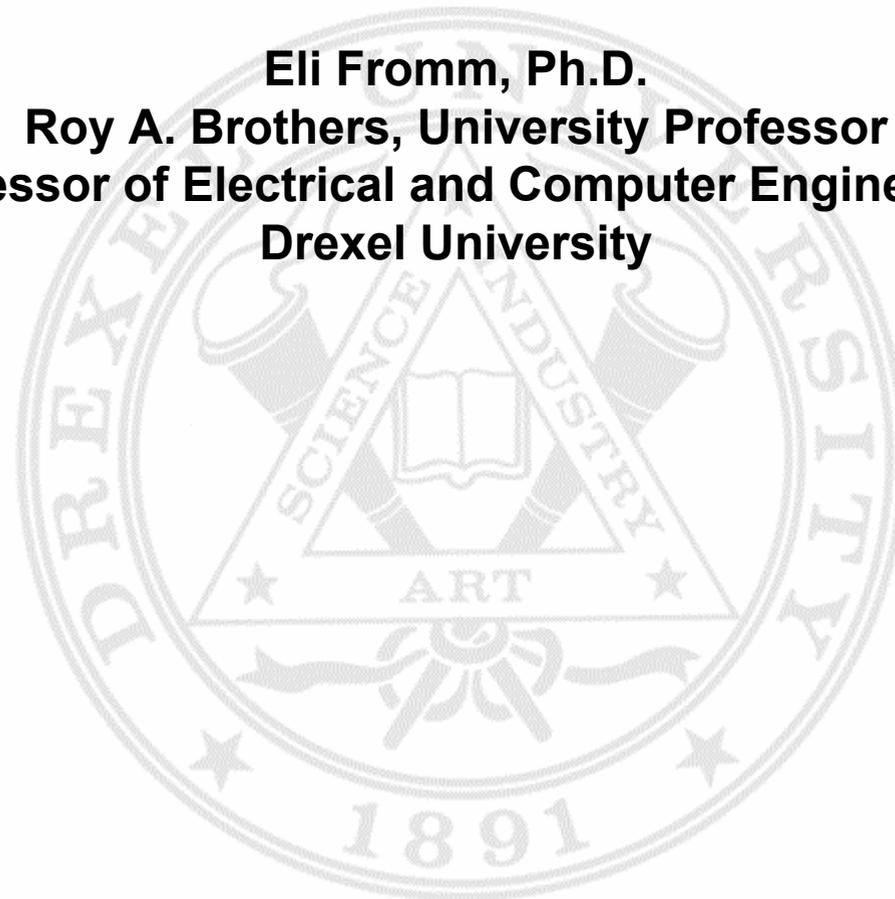


The Changing Engineering Educational Paradigm

Eli Fromm, Ph.D.

**Roy A. Brothers, University Professor
Professor of Electrical and Computer Engineering
Drexel University**



**Bernard M. Gordon Lecture
National Academy of Engineering
October 6, 2002**

Commonly Identified National Need

- **RETAIN STRONG FOUNDATION IN MATHEMATICS, NATURAL SCIENCES, ENGINEERING SCIENCES, AND FUNDAMENTAL CONCEPTS OF ANALYSIS AND DESIGN**
- **INCREASE EMPHASIS ON SYNTHESIS 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**

Response To The Challenge

~ A Process ~

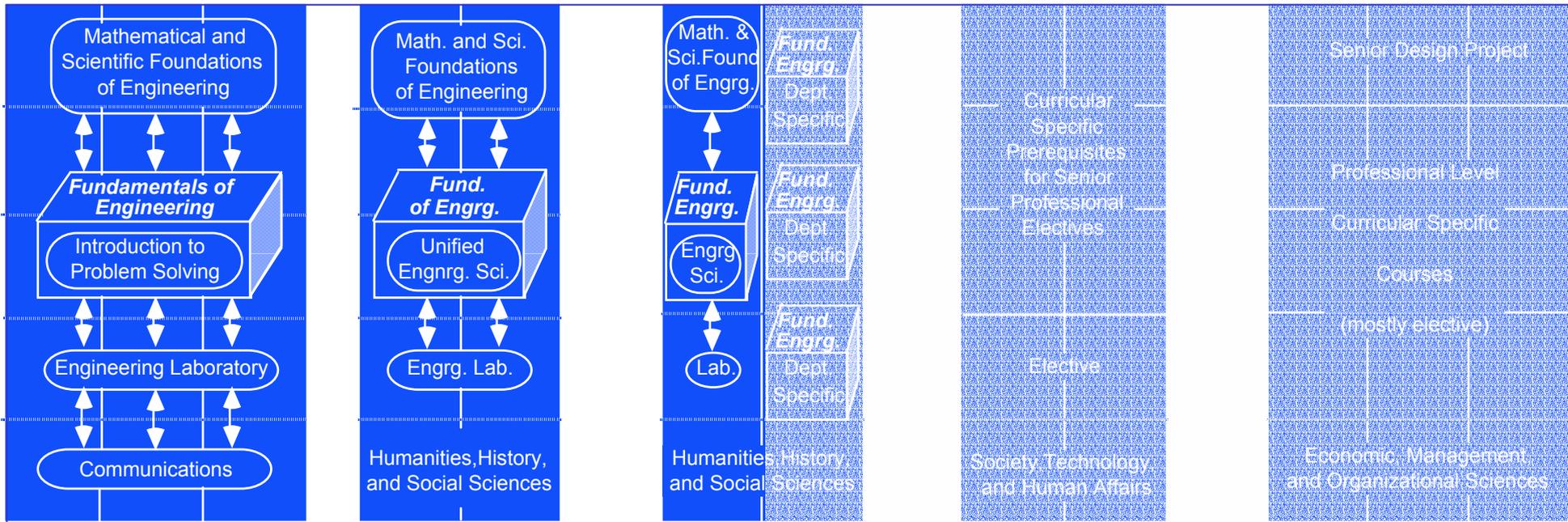
- **IDENTIFY DESIRED CHARACTERISTICS OF GRADUATES FOR THE 21ST CENTURY**
- **IDENTIFY PROGRAM EMPHASIS TO DEVELOP THESE CHARACTERISTICS**
- **ASSESS PRESENT PROGRAM EFFECTIVENESS IN THESE NEW TERMS**
- **IDENTIFY NEW PROGRAM COMPONENTS AND CHARACTERISTICS (CONTENT, STRUCTURE, AND METHODOLOGY) TO CREATE THESE NEW EMPHASES**
- **DEVELOP STRATEGY FOR IMPLEMENTATION WHILE RETAINING EXISTING STRENGTHS**

Vision

- Characteristics for the 21st Century -

- **A strong foundation in basic sciences, mathematics and engineering fundamentals**
- **A capacity to apply these fundamentals to a variety of problems**
- **Knowledge and experience in experimental methods**
- **Knowledge and skills in the fundamentals of engineering practice**
- **Advanced knowledge of selected professional-level technologies**
- **Strong oral and written communication skills**
- **A Sense of corporate and business basics**
- **A sense of social, ethical, political and human responsibility**
- **A historical and societal perspective of the impact of technology**
- **A unifying and interdisciplinary broad view**
- **A culture for life-long learning**
- **A creative and intellectual spirit, a capacity for critical judgment, and enthusiasm for learning.**

A Structural Concept



- **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**

tDEC - Engineering Core Curriculum

Freshman

MATHEMATICAL
Foundations of Engineering

PHYSICAL
Foundations of Engineering

CHEMICAL & BIOLOGICAL
Foundations of Engineering

The Art of Engineering
Engineering Design
Engineering Laboratory

Humanities
Communication Skills

Sophomore

Systems

Energy

Materials

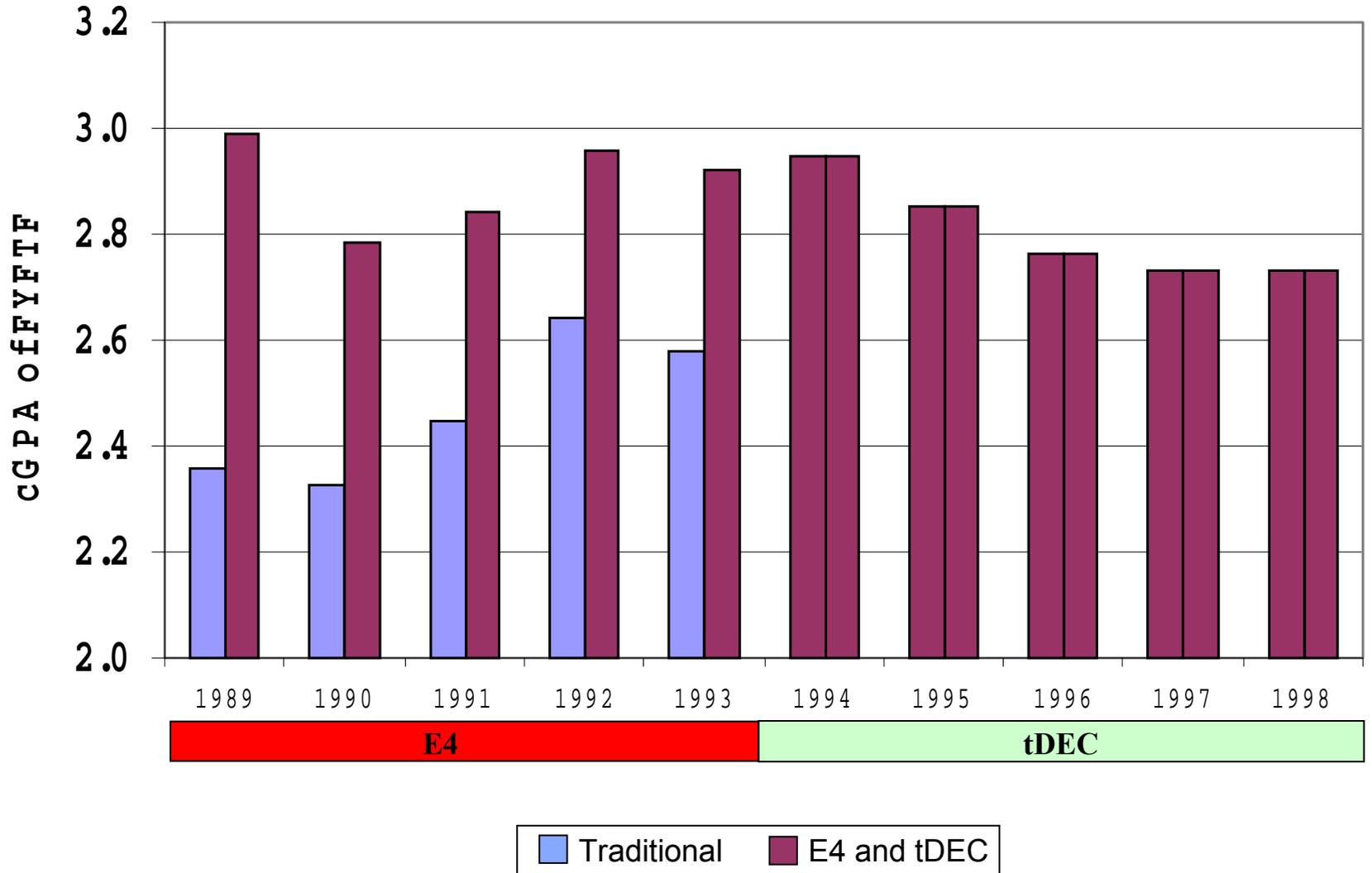
Intro. Professional
Courses

Evaluation/Presentation
of Data

Ethics, Professionalism
History of Technology

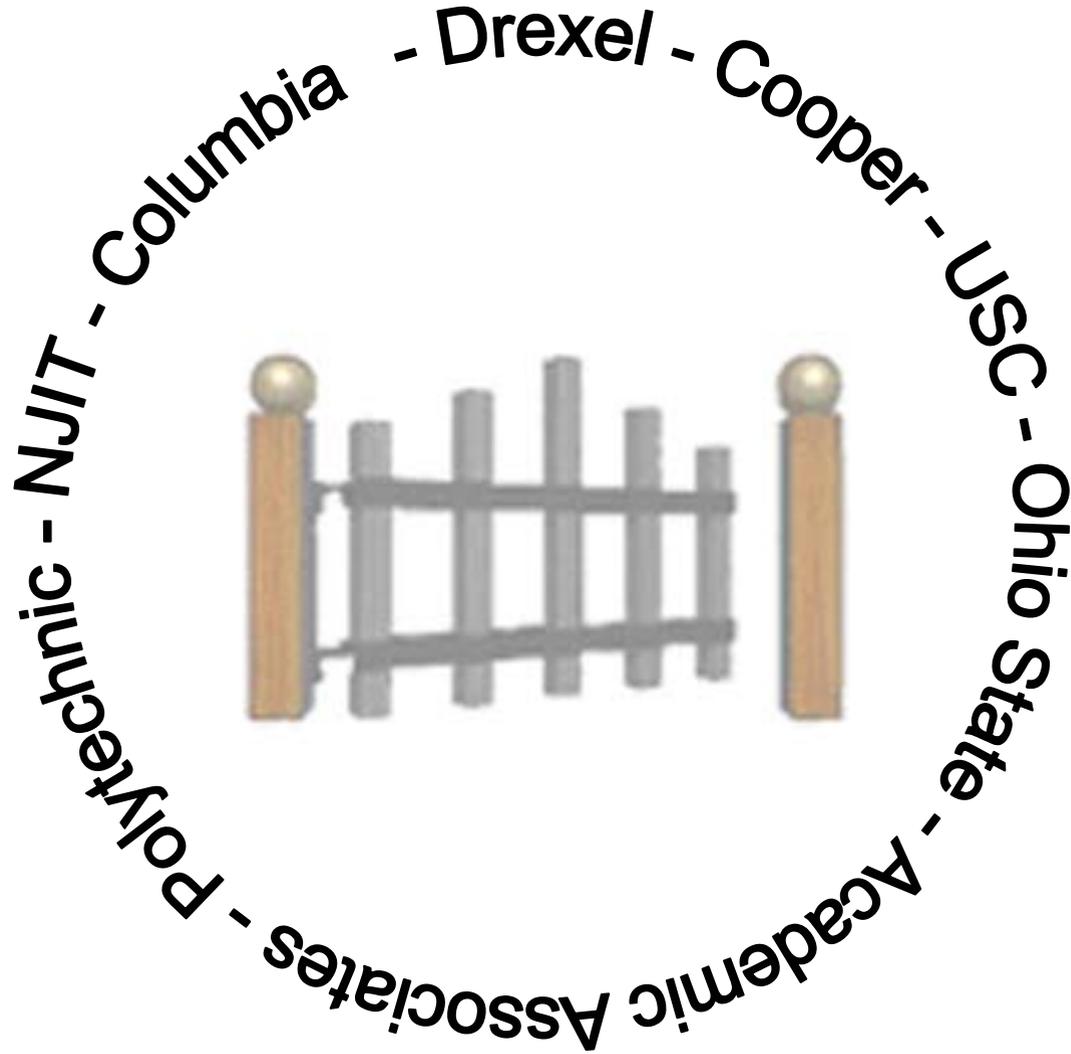
<http://wwwtdec.coe.drexel.edu>

Freshman Full-Year Performance: Initial period - Transition - Institutionalized



Gateway Engineering Education Coalition

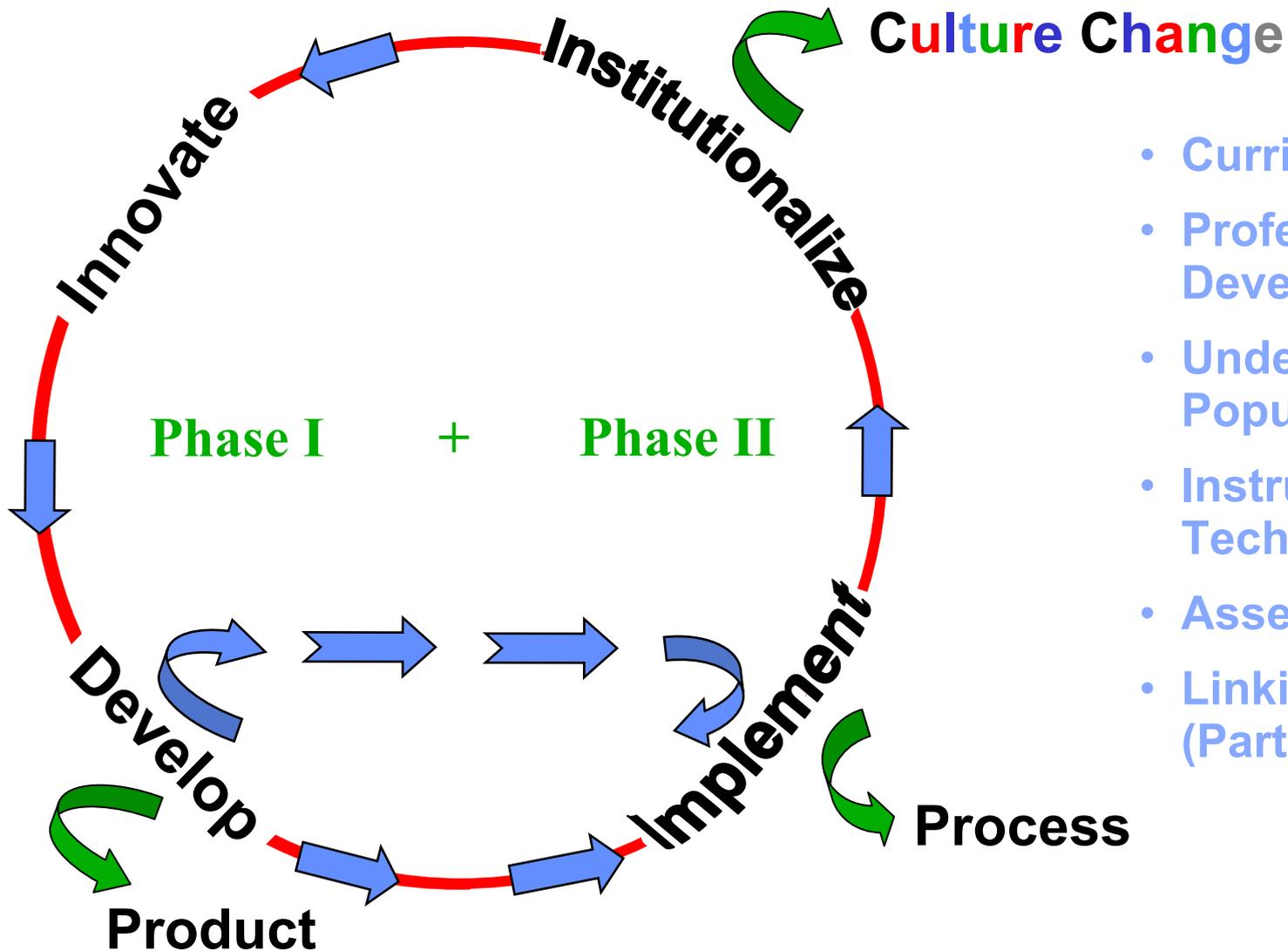
www.gatewaycoalition.org



Gateway Coalition - Broadly Defined Goals

- **Extend** the Drexel freshman/sophomore program to other Coalition members and to the upper division of undergraduate engineering education.
- Create and maintain **a curriculum that moves from a focus on course content to the development of human resources and the broader experience in which individual projects are connected and integrated.**
- Create, build on, and extend, the program of **faculty development** to draw engineering faculty to a dedicated investment in the teaching of undergraduates and **enhance the pedagogical abilities** of faculty to enable the skilled practice of undergraduate engineering education.
- Recruit and retain to the bachelor's degree an **increasing percentage of women and minorities** to undergraduate engineering education.
- **Implement & institutionalize** curriculum and related developments moving from pilot model to incorporation into the mainstream of each institution's programs.
- **Use modern assessment methods** to measure, assess and guide the Coalition.
- **Change the Culture of the Undergraduate Engineering Educational Enterprise.**
- Establish strong relationships and an active program of **dissemination among schools within the Coalition, other Coalitions, and with the wider engineering community.**

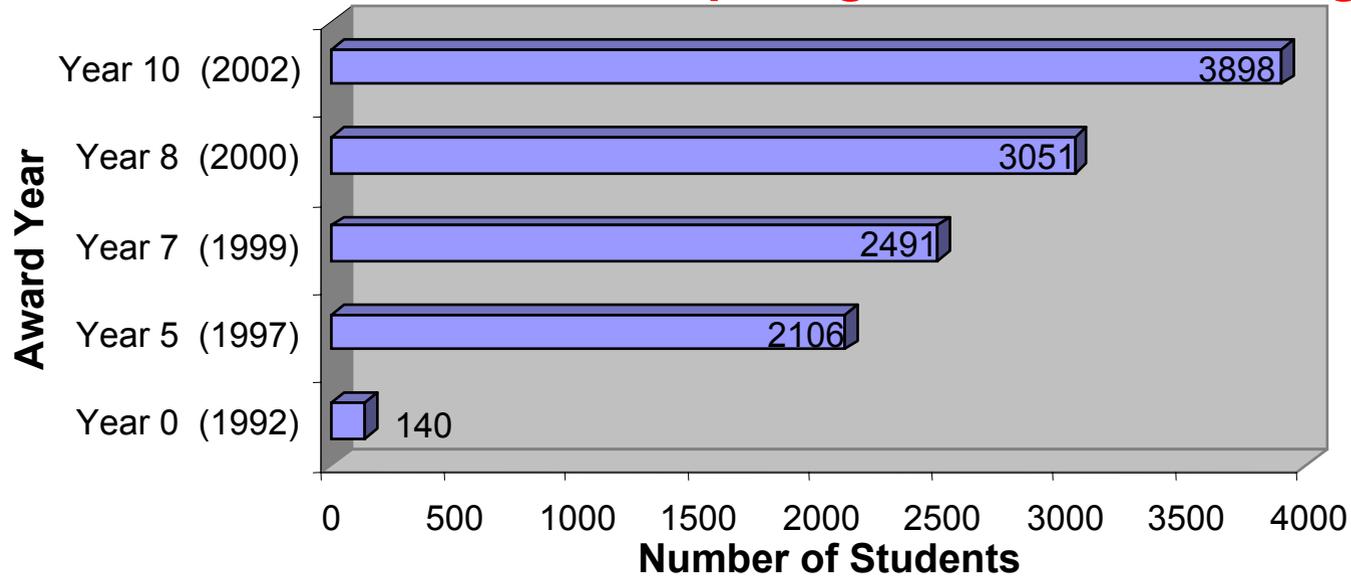
GATEWAY COALITION STRATEGIES



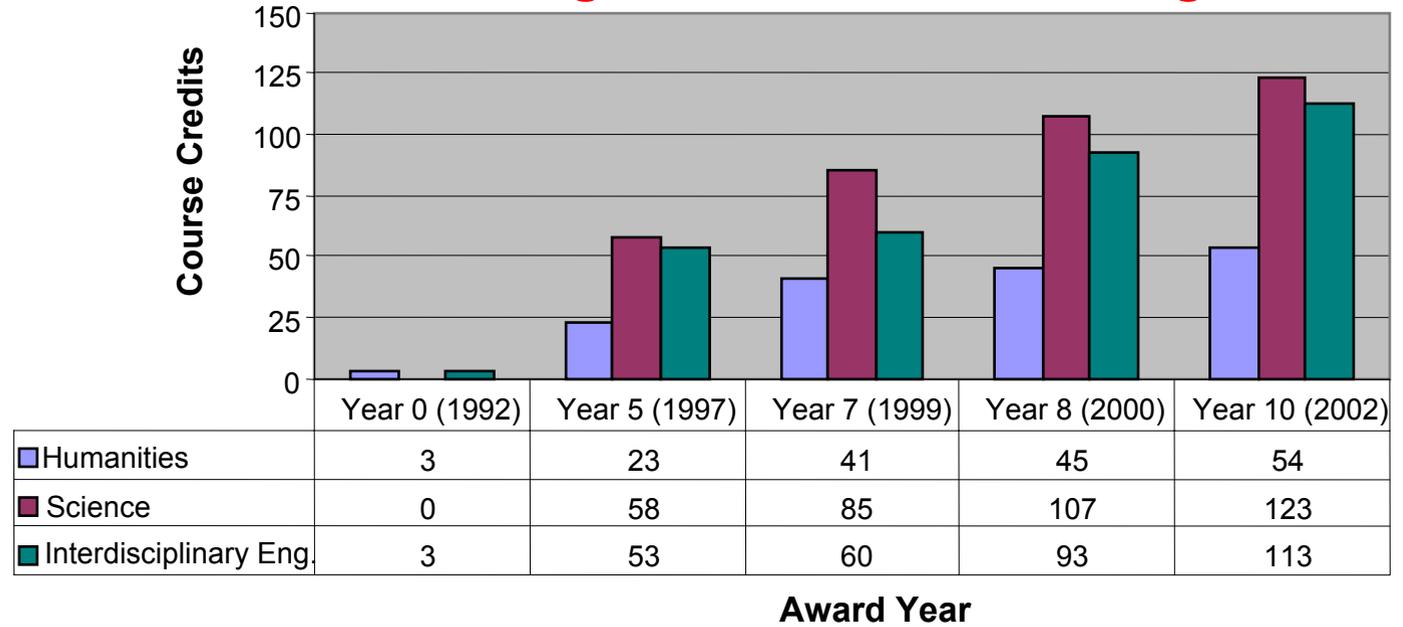
- Curriculum
- Professional Development
- Underrepresented Populations
- Instructional Technologies
- Assessment
- Linking/Sharing (Partnerships)



Students Participating in Freshman Design



Integrated Curricula Offerings





- gateway home
- Search**
- about gateway
- assessment
- professional development
- under-represented populations
- instructional technologies
- linking & sharing
- curriculum development & implementation

Other links

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curriculum development & implementation



CURRICULUM DEVELOPMENT & IMPLEMENTATION

In each of the following areas, there are groups of faculty with interest and demonstrated accomplishment in the subject content and, most importantly, the Gateway philosophy, vision, and cross coalition teaming.

It is not suggested that this set is all inclusive for a full curricular program. These are to be seen as models upon which further extension may subsequently be made as well as fostering inter-institutional teaming and cooperation.

- [freshmen/sophomore experience](#)
- [engineering biotechnology](#)
- [environmental engineering](#)
- [materials engineering](#)
- [concurrent/manufacturing engineering](#)
- [multi-year, multi-university](#)
- [additional upper division topics](#)
- [papers](#)

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Questions or comments? Contact gtwwebm@post.drexel.edu

Cross-Institutional Programs using Technology as a Bridge



Concurrent Engineering



SLA Network

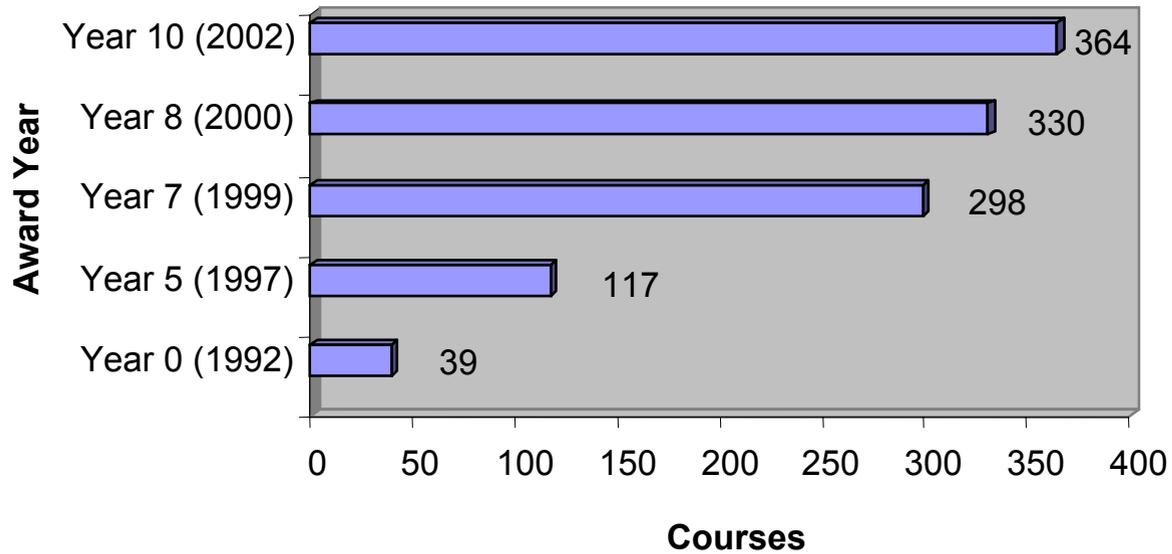


Rapid Prototype Design

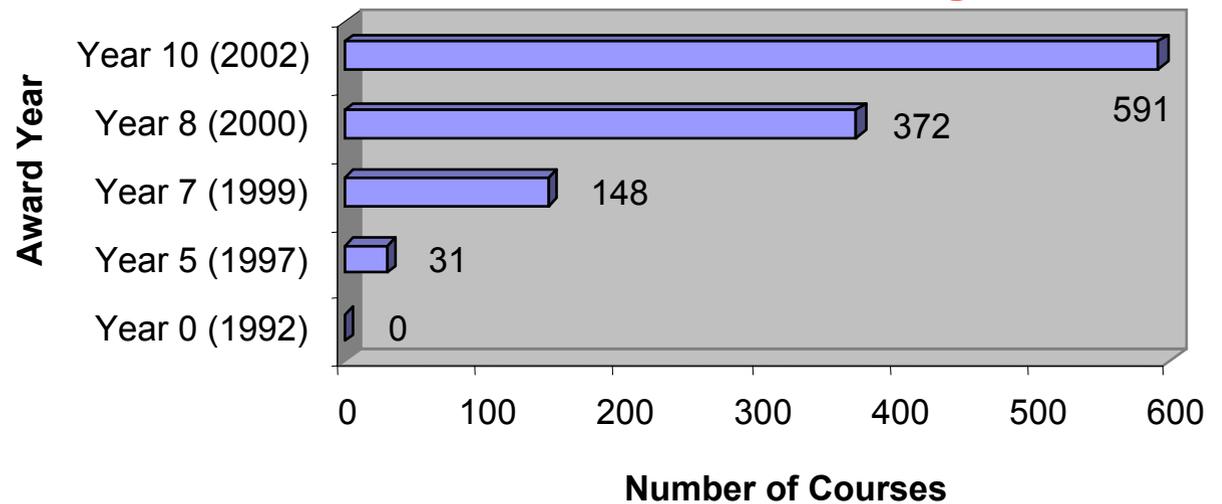
Professional Development Leading to Educational Culture Change

- **Students**
 - **Embedded within Curriculum**
 - **Communications**
 - **Ethics**
 - **Teamwork – Organizational Skills**
- **Faculty**
 - **Workshops & Conferences to Foster**
 - **Linkages across coalition institutions**
 - **Teaming in instructional design**
 - **Collaborative teaching and learning**
 - **Outcome-based assessment**
 - **New media technologies for instruction**
 - **Networked faculty sharing**

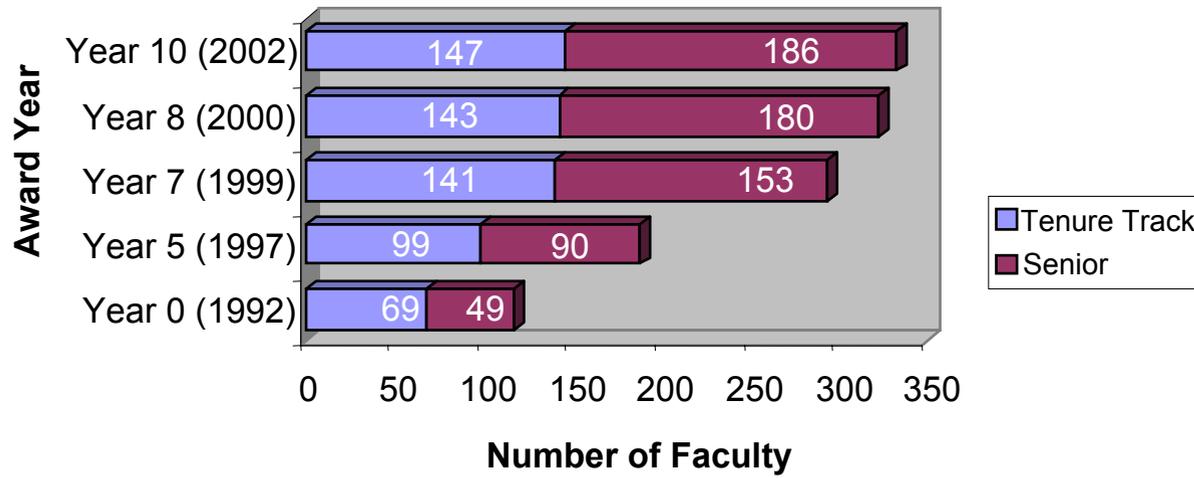
Courses Using Cooperative Learning Methodologies



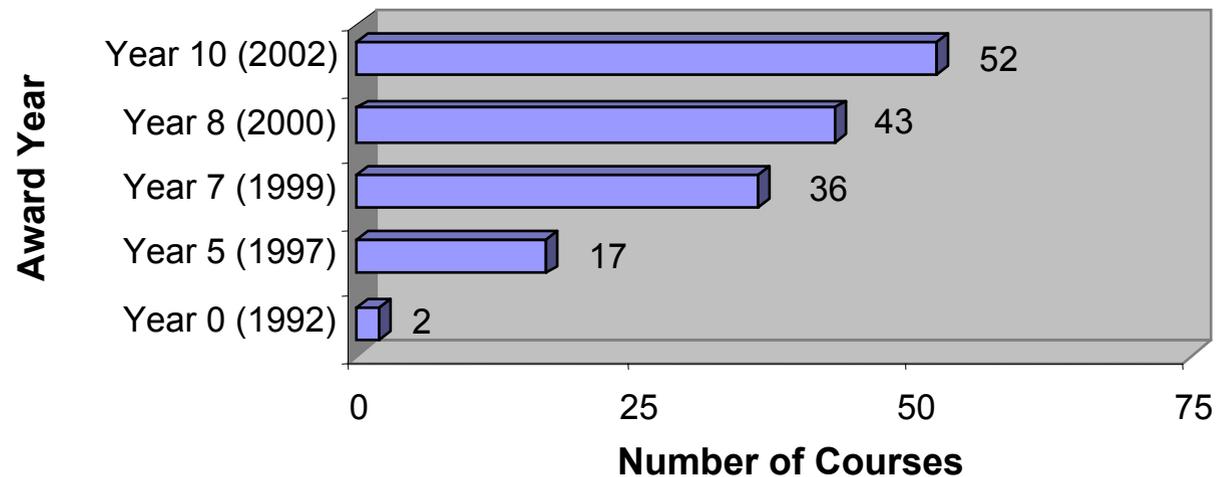
Courses Using New Media Technologies



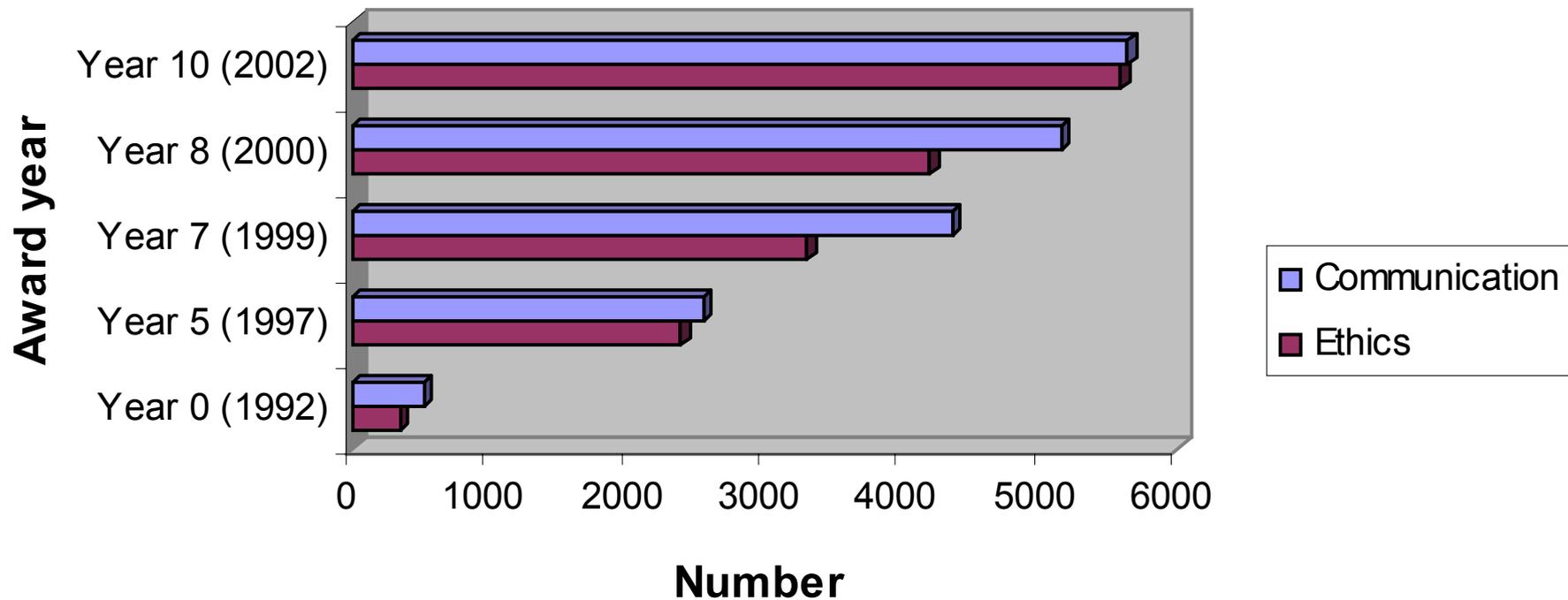
Faculty Teaching Lower Division Engineering Courses



Upper Division Courses Offered by Interdisciplinary Faculty Teams



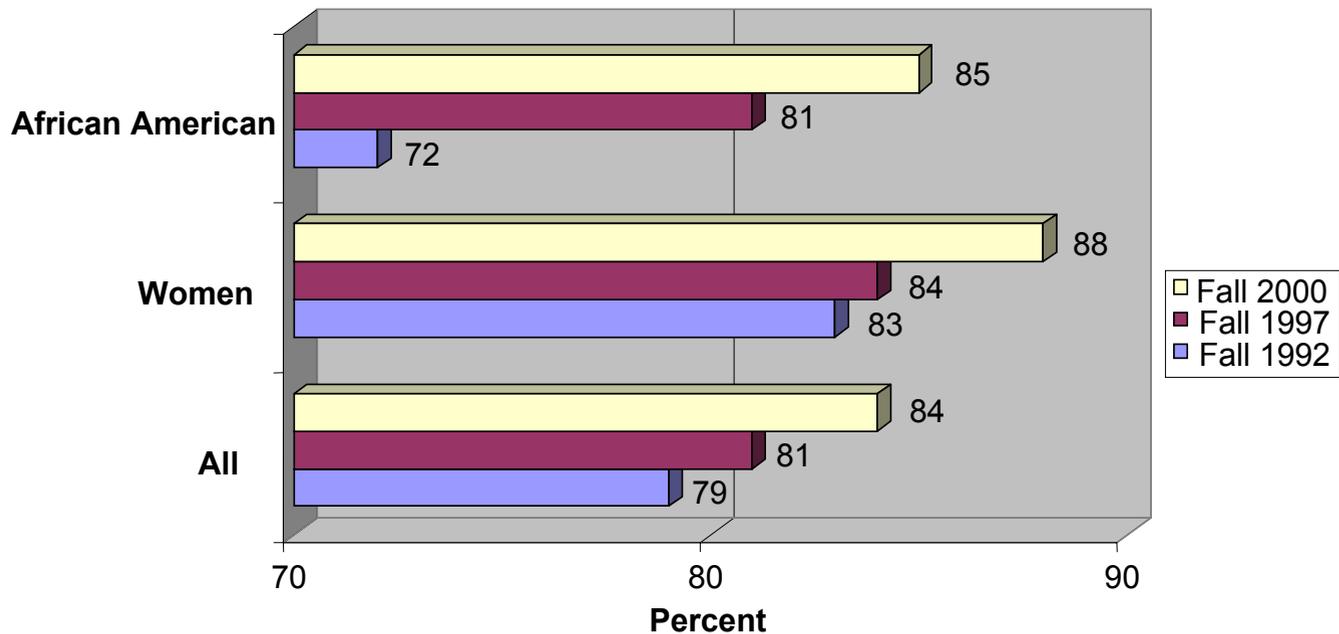
Students Participating in Courses that Formally Integrate Communication Skills and Ethics



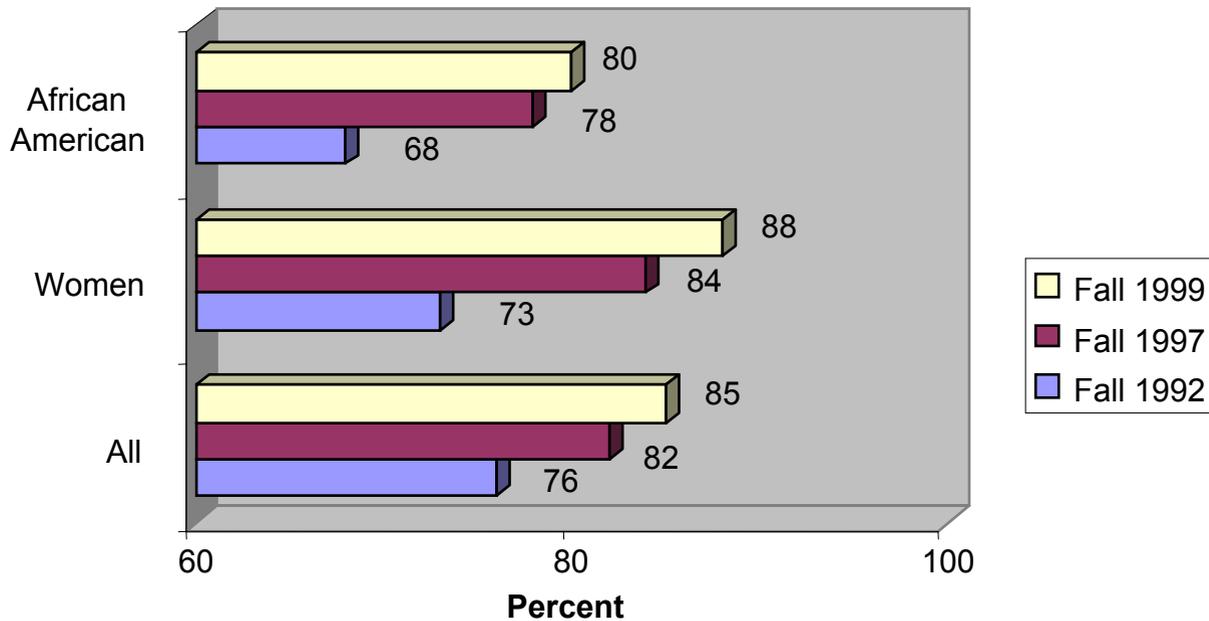
Outreach/Mentoring Programs

- **Building on existing institutional initiatives, implement specific programs to increase enrollment and retention of underrepresented populations.**
- **Linking with 2 yr. higher education institutions**
- **Engineering to the high school**
- **Engineering students in the k-12 classroom**
- **Mentoring and bridge programs**
- **Established several programs designed to support the diverse needs of students.**
 - **Women's Leadership Series,**
 - **Getting Plugged In (networking skills),**
 - **Educational Learning Assistants (Resident coaching and tutoring)**
- **Formal linkages with HBCU institutions**

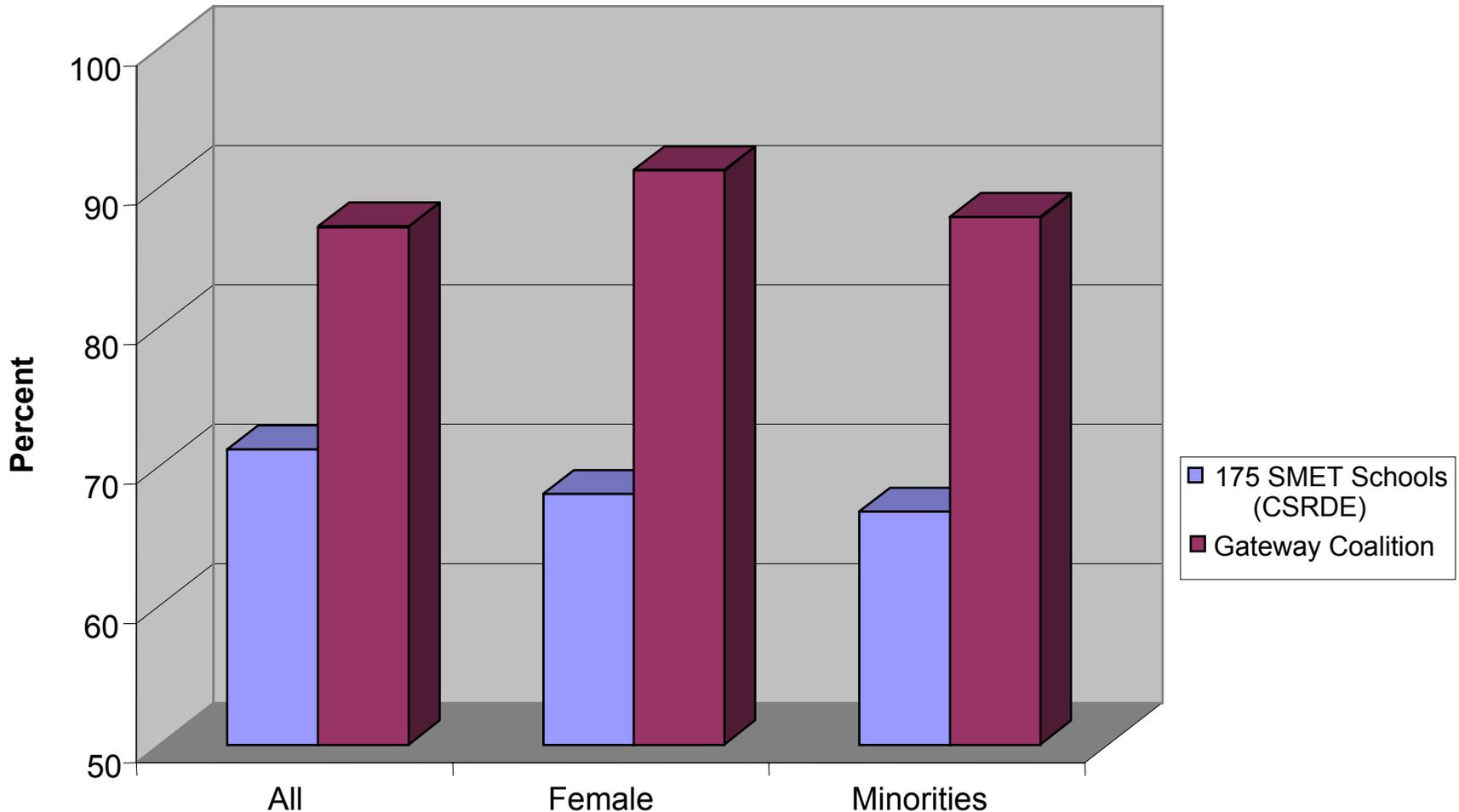
Coalition 1st to 2nd Year Retention Rates



Coalition 2nd to 3rd Year Retention Rates

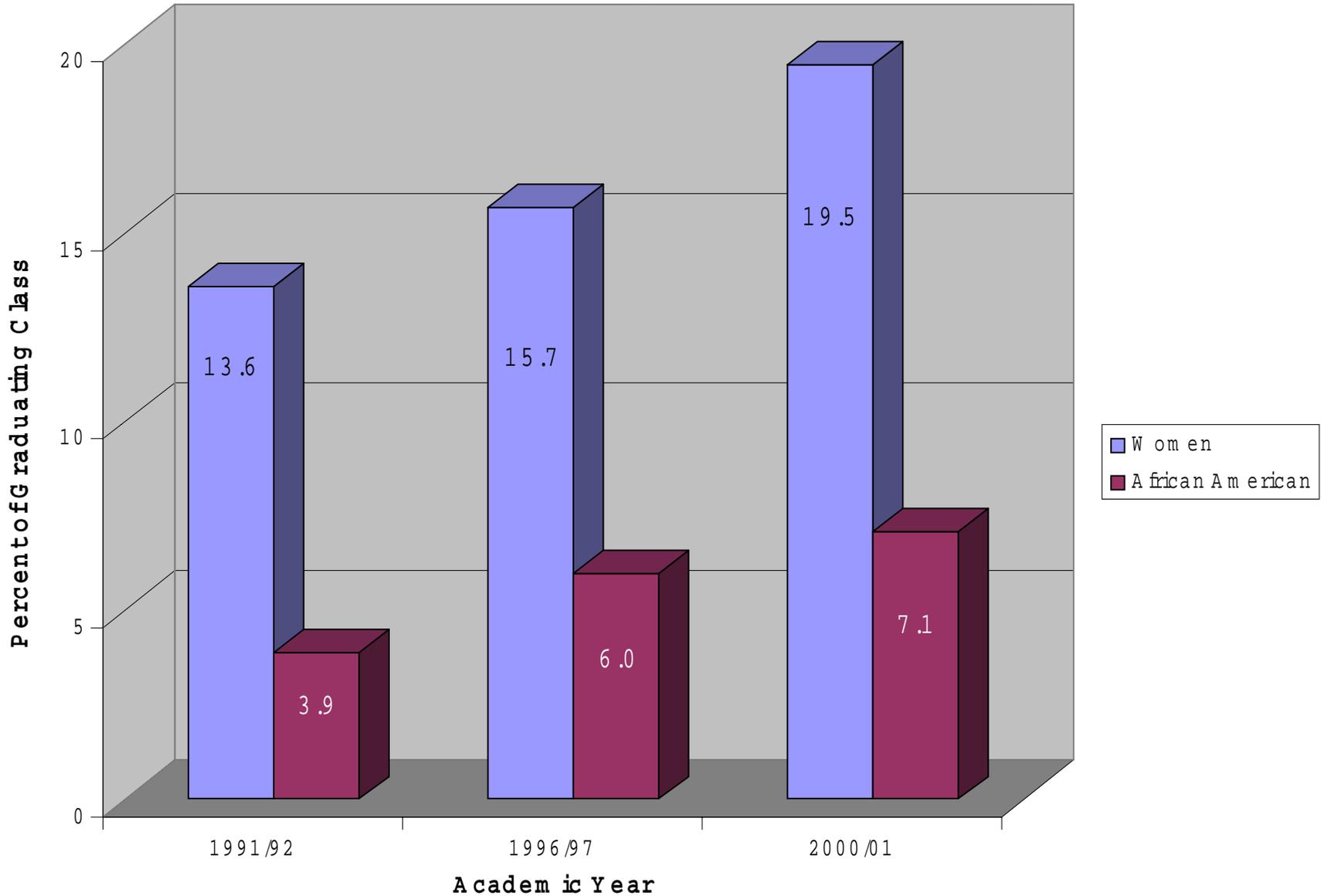


Comparison of Gateway Coalition's 1st to 2nd year Retention Rates against a National Sample



National sample of 1999 science, engineering, and technology majors as collected by the Consortium for Student Retention Data Exchange (CSRDE): www.occe.ou.edu/csrde

Underrepresented Student Graduation Rates (Percent Degrees Awarded)



Integrating Technology into the Educational Process

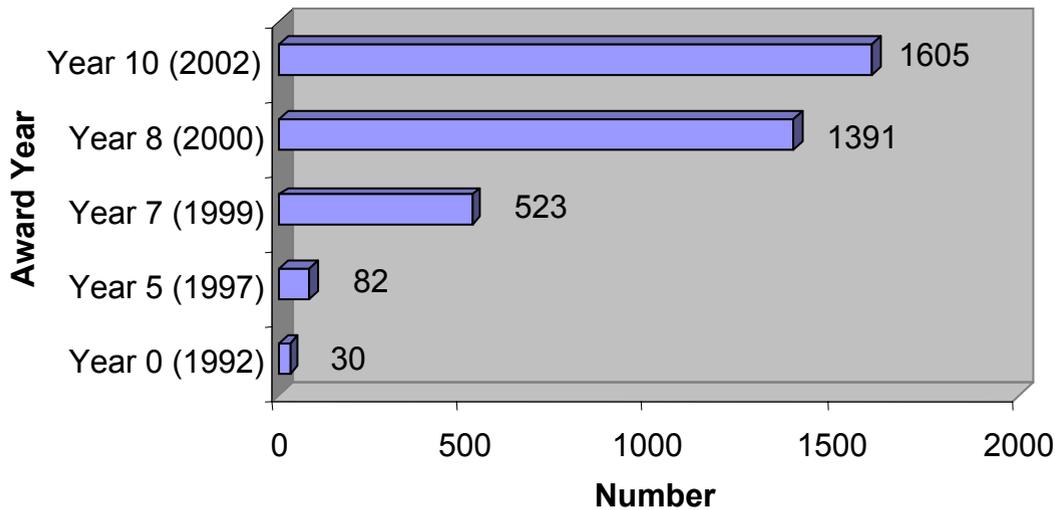
- **Web-based course delivery**
- **Bringing Multimedia into the classrooms**
- **Remote experimentation**
- **On-line assessment & evaluation applications**
- **Institutional support mechanisms such as student technology assistant programs**
- **Advanced multimedia learning centers and linked experimental facilities designed to increase faculty and student collaboration and innovation.**
- **Desktop collaboration capabilities for faculty and students to explore ways to increase collaboration both internally and external to their institution; cross institution, cross coalition, and beyond the coalitions to the broader engineering practicing and educational community.**

Structured Assessment Process

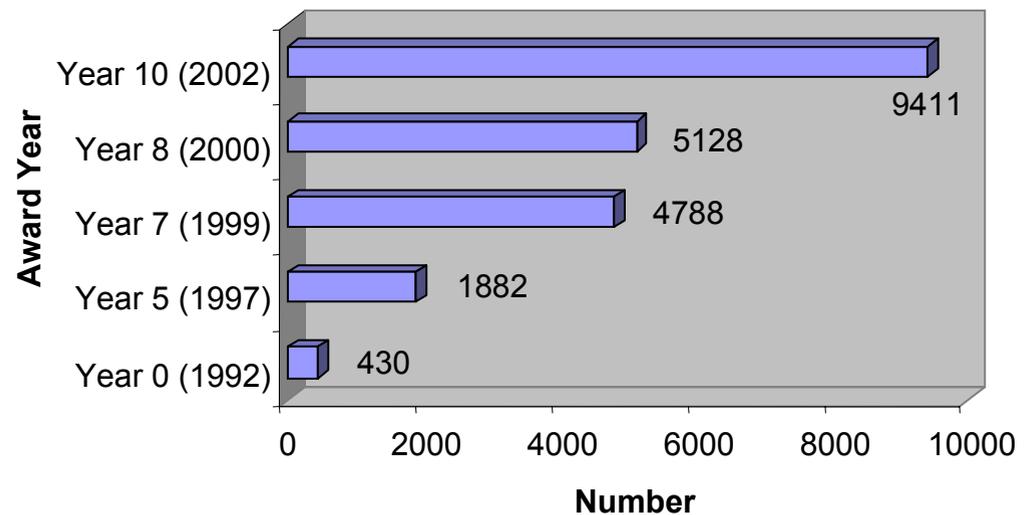
The process of identifying, defining, measuring, and analyzing institutional and educational outcomes is one of the drivers of culture change.



Courses with Documented Learning Objectives

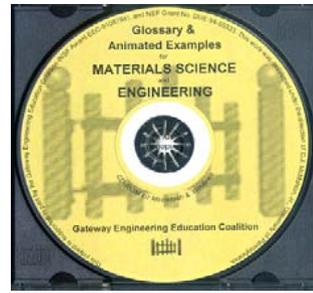
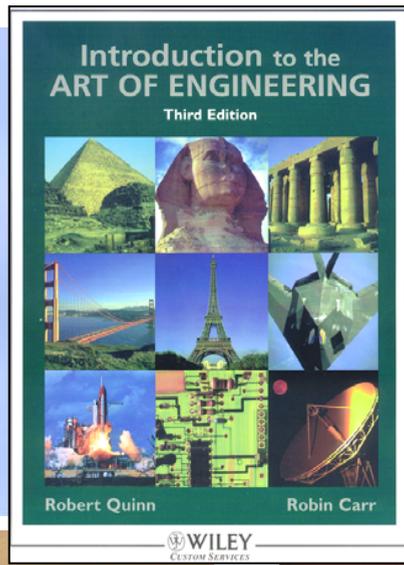
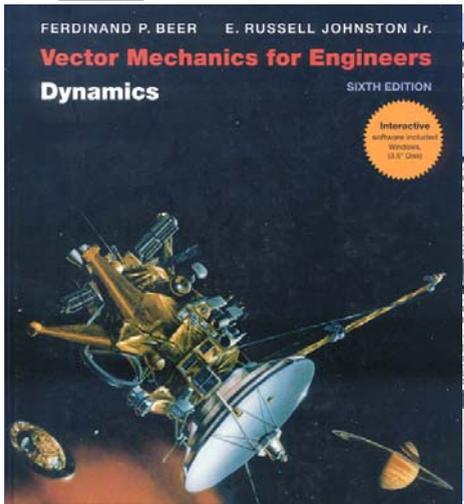


Students Participating in Outcome Assessment Processes



Diffusion Channels Educational Innovation

- **Interpersonal Channels**
 - Professional Conferences
 - Interactive Workshops
 - Institutional Partnerships
- **Mass Media Channels**
 - Publications (Journals & Books)
 - Electronic Media (CDs, Digital Books, etc.)
 - Digital Repositories



Tools and Tactics of Design

by
Peter Dominic
John Demel
Richard Freuler
Gary Kinzel
Eli Fromm

Work was supported, in part, by the National Science Foundation/Gateway Engineering Education Coalition (Award EEC-9727413)

WILEY

Engineering Explorations
with LabVIEW®

Murat Tanyel

Gateway Engineering Education Coalition
 ENGINEERING DESIGN FOR PRESIDENTS

J. Richard Wagon, P.E.
 Valorie M. Ames
 Mary M. Madsen
 James Mitchell, USA

Manual for Humanities (Fall 106, 107, 108)

1997-1998

Prepared by the Humanities Team
 Valorie Ames, Team Leader
 James Mitchell, Team Member

Fundamentals of Manufacturing

Gateway Engineering Education Coalition

The TEAM DEVELOPER: An Assessment and Skill Building Program
STUDENT GUIDESBOOK

JACK MCGOURTY
KENNETH P. DE MEUSE

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CUSTOM SERVICES

Engineering Explorations
with Maple®

Robin Carr and Murat Tanyel

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Engineering Biotechnology
A Gateway Coalition Project

Gateway Engineering Education Coalition

Development of this educational module was supported by the National Science Foundation-Gateway Coalition.

This module was developed at Drexel University Philadelphia, Pennsylvania

by
Dr. Gary A. Balluff and
Dr. Frederickson Bergerson

More About Credits Basics Performance Objectives Objectives Learning Objectives Prerequisites New Methods Summary

Link & Share through Texts, Multimedia Resources, and Workshops

Gateway Web Repository - The Legacy

The screenshot shows a Microsoft Internet Explorer browser window with the address bar set to <http://www.gatewaycoalition.org/>. The website content includes a navigation menu on the left, a main header, a central graphic with icons for various topics, a highlights box on the right, and a footer with support information.

gateway home

- Search
- about gateway
- assessment
- professional development
- under-represented populations
- instructional technologies
- linking & sharing
- curriculum development & implementation

The Gateway Engineering Education Coalition

The official home page of The Gateway Engineering Education Coalition.
We welcome your feedback. Please email gtwwebm@post.drexel.edu

Engineering Education Reform - Gateway -

- assessment
- instructional technologies
- professional development
- linking & sharing
- underrepresented populations
- curriculum development & implementation

HIGHLIGHTS

- [Gateway Director receives inaugural NAE Gordon Prize](#)
- [Gateway Coalition Outcomes](#)
- [Gateway Engineering Education Coalition receives THE COMPUTER WORLD SMITHSONIAN AWARD](#)
- [Gateway Engineering Education Coalition Brochure](#)
- [Gateway Publications](#)
- [Archives](#)

Other links

- [personnel directory](#)
- [gateway newsletter](#)

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Supported by the [Education and Centers Division](#) of the Engineering Directorate of the [National Science Foundation](#) (award numbers EEC-9109794 & EEC-9727413).

Internet

What Does the Future Portend ?



Looking Ahead

Engineering Programs:

Technology Driven

- **Global and Cross-Institutional Linkages**
- **Remote Control**
- **Sensory Feedback**
- **Strong Technical Content**
- **Self directed Integration non-technical issues through digital resources**

More Flexibility

- **Encourage and devise structure to permit intellectual breadth**
- **Codified Cross institutional combinations (many enabling structures)**
 - **Business (e-business), Management, Entrepreneurship, Education, Psychology, etc.**
 - **Mathematics, Physical Sciences**

Colleges of Engineering:

- **Cross Institution Technological Literacy Programs**
- **Service Courses**
- **Technologically oriented Liberal Arts and Support**