The Changing Engineering Educational Paradigm

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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 ~

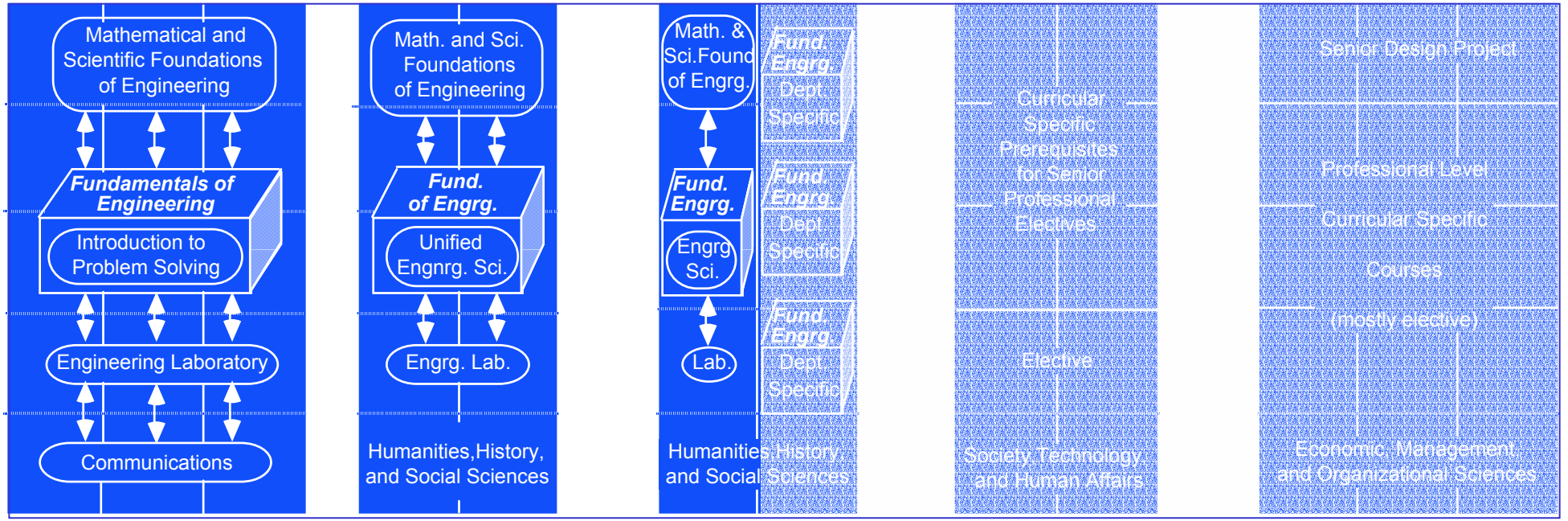
- IDENTIFY DESIRED CHARACTERISTICS OF GRADUATES FOR THE 21ST CENTURY
- IDENTIFY PROGRAM EMPHASIS TO DEVELOP THESE CHARACTERISTICS
- ASSESS PRESENT PROGRAM EFFECTIVENESS IN THESE NEW TERMS
- IDENTIFY NEW PROGRAM COMPONENTS AND CHARACTERISTICS (CONTENT, STRUCTURE, AND METHODOLOGY) TO CREATE THESE NEW EMPHASES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

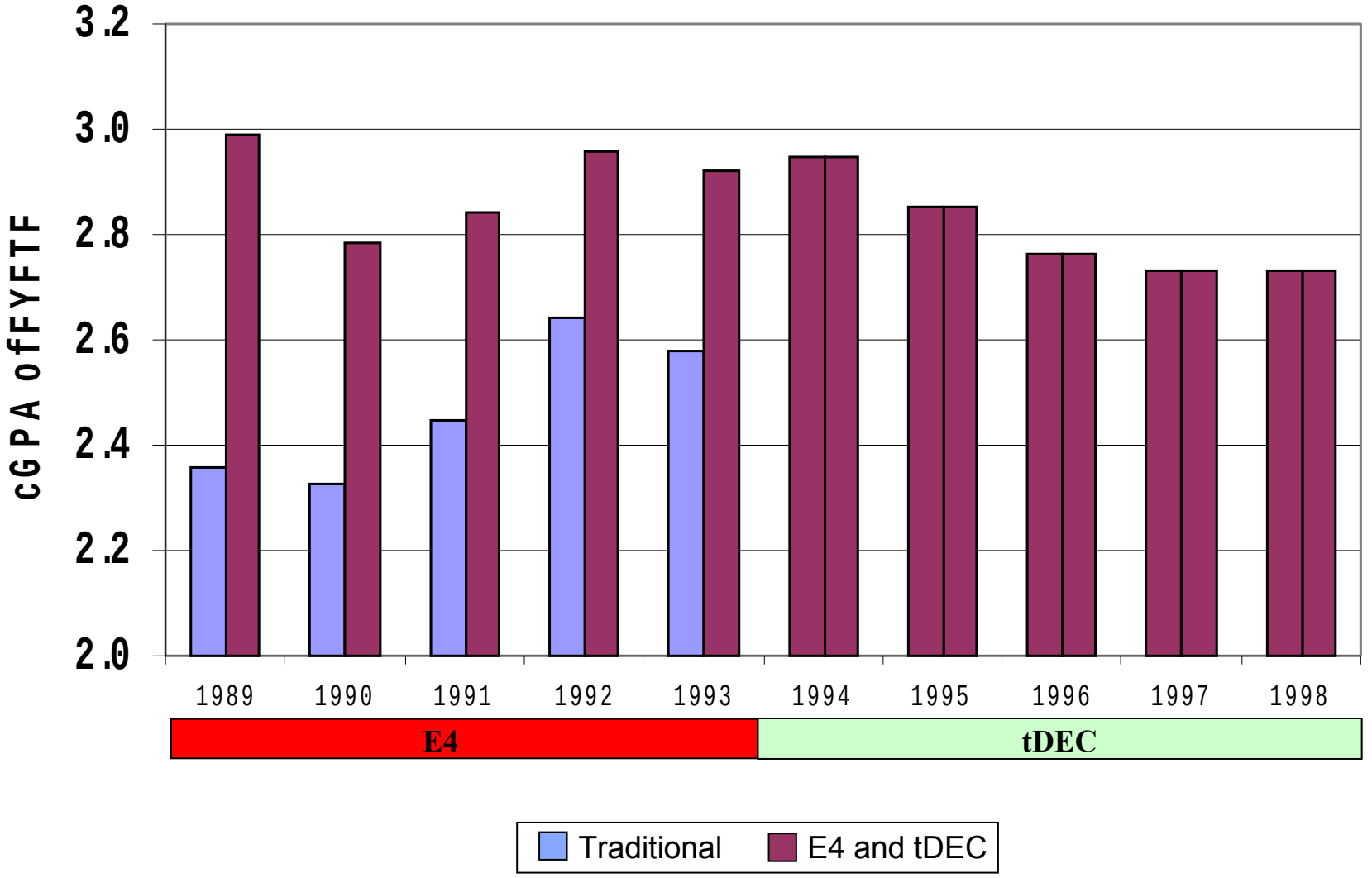
Sophomore

- Systems
- Energy
- Materials
- Intro. Professional Courses
- Evaluation/Presentation of Data
- Ethics, Professionalism History of Technology

http://wwwtdec.coe.drexel.edu

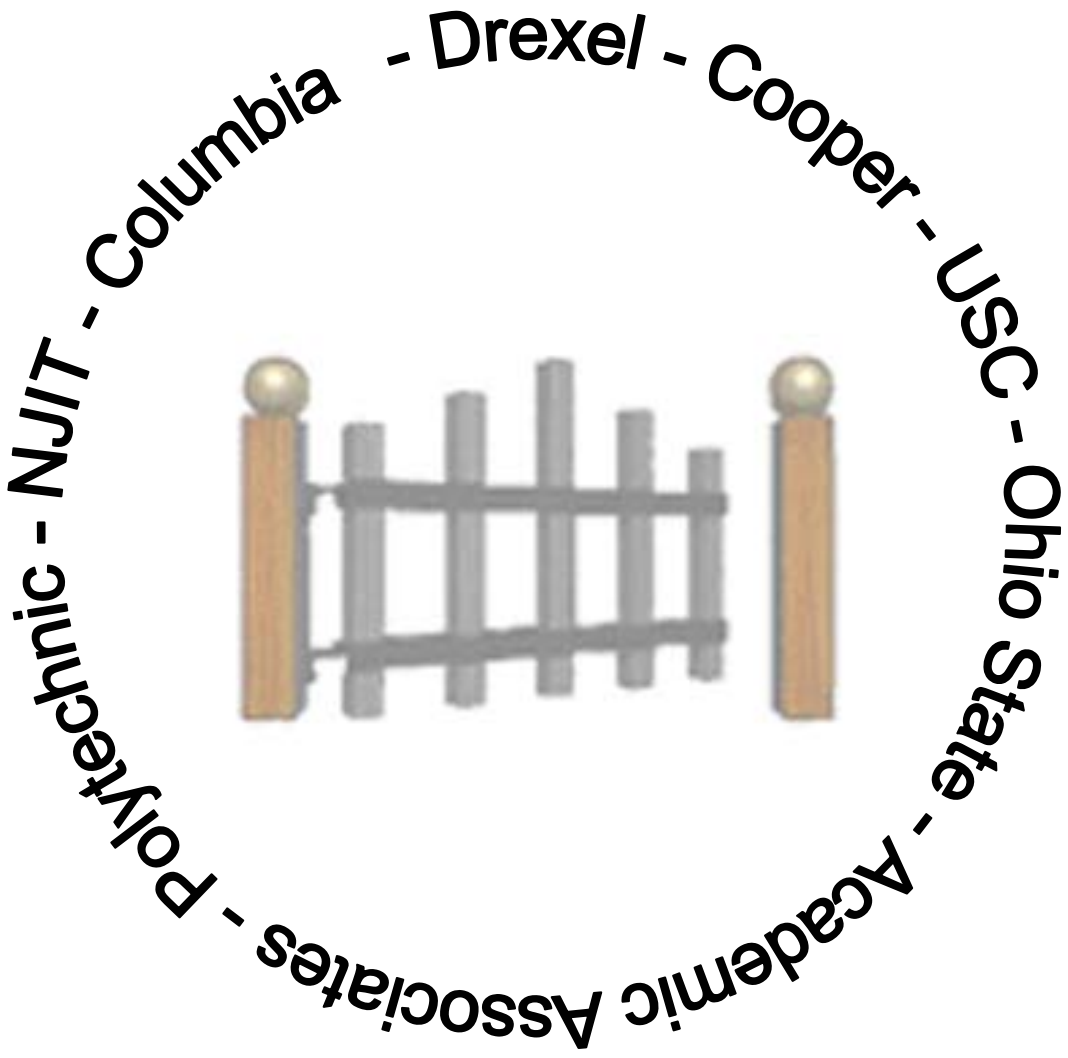
Freshman Full-Year Performance:

Initial period - Transition - Institutionalized



Gateway Engineering Education Coalition

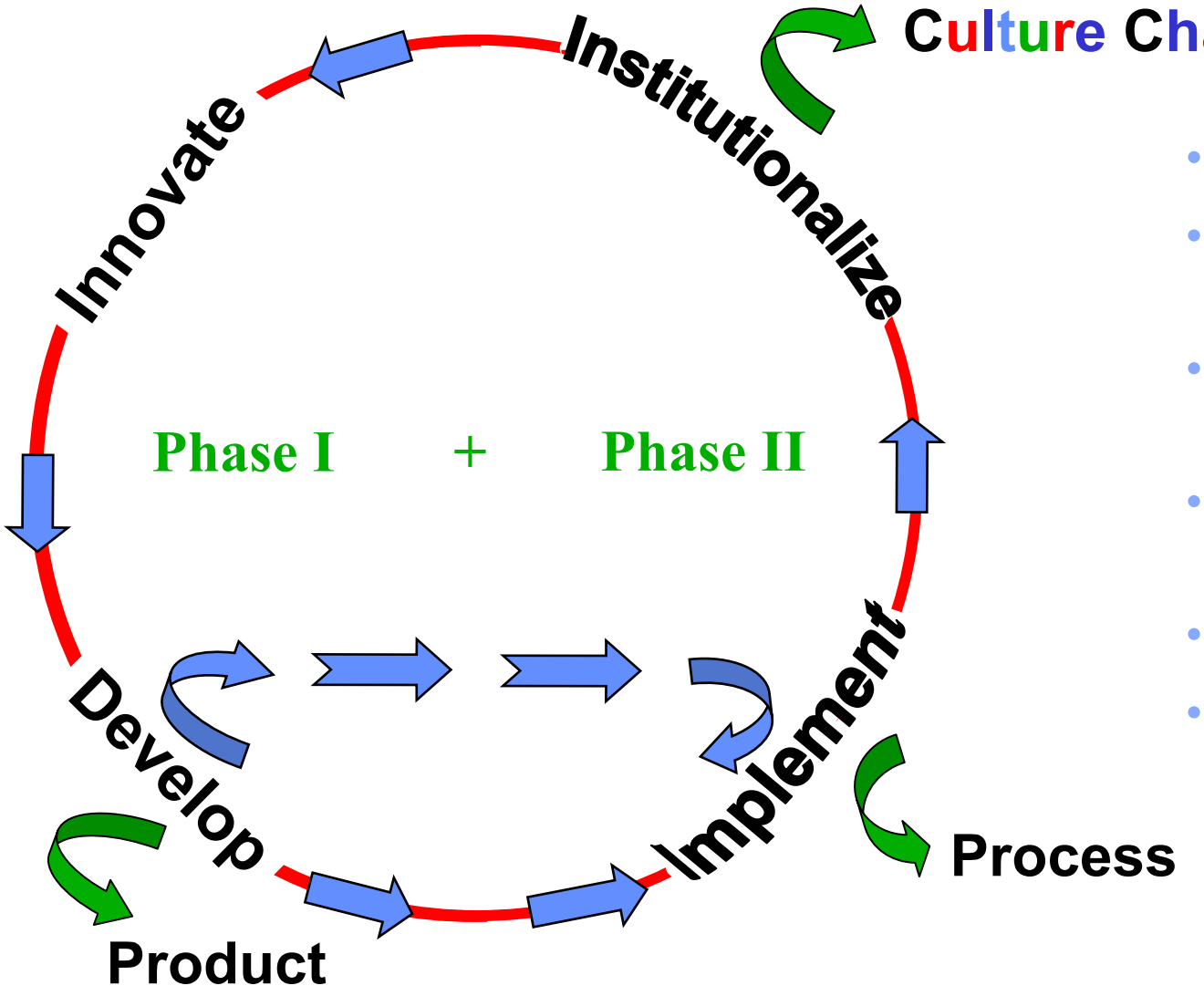
www.gatewaycoalition.org



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.**

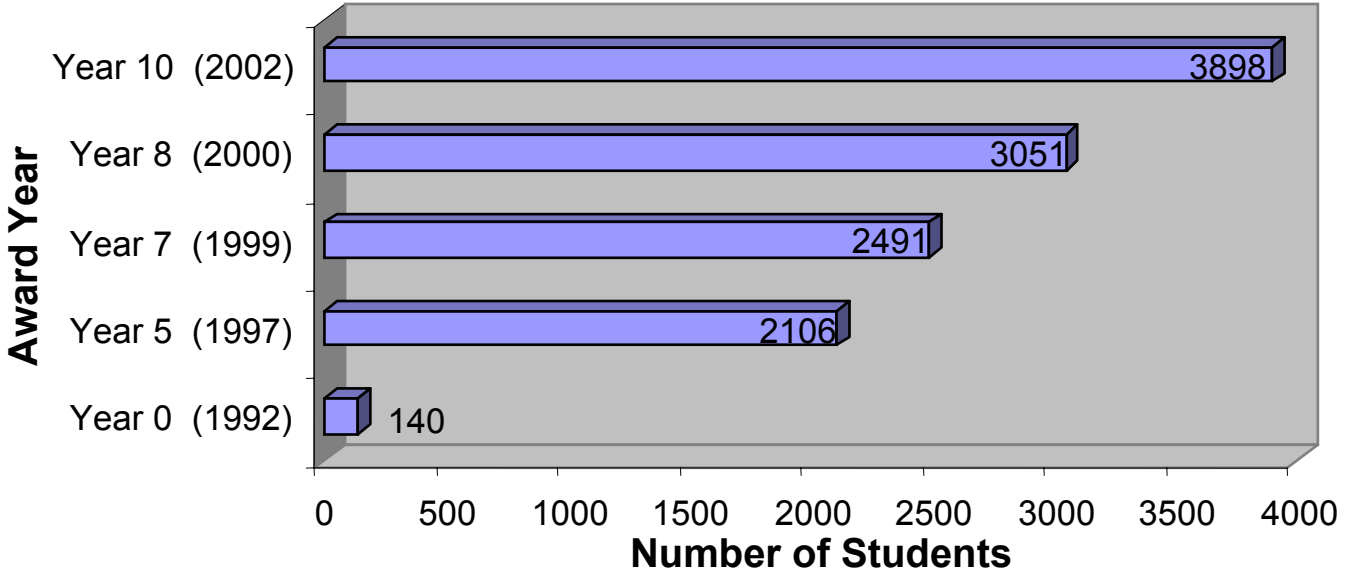
GATEWAY COALITION STRATEGIES



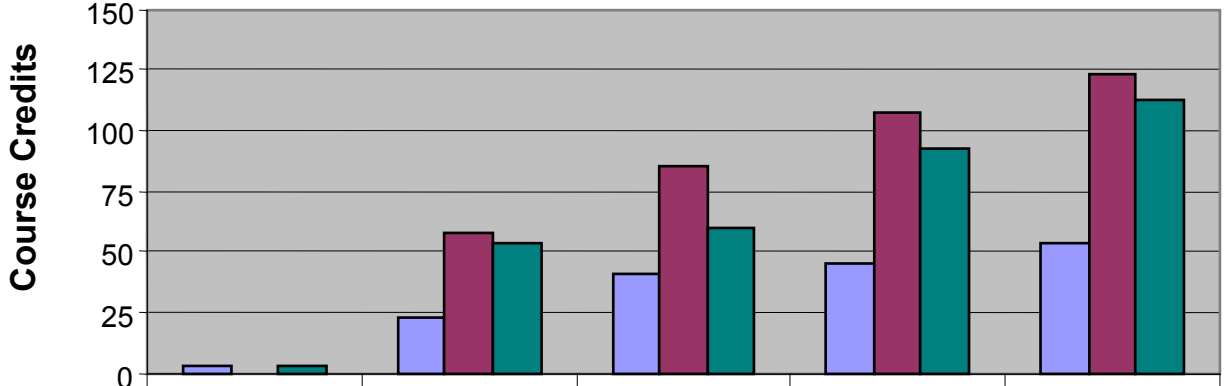
- Curriculum
- Professional Development
- Underrepresented Populations
- Instructional Technologies
- Assessment
- Linking/Sharing (Partnerships)

Curriculum

Students Participating in Freshman Design



Integrated Curricula Offerings

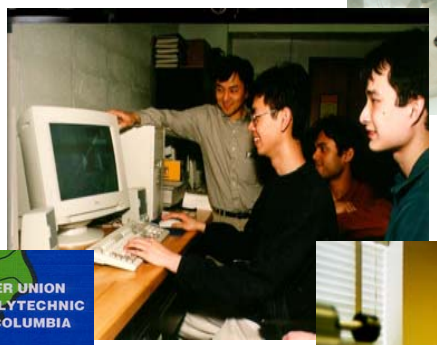


	Year 0 (1992)	Year 5 (1997)	Year 7 (1999)	Year 8 (2000)	Year 10 (2002)
Humanities	3	23	41	45	54
Science	0	58	85	107	123
Interdisciplinary Eng.	3	53	60	93	113

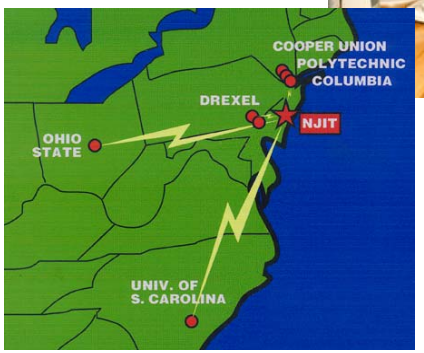
Award Year

Curriculum

Cross-Institutional Programs using Technology as a Bridge



Concurrent Engineering



SLA Network

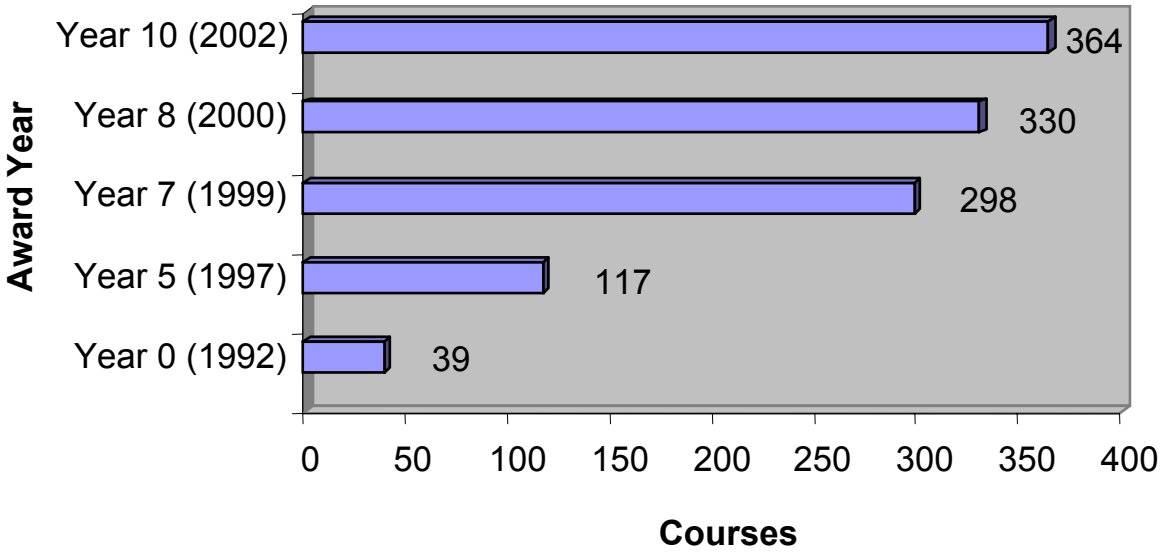
Rapid Prototype Design

Professional Development Leading to Educational Culture Change

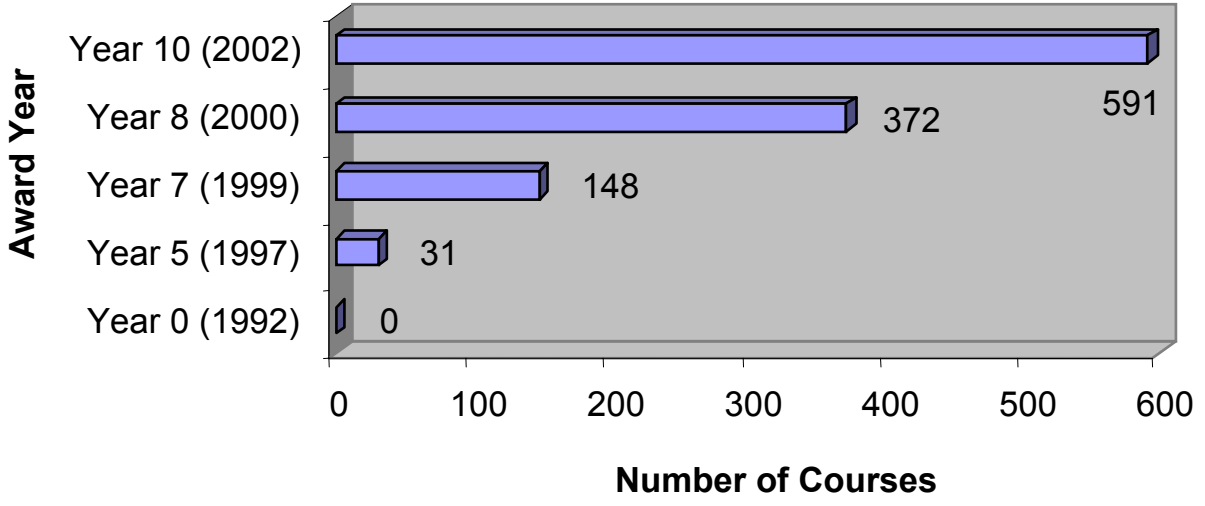
- Students
  - **Embedded within Curriculum**
    - **Communications**
    - **Ethics**
    - **Teamwork – Organizational Skills**
- Faculty
  - **Workshops & Conferences to Foster**
    - **Linkages across coalition institutions**
    - **Teaming in instructional design**
    - **Collaborative teaching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

Educational Culture

Courses Using Cooperative Learning Methodologies

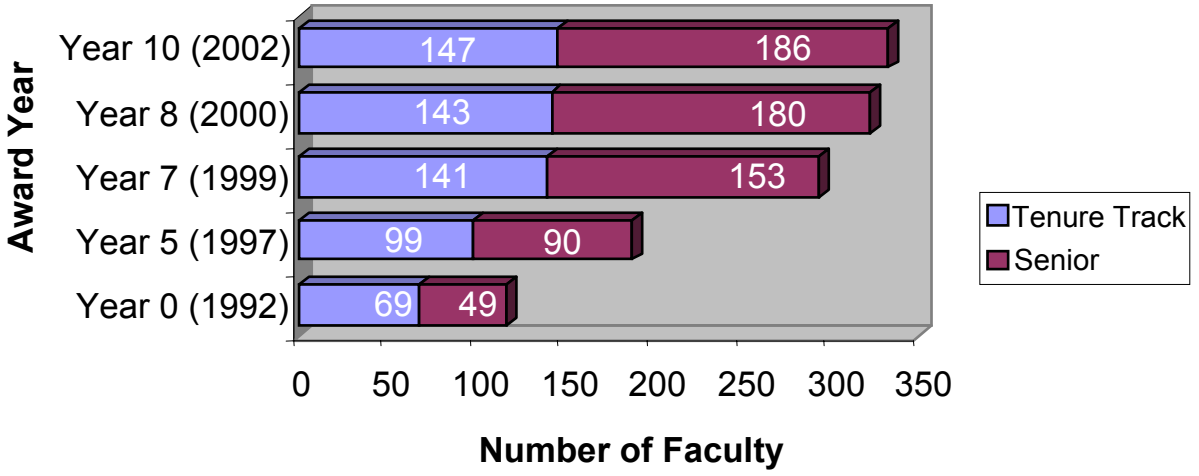


Courses Using New Media Technologies

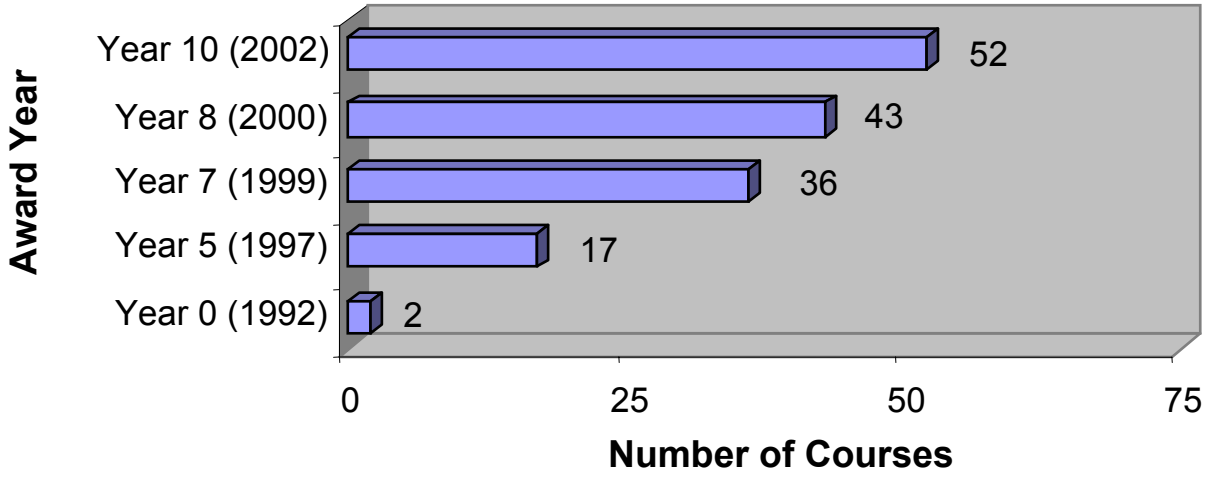


Educational Culture

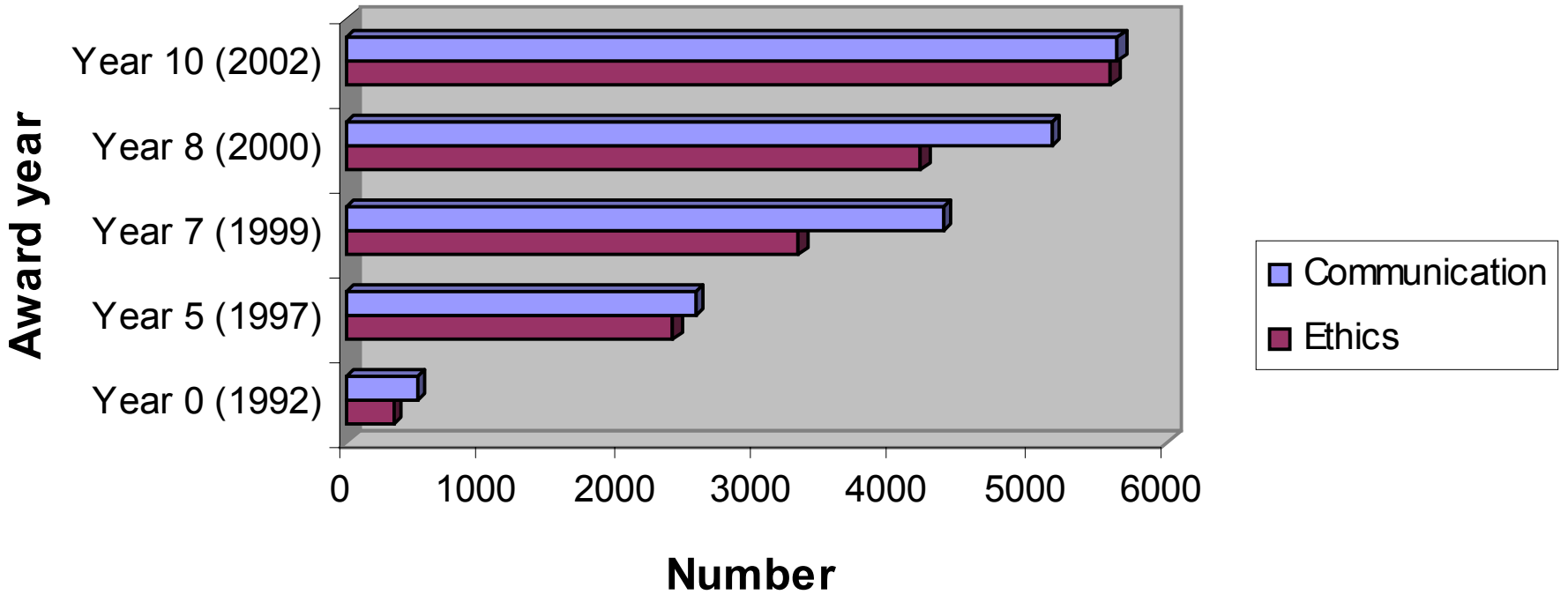
Faculty Teaching Lower Division Engineering Courses



Upper Division Courses Offered by Interdisciplinary Faculty Teams



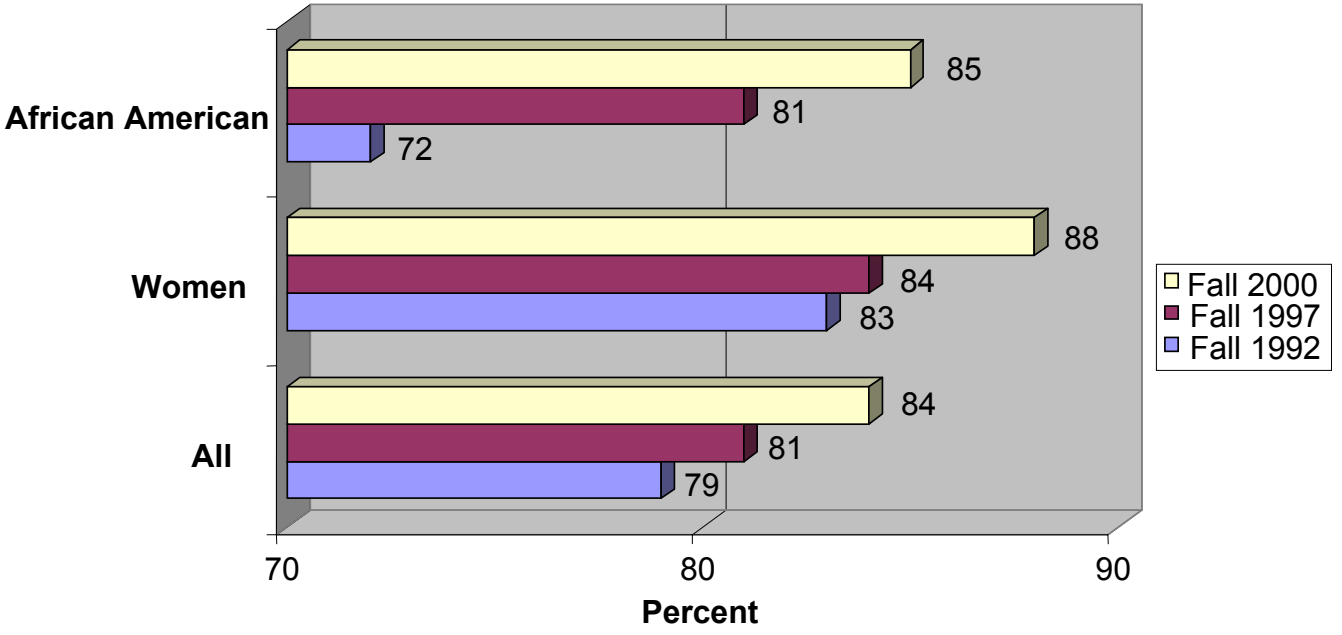
Students Participating in Courses that Formally Integrate Communication Skills and Ethics



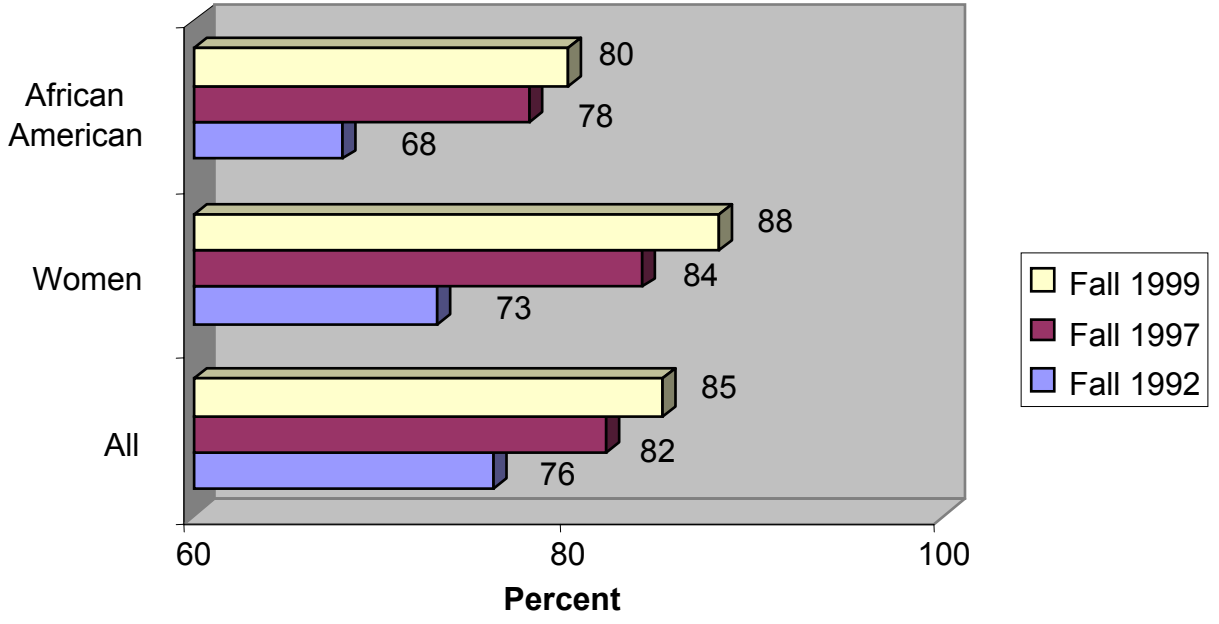
Outreach/Mentoring Programs

- 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

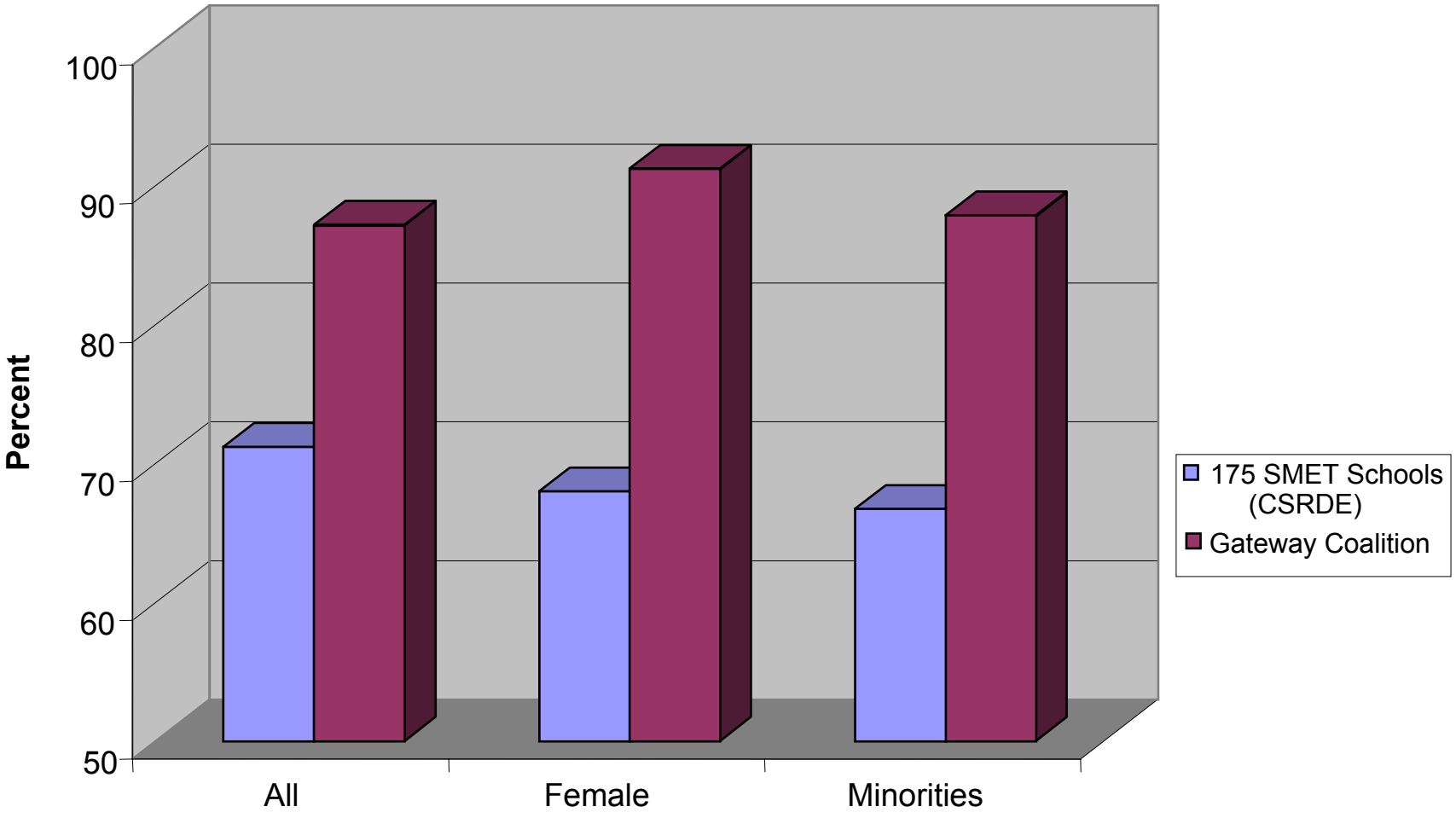
Coalition 1st to 2nd Year Retention Rates



Coalition 2nd to 3rd Year Retention Rates

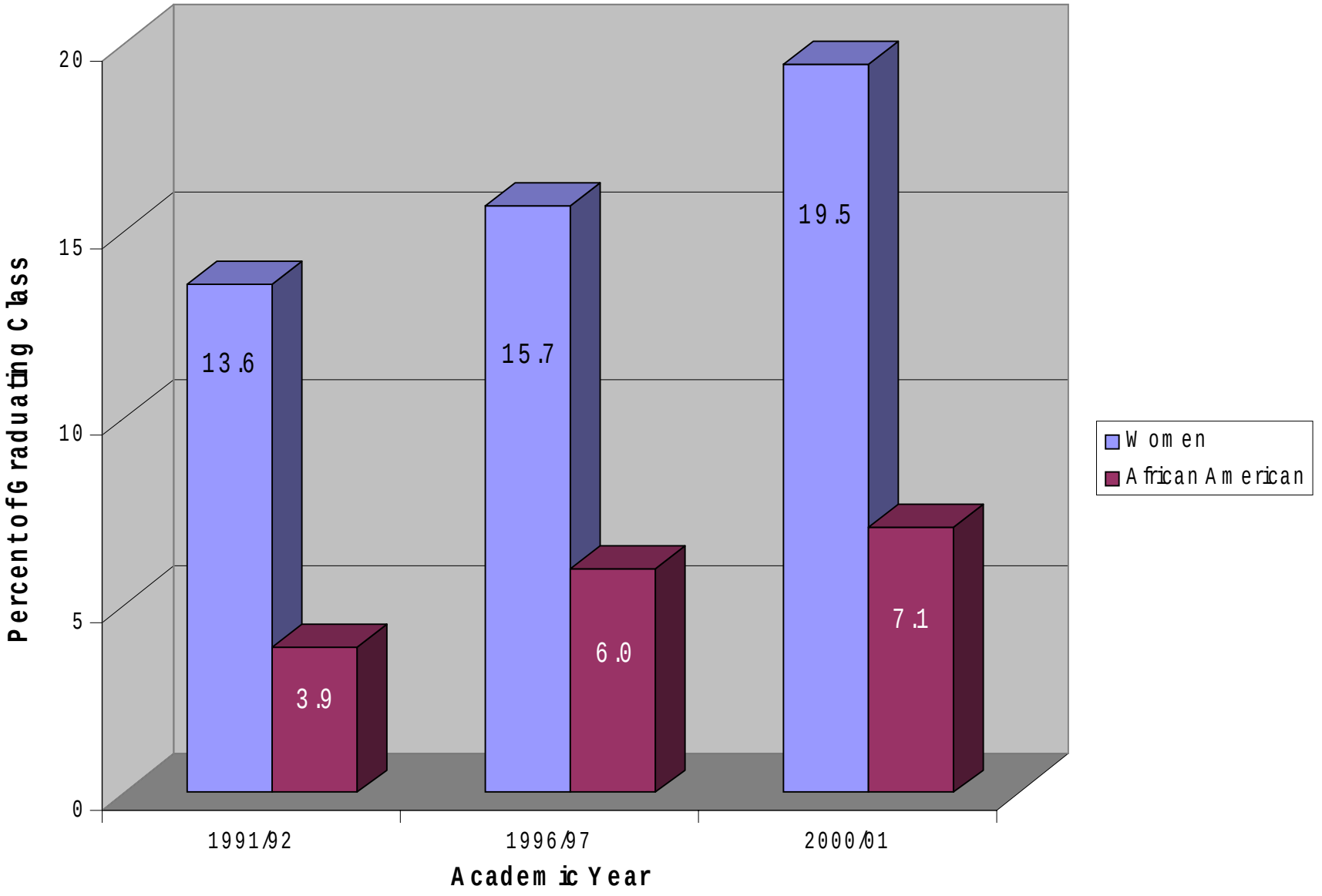


Comparison of Gateway Coalition's 1st to 2nd year Retention Rates against a National Sample



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)

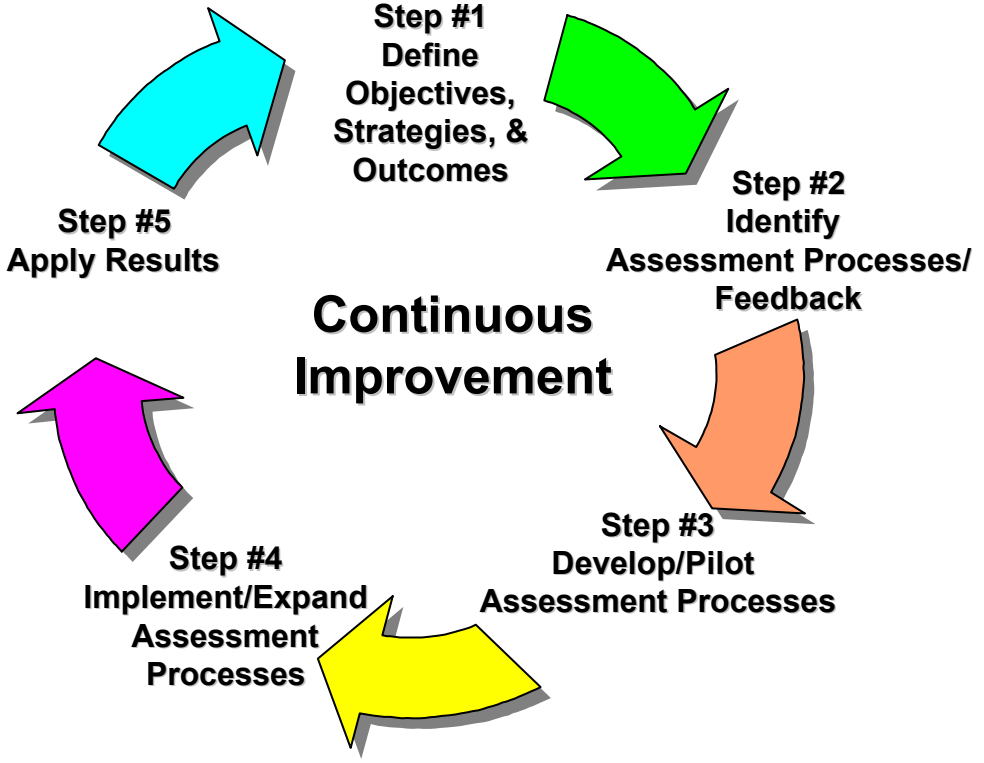


Integrating Technology into the Educational Process

- 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.

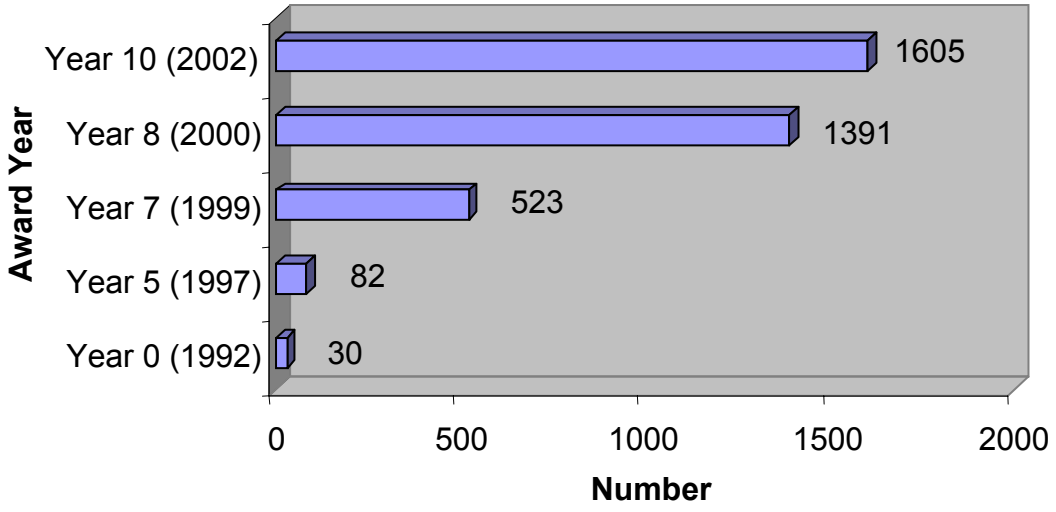
Structured Assessment Process

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

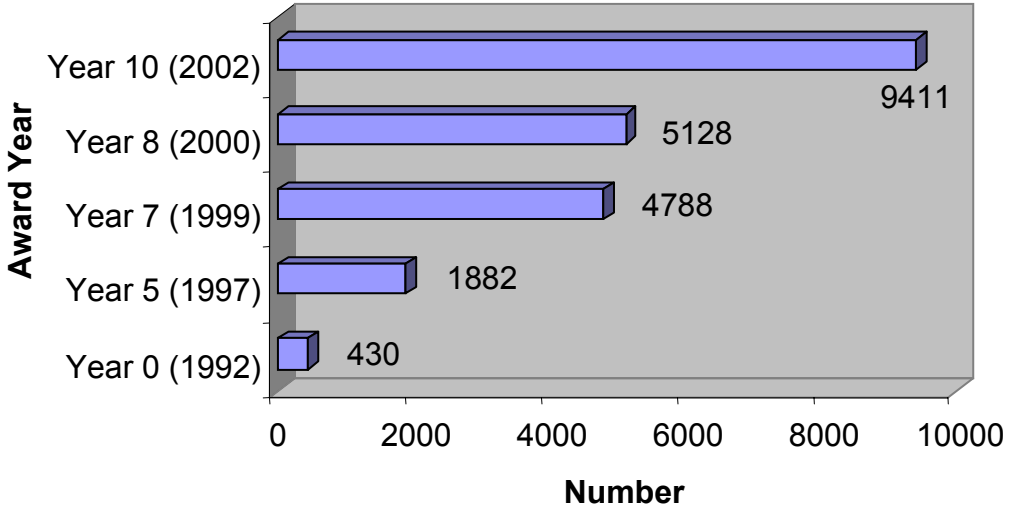


Assessment

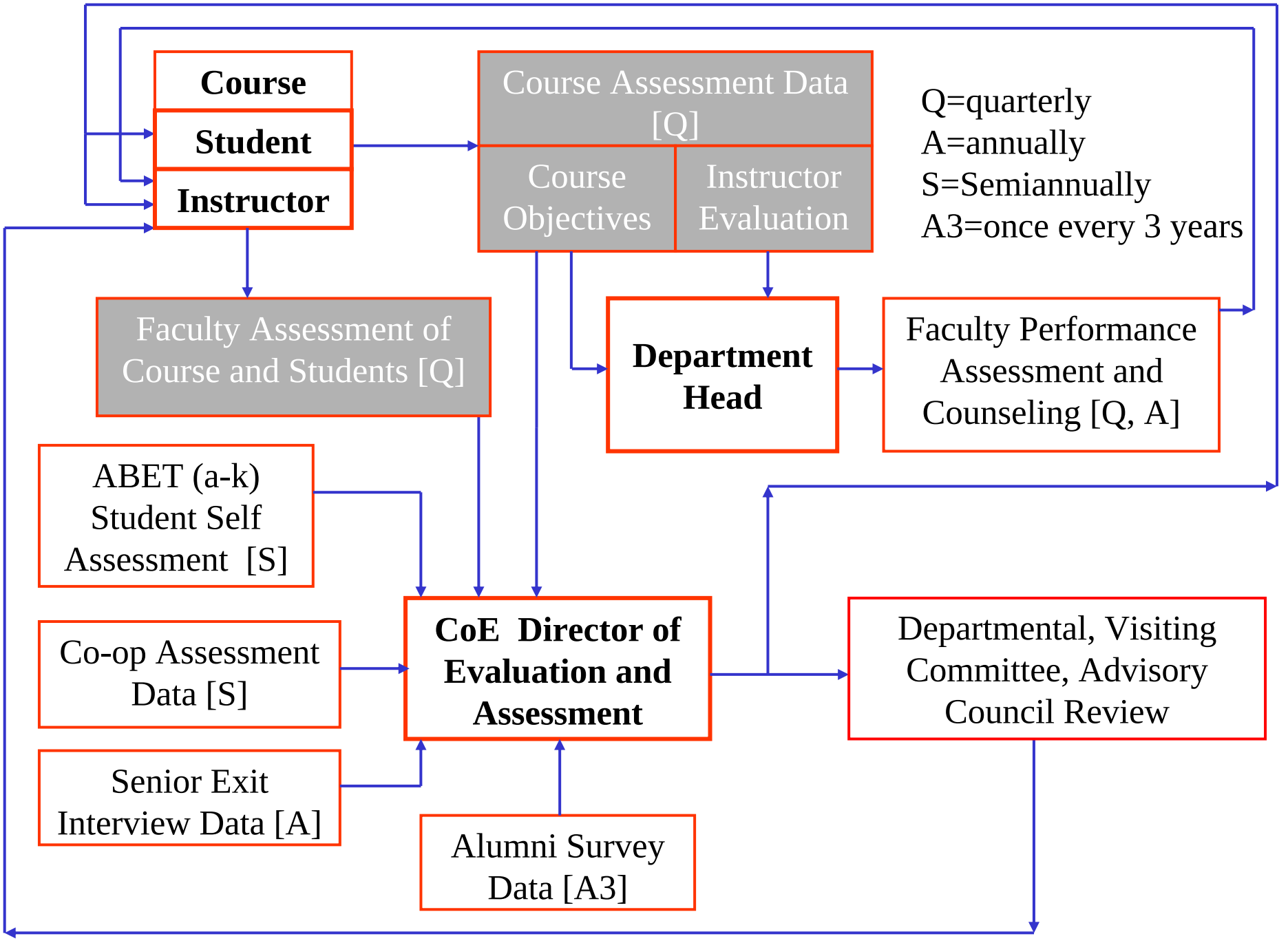
Courses with Documented Learning Objectives



Students Participating in Outcome Assessment Processes



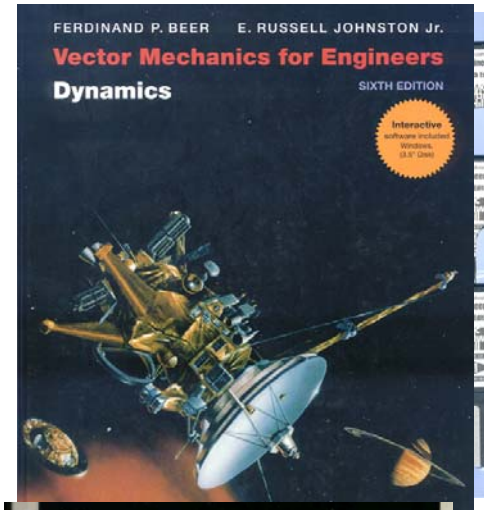
Assessment

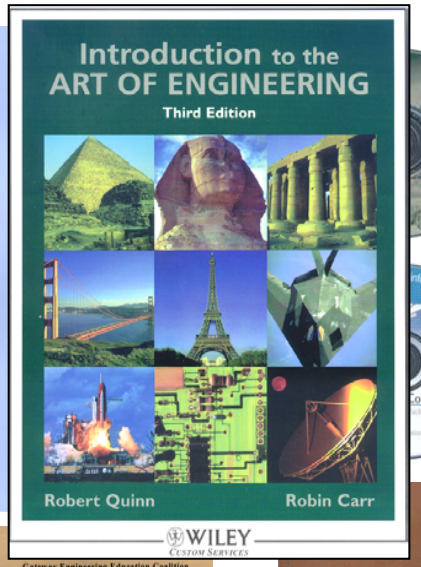

Course
Student
Instructor
Course Assessment Data [Q]
Course Objectives
Instructor Evaluation
Q=quarterly
A=annually
S=Semiannually
A3=once every 3 years
Faculty Assessment of Course and Students [Q]
Department Head
Faculty Performance Assessment and Counseling [Q, A]
ABET (a-k) Student Self Assessment [S]
Co-op Assessment Data [S]
CoE Director of Evaluation and Assessment
Departmental, Visiting Committee, Advisory Council Review
Senior Exit Interview Data [A]
Alumni Survey Data [A3]

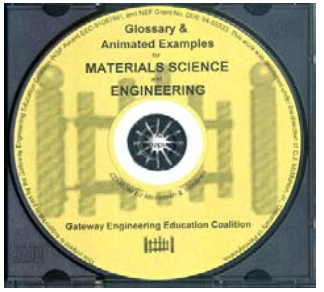
Diffusion Channels
Educational Innovation

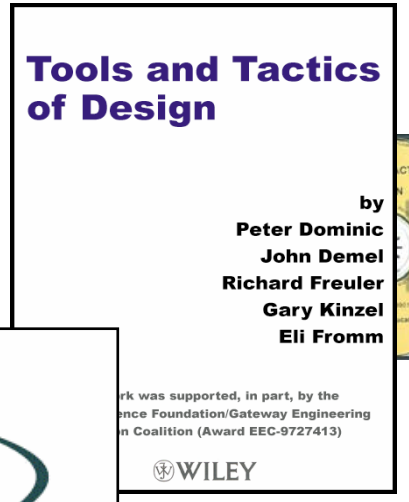
- **Interpersonal Channels**
  - Professional Conferences
  - Interactive Workshops
  - Institutional Partnerships
- **Mass Media Channels**
  - Publications (Journals & Books)
  - Electronic Media (CDs, Digital Books, etc.)
  - Digital Repositories

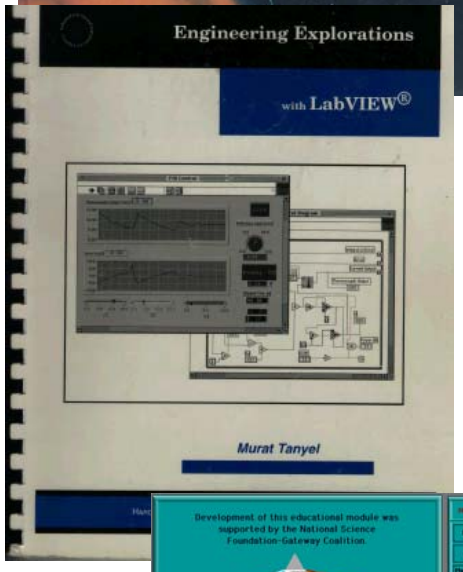
Dissemination

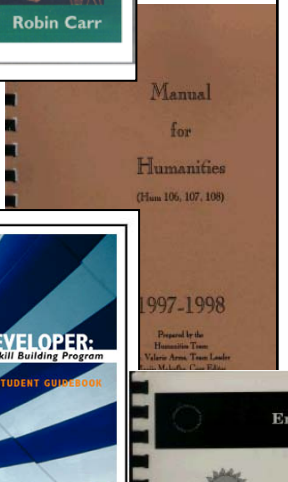


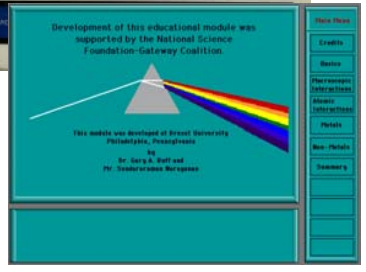


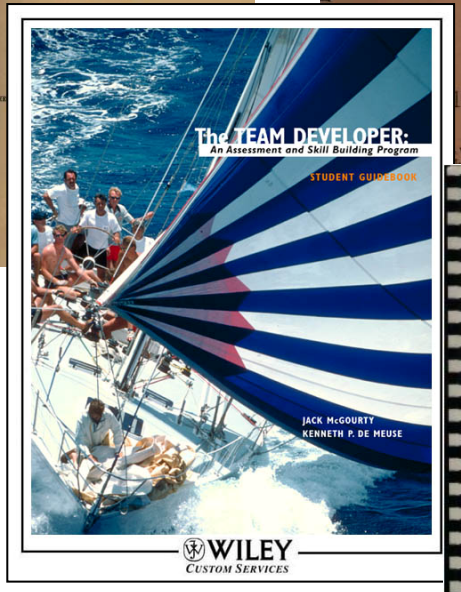


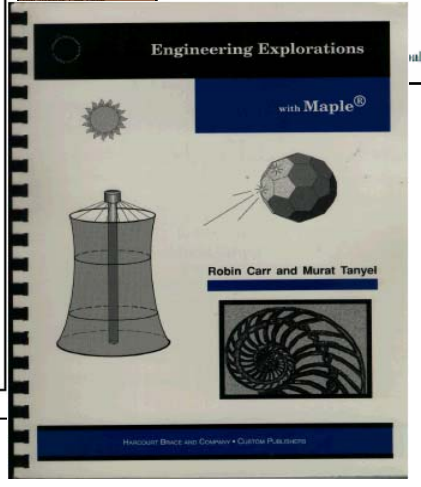


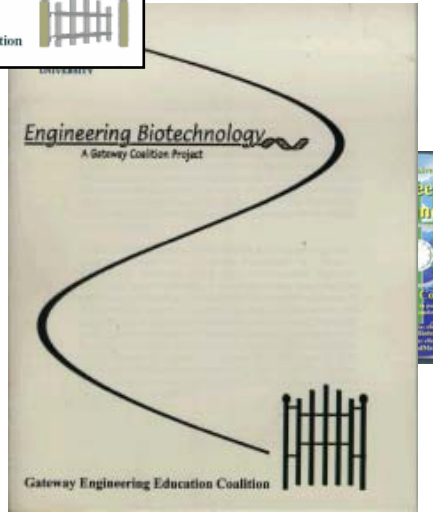






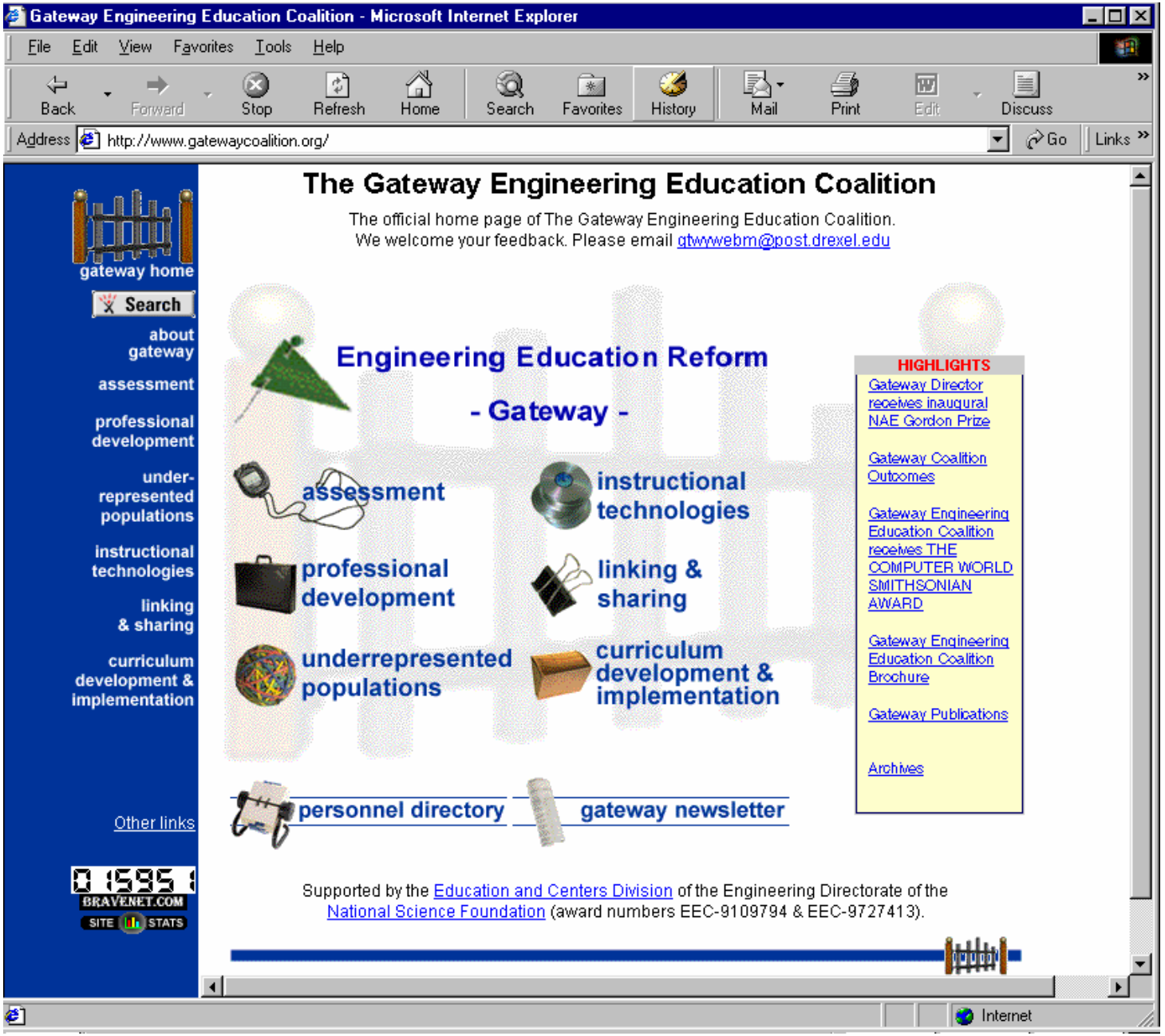






Link & Share through Texts, Multimedia Resources, and Workshops

Gateway Web Repository - The Legacy



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