INTRODUCING THE FUNDAMENTALS OF ENGINEERING DESIGN COURSE IN THE FRESHMAN YEAR WORKS

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UNIVERSITY OF FLORIDA
DOUBLETREE HOTEL AND CONFERENCE CENTER
GAINESVILLE, FLORIDA
MARCH 3-5, 2002

In the Past

Traditional Engineering Curricula

- Math, Physics, Chemistry 1st-2nd year
- Engineering Science and Basic Engineering Courses in the 2nd-3rd year
- Capstone Design and senior Laboratory Courses for each Discipline in the 4th year
- Approach Began to Change in the Late 1970's

HISTORY OF CURRICULUM CHANGE

- Academics jealously guarded prerogative of curriculum content
- Industrial feedback requesting an enhancement of graduates' non-technical capabilities
- Students began asking, " where's the beef"?

ADDRESSING STAKEHOLDER CONCERNS

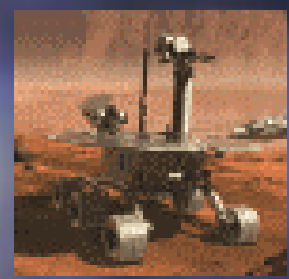
INDUSTRY

- Technical Skills
- Communication Skills
    a) Oral
    b) Written
- Computer abilities
- Team Player
- Off and Running

GOALS

ADMINISTRATION

- Student Retention
- Curriculum Revision
- Engineering Design Upfront
- Expose Student to Various Engineering Disciplines



STUDENT

- Interesting and Exciting Programs
- Exposure to Engineering early
- Acquire Experience with Minimal Effort

GOALS

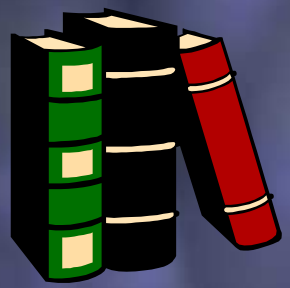
Instructor

- Teach Measurements through Experimentation
- Technical Aspect of Experimentation
- Team Work Concepts
- Report Writing
- Oral Presentation
- Real Engineering Exposure

- **Overall Objective**
  - To enable Freshman to work on real engineering problems
    - At start of their education and not only in the traditional senior capstone design courses

SPECIFIC OBJECTIVES

- Move Engineering Design to Freshman Year
- Team Approach to Problem Solving
- Ignite Interest in Freshman about Engineering with
  - **Hands on Experience**
- Improve Student Retention
- Initiate Curriculum Change
- Couple Freshman Engineering Design With Computer Science and Humanities
  - Learn computer applications early
    and
  - Learn to communicate both orally and in written reports early.



NJIT RESPONSE
1992

- **Initial Fundamentals of Engineering Design Program**
  - **•Real Engineering Up-Front**
  - **•Two Components of the Course**
    - **~ Engineering Design (Disciplinary)**
    - **~ Computer Aided Design/ Graphics (Mechanical Engineering Department)**

COMPUTER AIDED DESIGN/GRAPHICS CAD/ GRAPHICS
Mechanical Engineering Department

Course Content

- Technical Graphics
- Computer as a Technical Drawing Tool
  - Projections
  - Multi-view Drawings
  - Visualization
  - Geometry used in Engineering Graphics
  - Orthographic Projections
  - Dimensioning Techniques
  - Tolerancing
  - Introduction to auxiliary and sectional views
  - Application of the Software Program *pro/Engineer* to Problems in the Laboratory.

ENGINEERING DESIGN COMPONENT

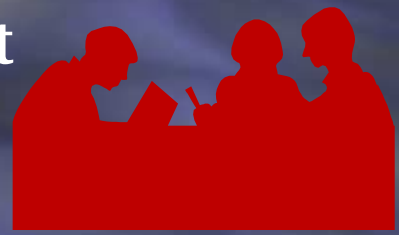
DISCIPLINARY DEVELOPMENT

- First Courses
- Modules
  - Chemical Engineering
  - Civil Engineering
  - Electrical Engineering
  - Mechanical Engineering
- Mechanical Engineering Module
  - Full Fourteen Week Semester
  - Required of all Students

DISCIPLINARY DEVELOPMENT (CONTINUED)

- Lecture Laboratory Format
  - Chemical Engineering
  - Electrical Engineering
- Design Orientation Format
  - Civil Engineering
  - Mechanical Engineering
- All Modules
  - Oral Final Report
  - Written Final Report

PROGRAM STRUCTURE



Engineering Component

- 14 Weeks
- 3 Modules
  - One 14 week, ME module that is required, 3 hours per week with CAD/Graphics
  - Two predetermined modules
    - 7 weeks, 3 hours per week
    - From ChE, CE, EE
  - Small Class Size, 15 – 18 Students
  - 5-6 groups of 3 students
  - Instructor plus 2-3 Teaching Assistants

Humanities Component

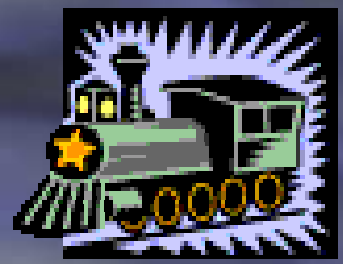
- Three Hours per week

FRESHMAN ENGINEERING DESIGN PROGRAM

Fundamental of Engineering Design- FED 101

- Initialized in 1994
- Offered to First-time, Full-time Freshman Engineering Students
- 1 Semester
- 6 hours
- 2 credits
- 3 Concurrent/Sequential Projects
- Paired with Humanities and Social Science Course of Communication Skills

DISCIPLINE SPECIFIC MODULES



Chemical Engineering

- Measurement Laboratory

Civil and Environmental Engineering

- Water supply from a Reservoir to a Local Community
- Transportation study to Transport Passengers from Pennsylvania Railroad Station to Newark Airport
- Roadway Design to Move Traffic from Two Major Highways to Downtown Newark
- Donald Trump’s Proposed Tower in Manhattan

DISCIPLINE SPECIFIC MODULES

Electrical and Computer Engineering

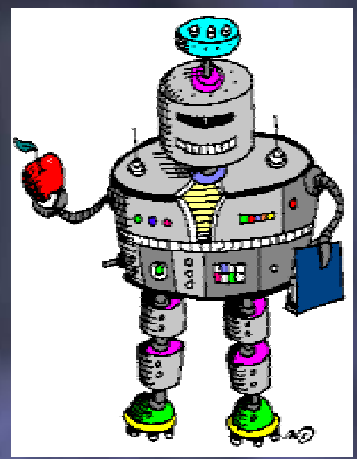
- Design of an Electrical Circuit with a Photo Resistor
- Applications of Electrical Circuits in Computers

Industrial and Manufacturing Engineering

- Manufacturing Processes and Floor Planning

Mechanical Engineering

- Toy Design
- Slider – Crank Mechanism Application
- Application Device for Photo Resistor Light
- Glider Airplane



NJIT RESPONSE
1996

- **STUDENT-FACULTY INTERACTIONS AND EVALUATIONS OF THE DISCIPLINARY COURSES LED TO NEW EXPERIMENTAL INTERDISCIPLINARY INITIATIVES TO ADDRESS THE PROBLEMS**

BACKGROUND

The Need

- Students
  - Preliminary courses were well received
  - Wanted more of these types of courses
- Faculty
  - Expand experience for students to two semesters in Freshman Year
    - The First Semester
      - Present traditional laboratory type courses

BACKGROUND
(Continued)

- The Second Semester
  - Present scaled down capstone type design courses that Freshman could handle with minimum faculty guidance
  - The courses were to be based upon interdisciplinary problems used in team building
  - Course to be for 14 weeks

INTERDISCIPLINARY EVOLUTION

- Developed pilot courses- Spring 1996
- Interdisciplinary
- Engineering Design and Manufacturing Integration

INTERDISCIPLINARY INVOLVEMENT

- Interdisciplinary Engineering problems
- Humanities Faculty work with Engineering Faculty in Teaching Communication Skills
- Mechanical Engineering CAD component
- Computer Science Component

TWO-SEMESTER EVOLUTIONARY
FE 102
Fundamental of Engineering Design

- 1 Semester
- 4.5 hours
- 2 credits
- Integrates Graphics and CAD with Engineering Design and Manufacturing Processes
- Team taught by Graphic Faculty and Engineering Faculty
- Project oriented with Emphasis on Design and Manufacturing

Biomedical and Electrical Engineering

- Electrocardiographic Device, Prep-check

Electrical and Mechanical Engineering

- Floppy Disk Drive of the Computer
- Heat Sink of the CPU Fan

Industrial and Mechanical Engineering

- Lawn Sprinkler
- Step Ladder

Civil-Chemical Engineering

Spring 1996

- Siting a Municipal Landfill in a Residential Community

Fall 1996

- The Design and Siting of a Municipal Wastewater Facility

Spring 1997

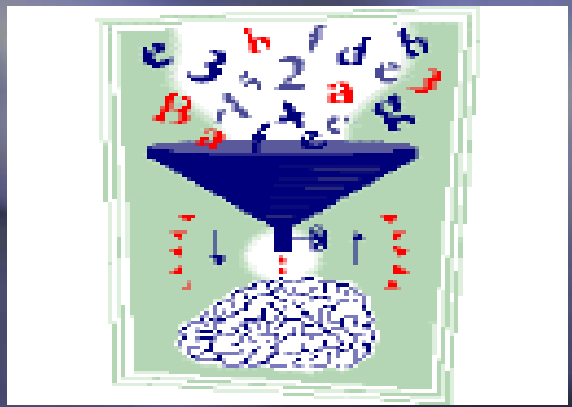
- The Design, Siting, and Environmental Analysis of a Major Connecting Highway
- The Design and Siting of a Hazardous Substance Manufacturing Facility (Aspirin Production)

Longitudinal Study of the Outcomes

- Comparative analysis of the Engineering Graphics (EG) and Fundamentals of Engineering Design (FED) Course
  - ~ graduation rates
  - ~ English, Math, and Engineering courses grades
  - ~ cumulative GPA

DATA: sample

- 240 engineering students who took EG course
- 126 engineering students who took FED course



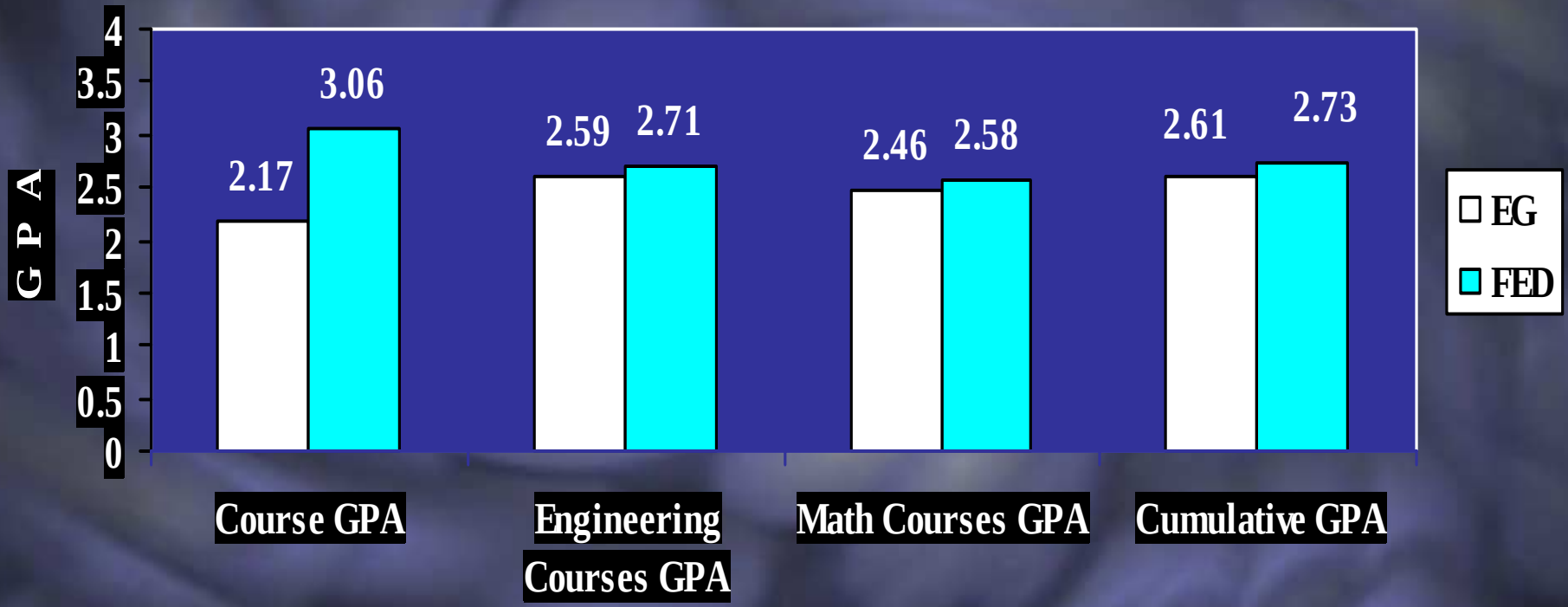
DATA: student characteristics

Characteristics	The EG (N=240)	The FED (N=126)
Gender		
Male	215 (90%)	105 (83%)
Female	25 (10%)	21 (17%)
Race		
White, non-Hispanic	127 (53%)	57 (45%)
Asian American	55 (23%)	26 (21%)
Hispanic	27 (11%)	19 (15%)
African American	23 (10%)	17 (13%)
American Indian	0	1 (1%)
Not reported	9 (4%)	6 (5%)

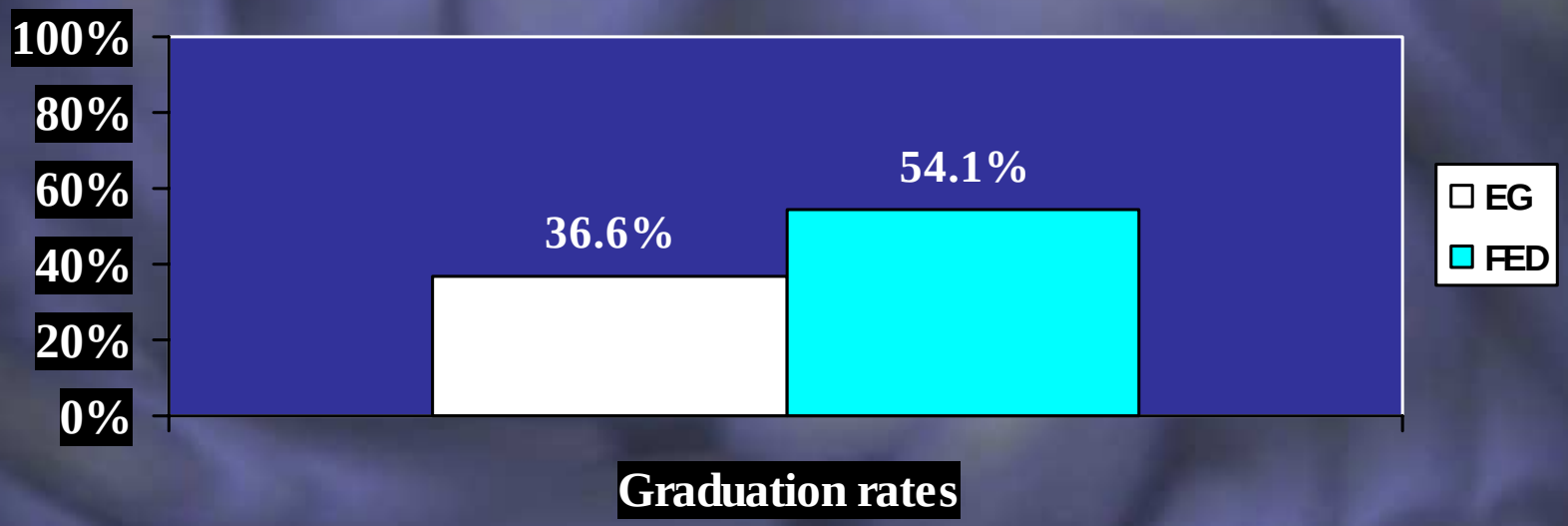
DATA: student characteristics
(continued)

Average age	18.2	18.2
Average number of credits enrolled	15.5	15.3
High school rank		
Average percentile	75%	81%
Top 10 percent	20%	31%
Top 25 percent	52%	67%
Top 50 percent	90%	91%
Average Math SAT	580	580
Average essay placement test score	7.6	7.8

RESULTS


GPA
4
3.5
3
2.5
2
1.5
1
0.5
0
2.17
3.06
2.59
2.71
2.46
2.58
2.61
2.73
Course GPA
Engineering Courses GPA
Math Courses GPA
Cumulative GPA
EG
FED

RESULTS (continued)



CONCLUSIONS

- An early exposure to the various Engineering disciplines did not help students decide on a career
- The students were inspired and enjoyed the course
- They enjoyed hands-on experimentation the most
- They disliked oral-presentations the most
- They disliked lengthy lab reports
- They disliked the analysis of data and calculations without adequate background
- They complained that it was too much work for one-credit hour course

CONCLUSIONS

- The best instructors in the department should be assigned to the course
- The administration was very enthusiastic with the curriculum revision and was supportive of the program, but was concerned about resources
- Research found that FED has a strong impact on student retention and graduation rates

FINAL OUTCOME AT NJIT

Spring 2000

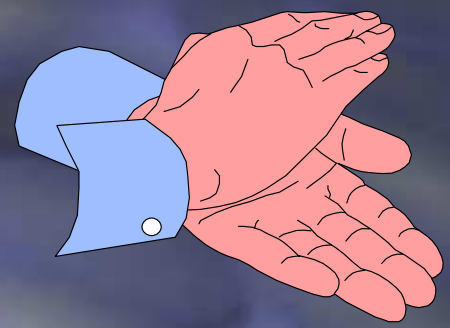
- **FED 101 Becomes Two Separate, Independent Courses, but incoming Freshmen must take both courses in the same semester**

- **FED 101C---Computer Aided Design(CAD)/ Graphics**
  - **2 hours and ten minutes per week**
  - **14 weeks per semester**
  - **1 credit**
  - **32 students per section**
  - **5 sections for incoming Freshmen and 1 continuing section**
  - **One instructor and two teaching assistants**

FINAL OUTCOME AT NJIT (Continued)

- FED 101D—Design
  - 2 hours and 10 minutes per week
  - 14 weeks per semester
  - 1 credit
  - 20 students per section
  - 8 sections for incoming Freshmen and 1 continuing section
  - One Instructor and one Teaching assistant if needed

ACKNOWLEDGEMENTS



The authors wish to thank

- The NSF – Gateway Coalition
- The State of New Jersey
- New Jersey Institute of Technology

for the financial support for Program Development

and

their students over this entire period without whose help these programs would not have been possible