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

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SHARE THE FUTURE- III
A WORKING CONFERENCE
SUCCEED, GATEWAY, FOUNDATION AND GREENFIELD COALITIONS
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)
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

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>The EG (N=240)</th>
<th>The FED (N=126)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>215 (90%)</td>
<td>105 (83%)</td>
</tr>
<tr>
<td>Female</td>
<td>25 (10%)</td>
<td>21 (17%)</td>
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<tr>
<td><strong>Race</strong></td>
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<td></td>
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<tr>
<td>White, non-Hispanic</td>
<td>127 (53%)</td>
<td>57 (45%)</td>
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<tr>
<td>Asian American</td>
<td>55 (23%)</td>
<td>26 (21%)</td>
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<tr>
<td>Hispanic</td>
<td>27 (11%)</td>
<td>19 (15%)</td>
</tr>
<tr>
<td>African American</td>
<td>23 (10%)</td>
<td>17 (13%)</td>
</tr>
<tr>
<td>American Indian</td>
<td>0</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Not reported</td>
<td>9 (4%)</td>
<td>6 (5%)</td>
</tr>
<tr>
<td>DATA: student characteristics (continued)</td>
<td></td>
<td></td>
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<tr>
<td>-----------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average age</td>
<td>18.2</td>
<td>18.2</td>
</tr>
<tr>
<td>Average number of credits enrolled</td>
<td>15.5</td>
<td>15.3</td>
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<tr>
<td>High school rank</td>
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<td></td>
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<tr>
<td>Average percentile</td>
<td>75%</td>
<td>81%</td>
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<tr>
<td>Top 10 percent</td>
<td>20%</td>
<td>31%</td>
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<tr>
<td>Top 25 percent</td>
<td>52%</td>
<td>67%</td>
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<tr>
<td>Top 50 percent</td>
<td>90%</td>
<td>91%</td>
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<tr>
<td>Average Math SAT</td>
<td>580</td>
<td>580</td>
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<tr>
<td>Average essay placement test score</td>
<td>7.6</td>
<td>7.8</td>
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RESULTS

Course GPA: 2.17
Course GPA: 3.06

Engineering Courses GPA: 2.59
Engineering Courses GPA: 2.71

Math Courses GPA: 2.46
Math Courses GPA: 2.58

Cumulative GPA: 2.61
Cumulative GPA: 2.73
RESULTS (continued)

Graduation rates

36.6%  54.1%

EG  FED
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

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and

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