The Pre -Engineering Instructional and Outreach Program at the New Jersey Institute of Technology

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- The Pre-Engineering Instructional and Outreach Program
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  - Electricity & Magnetism
  - Machines & Energy
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The Center for Pre -College Programs

A Center for Education, Research & Service

Center for Pre-College Programs

A Center for

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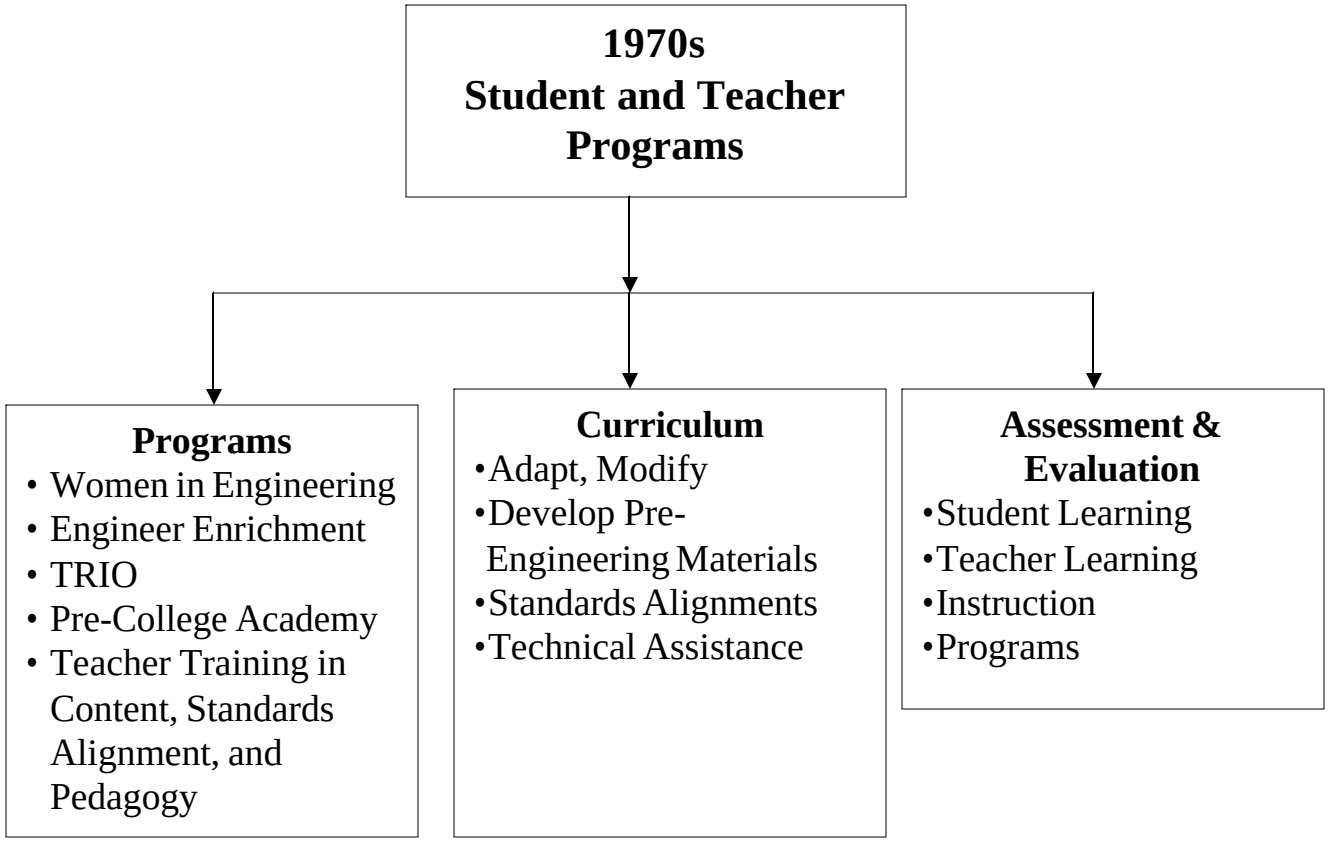


Center for Pre -college Programs ' Mission

- Establish coordinate, and assess academic programs to serve elementary and secondary school students and teachers
- Improve the quality of education in the elementary and secondary schools of urban districts; and
- Ensure that adequate resources and financial support are available to support the Center's programs.

Thrusts of the Center for Pre -college Programs

- Teaching, Curriculum Reform & Standards
- Professional Development Programs
- Science & Math for Special Education Populations.
- National Trio Programs
- Women in Engineering & Technology
- Bridge to Engineering Programs
- Pre-College Academies and 12th Grade Option

Some students

EMSCP, '97, Participant
- A ninth -grader from Newark says, "NJIT was not only a summer program, but was a place where I really enjoyed myself, EMSCP gave me a chance to learn about difference careers and meet new people. "

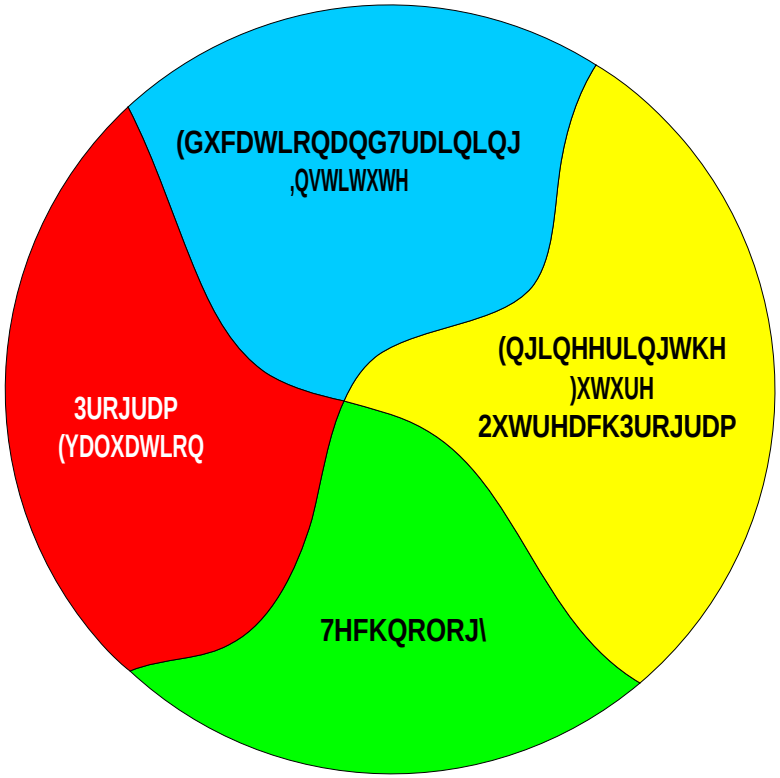
FEMME, '96, '97, '98 Participant
- An eighth -grader at South Orange Middle School, in South Orange, N.J., says, "The FEMME program opened my eyes to new things, making me realize that any - one – even women – can do what - ever they want as long as they try. "

IChIME, '97, UCESI, '98 Participant
- A 10th –grader at Montclair Kimberley Academy says, "I really enjoyed the programs as they helped me decide on a career in engineering. "

The Pre-engineering Instructional & Outreach Program (PrE -IOP)

- A collaborative effort of Newark College of Engineering and the Center for Pre-college Programs.
- A program designed to enlarge the future pool of qualified high-tech workers by:
  - adapting pre-engineering curricula for middle and high school science classrooms and teacher training; and
  - providing a comprehensive information campaign about the rewards of science, engineering, mathematics and technology (SMET) professions.

PrE-IOP Structure



Instructional Component

- Curriculum development focusing on teaching pre-engineering skills, while integrating science, math, and technology instruction aligned with the Standards.
- Adaptation of instructional materials as a complete engineering curriculum (E.g., PLTW) or as modules.
- Summer teacher training institutes on the use of modules or pre-engineering curriculums and meeting the Standards.
- Follow-up provided through the WWW and classroom visits by NJIT faculty and staff.

NJIT

Examples of ICMs

- High School (Grades 9-12)
  - Integrating Chemical Engineering in High School Science
  - Biomedical Engineering
  - Civil Engineering - Structures
  - Integrating Engineering into High School Mathematics
- Middle School (Grades 6-8)
  - Machines in Energy
  - Electricity & Magnetism
  - Vehicular Motion

Outreach Component

- Use state-of-the-art multimedia presentations, videos, interactive CD-ROMs, web sites, and informational and career conferences.

- Exploration of SMET careers featuring profiles of professionals while offering advice on career preparation.

Integrating Chemical Engineering into High School Science

- 2-week short course for high school teachers (grades 9-12)
- Exploring chemical engineering applications as vehicle to enhance science instruction

Connecting the Scientific Concepts with Engineering Applications

- Select process for a well-known product.
- Relate concepts taught in high school science to chemical engineering practice.
- Provide “hands-on” projects, lab experiments, and activities that can be taken back to the high school science classroom.

Using the Aspirin manufacturing process, the module focuses on

- Science concepts taught in high schools
- Relevance to chemical engineering principles; e.g.,
  - Material Balances
  - Energy Balances
  - Heat, mass and momentum transfer (fluid flow)
  - Reaction Kinetics
  - Separations

"Selected" Unit Operations

- Heat Exchanger
- Agitation and Mixing
- Dissolution Vessel
- Chemical Reactor
- Crystallization Vessel
- Distillation Units

All Chemical Processes are composed of Three Key Components

- Pre-Reaction Physical Preparation Steps
- Reaction Steps
- Post-Reaction Physical Separation Steps

Integration of Chemical Engineering into the Science Classroom

Chemical Engineering – the Applied Science	**Chemistry – the Basic Science**
Material Balancing	Stoichiometry Chemical Equations
Energy Balances Heat Transfer (e.g., heat exchangers)	Thermochemistry and Thermodynamics
Multiphase Systems Separation Processes (e.g., extraction, distillation)	States of Matter Physical Equilibria
Reactor Design (Isothermal & non-isothermal systems, fluid flow, concentration gradients)	Rates of Reactions (Parameters affecting reaction kinetics – e.g. concentration, temperature, solubility)

Electricity and Magnetism

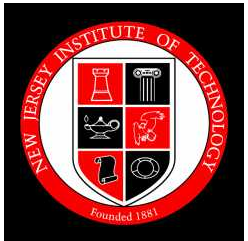
- 2-week short course for middle school teachers (grades 5-8)
- Three sections
  - Introduction to engineering
  - Electricity and magnetism
  - Boolean logic and digital circuits

Electricity and Magnetism

- Introduction to Engineering
  - Engineers in society and everyday life
  - Case studies
  - Problem solving process
  - Greatest Engineering Achievements of the 20th Century (NAE)
  - Paper drop competition

Electricity and Magnetism

- Electricity
  - Basics: electrons, charge, current, voltage
  - Resistance: Ohm's Law, series and parallel resistance
  - Laboratory experiments
- Magnetism
  - In nature and in everyday life
  - Laboratory experiments



Boolean Logic and Digital Circuits

- Basic Boolean functions
  - AND, OR, XOR, NOT
- Compound Boolean functions
  - Real-world situations
- More complex digital components
  - Registers, decoders, counters, and multiplexers
- Laboratory experiments

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Machines and Energy

- 2-week short course for middle and high school teachers (grades 6-12)
- Mass, motion, work, power, energy
- Hands-on experience

Machines and Energy

- What are science and engineering?
- Engineering design
- Simple machines
  - Inclined plane, lever, wedge, screw, pulley, wheel and axle
- Mechanisms and robots

Machines and Energy

- Complex machines
- Work and power
- Types of energy
- Storing energy
- Environmental impact

Readiness to Teach Machines and Energy

Item: How ready are you to teach about…	I would have to start from scratch	I would more training on the topic	I would have to look at my notes.	I could teach a lesson on this topic tomorrow.
Engineering Design	6.3 (1)	25 (4)	56.3 (9)	12.5 (2)
Work & Power		12.5 (2)	31.3 (5)	56.3 (9)
Simple Machines		6.3 (1)	25 (4)	68.8 (11)
Machine Design		43.8 (7)	50 (8)	6.3 (1)

Acknowledgments

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