Exploring Industrial Engineering

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What is Industrial Engineering?
Who is Frederick Taylor?
Who is Frank Gilbreth?
Who is Lillian Gilbreth?
Who is Henry Ford?
What is Industrial Engineering?

Or this the airport?

Or this at the doctor’s office?

Have you ever thought – there must be a better way?

What is Industrial Engineering?

Do you ever feel like you are being run around?
What is Industrial Engineering?

At the store, do you like to see this?
How does this happen?

What is Industrial Engineering?

Do you ever see this?
Why?

What is Industrial Engineering?

Do you see this?
And think it could look like this?
What is Industrial Engineering?

And think it could look like this?

Or this?

Or maybe this?
Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of people, material, information, equipment, and energy. It draws upon knowledge and skills in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems.

Industrial Engineering is the branch of engineering that focuses on improving the efficiency and effectiveness of systems and processes.

What do IEs do?

Take a look at this video produced by the Institute of Industrial Engineers...

[Video Link]

Where do IEs work?

List of companies such as Alcoa, OfficeMax, DELL, OLD NAVY, Mitt, and others.
Concentrations within IE

- Operations Research & Computer Modeling
- Product Development & Manufacturing Systems
- Statistics and Data Analysis
- Engineering Management
- Health Systems Engineering
- Human Factors and Safety

Operations Research and Computer Modeling

Solve complex problems by understanding and formulating them, gathering data, modeling (using quantitative and analytical techniques) and implementing the solution.

Career Opportunities
- Optimize logistics for a transportation or shipping company
- Business analyst for a sports team
- Modeling amusement park queue sizes
- Design production schedules for a manufacturing organization
- Optimize the distribution of critical health care services

Vaccine Delivery

- Delivering vaccines - Niger, Africa
- Objective – Maximize children vaccinated
- Constraints
  - Cold chain capacity
  - Transportation
  - Vaccine wastage
  - Skilled personnel
**Vaccine Delivery**

- Network Design Models
- Simulation
  - Model vaccine delivery
  - Change storage and transport capacity
- “What if” analysis
  - New vaccines
  - Change in population
  - Campaigns

**Assess New Technology**

- Model new storage devices (Global Good)
  - Size
  - Weight
  - Use cases

**Statistics and Data Analysis**

Analyze data using data processing, statistical and modeling tools with the goal of discovering useful information, relationships, and to support decision making.

**Career Opportunities**

- Analysis of social media and internet usage patterns
- Data mining for credit card default patterns
- Public health trends and patterns
- Evaluate the effectiveness of marketing campaigns
Statistics and Data Analysis Examples

- Pediatrics vaccine promotion
  - Different time periods
  - Different offices
- Google Flu - predict regional outbreaks of flu using search patterns
  - Faster than using standard public health surveillance
- Internet retailers - evaluate the effectiveness of website content and design on sales
- Retail affinity analysis - identify items that are often purchased together

Space Shuttle Challenger

- Concern regarding O-ring performance on cold days

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Space Shuttle Challenger

Product Development and Manufacturing Systems

Career Opportunities
- Work on a team focused on new product development
- Design an automated manufacturing system
- Control production & quality in a manufacturing facility
- Develop innovative manufacturing methods

Why Sunlight?
- Unlimited Supply
- More energy hits earth's surface in 1 hour than all humans use in 1 year
- Environmentally Friendly
- No greenhouse gas emissions
- Fossil fuels are nonrenewable
- Bring electricity to world's poor

1.6 billion people in world without electricity
Or 1 in every 5 humans

Research advanced materials to lower costs and increase efficiencies of solar cells

- Nanosphere coatings
- Metal Nanomeshes
- Nanowires
- Nanoholes

Combine with Solar Simulations

Absorption spectra

Electric field intensity

Carrier Generation

Medical Device Manufacturing Research

- Design and Manufacturing a Neurovascular Device to Treat Brain Aneurysms
- Design and Manufacturing a Tongue Prosthetic Assist Device (TPAD) to Treat Dysphagia

- Dysphagia: difficulty in swallowing in oral and pharyngeal regions
- ~15 million people (U.S.)
- Complications include aspiration pneumonia and malnutrition.
- Brain aneurysm: an abnormal widening or ballooning of a portion of an artery in brain
- > 5% population in US/year
- Risk: bleeding into the brain, stroke, brain damage, and death
Career Opportunities

- Risk analysis and decision theory
- Manage continuous improvement initiatives
- Project management
- Financial engineering

Use management and technical expertise to manage projects, formulate technical strategies, and work with people to make and implement decisions.

Engineering Management Examples

- Change management
  - People do not like to change!
- Coordinating teams
  - Design
  - Manufacturing
  - Marketing
- Leading continuous improvement efforts
  - Manufacturing
  - Retail
  - Healthcare

Workspace Organization

5S (6S)

- Seiri - Sort, Housekeeping
- Seiton - Set in order, Workplace organization
- Seiso - Shine, Cleanup
- Seiketsu - Standardize
- Shitsuke - Sustain
- Safety
Health Systems Engineering

Career Opportunities
• Streamline patient flow to reduce patient service time
• Optimize physician and nurse staffing schedules
• Improve operating room efficiency
• Minimize medication errors and increase patient safety
• Direct lean and continuous improvement initiatives

Use systems analysis and industrial engineering methods to improve the effectiveness of healthcare delivery - focusing on operations, personnel, and system design.

Surgery Scheduling

• Surgery accounts for the largest part of a hospital’s total expenses
• High demand for surgical resources
• Surgery scheduling is complicated by:
  - Competing performance criteria
  - Uncertainty in surgery durations
  - Limited capacities

Surgery Scheduling

Current Policy:
• Surgery length is assumed to be a constant
• A fixed value of 30 minutes is used for the inter-op time
• Blocks are “packed” to the extent possible
• No explicit consideration of randomness
Outpatient Clinic Access

• What affects wait time?
  • Supply and Demand
    o Number of patients
    o Number of providers (doctors, nurses, etc.)
    o Number of rooms
  • Other factors
    o Appointment duration
    o No-shows
    o Walk-ins
• Simulate patient flow

Human Factors and Safety Engineering

Career Opportunities
• Design airplane cockpits, automobiles & race cars
• Design the control room layout of a nuclear or natural gas fired power plant
• Reduce the risk of injury through design of a health and safety management system
• Improve human performance in industry, sports, healthcare or military applications

Use industrial engineering methods to improve the design of the human-machine interface to reduce worker injuries, promote worker well being, reduce errors and increase user satisfaction.

Human Factors and Safety Engineering Opportunities

• Improve athletic performance and sports-related protective equipment design
• Improve military performance through human centered design of Weapons systems and other equipment
• Improve industrial performance through improved cognitive and ergonomic designs
Why Industrial Engineering?

- Broad field
- IEs solve complex problems and bridge the gap between management and operations
- IEs improve productivity and quality
- IEs work with people
- High demand for IEs
  - Median annual salary (entry level, Pittsburgh area) - $57,000
- Opportunities in any type of industry or institution including manufacturing, retail, logistics, health care, finance, law, consulting, education, energy, and entrepreneurial ventures

“Famous” IEs:

- Joe Girardi - Manager of the Yankees
- Mike Duke – President and CEO of Wal-Mart
- Tim Cook – CEO of Apple Inc.
- Chuck Armstrong - President and COO Seattle Mariners
- Jack Guynn - Retired President Federal Reserve Bank, Atlanta
- Tom Usher - former CEO US Steel
- Joe Hardy - Founder and President 84 Lumber

"I would highly recommend an IE degree to all freshman engineering students, as I believe it provides a broad appreciation of engineering, technology, business and management. One of the growing areas for IE is in Enterprise Transformation, and IEs are uniquely positioned to contribute and lead in this area.”

Roman Hlutkowsky
Retired Senior Vice President, Human Resources
FedEx Ground
BSIE 1980, MSIE 1983

“Within the role of Manufacturing Engineering, I have applied my IE skill set to tasks I perform from Statistics, Inventory Control, Human Factors, Facility Layout and General Engineering Management. My education has positioned me to be lead on all operational activities for the product lines I am responsible for.”

Andy Hutelmyer
Manufacturing Project Engineer
MEDRAD
BSIE 2003; MSIE/MBA 2005

“Industrial Engineering is a highly respected department at WDW... when management positions open up even outside of the department, IEs are often considered for the roles.”

Kaleigh Muller
Associate Industrial Engineer
Walt Disney World, Orlando Florida
BSIE 2008
“My IE degree was invaluable in helping me break into the sports industry. I was able to sell my strengths in statistical/quantitative analysis and system optimization, skills that can translate into almost any professional discipline. Now that I am working full time with a professional sports team, I constantly rely on my knowledge of operations research (maximizing concessions revenue through optimized product mix and pricing), database management (pulling relevant ticket sales data), and economic analysis (calculating ROI on capital expenditures for the ballpark). Because IE focuses on approaches for solving broad organizational issues, I have been able to add value early on despite a lack of institutional knowledge. Overall, I would not have been able to land a job in sports without my BSIE from the University of Pittsburgh, and certainly would not be providing the value I currently am without the core skills I acquired as a result of the degree!”

Yi Zhuang  
Business Analyst  
Boston Red Sox, San Diego Padres, San Francisco 49ers  
BSIE 2009

What classes do IEs take?

- IE Coursework  
  - Information Systems  
  - Probability & Statistics  
  - Human Factors / Ergonomics  
  - Engineering Economy  
  - Computer Aided Design  
  - Manufacturing Processes and Analysis

- Supply Chain Management  
  - Simulation  
  - Facility Layout and Material Handling  
  - Probabilistic Methods  
  - Engineering and Project Management  
  - Operations Research

Employment Opportunities for Pitt IEs

- Accenture  
- Booz-Allen  
- Estee Lauder  
- Giant Eagle  
- Hershey Foods  
- Mitsubishi  
- PNC Bank  
- Respimtics  
- Timken Co.  
- Walmart  
- Bayer (Medrad)  
- Deloitte Consulting  
- FedEx Ground  
- Harley-Davidson  
- Honda  
- MSA  
- PPG industries  
- Sam’s Club  
- UPS  
- Walt Disney World  
- Boeing  
- EPIC  
- General Electric  
- Heinz  
- LMI  
- Pepsi Co.  
- Rand Corporation  
- Siemens  
- Virtua Hospital Systems  
- Westinghouse
Are you an IE candidate?

- Are you strong quantitatively?
- Do you enjoy modeling and solving complex problems?
- Do you like to integrate the technical and business aspects of a problem?
- Do you like to look at the big picture?
- Do you have a strong interest in planning and organizing projects?
- Do you enjoy working with people?
- Do you enjoy variety?

I’m interested! What next?

- Visit our departmental web page at http://www.engineering.pitt.edu/industrial/
- Visit the Institute of Industrial Engineers (IIE) web page at www.iienet.org
- Contact Dr. Karen Bursic
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Questions

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