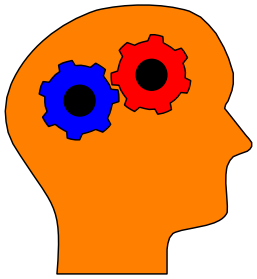
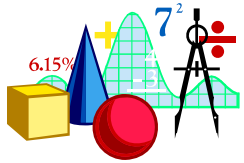
Mechanical & Aerospace Engineering Today

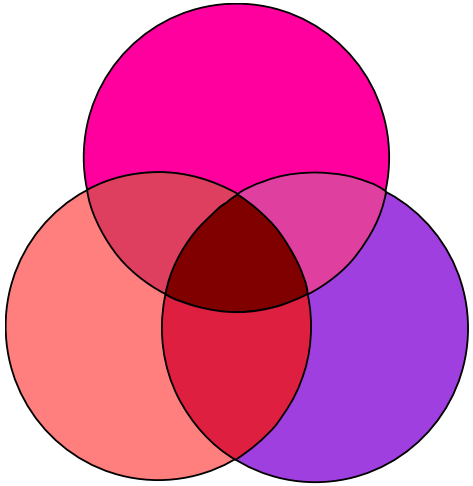




by
Joseph Majdalani, Ph.D., P.E.

Agenda

- Thank You
- The Profession
- Our Program
- The Jesuit Tradition
- Questions
- Laboratory



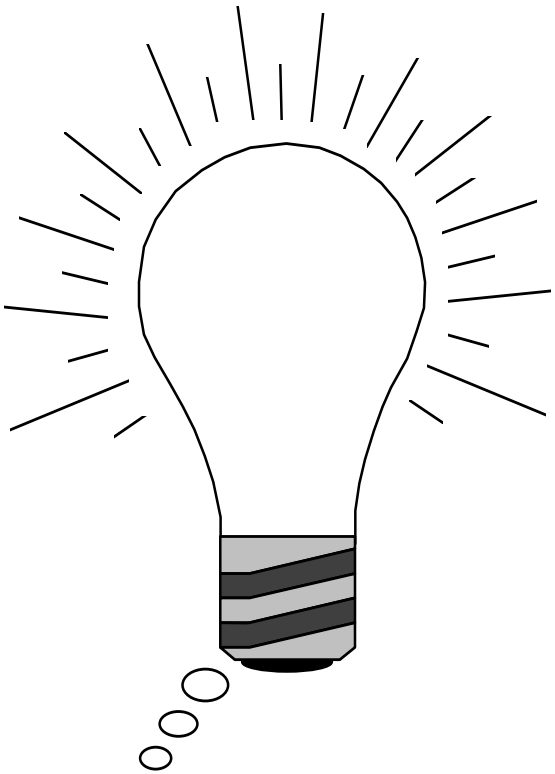
The Profession

"The engineer creates what has not been."

–Von Karman

Engineers

- Engineers *develop* concepts, ideas & theories, then transform them into *realities* in order to meet *needs*.
- They couple their understanding of science & mathematics with "engineering sense."



A Mechanical Engineer

- Deals with the production of power from fire, earth, water & air
- Harnesses & converts energies to serve man
- An unmoved mover
- Removes conflicts & solves problems

Mechanical Engineering Offers

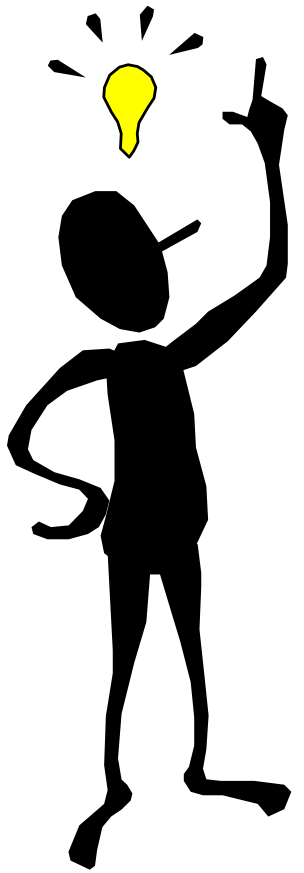
- Challenging jobs
- Good pay & benefits
- Lasting & tangible products
- Help to mankind
- Prestige & status
- A road to scholarship

The Engineering Team

- Engineers
- Scientists
- Technologists
- Technicians
- Accountants
- Attorneys
- Consultants

Engineers vs. Technicians

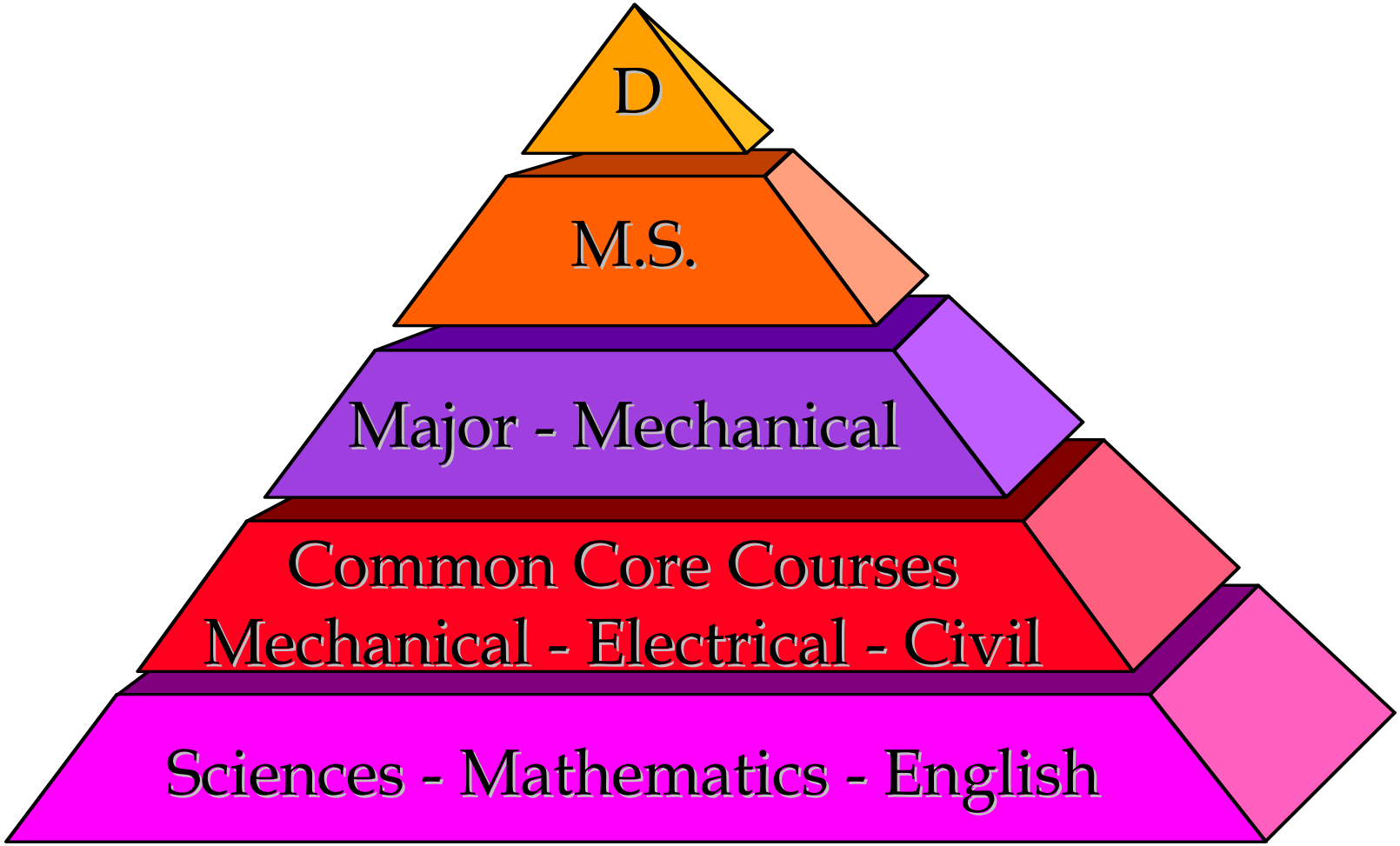
- Technicians implement plans formulated by engineers
- The engineer designs the system/device; the technician builds it



Preparing for the Challenge

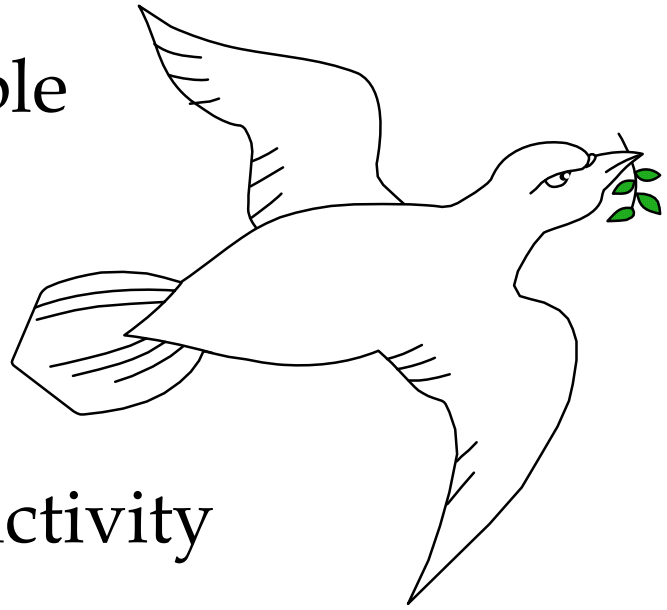
- Algebra I & II
- Geometry
- Trigonometry
- Calculus
- Physics
- English (4 units)
- Computer Programming
- Computer Applications
- Social Studies (3)
- Fine Arts
- Humanities
- Foreign Language (2)
- Biology
- Chemistry

Progression



What Mechanical Engineers Do

- Make lives more comfortable
- Turn ideas into reality
- Improve methods
- Improve materials
- Improve products & productivity
- Develop machines for the production of power, goods & advanced military weapons in times of peace & hostility



Tasks

- Computers in design
- Aerodynamics of jet fighters of tomorrow
- Engine performance & control devices
- Rockets, propulsion
- Tanks, helicopters
- Micro probes
- Smart automotive components
- Satellites/GPS
- Robots
- Advanced Materials
- Energy & pollution management
- Technical sales

Other Related Specialties

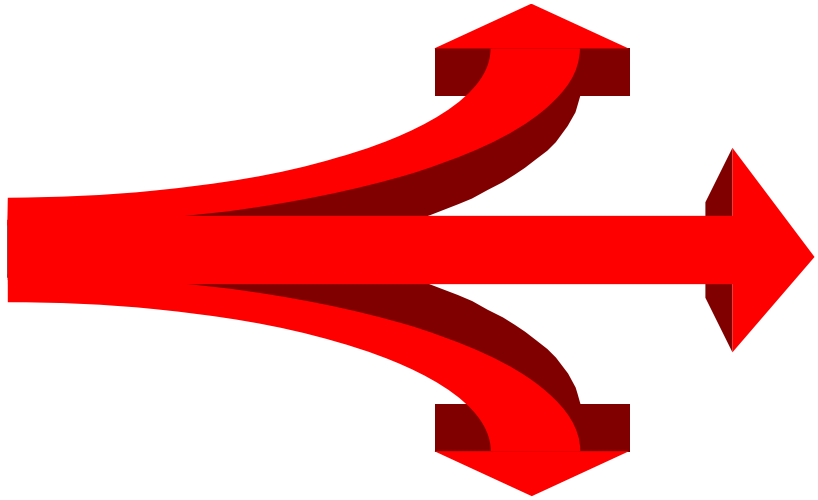
- Aerospace Eng'g
- Aero/Astronautical
- Agricultural
- Bio-Eng'g
- Ceramic Eng'g
- Corrosion Eng'g
- Cost Eng'g/Manag.
- Facilities Eng'g
- HVACR Eng'g
- Naval/Ocean Eng'g
- Nuclear
- Optical
- Petroleum
- Plant Eng'g
- Plastics Eng'g
- Transportation Eng'g

Paying For College

- Family support
- Scholarships & grants
- Loans
- Co-op & work-study
- Part-time & summer jobs
- Special programs/ROTC

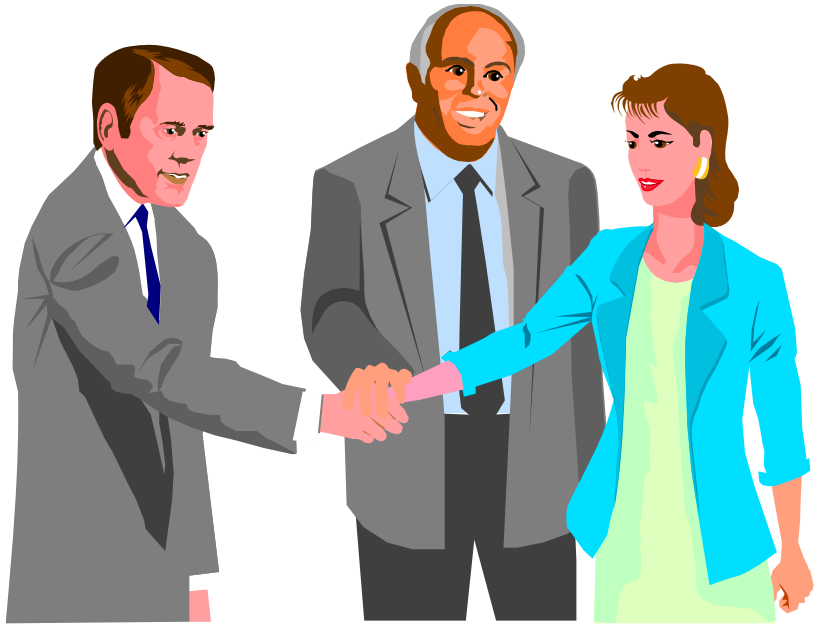
Career Orientation Tracks

- Theory: Research - Development - Design
- Hardware: Installation - Testing - Operation
- People: Marketing - Sales - Management



Career Options

- R&D/Teaching
- Military
- Industry/Computers
- Consulting/Law
- Management
- Government
- Marketing/Sales
- Business

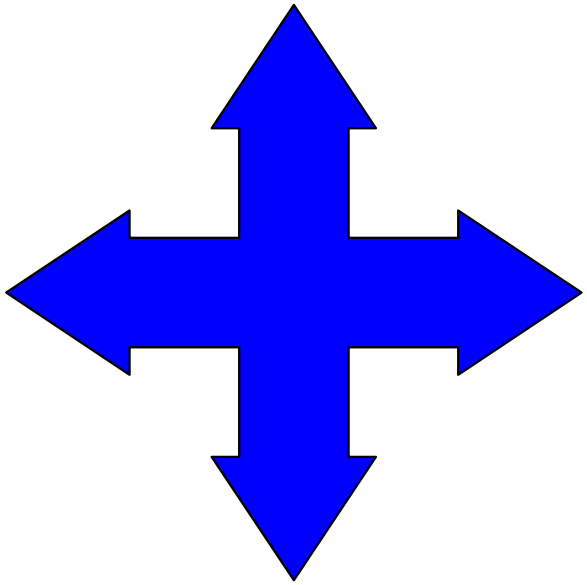


Career Titles

- Energy Specialist
- Application Engineer
- Process Engineer
- Sales Engineer
- Project Engineer
- Chief Engineer
- Corporate Engineer
- Patent Engineer
- Product Liability
- Research Engineer
- Development Engineer
- Design Engineer
- Testing Engineer
- Production Engineer
- Operation Engineer
- Maintenance Engineer
- Automotive Engineer
- QA/QC Engineer

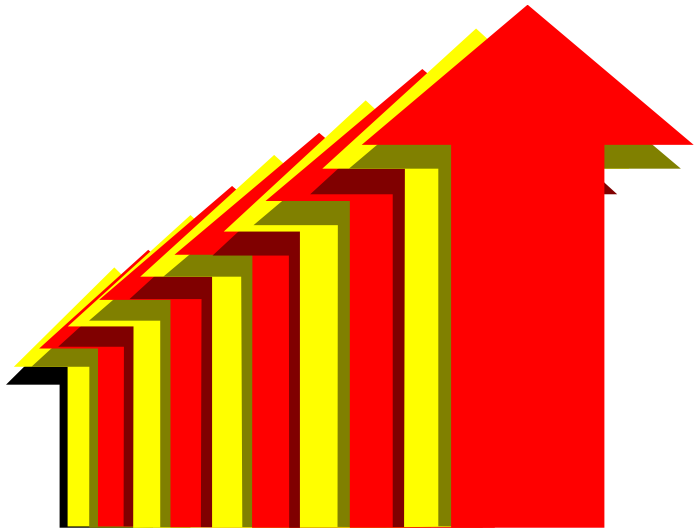
Functions

- Understand the bases of mechanical science
- Create via RDD: Analyze complex systems, synthesize & invent
- Produce via planning, operation & maintenance
- Coordinate via management, consulting & marketing



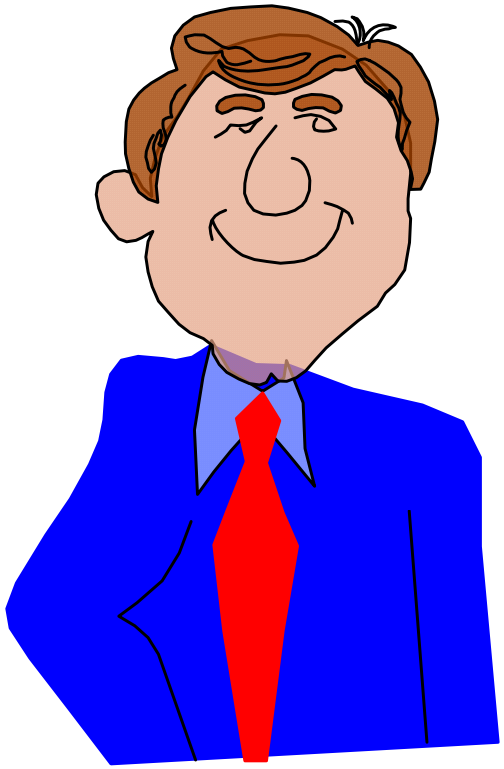
Top Areas of Responsibility

- Product Design
- Management
- Systems Design
- Plant Operations
- Consulting



Good Engineers

- Are basically & rationally lazy
- Very well prepared
- Very well organized
- Document everything
- Keep themselves well informed
- Are open to new ideas
- Are not deterred by challenges



Our Program

"Here Wisdom calls, 'Seek virtue first, be bold;
As gold is to silver, virtue is to gold.'"

–Pope

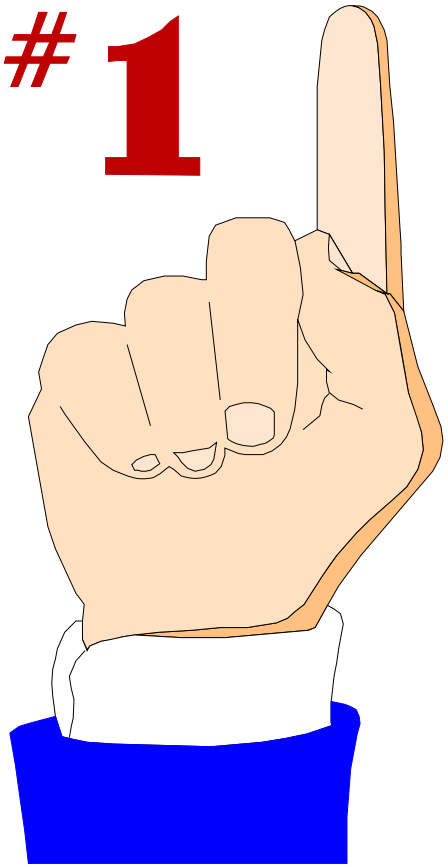
Our Program

It is written, “Man shall not live by bread alone.”

-Mathew 4:4, Luke 4:4

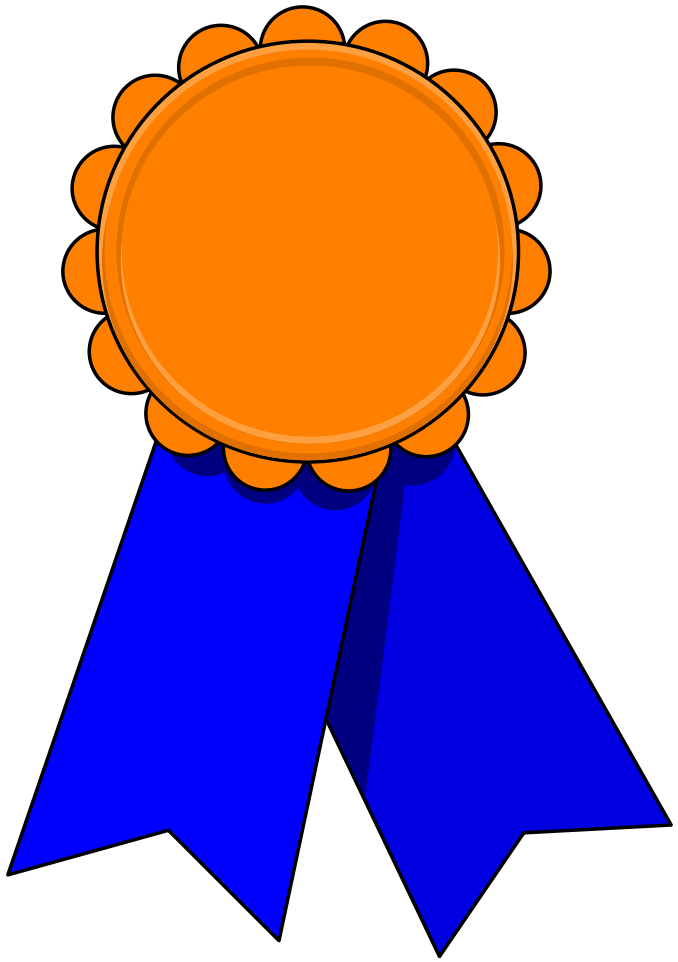
We're Number One

- Largest Catholic college of engineering in the nation, 1300u
- Number one among 28 Jesuit engineering universities
- Top 20 nationwide in percent of women graduates (20%)



College of Engineering

- All degree programs ABET accredited
- Interdepartmental transfer not restricted by limits or quotas
- B.S., M.S. & Ph.D. degrees available in all departments
- Direct admission

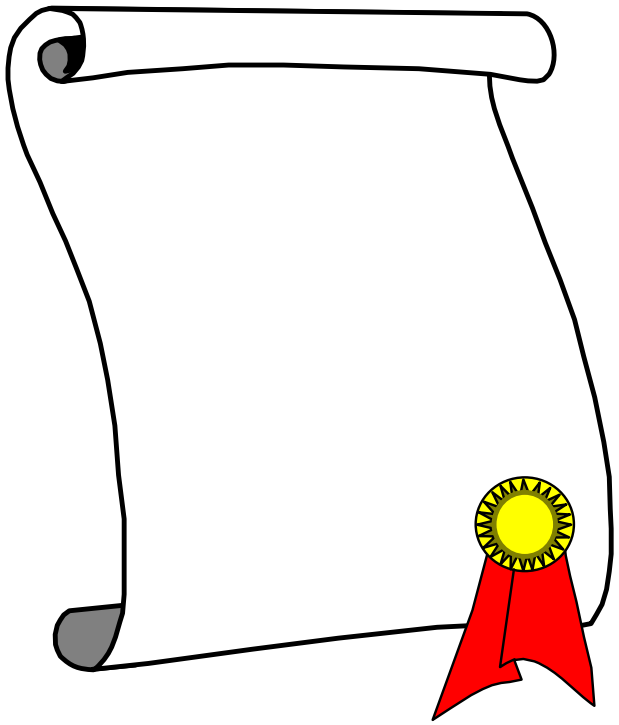


Co-op Opportunities

- Nationwide opportunities
- Average monthly starting incomes of $1,810
- 42% participation among undergrads

When Can I Graduate?

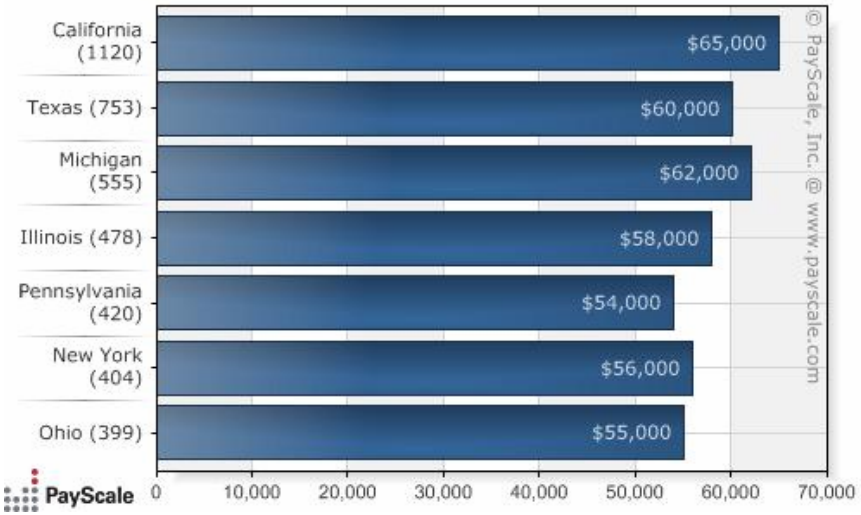
- Without co-op, offerings to graduate in 3 years
- Guaranteed offerings to graduate in 4 years
- 5-year B.S./M.S. program offered
- Minor -BA (18 cr.)

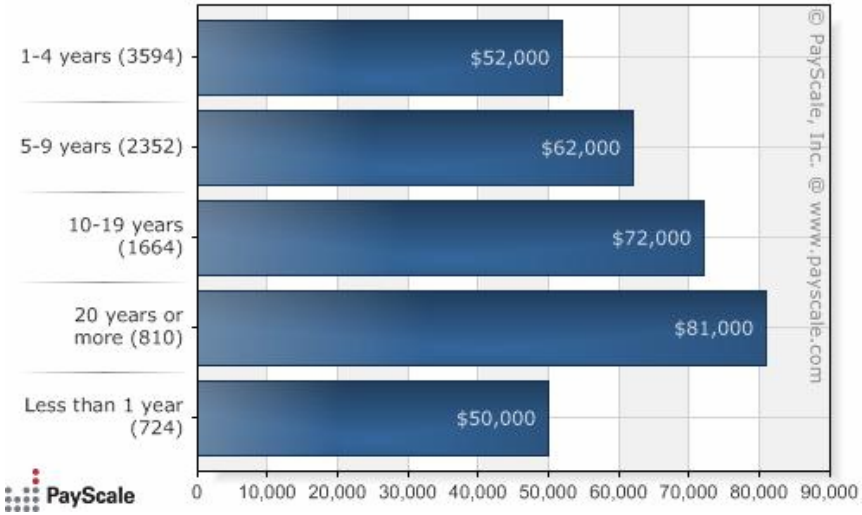


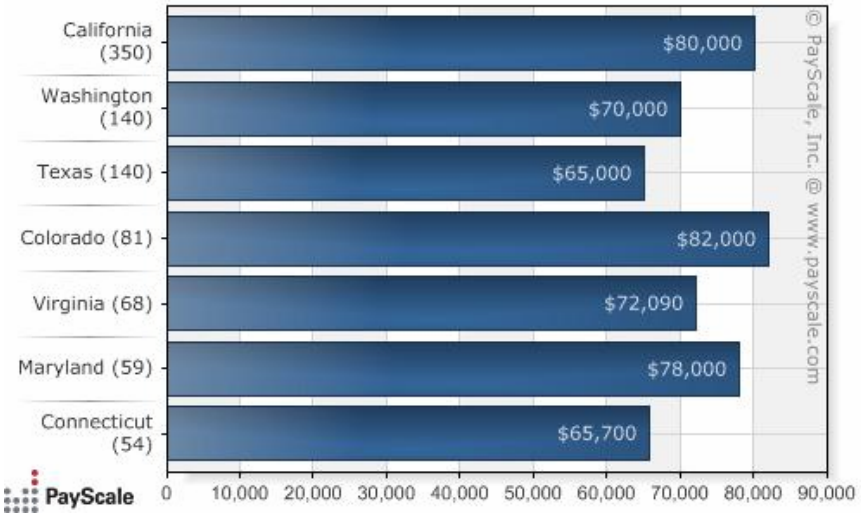
After the B.S.

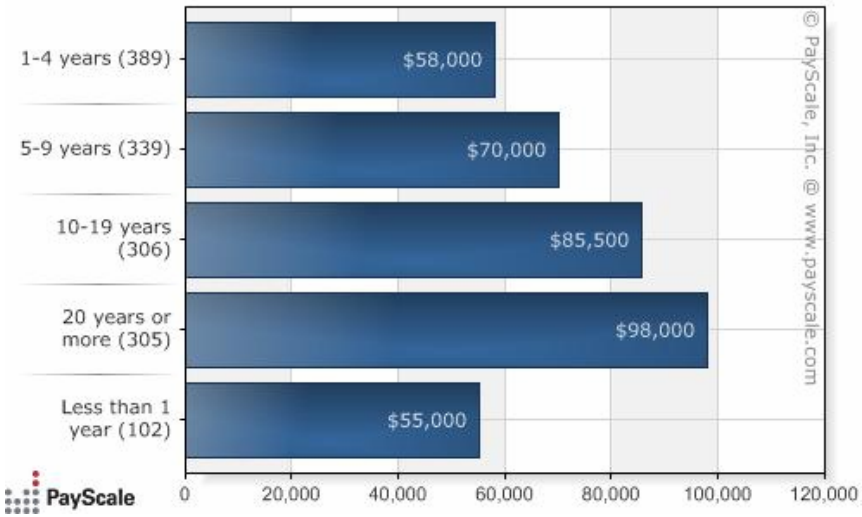
- Graduate program #1 among Jesuit colleges
- May lead directly to law, medicine or MBA
- 99% of recent grads had jobs within 6 mos.
- Average starting salaries above national average

2007 Salaries of MEs/AEs









Today's Situation

- 21st century
- Age of information
- Medical wonders
- Manufacturing
- World market
- Competitiveness

Today's Vision

"Engineers put things together to make things that haven't been around before. To accomplish this, they must work with people, resources & policies, & they must consider social needs. In short, engineering is an integrative process & engineering education should be dedicated to that end."

–Joe Bordogna

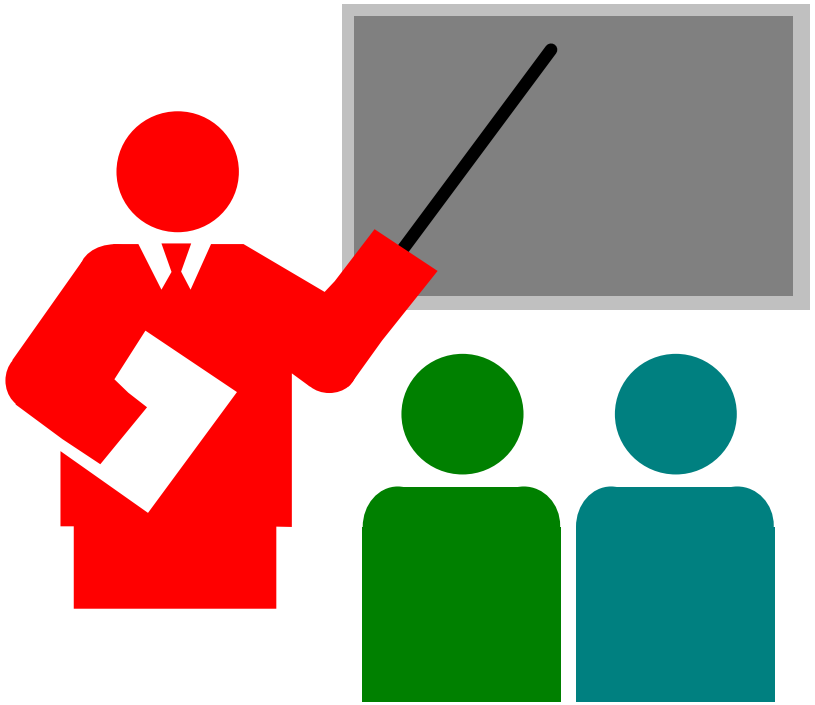
NSF Assistant Director

The Key

- Controlled membership
- High standards
- Organization
- Cross-disciplinary
- Hands-on experience
- Passive education
- Communication skills
- Career orientation

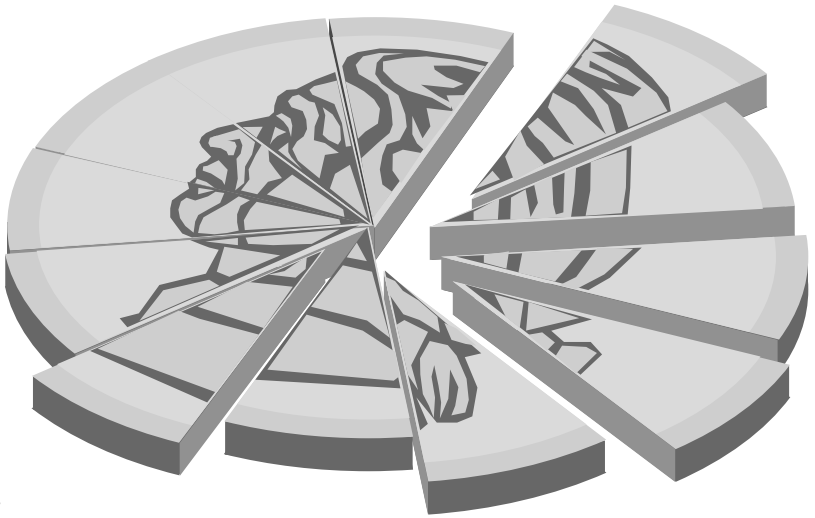
Continual Improvement

- Improve existing courses
- Add new material, courses, workshops & extra-curricular activities
- Add new policies to control the quality of instruction



Improve Existing Courses

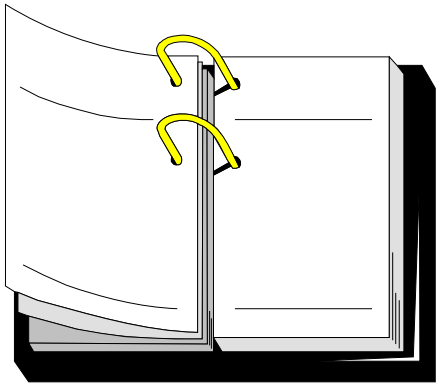
- The student portfolio
- Case studies
- Research/design projects
- Assembly projects
- Computer projects
- Professional principles
- Other tips



The Student Portfolio

- A holistic self-assessment tool
- To evaluate a student's progress
- To demonstrate organized learning
- To assess the overall course effectiveness
- A marketing device
- Reference aid

- MIT & CUNY
- Univ. of Colorado
- Arizona State Univ.
- Fairfield Univ.
- CO School of Mines



Case Studies

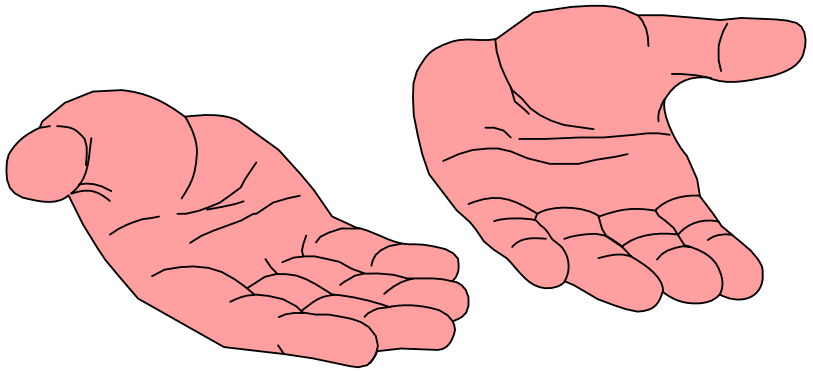
- Real-life issues
- Integrated into what students are learning
- Actual industry
- Demonstrate business, social & legal considerations
- Interaction with non-engineers
- Early knowledge of what engineers do
- Equipping them with tools to aid in making decisions
- How to deal with open ended problems
- Putting students to work on cases

Research/Design Projects

- Provide guidance to independent work
- Drive & self-motivation
- Creativity & logic
- Persistence & the desire to excel
- Ability to communicate results
- Cooperation & team work
- Temper & honesty
- Technical ability
- Local & global community interests
- The importance of keeping up with current knowledge

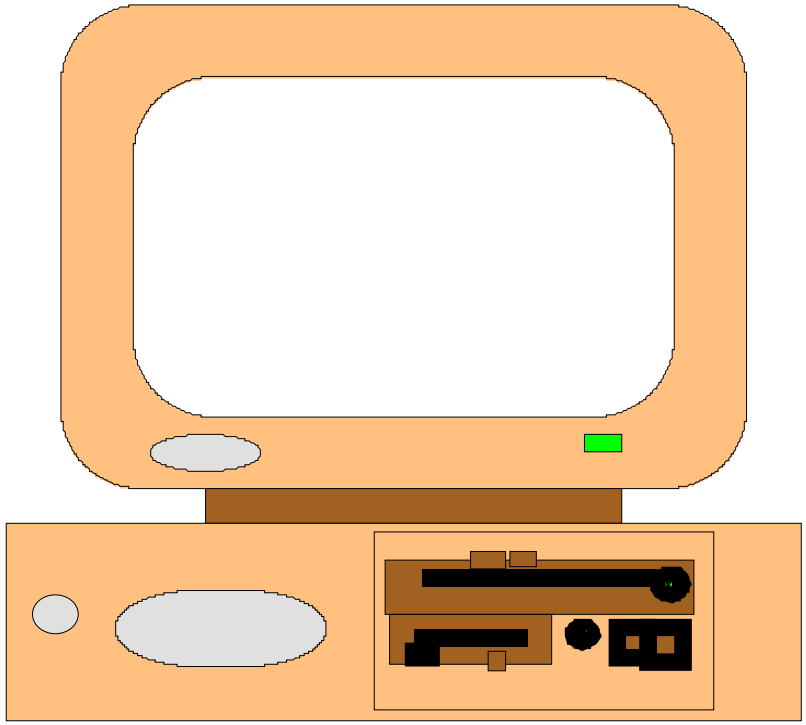
Assembly Projects

- Disassembling , sketching & reassembling common mechanical devices
- Course related
- Power tools, guns, disposable cameras & other domestic accessories



Computer Projects

- Programming skills
- Electronic research & connectivity
- Convenient posting of student & course home pages
- Working in groups on projects that involve integrating several disciplines



Professional Principles

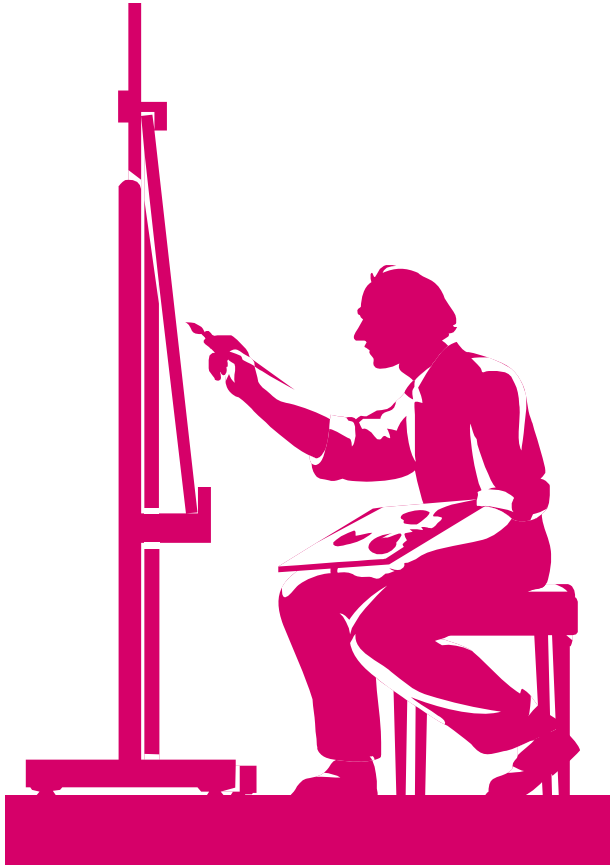
- Promote awareness of professional codes & organizations in individual fields
- Implement three characteristics that make engineering a profession:
    1. High ethical standards
    2. Controlled membership, based on proven skill & conditioned on ethical behavior
    3. Specialized skill that is important to human welfare

New Material . . .

- Early drafting skills
- Reports & proposals
- Business links
- Group projects
- Internships
- Passive learning

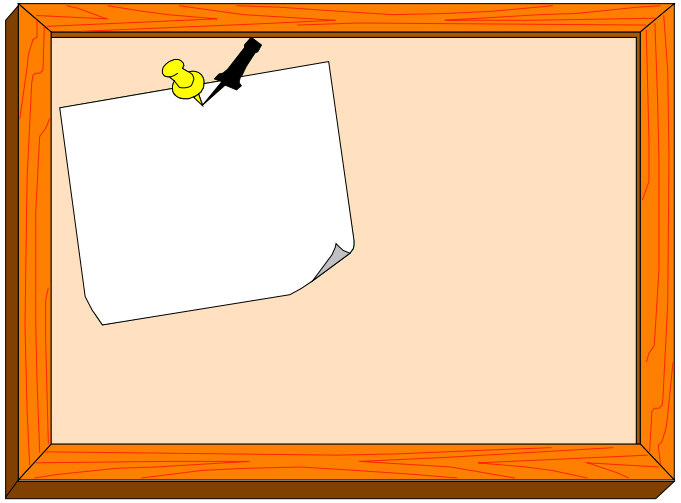
Drafting Skills

- SolidWorks- Pro-Engineer, AutoCAD, Cadkey, . . .
- Does not require eng'g knowledge
- Gives students time to gain experience
- Needed in industry



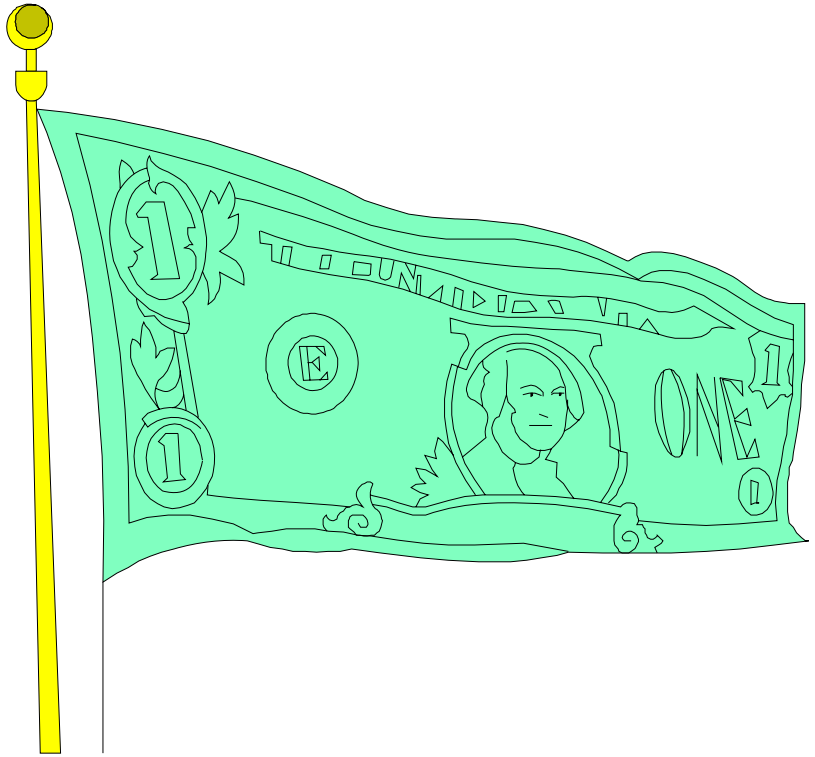
Reports & Proposals

- Compete to gain funding from local industry
- Proposal writing, budgeting, manpower allocations, personnel management & overseeing the lab.
- External assistance



Business Links

- Electives in business administration, accounting, personnel management & business law



Group Projects

- Internal, within the college
- External, with industry

Internal Group Projects

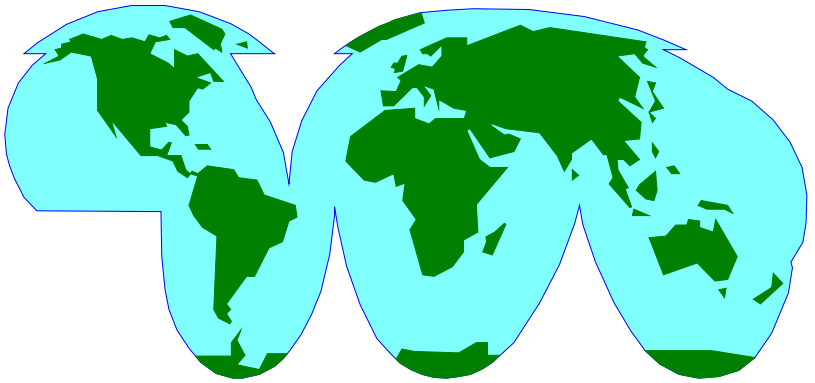
- Formed from students sharing the same interests
- Each group designs & constructs its process
- Writes a report & makes an oral presentation
- Hardware contribution from local industry
- Using toolkits donated from various contributors
- Simple examples, solar cookers, windmills, water pumps, etc.

External Group Projects

- Projects funded by industry, $10-20 K range
- Proposals won by faculty & students
- Work supervised by faculty
- Partial reinvestment in improving labs
- Practical experience leads to prospective employment
- Students given credit

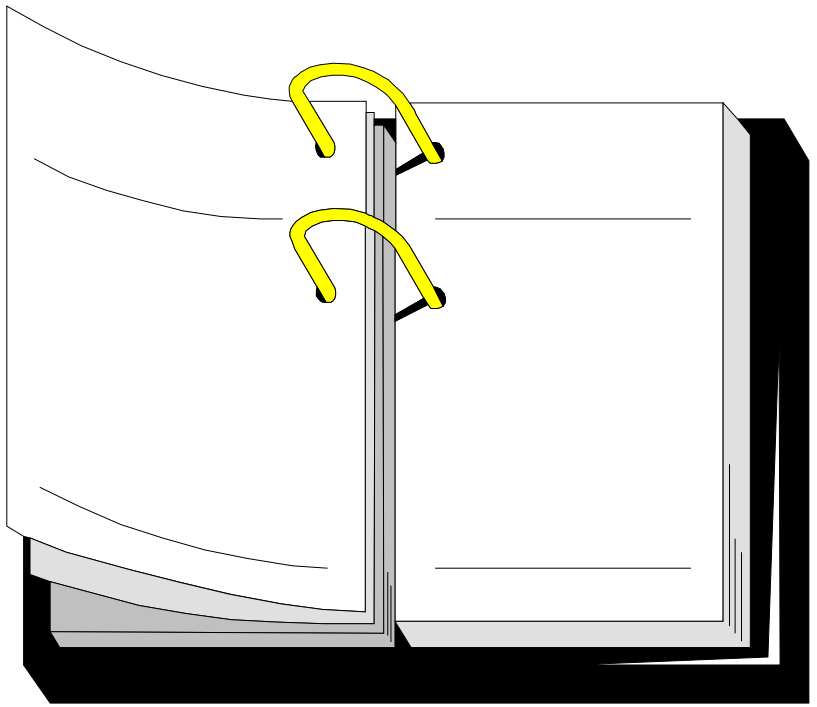
Internships

- With industry
- Student exchange programs with universities in Germany, France, England & Canada
- Promoting exposure to other cultures
- Foreign language benefits



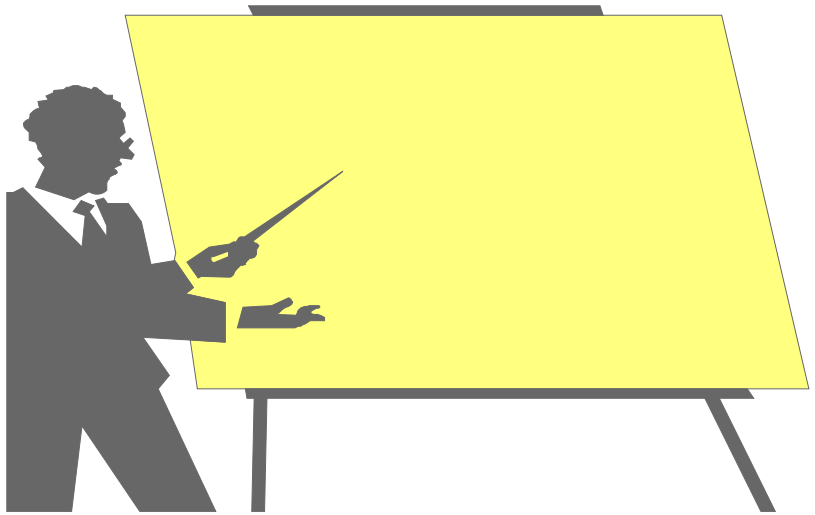
Passive Learning

- Guest lecturers from industry
- Circulating videos & multimedia related to class material
- Factory tours, safety workshops, career placement seminars, etc.



Quality Instruction

- The teaching dossier
- Student feedback
- Academic advising



The Teaching Dossier

- Statement of philo
- Student comments
- Teaching awards
- Innovative materials
- Syllabi, exams, notes
- Design/research projects, case studies
- Evidence of modern integrative methods
- Solid evidence of instruction quality
- An expression of scholarship
- Organizing material leads to improved class performance
- Used in Canada & 700 U.S. institutions

Student Feedback

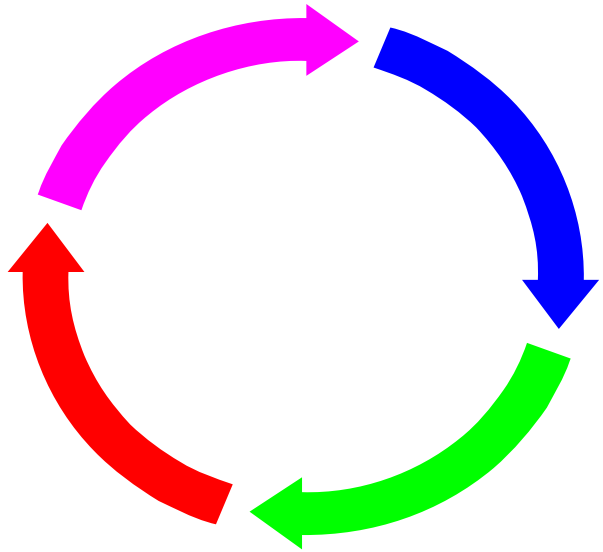
- 1st-hand appreciation
- 1-minute forms
- Elite volunteer teams
- Continuous feedback
- Equal footing
- Classroom Assessment Techniques

Academic Advising

- Problem: 30% switch out
- Up-to-date, well informed
- Assess student's ability
- Listen to personal issues
- Assistance programs
- Career options/interests
- Enough to write a recom.
- Call or email

Fundamental Groups

- Energy Systems
- Manufacturing
- Materials Science & Engineering
- Mechanical Systems

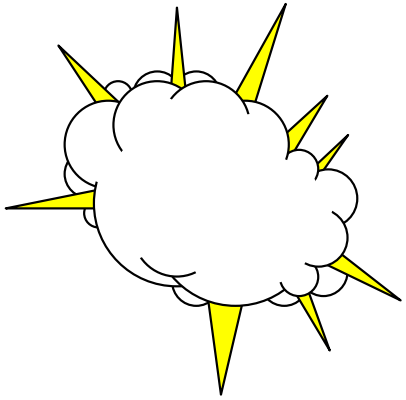


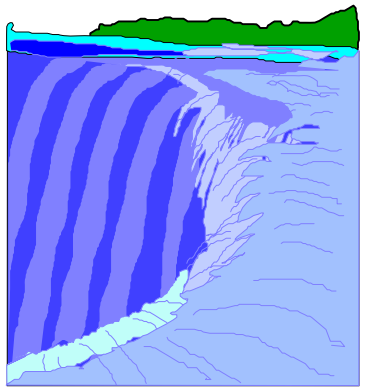
Fundamental Areas

- Energy - Systems (power plants, vehicles), Equipment (engines, turbines) & Processes (modeling, optimization)
- Manufacturing - Systems (assembly, transfer, automation), Equipment (tools) & Processes (machining, forming)
- Materials - Selection & Characterization, Processing & Development
- Mechanical Systems -Mechanics, Vibrations, Stress Analysis

Energy Systems

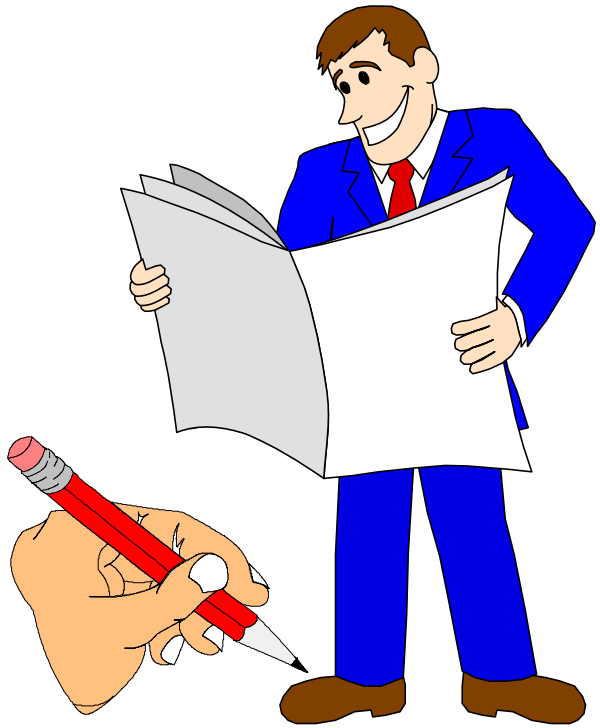
- Heat Transfer
- Thermodynamics
- Fluid Mechanics
- Computational Methods
- Propulsion
- Turbomachinery
- Solar Energy
- Wind Energy





Manufacturing

- Design
- Controls
- Processes
- Ergonomics & Safety
- Quality & Reliability

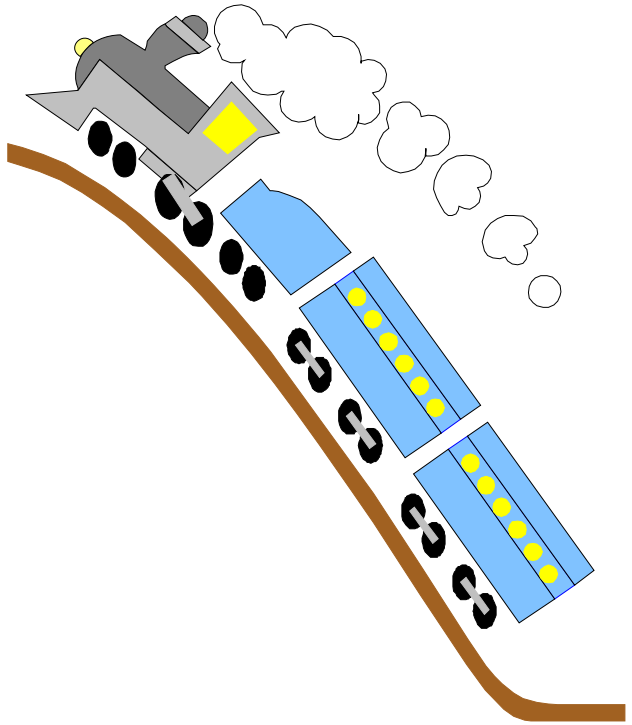


Materials Science & Engineering

- Metallurgy
- Smart Materials
- Solidification
- Ceramics
- Composites
- Phase Transformations
- Thermodynamics & Phase Equilibria

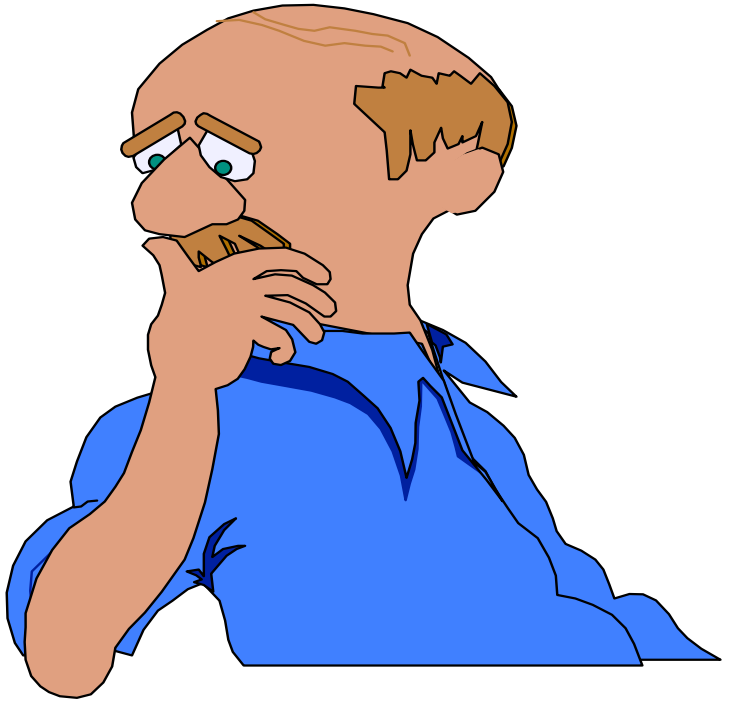
Mechanical Systems

- Elasticity
- Strength of Materials
- Dynamics & Vibrations
- Automotive
- Robotics
- Materials Engineering



Will It Change in the Future?

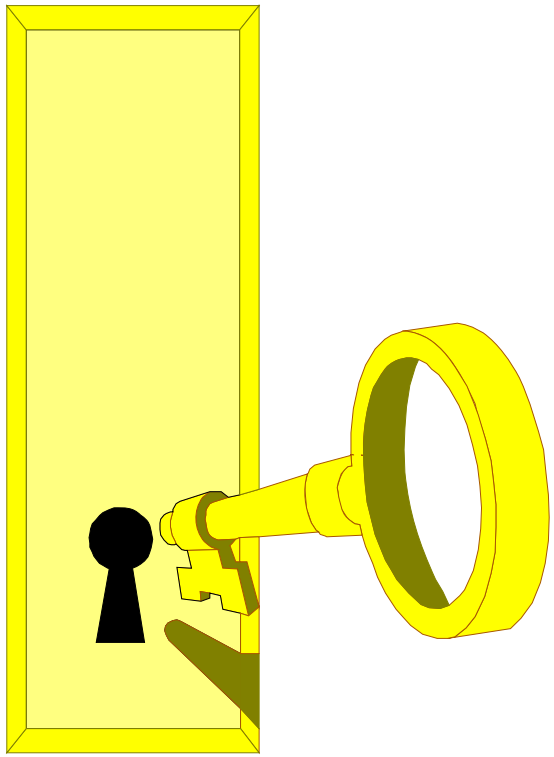
- Engineering activities will remain essentially unchanged
- The engineering branches will remain essentially unchanged –new may surface



- Greater emphasis will be placed on the cross-disciplinary approach & team player function

The Keys to Success

- "Love is the pursuit of the whole" -Plato
- Faith
- Dedication & effort "study hard"
- Discipline & attitude "study smart"
- Determination "don't give up"



The Jesuit Tradition

"A.M.D.G."

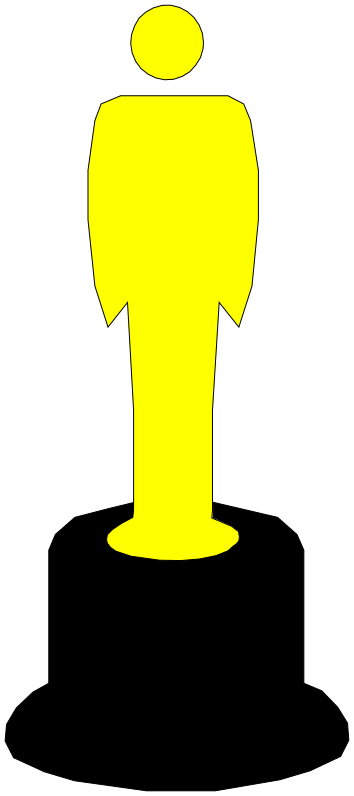
The Jesuit Tradition

"The engineer should use his talents in order that man may have more power, but must guard against depreciating human values."

–A.A. Potter

St. Ignatius of Loyola

- 1491–1556
- 1521, Pamplona
- Sept 27, 1540
- Pope Paul III
- Company of Jesus
- Spiritual Exercises



St. Jean-Baptiste de La Salle

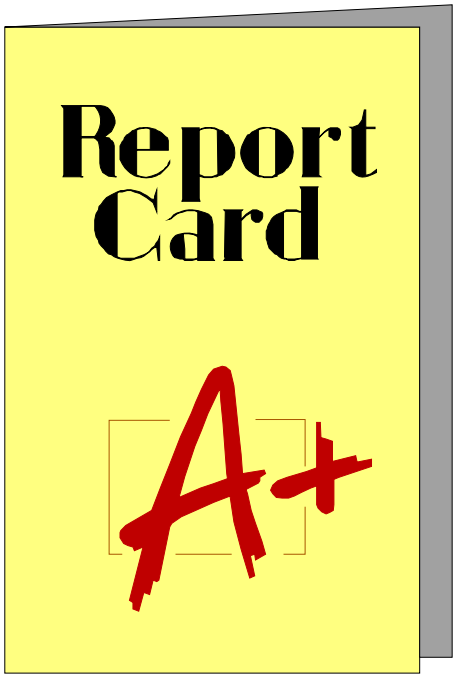
b. April 30, 1651, Reims, France--d. April 7, 1719, Rouen; canonized 1900; feast day April 7), French philanthropist, educator, and founder of the Brothers of the Christian Schools, the first Roman Catholic congregation of male nonclerics devoted solely to schools, learning, and teaching. Of noble birth, La Salle was ordained priest in 1678 and devoted himself to education of the poor. He helped to establish charity schools in Reims and subsequently formed his teachers into a religious order (1680). He also set up boarding schools for middle-class boys, reformatories, and--for the first time--training colleges for secular teachers. In 1725 Pope Benedict XIII raised La Salle's congregation to the status of a papal institute. Among his writings are Les Devoirs d'un chrétien (1703; "The Duties of a Christian"), two series of Méditations (1730–31), and La Conduite des écoles chrétiennes (1720; "The Conduct of Christian Schools").

The Ancient Code of the Warrior

- A knight is sworn to valor
- His heart knows only virtue
- His blade defends the helpless
- His might upholds the weak
- His word speaks only truth
- His wrath undoes the wicked

Purpose of Jesuit Education

- Finding God in All Things
- Laboring For the Greater Glory of God & the Good of Souls
- Cura Personalis
- Aiming for the Magis
- Fostering teamwork and lasting friendships
- Reflection for the purpose of self-betterment



The Universal Good

"The more universal the good is, the more it is divine. Therefore preference ought to be given to those persons & places which, through their own improvement, become a cause which can spread the good accomplished to many others who are under their influence or take guidance from them."

–St. Ignatius of Loyola

Serving a Greater Cause

"For the same reason, preference ought to be shown to universities which are generally attended by numerous persons who, by being aided themselves, can become laborers for the help of others."

–St. Ignatius of Loyola

Faculty Creed

"We believe in providing engineering education to our students in the Jesuit tradition in order to prepare them to enter society both as outstanding engineers & as persons with high moral values & ethical standards who possess a zeal to work for the benefit of all humankind."

Goals & Objectives

- The making of a fine engineer
- Analytical, numerical & experimental
- Serious, dedicated & talented
- Broad-minded & holistic
- Well-prepared to work with industry
- To pursue graduate work

By Word & Deed

"If you live & work in such a way that proclaims you have values in your lives, that proclaims the worth of other persons, that proclaims that you are using your education in the service of others, that proclaims you are a humane leader, then we can say that we have given you an education in the Jesuit tradition."

Enduring Values & Aspirations

- *Cura personalis* - care for the individual
- *Magis* - seeking the "more"
- Women & men for others
- Unity of heart & mind - education of the whole person
- Contemplatives-in-action

MAGIS

CONTEMPLATIVES-IN-ACTION

LEADERS-IN-SERVICE

"We want graduates who will be leaders concerned about the society & the world in which they live, desirous of eliminating hunger & conflict in the world, sensitive to the need for more equitable distribution of God's bounty, seeking to end sexual & social discrimination, eager to share their love with others. In short, we want our graduates to be leaders-in-service. That has been the goal of Jesuit education since the 16th century. It remains so today."

Distinctive Quality

"The most distinctive quality of a Jesuit University is the fact that it takes its mission of service to all members of the community far more seriously than its secular counterparts. Knowing what the institution stands for & what it aspires to be, students will modify their behavior in a manner consistent with the institution's values & aspirations."