THE ENGINEER

Chapter 1

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Introduction to Engineering

- Definitions
- Technology Team
- Engineering Disciplines at WVU
- Engineering Functions
- Career Paths
- ABET Requirements
- Engineering Profession

What is Engineering?

- The Accreditation Board for Engineering and Technology (ABET) defines engineering: “the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.”

What is Engineering?

- Engineering is a profession like medicine, law, etc. that aspires to high standards of conduct and recognizes its responsibility to the general public.

Technology Team

- Scientist - Like an engineer, but her/his primary goal is the expansion of knowledge and understanding physical processes.
- Engineer - Applies knowledge of math and the physical sciences to the efficient design and construction of usable devices, structures and processes.

Technology Team

- Technologist - Technologists focus on direct application of established engineering principles and processes. Math, the physical sciences, and underlying engineering theory receive limited coverage. More interested in hardware and processes.

Technology Team

- Technician - Completes a 2 year degree in a narrow technical area such as electronics, drafting, or machining.
- Artisans - Training may be a combination of schooling and work experience. Examples include, welders, machinists, electricians, carpenters, painters, steel workers, and artists.

Engineering Disciplines at WVU

- Chemical
- Civil & Environmental
- Computer Science and Electrical
- Industrial & Management Systems
- Mechanical & Aerospace
- Mining
- Petroleum & Natural Gas

Engineering Functions

- The focus of an engineer's work typically falls into one or more of the following areas:
  - Research - explore, discover and apply new principles
  - Development - transform ideas or concepts into production processes
  - Design - link the generation of ideas and the production

Engineering Functions

- Production and testing - manufacture and assemble components or products.
- Sales - market engineering products.
- Operations - maintain equipment and facilities.
- Construction - prior to construction organizes bids, during construction supervises certain components of process.

Engineering Functions

- Management - optimize the use of resources (equipment, labor, finances)
- Education - teach engineering principles in university and industrial settings.
- Consulting - provide specialized engineering services to the clients. May work alone or in partnership with other engineers.

Who employs engineers?

Sector of Employment	Aero	Chem	Civil	Elec	Ind	Mech
Industry	63.3	74.0	48.9	69.6	76.7	75.8
Self	11.1	12.7	14.4	12.2	11.5	11.4
Education	3.5	5.0	3.0	4.9	3.6	3.9
Non-profit	2.4	1.7	0.5	1.5	1.7	1.1
Fed. Govt.	4.7	4.6	9.3	9.3	4.6	6.1
Military	4.3	0.3	1.3	0.9	0.3	0.4
Other Govt.	0.4	1.3	22.1	1.1	1.4	0.9
Other	0.3	0.4	0.5	0.5	0.2	0.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Percentages of Employed Engineers by Major Fields and Sector of Employment (Based on 1988 data from Wright)

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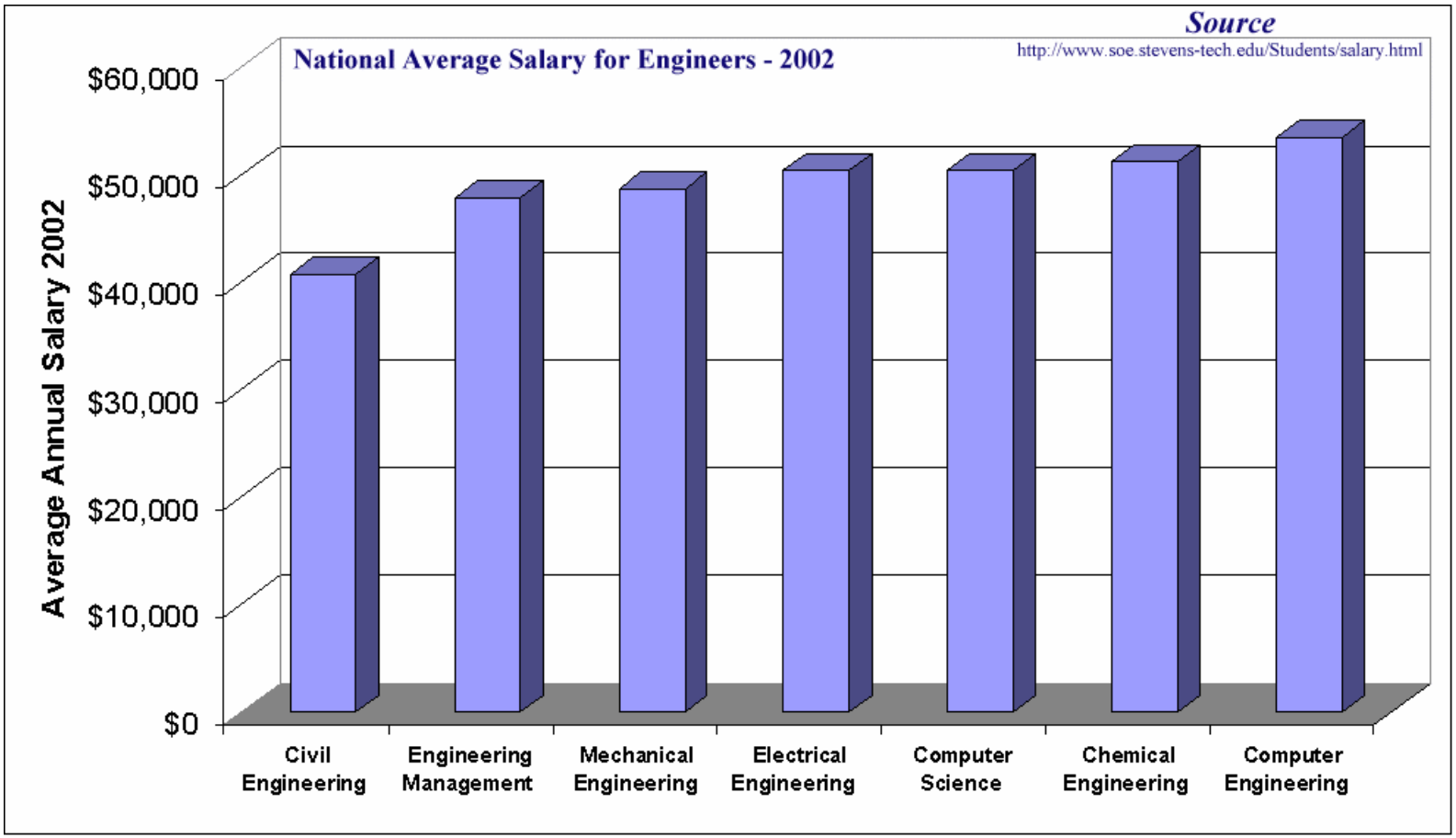
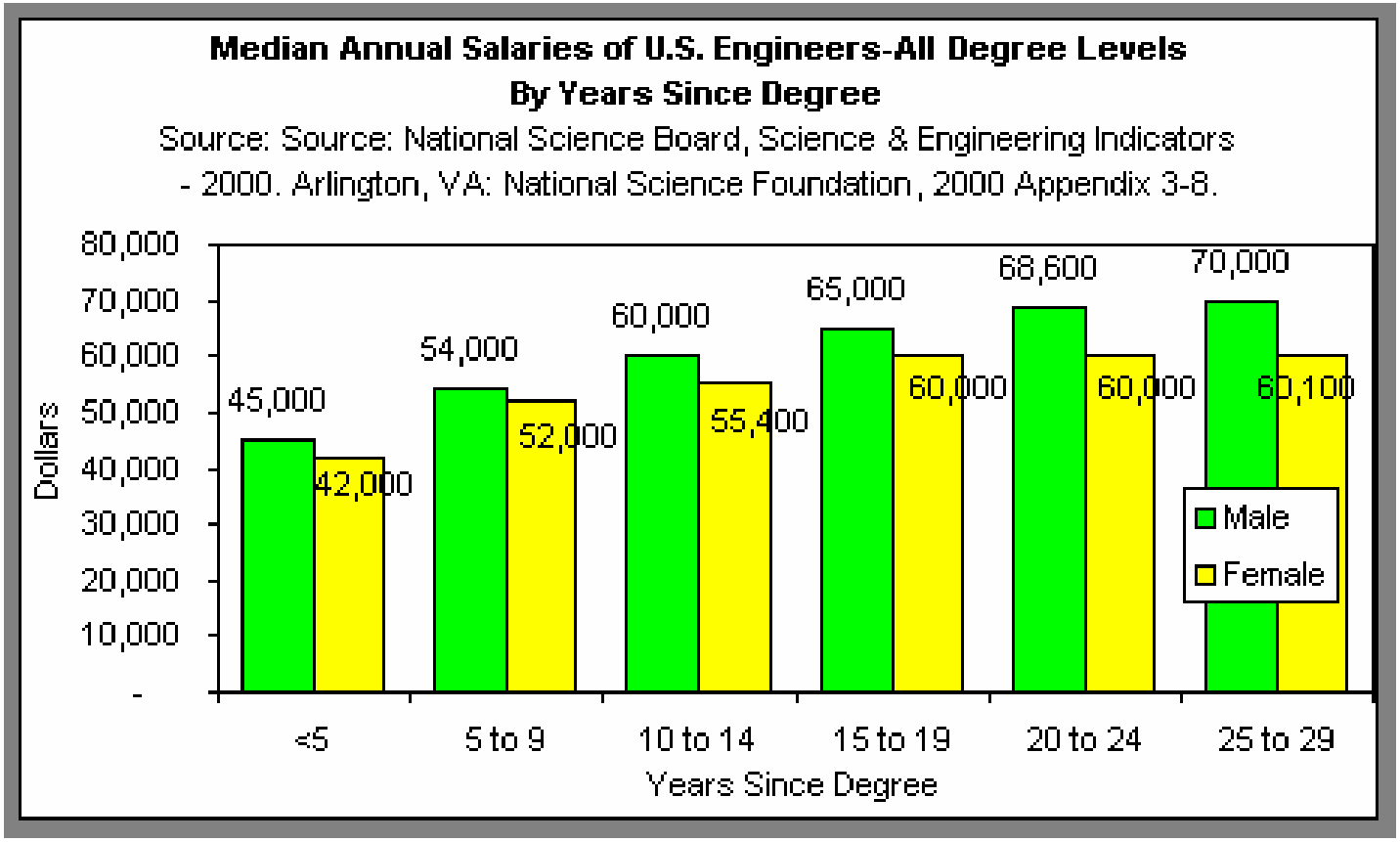
Adapted From 1990 Census

Engineers	Men	Women	Total	% Men	% Women
Electrical & Electronic	420,471	46,552	467,023	90.0%	10.0%
Civil	235,162	17,646	252,808	93.0%	7.0%
Mechanical	176,092	9,780	185,872	94.7%	5.3%
Industrial	151,859	24,474	176,333	86.1%	13.9%
Aerospace	131,786	11,648	143,434	91.9%	8.1%
Chemical	57,163	7,157	64,320	88.9%	11.1%
Petroleum	22,908	1,657	24,565	93.3%	6.7%
Metallurigical & Materials	17,021	2,209	19,230	88.5%	11.5%
Nuclear	10,108	693	10,801	93.6%	6.4%
Mining	6,063	415	6,478	93.6%	6.4%
Agricultural	2,012	136	2,148	93.7%	6.3%
Marine & Naval Architecture	12,776	493	13,269	96.3%	3.7%
Other	308,540	33,423	341,963	90.2%	9.8%
Total	**1,551,961**	**156,283**	**1,708,244**	**90.9%**	**9.1%**
Other Professionals					
Lawyers	564,332	182,745	747,077	75.5%	24.5%
Physicians	465,468	121,247	586,715	79.3%	20.7%
Pharmacists	114,949	66,849	181,798	63.2%	36.8%
Architects	133,212	23,662	156,874	84.9%	15.1%
Dentists	135,588	19,941	155,529	87.2%	12.8%
Total	**1,413,549**	**414,444**	**1,827,993**	**77.3%**	**22.7%**
Scientists					
Chemists	102,505	38,750	141,255	72.6%	27.4%
Biologists	36,207	25,930	62,137	58.3%	41.7%
Physicists	24,238	3,604	27,842	87.1%	12.9%
Total	**162,950**	**68,284**	**231,234**	**70.5%**	**29.5%**
Total Employed	**3,128,460**	**639,011**	**3,767,471**	**83.0%**	**17.0%**
Total U.S. Population	**121,172,379**	**127,537,494**	**248,709,873**	**48.7%**	**51.3%**

Engineering Salaries



Engineering Salaries

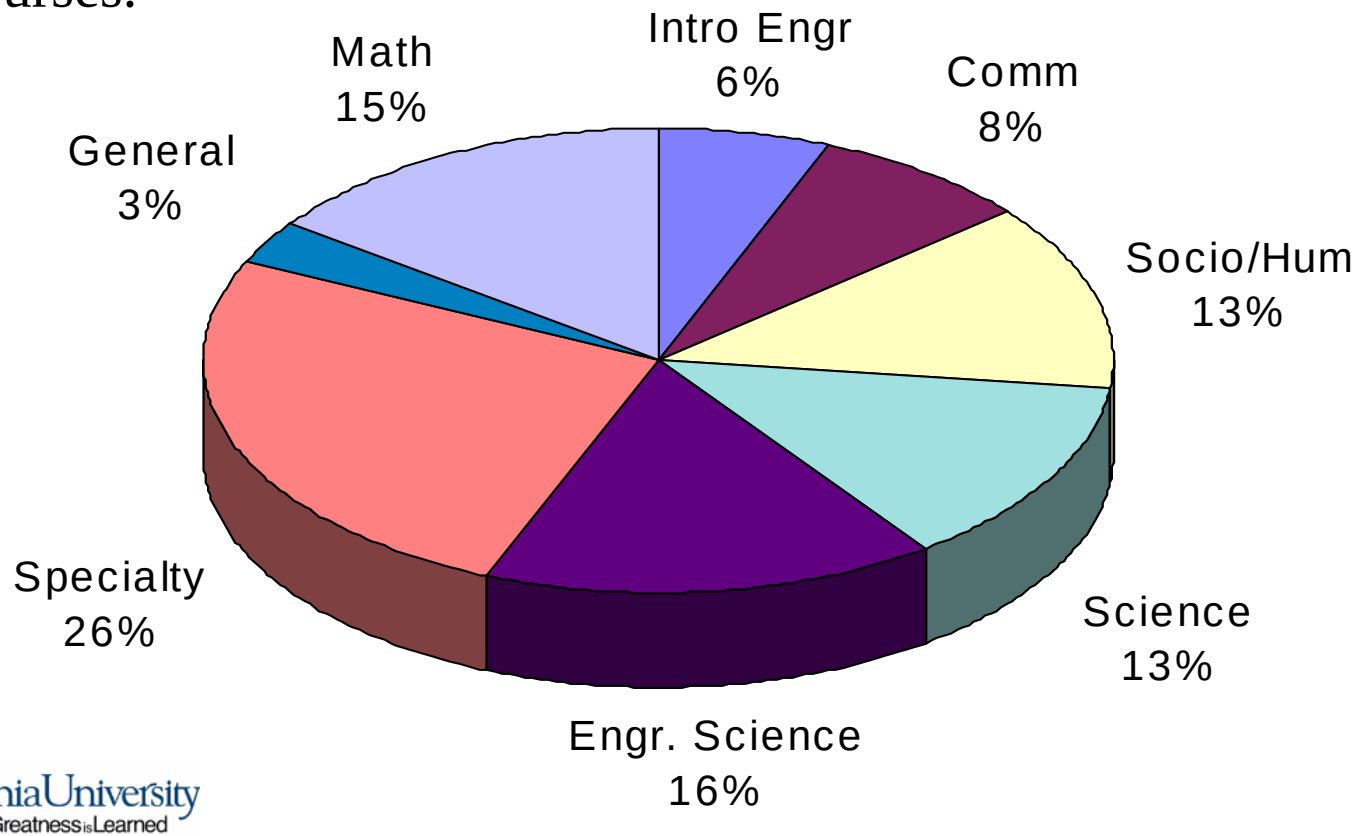


Career Paths for Engineers

- There are at least seven career options for graduating engineering students:
  1) Corporate ladder
  2) Independent entrepreneur
  3) Military or government
  4) Engineering and social services abroad
  5) Professor/engineer
  6) Graduate work outside engineering
  7) A mix of first six options

ABET Engineering Curricula

Four year engineering programs approved by The Accreditation Board for Engineering and Technology (ABET) includes a broad range of courses.



Why do I care about ABET accreditation?

- ABET audits engineering programs on a regular basis to assure that the program maintains high standards.
- Having an engineering degree from a four-year accredited engineering program is required to become a registered professional engineer.
- All degree programs in the College of Engineering & Mineral Resources at WVU are accredited by ABET.

Engineering as a Profession

- Engineering possesses those attributes that typically characterize a profession:
  - Satisfies an indispensable and beneficial need.
  - Requires the exercise of discretion and judgment and is not subject to standardization.

Engineering as a Profession

- Involves activities that require knowledge and skill not commonly possessed by the general public.
- Has group consciousness for the promotion of knowledge and professional ideas and for rendering social services.
- Has a legal status and requires well-formulated standards of admission.

Professional Registration

Six steps are typically required to become a registered professional engineer:

1. Graduate from an ABET approved (4 year) engineering curriculum.
2. Pass the fundamentals exam (FE) engineer in training exam in their last term or after graduation.

Professional Registration

3. Complete a minimum of four years of engineering practice.
4. Obtain letters of references and approval to take PPE.
5. Pass the Professional Exam (PE) or the Principals and Practice Exam (PPE).
6. Apply to individual states for professional license.

Professional Organization Student Chapters

- Every engineering discipline at WVU has a student chapter for its professional society.
- Contact your department for more information.
- You are encouraged to get involved with your student chapter.

THE SCIENTIFIC METHOD

- Develop a hypothesis of a physical phenomenon.
- Design an experiment to test the hypothesis.
- Perform the experiment & analyze the results.
- Generalize the experimental results into a law or theory.
- Publish the results.

The Engineering Design Method

- Scientists are concerned with discovering *what is*, whereas engineers are concerned with designing *what will be*.

The Engineering Design Method

- Identify and define the problem.
- Assemble a design team.
- Identify constraints & criteria for success.
- Analyze potential solutions.
- Choose the best solution.
- Document the solution.
- Communicate the solution to the management.

The Engineering Design Method

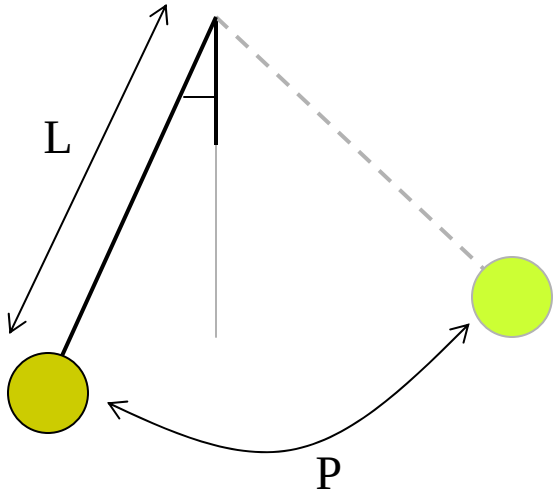
- Construct the solution.
- Verify and evaluate the performance of te solution.

The Engineering Design Method

- Your engineering education will focus primarily on ANLYSIS.
- During the analysis of physical systems, engineers use MODELS.
  - A model represents the real system of interest.
  - A model should be an accurate representation of reality.

MODELS

- Qualitative Models
  - Longer string lengthen the periods.
  - A simple and useful relationship but insufficient for analysis

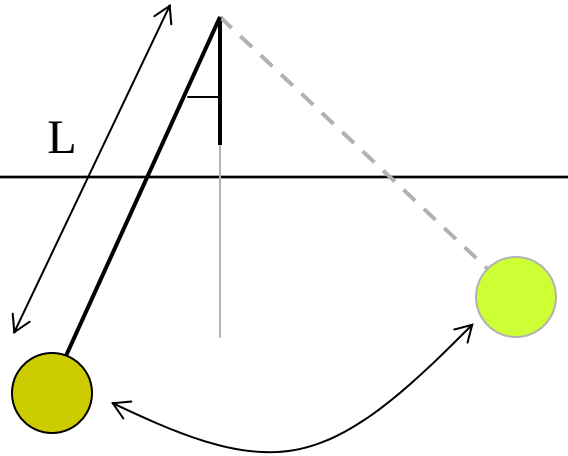


MODELS

- Mathematical Models
  - Engineers need quantitative values.
  - Qualitative ideas should be formulated into equations (that is why you need math) in order to be analyzed.
  - Take the pendulum problem, for example

MODELS

- Mathematical Models



$$P = 2\pi\sqrt{\frac{L}{g}} = \frac{2\pi}{\sqrt{g}}\sqrt{L} = k\sqrt{L}$$

Period

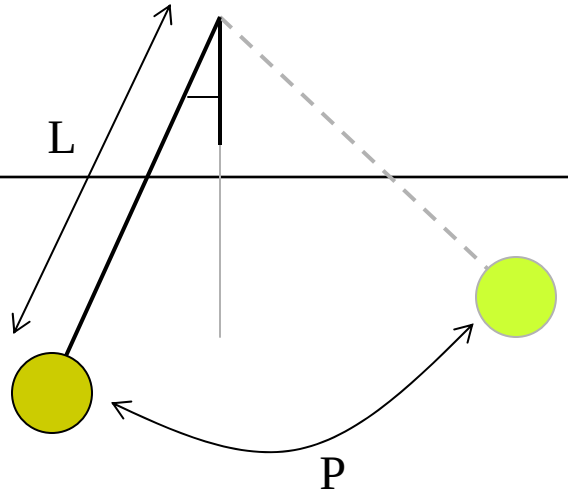
Length
(measured from the pivot to the center of the pendulum mass)

Proportionality Constant

Acceleration due to gravity 9.8 m/s^2

- This is not an exact model. Many assumptions have been made.
- A complete model is hopelessly complex.

MODELS



- Mathematical Models

$$P = 2\pi\sqrt{\frac{L}{g}} = \frac{2\pi}{\sqrt{g}}\sqrt{L} = k\sqrt{L}$$

- Why is the model not exact?
  - Air drag
  - Friction @ pivot
  - Buoyancy of the mass in air
  - g decreases at distances from center of earth
  - …

MODELS

- Digital Computer Models
  - Using computers to solve the mathematical model.
  - Calculate the position of pendulum with time.
    - Air density
    - Buoyancy forces
    - Acceleration due to gravity
    - Air drag
    - Friction
    - …..

MODELS

- Digital Computer Models
  - Using finite difference (element) calculus.
  - Take small steps in time and space
  - Lots of work.
  - Once formulated, the computer does all the work.

MODELS

- Analog computer models
- Using electronic circuits to simulate physical systems.
- Rarely used, now that digital computer models can be built.

MODELS

- Physical Models
- For highly complex and sensitive systems a physical model may be necessary.
  - Wind tunnel models for space shuttle.
  - Silt deposits and rainfall effect on the Mississippi river's flow rate.
  - Pilot plans to test chemical processes before industrial-scale plants.

TRAITS OF AN ENGINEER

- Interpersonal Skills
- Communication Skills
- Leadership
- Competence
- Logical Thinking
- Quantitative Thinking
- Follow-Through

TRAITS OF AN ENGINEER

- Continuing Education
- Maintaining a Professional Library
- Dependability
- Honesty
- Organization
- Common Sense
- Involvement in Community
- Creativity

CREATIVITY

"Imagination is more important than knowledge"

Albert Einstein

- Arguments about teaching creativity:
  - Creativity must be expected & fostered.
  - Education above evaluation (grading).
  - We know enough about creativity to foster it.

CREATIVITY

- It is rarely addressed during an engineering education.
- Your education is concentrated mainly on knowledge.

CREATIVITY

- Problem solving requires manipulation of knowledge through:
  - Analysis
  - Synthesis
- Very little, if any, emphasis is put on synthesis during your engineering education.
- We usually focus on analysis.

CREATIVITY

- Authors, Artists, Composers & ENGINEERS?!!!!
- Do we belong to this group?
- We all create and must be creative.
- Our constraints cannot be ignored ….
- Therefore our creativity is far more complex.

CREATIVITY

- KISS : Keep It Simple, Stupid.