The Making of an Engineer

– *ABET's Criteria and*
– *What you need to know*

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Video & Audio available: http://screencast.com/t/BGkoOWaW

ABET

Accreditation Board for Engineering and Technology

ABET, incorporated in 1932 as the Accreditation Board for Engineering and Technology, Inc., is a non-governmental organization that accredits post-secondary education programs in applied science, computing, engineering, and engineering technology.

www.abet.org

http://www.abet.org/accreditation/accreditation-criteria/

ACCREDITATION CRITERIA AND SUPPORTING DOCS

MENU

The *Accreditation Criteria* and the *Accreditation Policy and Procedure Manual* may change from one accreditation cycle to the next. Please see Accreditation Alerts for a summary of the important board-approved changes for each year.

ACCREDITATION POLICY AND PROCEDURE MANUAL

REQUEST FOR EVALUATION (RFE)

WHY ACCREDITATION MATTERS

NEW TO ACCREDITATION?

GET ACCREDITED

ACCREDITATION CRITERIA

Accreditation Criteria & Supporting Documents

Current ABET Student Outcomes: Graduates will

- identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
- communicate effectively with a range of audiences
- recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
- function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- acquire and apply new knowledge as needed, using appropriate learning strategies.

“recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

- Professional and Ethical Responsibilities
- Informed Judgements
  - Technical Competency
  - Safe Practices
  - Contemporary Issues
  - –
- Engineering's Context
  - Global,
  - Economic,
  - Environmental,
  - Societal

Expectations for You

- Technical Competence
- Informed Decisions
- Ethical Practice and Behavior
- Aware of
  - Global Interface
  - Environment
  - Economics
  - Societal Impact
  -

Why Care?

Case Study Resume

- Career Goal

  Work as an architect to design new structures employing modern construction materials and techniques
- Education
  - BS. Architecture; postgraduate studies
- Interests
  - Skiing
  - mountaineering.
  - mathematics
  - football
- Certifications
  - Passed EIT exams
- Honors
  - Selected as Assistant to Professor Tessenow

Our Case Study

"For the commission to do a great building, I would have sold my soul like Faust. Now I had found my Mephistopheles. He seemed no less engaging than Goethe's."

Words for the Day

MEPHISTOPHELES

Mef-*uh*-stof-*uh*-leez

a chief devil in the Faust legend

MEPHISTOPHELIAN

Me · phis · to · phe · lean

Adjective, Wicked, fiendish

Mephistopheles was the Chief Devil in Goethe's Tragic Play *Faust,* 1772

Our Case Study

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Albert Speer

Third Reich's Architect +

"I was *intoxicated* by what I heard and saw when I joined the Nazi Party" [at age 26 in 1931]

– – –

He was thinking of opportunity for himself, not the consequences of his actions or the causes to which he gave his talents

Someone designed the furnaces –

– of the Nazi death camps.

Someone measured the size and weight of a human corpse to determine how many could be stacked and efficiently incinerated within a crematorium.

Someone sketched out on a drafting table the decontamination showers, complete with the fake hot-water spigots used to lull and deceive doomed prisoners.

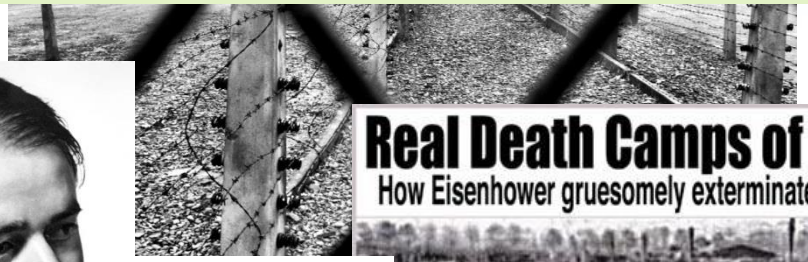
Someone, very well educated, designed the rooftop openings and considered their optimum placement for the cyanide pellets – –

http://www.thenewatlantis.com/publications/the-architecture-of-evil

Someone – , Someone – , Someone –
Someone became the poster child –

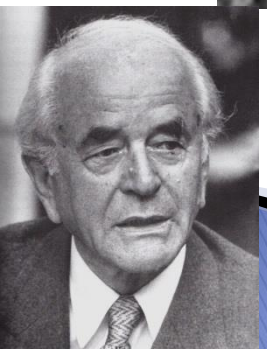
Why?

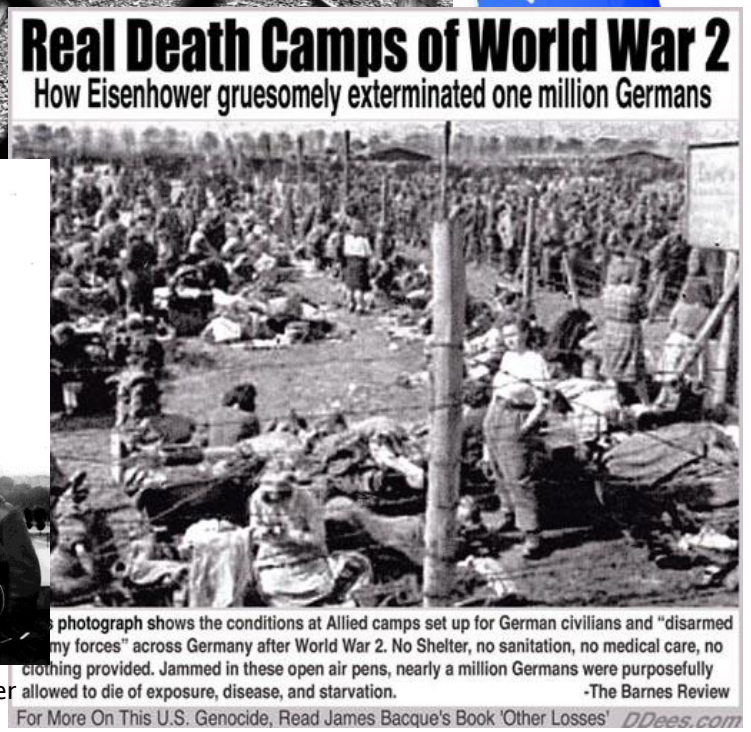
To prevent the graduation of robot-like engineers like those who engaged in WW II atrocities



Albert Spear

http://en.wikipedia.org/wiki/Albert_Speer





http://justice4germans.com/

Professional and Ethical Responsibilities

Ethics: the *moral principles that govern a person's behavior or the conducting of an activity*

Professional Ethics: *the personal, organizational, and corporate standards of behavior expected by* ***professionals****. The term professionalism originally applied to vows of a religious order (i.e. to* Profess)

Engineering Code of Ethics

I. Fundamental Canons
II. Rules of Practice
III. Professional Obligations

https://www.nspe.org/resources/ethics/code-ethics

I – Fundamental Canons

1. Engineers, in the fulfillment of their professional duties, shall:
   a. Hold paramount the safety, health, and welfare of the public.
   b. Perform services only in areas of their competence.
   c. Issue public statements only in an objective and truthful manner.
   d. Act for each employer or client as faithful agents or trustees.
   e. Avoid deceptive acts.
   f. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.
2. – –

https://www.nspe.org/resources/ethics/code-ethics

II. Rules of Practice

1. Engineers shall hold paramount the safety, health, and welfare of the public.
   a. If engineers' judgment is overruled under circumstances that endanger life or property, they shall notify their employer or client and such other authority as may be appropriate.
   b. Engineers shall approve only those engineering documents that are in conformity with applicable standards.
   c. Engineers - - - -

https://www.nspe.org/resources/ethics/code-ethics

III. Professional Obligations

1. Engineers shall be guided in all their relations by the highest standards of honesty and integrity.
   a. Engineers shall acknowledge their errors and shall not distort or alter the facts.
   b. Engineers shall advise their clients or employers when they believe a project will not be successful.
   c. Engineers shall not accept outside employment to the detriment of their regular work or interest. Before accepting any outside engineering employment, they will notify their employers.
   d. Engineers shall not attempt to attract an engineer from another employer by false or misleading pretenses.
   e. Engineers shall not promote their own interest at the expense of the dignity and integrity of the profession.
   f. _ _ _ _

https://www.nspe.org/resources/ethics/code-ethics

Informed Judgements

- Technical Competency
- Safe Practices
- Contemporary Issues

Grandpa Schnabel Talks Safety

https://www.youtube.com/watch?v=F3SO67AHxIk

Contemporary Issues

- Environmental vs. Economics
- Exploitation vs. Development
- Climate Change ?
- Wealth Transfer
- Social Justice
- Land Use
- Community Concerns
- The *Right Thing*
- – –
- – –

The Global and Societal Context of Engineering

Global

&

Societal

Not just
"Global Societal"

The Global and Societal Context of Engineering

Global
&
Economics
&
Environmental
&
Societal

Not just
"Global Societal"

Global and Societal Drivers

- Population
- Scientific and Technical Advances
- Optimization Techniques
- Political Stability
- Legal Protection
- Financial Systems

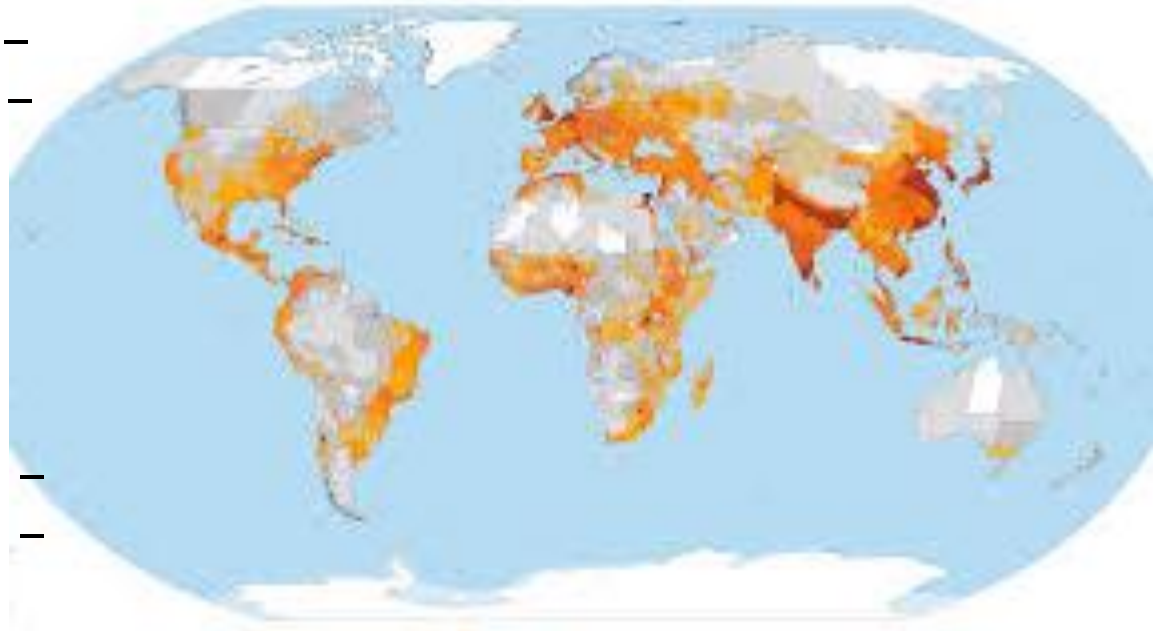
Fire Invented!

"If this gets out, we're going to need pollution controls."

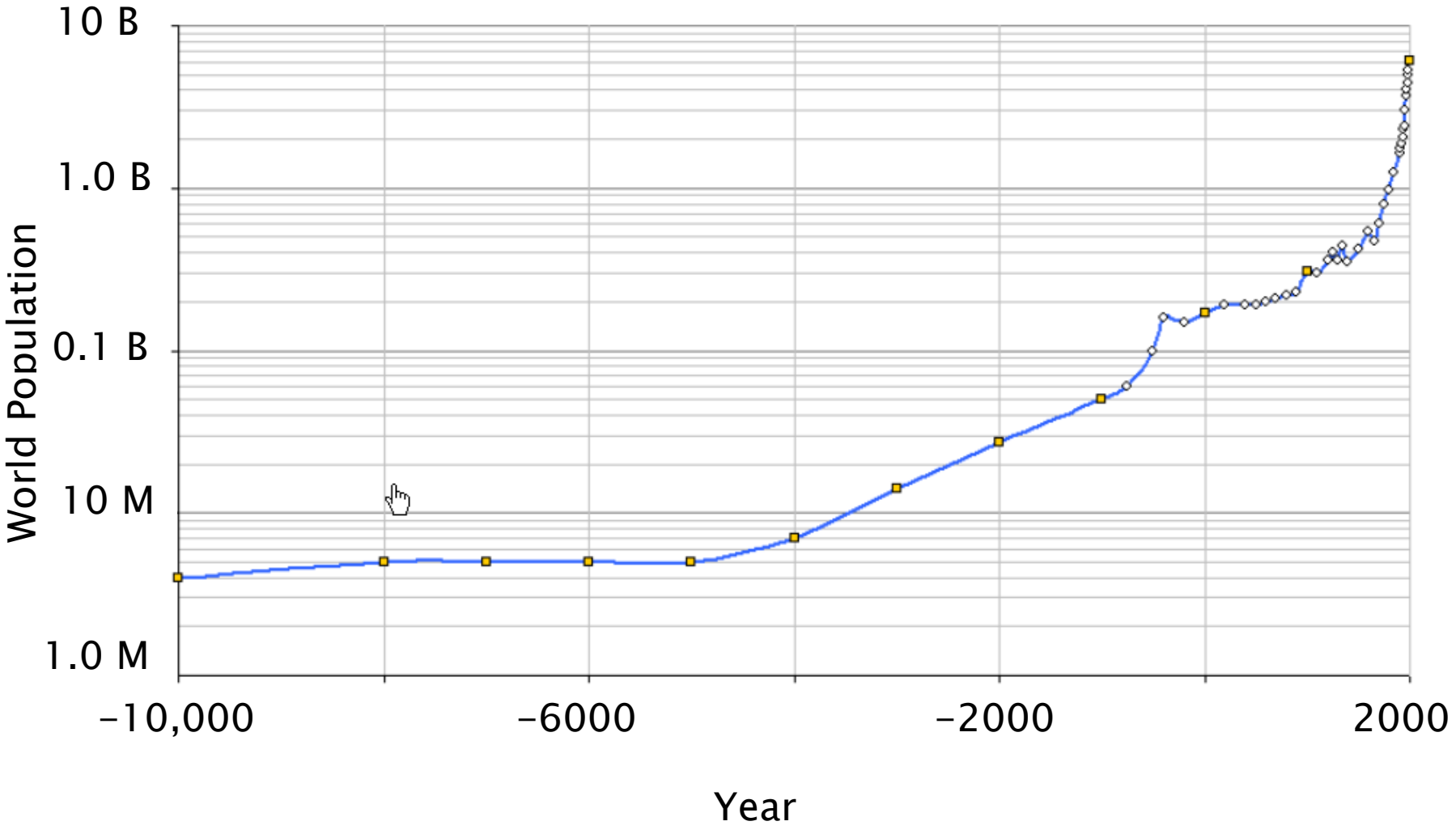
Global and Societal Context Drivers:
– Population Density

Civilization Ages
- Stone: 3.4M BC –
- Agricultural: 5500 BC –
- Industrial: 1760–
- Information: 1960 –

Material Ages
- Stone
- Bronze 3300 BC –
- Iron: 1200 BC –
- Silicon: 1950 –



World Population



World Population Growth Waldir, based wiki/File:Population_curve.svg © CreativeCommons.org

A Tale of Two Worlds

Hell

vs

Unicore

The Global and Societal Context of Engineering

- Why

A reaction to the amplified effect technology and science makes possible evidenced by

- Mass destruction capability
- Environmental threats
- Empowered individuals (legal and financial)

http://blogs.reut

AKE GIFS AT GIF

284.photobucket.com/

http://www.cbsnews.com/

The Global and Societal Context of Engineering

- **Why**

  Technology has caused huge problems

http://bloomtrigger.com/

The Global and Societal Context of Engineering

- **Why**

  And because Technology is also the solution to problems

The Global and Societal Context of Engineering

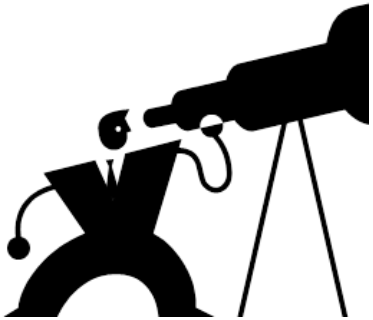
Technology
is
the
Problem
and
the
Solution

The Global and Societal Context of Engineering

Old – Myopic

Vs.

New – Global



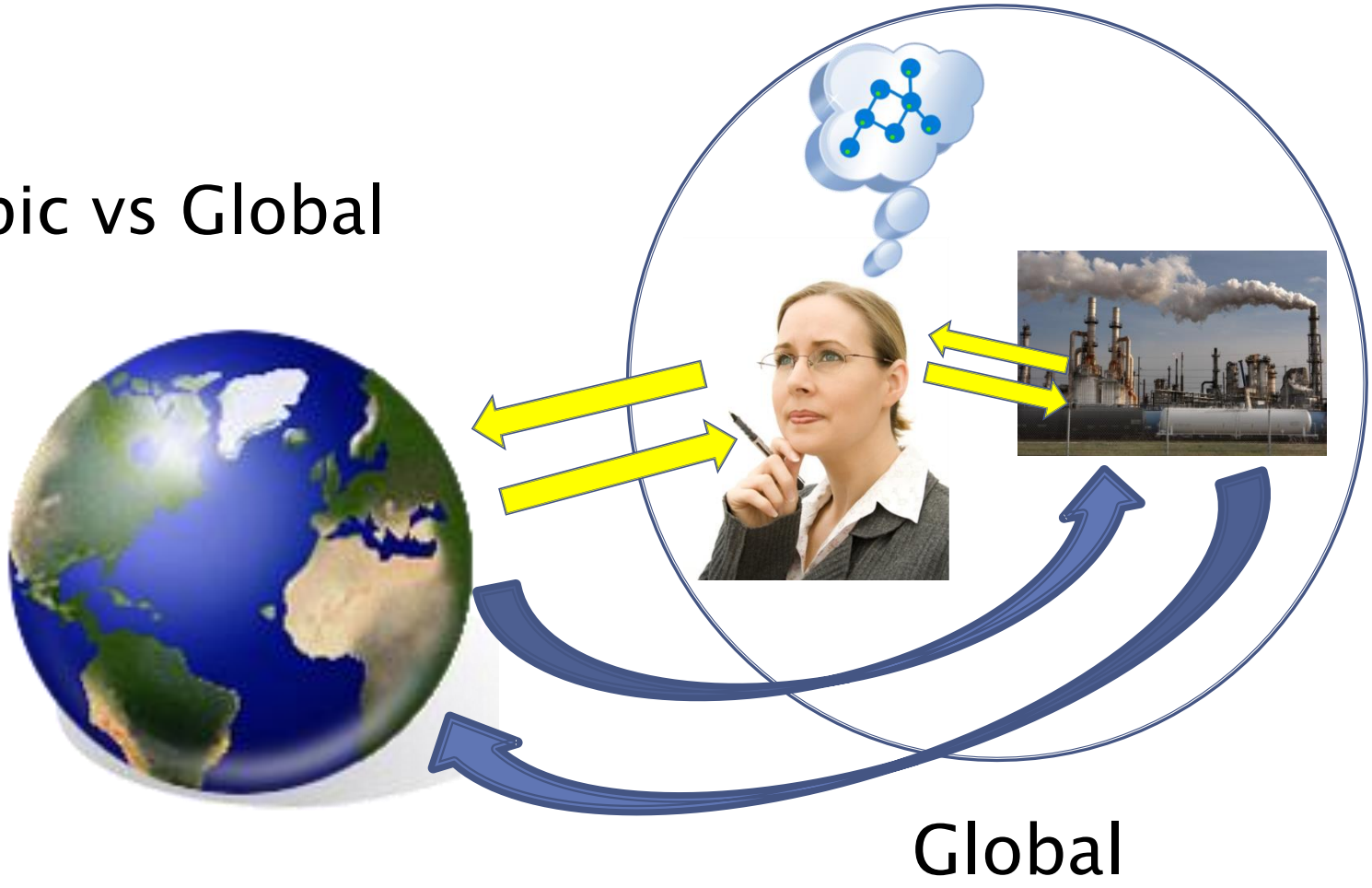
The Global and Societal Context of Engineering

Myopic vs Global

Myopic

The Global and Societal Context of Engineering

Myopic vs Global



Global

Examples of Problems arising from Localized Thinking

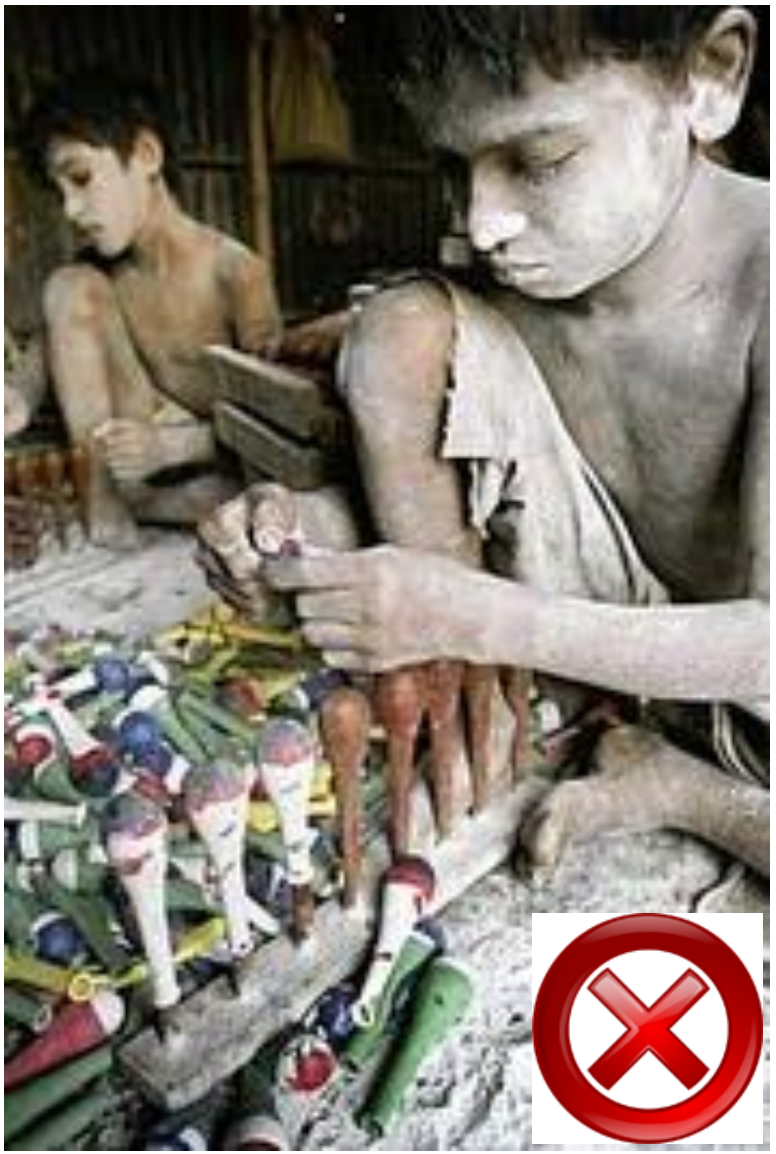
- Air and water pollution
- Importing of *sweat shop* goods
- Purchase/use Ivory
- Accumulating debt
- Solid waste disposal
- Aquifer drawdown
- Land mines

Examples of Problems arising from Localized Thinking

Sweat shop

Vs

Sweet Cost



Examples of Problems arising from Localized Thinking

Elephant poaching

vs

Ivory

Examples of Problems arising from Localized Thinking

Accumulating Debt

Current Consumption

vs

Generational Transfer

$19,860,680,000,000

Examples of Problems arising from Localized Thinking

Solid waste disposal

vs

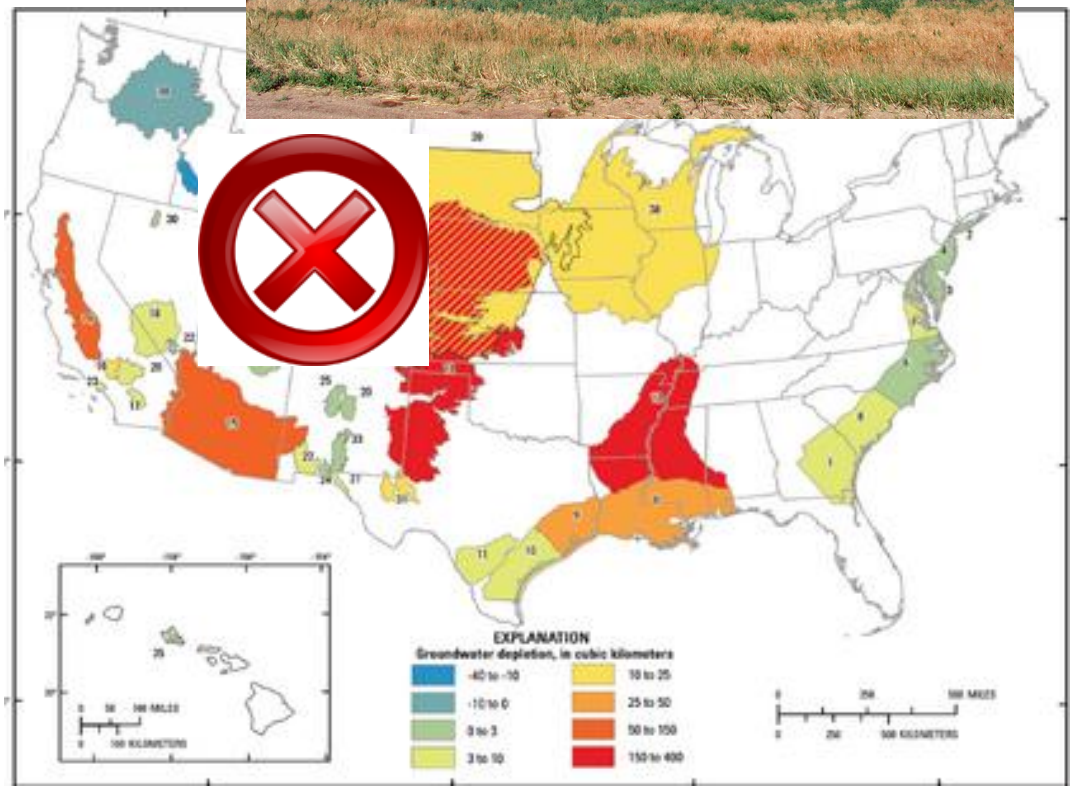
Convenience and cost

Examples of Problems arising from Localized Thinking

Aquifer Depletion

vs

Farm Prosperity

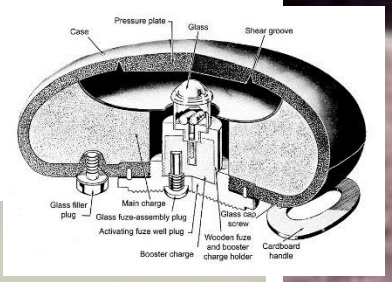


Examples of Problems arising from Localized Thinking (Now vs. Later)

Unit Protection

vs

Land Mines



The Global and Societal Context of Engineering

- What does it mean?

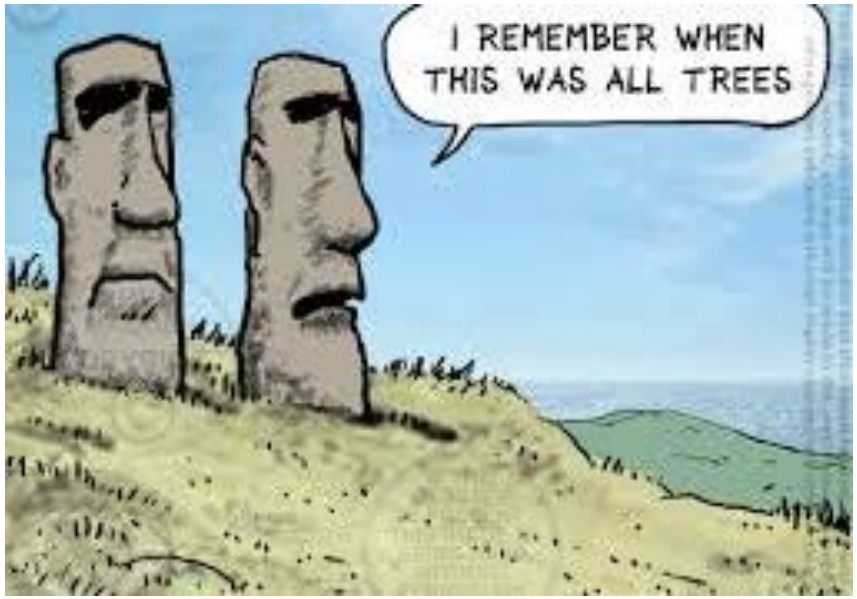
- It is a call to have a *Global view* *

- * *Over distance and time and across classes*


Easter
Island

A Response to Disasters Past

- Easter Island Extinction – the Rapa Nui
  - 1600's Pop: 15,000
  - 1722 Pop: 2,000–3,000 (European arrival)
  - 1860 European diseases and Peruvian slave trade
  - 1877 Pop: 111 http://en.wikipedia.org/wiki/Easter_Island
- Deforestation
- Buffalo near extinction



Managing Engineering's Impacts

- Avoiding Unforeseen Consequences
- Working with Society
- Openness vs. Secrecy – when and why

Unforeseen Consequences Classic Example #1

Original Problem:
Soil Erosion

Solution: Introduce Kudzu from Japan

Unintended Consequence:
Overrun with Vines
Killing of Other Vegetation
Power Lines Shorting Out
Etc.

Southeastern USA Kudzu
Credit: Harold P. E. Stern

Unforeseen Consequences Classic Example #2

Original Problem:
- Manual Labor
- Low Productivity
- Slow Transportation

Solution: Industrialization

Unintended Consequence:
- Air Pollution
- Sweat Shops
- Urban Problems

Santiago Chile Smog

Credit: http://www.planetark.org/envpicstory.cfm/newsid/17148

Actions have Unforeseen Consequences

Consequences are more likely to be identified when people with varied expertise and perspectives offer input.

$$\left[\text{Identifying Consequences}\right] \propto \left\{\begin{array}{l}\text{Number of People of Varied}\\ \text{Backgrounds Offering Input}\end{array}\right\}$$

Procedures to

Limit Unintended Consequences and Gain Public Consent

- Study similar problems and previous solutions to determine their societal impact
- Identify technological trends associated with the proposed solution
- Project possible societal impacts of these trends to limit unintended consequences
- Research all laws and regulations that may exist concerning a proposed solution
- Determine the appropriate ways to inform society and achieve an informed consensus

*

Resources Available

- Prior projects
- Codes and regulations
- Editorials
- Case studies

*

Resources Available to Identify Trends

- Codes
- Phased Implementation of Laws
- World Initiatives
- Professional Societies

*

Resources Available to Research Laws and Regulations

- Governmental Agencies
- Other Designers
- Patents
- Professional Societies/Associates/Groups

*

Resources Available to Achieve an Informed Consensus

- Public Meetings
- Elections
- Environmental Impact Report (EIR)
- Environmental Impact Statement (EIS)

*

Issues Concerning Openness

Secrecy


- National Security


- Competitive Edge


- Streamline Effort


- Cut Costs


- Save Time


- “What They Don’t Know Won’t Hurt Them”

When Should Secrecy be Maintained?

When Could Secrecy Appropriately be Maintained?

- National security restricted by legally authorized government oversight
- Private activities involving only intellectual property
- Product and process development with consequences limited to consumer choice

Exercise

Evaluate Recent Projects in the Region

Exercise

- Rank the following engineering accomplishments in each of the categories.
- Use the following scale:
  - 3 – Highest
  - 2 – Moderate
  - 1 – Low
  - 0 – None Unknown

Exercise

Engineering Development	Need for Public Input	Controversial	Is Secrecy Justified	Need for Government Regulation	Good (10) – Bad (0)
Oil Pipeline					
Edgemont U Solution Mining					
Advanced Repair of B-1's					
Permitting New Asphalt Plant					
Expanded Gold Mining in BH					

3 – Highest
2 – Moderate
1 – Low
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"5. *Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts."*

- Professional and Ethical Responsibilities
- Informed Judgements
  - Technical Competency
  - Safe Practices
  - Contemporary Issues
- Engineering's Context
  - Global,
  - Economic,
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Summary – ABET Outcome #5

- Professional and Ethical Responsibilities
- Informed Judgements
  - Technical Competency
  - Safe Practices
  - Contemporary Issues
- Engineering's Context
  - Global,
  - Economic,
  - Environmental,
  - Societal
- Gaining Public Trust and Avoiding the Unintended

The Making of an Engineer
– *ABET's Criteria and*
– *What you need to know*

More information on ABET and the SDSM&T Met Eng BS Degree Continuous Improvement Program at

www.abet.org

www.AbetMetEng.org/SD

1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. Apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline.
3. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
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5. **Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.**
6. Recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge.
7. Function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment.

ABET STUDENT OUTCOMES

(a) Apply knowledge of mathematics, science, and engineering
(b) Design and conduct experiments, as well as to analyze and interpret data
(c) Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) Function on multidisciplinary teams
(e) Identify, formulate, and solve engineering problems
(f) Understand professional and ethical responsibility
(g) Communicate effectively
(h) Understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) Recognize the need for, and plan to engage in life-long learning
(j) Know contemporary issues
(k) Use the techniques, skills, and modern engineering tools necessary for engineering practice.

ABET Student **Outcomes**

a) Apply Knowledge of Math, Science, and Engineering
b) Design and Conduct Experiments and Analyze and Interpret Data and Information
c) Optimally Select Material and Design Materials Treatment and Production Processes
d) Function Well on Teams
e) Identify, Formulate, and Solve Engineering Problems
f) Know Professional and Ethical Responsibilities and Practices
g) Communicate Effectively
h) Know Engineering's Global and Societal Context
i) Engage in Life-Long learning
j) Know Contemporary Issues
k) Use Engineering Techniques, Skills, and Tools

www.ABETMetEng.org/SD

ABET **Program Outcomes**

a) Apply Knowledge of Math, Science, and Engineering

b) Design and Conduct Experiments and Analyze and Interpret Data and Information

c) Optimally Select Material and Design Materials Treatment and Production Processes

d) Function Well on Teams

e) Identify, Formulate, and Solve Engineering Problems

f) Know Professional and Ethical Responsibilities and Practices

g) Communicate Effectively

h) Know Engineering's Global and Societal Context

i) Engage in Life-Long learning

j) Know Contemporary Issues

j) Use Engineering Techniques, Skills, and Tools

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ABET **Program Outcomes**

a) Apply Knowledge of Math, Science, and Engineering

b) Design and Conduct Experiments and Analyze and Interpret Data and Information

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