Ethics in Engineering and Research

Lecture #5 Engineering as Social Experimentation

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Engineering as Social Experimentation

- Example: Titanic in 1912
  - The greatest engineering achievement ever
  - It is believed to be virtually unsinkable
  - 1522 dead due to lack of extra precautions
- Many products of technology present potential dangers
- Engineering projects are experiments that involve technology development and human

The Design Process

Engineering product design steps:

Concepts
Preliminary designs, tests
More detailed designs
More tests (? - may cost $$)
Production
More tests! (? - may cost $$$)

The public purchases/uses the product

More tests!!! How to gather results of these tests?
Role of profits/competition with other companies?

Dangerous!!! Engineers are asked to do this!

Similarity to Standard Experiment

- Any project is carried out in potential ignorance
  - ❑Uncertainties in the design calculation, materials purchased, material procession and fabrication etc.
- The final outcomes of engineering projects are uncertain
  - ❑High risk for even seemingly safe projects/products
  - ❑Example: reservoir affect ecosystem , hair dryer causes lung damage from the asbestos insulation
- Effective engineering relies on knowledge gained about products both before and after they leave the factory
  - ❑Knowledge is needed for improving current products and creating better ones.
  - ❑Monitoring is as essential to engineering as it is to experimentation in general.

Using the public to perform tests…

- We redesign using the public to test our products!
- Special care is *obviously* needed for safety, avoiding loss of customers
- Example: Software test for popular software (e.g., word processing programs, spreadsheets, etc.), computer hardware
- Diligence helps, but also…

Learning from the Past

- Product history matters! Respect the past!
- Can you always know it? Competence, openness to learning. Do not be afraid to ask!
- Can you know about a competitor's safety statistics?
- Are there good communication channels in your own company?
- Between different departments?
- Across "generations" of engineers?
- Is there a dangerous "generation gap" between young and old engineers?

Contrasts with Standard Experiments

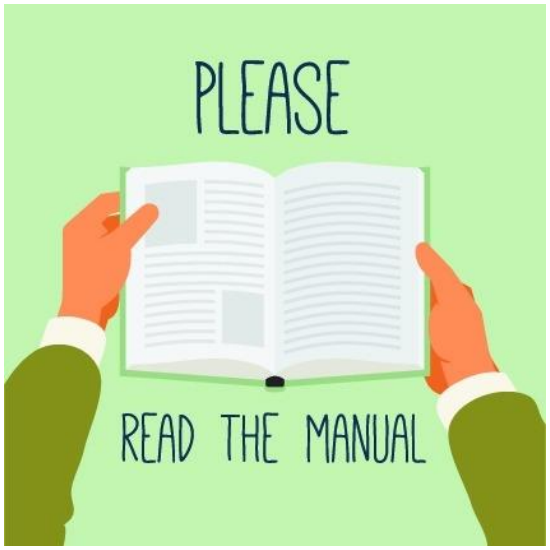
- Experimental control
  - ❑Cannot control what humans may do with a product
  - ❑What applications will it be used for?
  - ❑Will they subject it to unforeseen stresses?

- Informed consent (e.g., in medical trials)
  - ❑The consent is given voluntarily.
  - ❑The consenter is competent to make rational decisions
  - ❑The information is stated in understandable form.
  - ❑Concerns, exposure to risk

- Knowledge Gain? See unexpected

Misuse of the products (example)

Misuse of the products



Further Reading
https://www.natlawreview.com/article/when-do-manufacturers-need-to-anticipate-misuses-and-abuses-their-products?amp

Responsible Experimentalists

1. Conscientiousness: Protect safety knowledge, respect right of consent of public
2. Comprehensive perspective: Awareness of experimental nature of projects, forecasting, monitoring
3. Moral autonomy: Personally engaged, thoughtful, involvement in project
4. Accountability: Accept responsibility for results of a project *(avoid fragmentation, diffusion, time pressures)*

Taking charge…

- Engineers are not the sole experimenters
  - Managers
  - Marketing people
  - Public
- But, "with knowledge comes responsibility"
- Engineers are in a unique position to:
  - Monitor projects
  - Identify risks
  - Develop facts for informed consent
- An engineering professional will take on the responsibility!

Role of Laws in Engineering

"Rules of responsible experimentation:"

- Laws can produce many benefits
- Produce minimal standards of professional conduct
- Provide motive to comply with standards
- Provide support and defense for people who wish to act ethically

Balanced Outlook on Law: Rules of Experimentation?

- *Not covering engineering law here*
- You may learn some on-the-job
- Likely to learn some "industrial standards," some of which directly pertain to safety
- Tendency toward more detail...
- "Minimal compliance" Is it enough?
  - Morally acceptable?
  - What about push of new technologies? Areas where there is no law?
- Government/law can be too detailed - can squash moral autonomy of engineers - good balance?

Study the following case studies and discuss the below questions.

- Is there any social experimentation in each case study?
- If Yes, is the social experimentation appropriate to test?
- If the proposed social experimentation is not appropriate, how should you implement as an engineer?

Case studies (from students) for Engineering as Social Experimentation Software…

- Student: "I was involved in designing and testing network communication software. Some tests were still being run when clients requested the software. We were unable to finish the tests, and gave the product to the customer knowing that the system caused lock-ups and loss of data. We then used the feedback from these clients to debug the software, and repeated the process." What to do?
- Similar student case: "In software engineering I have encountered problems in that the time required for testing the product and the deadline for testing may conflict, and some parts of the testing may have to be compromised to meet those *deadlines*." What factors enter the compromise in deadlines?

Answer for network communication software case study

- Admit to the mistake
- Inform the client
- Improve the product
- Reflect on the incident (how they can prevent similar situations from happening in future)
- Seek guidance (senior engineers, professional organization such as IEEE)
- In this case study, it is not appropriate to engage in social experimentation as it involves potentially harmful consequences for the end-users.

Answer for conflict in deadline

- What factor enter the compromise in deadlines?
- Project management issue (inadequate planning, lack of communication, etc.)
- Technical challenges
- Client demand
- Budget constraints

Meeting specifications…

Student: "At my co-op position I was placed in a design team to create an audio system. The project was a classic example of marketing wanting the product so bad that time lines were regarded higher than the quality of the product. The audio system's first prototypes arrived with many problems, some of which could not be resolved until after the product was released. It basically came down to the decision of letting the consumers find all the problems, and then hoping that the management would provide the team with more time and funding to fix the problems, to try to keep the customers happy." What should the student do?

- To ensure that products meet certain quality standards and do not harm the end-users
- To comply with ethical principles of engineering (professionalism, responsibility, and integrity)

Environment…

Student: "In wastewater treatment plants, control systems are tested in the field. The control systems are designed according to specifications and ISA/IEEE rules, but the testing of how the systems will operate under real life situations is done after installing them. Two questions arise, then: first, can the plant design withstand additional rain, population increases, weather problems, etc? Second, can the control system adequately analyze these new factors and operate the plant successfully? If anything fails, the great danger is the release of raw sewage/sludge and bacteria onto land and into the water supply."

What can the engineer do? Will competence solve the problem?

- Test the control system under different scenarios (increased population, weather problems and additional rainfall)
- Review the design (to ensure that it can withstand any potential changes in weather or population)
- Conduct the regular maintenance
- Stay up-to-date with regulations
- Work collaboratively with other stakeholders

Law, minimal compliance…

Student: "My problem came with a company involved in the design and manufacturing of PC power supplies. Some manufacturing organizations, have focused on 100% minimal compliance and hence substituted parts to achieve their cost objectives. This resulted in unsafe final consumer products. An industry push for CSA and UL certification of power supply modules enhanced the minimal level achieved for standard sub assemblies. Since the FCC and FTC act as police organizations, it is not usually known that there is a problem until much mayhem occurs. When other companies began selling "smoking PCs" the industry began to push to use only modules which would meet UL and CSA standards. The minimalists were forced to up the ante or lose considerable business."

Should an engineering professional be a "minimalist"? Role of tests?

up the ante = increase your risks or demands in order to get a greater advantage
mayhem = chaos

- Engineering professional should not be “minimalist” when it comes to ensuring the safety of consumer products.
- The role of test:

❑To ensure that the products meet the required safety standards

❑To identify any potential safety issues and address them before the product is released

❑Pushing for CAS and UL certification enhanced “minimalist” standard.

Meeting specifications…

- Student: The heated hoses we manufacture were using a 100 ohm platinum RTD substitute. The hose resellers were rating the range of heat as higher than the RTDs could actually model linearly. We had years with no problems until one customer started running the product at the top of the temperature rating. We immediately stopped production and found another RTD that would be suitable. All stock was pulled and rebuilt. The fix took almost a year. Is this cost, worth getting it right?

RTD = Resistance Temperature Detector

Successful use of customers in testing

- Student: Welders built for an alpha run of production were sent to a select group of customers to be tested in the field. The customers did have "informed consent" that these machines were in the early stages of testing. Many changes were made based on their feedback. A proper approach to design?

Recognizing social experimentation: NSPE, BER Case 96-4

- Engineer A is employed by a software company and is involved in the design of specialized software in connection with the operations of facilities affecting the public health and safety (i.e., nuclear, air quality control, water quality control). As the part of the design of a particular software system, Engineer A conducts extensive testing and although the tests demonstrate…

that the software is safe to use under existing standards, Engineer A is aware of new draft standards that are about to be released by a standard setting organization-standards which the newly designed software may not meet. Testing is extremely costly and the company's clients are eager to begin to move forward. The software company is eager to satisfy its clients, protect the software company's finances, and protect…

…existing jobs; but at the same time, the management of the software company wants to be sure that the software is safe to use. A series of tests proposed by Engineer A will likely result in a decision whether to move forward with the use of the software. The tests are costly and will delay the use of the software by at least six months, which will put the company at a competitive…

…disadvantage and cost the company a significant amount of money. Also, delaying implementation will mean the state public service commission utility rates will rise significantly during this time. The company requests Engineer A's recommendation concerning the need for additional software testing.

Where is the social experimentation in this case study?

- It is in the case study since it was via social experimentation that they came up with the new standards
  - Old standards, show that there is not enough testing to catch a problem with the software
  - New standards invented to capture the problem via new testing

- Self-driving Car Ethical Dilemma – Video