ECE 481

Ethics in Electrical and Computer Engineering

Lecture #4: Engineering as Social Experimentation

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Engineering as Experimentation

- Example: Titanic (1522 dead)!
  Affected ship design...
- Example: Software engineering and test:
  - How much? Expensive!
  - Sophistication level of software, how deployed matters
  - Historical information about software test is used to know how much is needed now
  - But your project helps contribute knowledge to how much is needed later!
- Engineering projects are experiments that involve technology development and humans

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!

Similarities to Standard Experiments

- Projects carried out in partial ignorance, outcomes are uncertain
  - Engineers are asked to make things work *without all the available scientific knowledge* (including that about humans), safety facts, environment, health, social influences, etc.
  - *Good design relies on information gathered before and after a product leaves the factory* - especially when the product is tested in its true "environment," not fake ones used to simulate the real environment (e.g., temperature cycling electronic products)

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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?

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Contrasts with Standard Experiments

- Experiment control?
  - Cannot control what humans may do with a product
  - What applications will it be used for?
  - Will they subject it to unforseen stresses?
- Informed consent? (e.g., in medical trials)
  - Keystone of engineer - public interaction
  - What "experiments" are acceptable? Keep in mind that there is a large variance on the types of customers you might have. Can they all read?
- Knowledge gained? Seek the *unexpected!*

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!

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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?

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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*.”

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Computer testing…

Student: "On a recent co-op job my company had just shipped its latest and greatest computer product. After a few months in the field it was found to vastly lack the processor power it needed to do what it claimed to do. The fix that followed had to have the shortest turn around time I had ever seen. The fix was top quality, but the damage had been done. A full scale test, or even simulation, would have predicted this problem before shipping." What should the co-op do? Trust specifications of other's subcomponents?

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 to do?

Environment…

Student: “A turbidity meter was used to monitor if contaminants were getting into the water that goes into the river. When those meters failed to alarm us, and a white pigment went into the river, my project that focused on redesigning the monitoring station was given support.”

Can/should the engineer do anything?

Creative solutions?

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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?

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?

Attendance Question

- **Name as many technologies or systems that ECEs are involved in designing, maintaining, or improving and that involve important safety considerations**

Please: Put your name on the sheet of paper and turn it in...