

# Ethical Issues in Engineering Practice

Lecture 6



# The Case of Therac-25 (1985–1987)

- Therac-25 was a radiation therapy machine capable of irradiating tumors with either electrons or X-rays.
- First to incorporate significant computer controls.
- The computer software used to control the machine and monitor the dose delivered to the patient was inadequate.
- The software allowed the machine to be energized when it wasn't in the correct configuration.
- When this happened, patients could receive doses orders of magnitude larger than planned.
- At least six patients using the Therac-25 were exposed to high doses of radiation, leading to serious injury or death.

# Three important areas where engineers may encounter ethical concerns

**01**

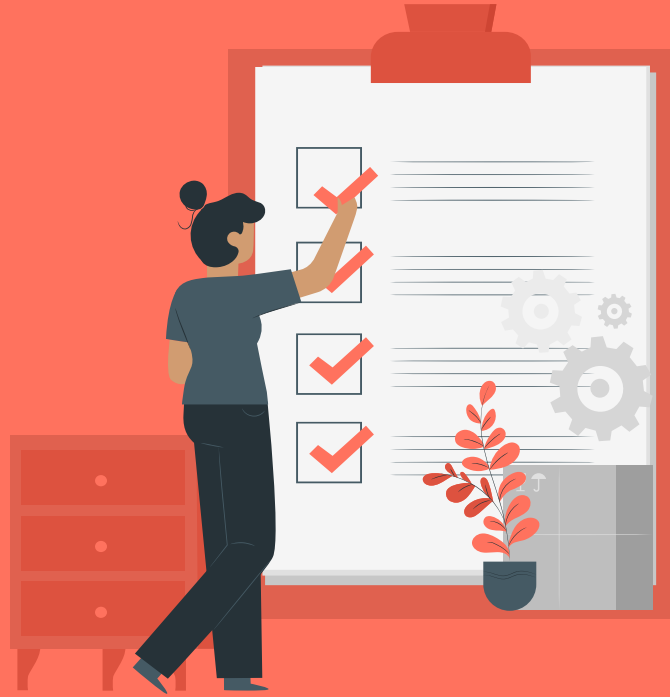
**Environmental  
Ethics**

**02**

**Computer  
Ethics**

**03**

**Ethics and  
Research**



# Environmental Ethics

**A political issue of the 20th and the early 21st centuries**

---

# Environmental Ethics

- **Environmental protection** and rise of **environmental movement**
- **Environmental movement:** To control the introduction of toxic and unnatural substances into the environment, to protect the integrity of the biosphere, and to ensure a healthy environment for humans.
- Engineers have a **responsibility** to use their knowledge and skills to help protect the environment
- Denoted with phrases such as “**sustainable design**” or “**green engineering**.”
- Sustainable design includes not only ensuring that a product has **minimal environmental impact** during its use, but also that it can be manufactured and disposed of **without harming the natural world**.



# Resolving environmental problems

**Cost-oblivious approach:** Cost is not taken into account, but rather the environment is made as clean as possible. No level of environmental degradation is seen as acceptable. This approach bears a striking resemblance to **rights and duty ethics**.

**Cost-benefit analysis:** Derived from **utilitarianism**. In this approach, the goal is not to achieve a completely clean environment, but rather to achieve an economically beneficial balance of pollution with health or environmental considerations.



# Problems with cost-benefit analysis

- What is the true cost of a human life or the loss of a species or a scenic view? These values are difficult, if not impossible, to determine.
- It is difficult to accurately assess costs and benefits, and much guesswork must go into these calculations.
- Doesn't necessarily take into account who shoulders the costs and who gets the benefits.
- Cost-benefit analysis doesn't necessarily take morality or ethics into account.



# Responsibilities of an engineer towards the environment



- When looking at the environmental aspects of his work, an engineer can appeal to both professional and personal ethics to make a decision.
- Must follow the applicable federal, state, and municipal laws and regulations.
- Professional codes of ethics tell us to hold the safety of people and the environment to be of paramount importance.
- Our personal ethics can also be used to determine the best course when we are confronted with an environmental problem.
- An engineer should not make decisions in areas in which he isn't competent.





# Computer Ethics

**Ethical problem-solving techniques used for other engineering ethics problems are equally applicable to computer ethics issues**

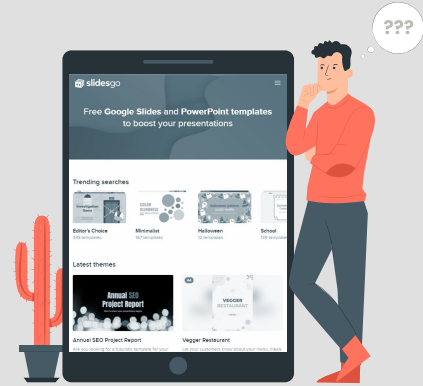


# Computer Ethical Problems

Using the computer to **commit** an unethical act such as the use of a computer to **hack** into a database



**Using** the computer as an engineering tool, but **improperly**



# Computers as a Tool for Unethical Behavior

Many of these uses are **merely extensions** to computers of other types of unethical acts.

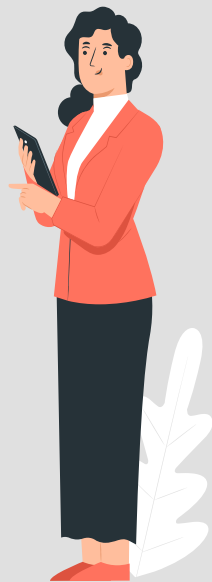
For example, computers can be used to more **efficiently** steal money from a bank. A more traditional bank-robbery method is to put on a mask, hand a note to a bank teller, show your gun, and walk away with some cash.

Computers can be used to make bank robbery easier to perform and harder to trace.



# Computers as a Tool for Unethical Behavior

- Similarly, computer ethics issues arise with **regard to privacy**. Computers did not create the issues involved in privacy, but they certainly have exacerbated them
  - By **privacy**, we mean the basic right of an individual to control access to and use of information about himself
- Copyright infringement is also a concern in computer ethics. Computers and the Internet have made it easy to **share copyrighted materials**.
  - **Copying** without the permission of the owner of the copyright is illegal and unethical.
- Ethical issues also arise when computers are used for “**hacking**.” Hacking comes in many forms:
  - **Unauthorized access** to a database
  - **Implanting false information** in a database
  - **Disseminating viruses** over the Internet.



# Computers as an Engineering Tool

- Who is responsible when a flaw in software used to design a bridge leads to the failure of the bridge?
- Is it the fault of the engineer who designed the bridge? Or is it the fault of the company that designed and sold the defective software?
- Who is at fault when a software package is used for a problem that it isn't really suited for?
- What happens when existing software is used on a new and innovative engineering design that software hasn't yet been developed for?



# Computers as an Engineering Tool

- Software can never be a substitute for good engineering judgment.
- The engineer who uses software in the design process is still responsible for the designs that were generated and the testing that was done using a computer.
- Engineers must be careful to make sure that the software is appropriate to the problem being worked on
- Engineers should be knowledgeable about the limitations and applicability of a software package



# Ethics and Research



# Ethics and Research

## Honesty in approaching the research problem

Avoiding preconceived notions about what the results will be, being open to changing the hypothesis when such action is warranted by the evidence, and generally ensuring that an **objective frame of mind** is maintained.



## Honesty in reporting the results

Results must also be **accurately reported**. The results of the experiment must not be overstated, but rather an accurate assessment and interpretation of the data must be given



# Analyzing Ethical Problems in Research

- The easiest means to determine the best ethical course in performing research and experiment is to **consult the codes of ethics** of the engineering professional societies.
- All of the codes include language requiring engineers to be honest in reporting the results of work and assigning credit for work done
- Utilitarianism or rights and duty ethics can be applied to research, but it is perhaps **easiest to examine research issues using virtue ethics**.
- Virtue ethics clearly tells us that the **inaccurate reporting** of experimental results is unethical.
- Likewise, **not giving credit** to everyone who has participated in a project is dishonest, and virtue ethics indicates that this practice is unacceptable.



# Read Case Studies

- The Therac-25
- The City of Albuquerque vs. Isleta Pueblo Water Case
- The N-Ray Case

From Engineering Ethics by  
Charles B. Fleddermann  
Chapter 7

