Role of the Engineer

-safety
-ethics
-environment

Introduction

Engineering ethics: rules and standards governing the conduct of engineers in their role as professionals.

Introduction

Ethical dilemmas: situations in which moral reasons come into conflict and it is not immediately obvious what should be done.

Introduction

Professional conflicts of interest: situations where professionals have an interest that, if pursued, might keep them from meeting their obligations to their employers or clients.

Special interests that could affect judgement:

- Financial Interests
- Family Connections
- Personal Relationships
- Etc.

Story 1

Andrew is a young engineer working for a mobile phone design company. When doing a bit of off the job research he reads the latest report about the **susceptibility of the brain to radiation**.

The next day he reviewed the calculations of the radiation given off by the antenna of his company's hottest selling cellular phone and it was a little high.

Later that afternoon he visited his boss (Diane, head engineer) with a suggestion to modify the antennas on the phones and perhaps doing a recall on the ones already sold.

"*Andrew*," screamed Diane, "***what you're suggesting would cost us hundreds of thousands of dollars! You can't possibly be serious. That's our fastest seller. Recalling them would be a disaster and there are more important things to be done. You don't even know that this is dangerous!***".

"***But what about our obligation to the public*?**" Andrew said.

Diane said: "***What about your obligation to the company? Look, I don't want to make a big issue out of this. We're within IEEE standards and unless we have further word from them then we're in the clear.***"

IEEE (Institute of Electrical and Electronics Engineers): professional association for electronic engineering and electrical engineering.

Story 1

What would you do if you were in Andrew's shoes? Would you talk to someone above Diane or try to convince her?

Can you think of options that would be fair both to the company and to the public, especially in the light of the uncertainty about the health risks?

Assume that Andrew asks Diane for paid time to research the matter further and Diane refuses his request. Now what should Andrew do?

Story 2

You are a Project Engineer at a company. The company that you work for, has just been selected, but the contract not yet signed, for doing the detail design and engineering and construction management for a new water supply system for a city. The system will serve about 50 thousand residences. This is a job with an estimated constructed value of between ¥10M - ¥15M. Your company and the competition each submitted a comprehensive proposal and sealed (secret) bid. The selection was based strictly on low bid and the proposed design meeting technical requirements. All bids are public record after opening. The company that you work for has bided ¥12.88M. The two competitors' bids were: Company A at ¥13.38M; Company B at ¥14.11M.

A few days later, you and the Chief Engineer discover that an important part of the purification system has been underestimated in cost. This occurred because part of the preliminary design concept was done without adequate analysis. The current design would result in the output water not meeting the Regulations. To do it right (and meet the Standards) would add ¥1.5m in cost. Your company's profits for the preceding year were ¥1M. It is likely that this job is the only large job to be booked by the company this year.

Story 2

Based on the information above, what is your recommendation to your boss, the Chief Engineer?

Suppose, independent of your recommendation, the Chief Engineer tells you: "**Let's keep this to ourselves. Once we get the job we'll slip in some change orders to get our true cost plus a reasonable profit. After all, we disclosed all they asked for in our submitted design. If they didn't catch it that's their problem.** "

What is your response to the Chief Engineer?

Now suppose that it was decided by your company to accept the Chief Engineer's scheme and to proceed normally until there is an opportunity to sort out matters. You attend a combined public hearing and press conference in the City Hall. You are part of a small panel of engineers and managers asked to tell about the design and answer questions from the floor.

At the public meeting should you mention voluntarily the design shortcoming and associated costing error?

Suppose a person in the audience asks you on how your company was able to underbid the competition? Nobody mentions the design shortcoming and cost error. What do you do?

Another Question

I have the choice of using cheaper components that will age quickly and are likely to start failing in about 12 months time, just after the warranty on the product ends.

The product is highly compact and is not suitable for repair.

Discuss!

IEEE Code of Ethics

- The Institute of Electrical and Electronics Engineers (IEEE) is a professional association for electronic engineering and electrical engineering (and associated disciplines) with its corporate office in New York City. It was formed in 1963.
- It is the world's largest association of technical professionals with > 400,000 members in >160 countries.
- IEEE Code of Ethics has been in existence since its founding. Every IEEE member agrees to abide by the IEEE Constitution, Code of Ethics, Bylaws, and Policies when joining.
- It recognizes the importance of electronic technology has on the quality of life and its impact on the society and the environment. It sets out the standard for professional and ethical conduct for electrical and electronic engineers.

A copy of the IEEE Code of Ethics is provided on Moodle.

Dangers of Electronic Components to the Environment

Some Process Gases and Chemicals Used in Semiconductor Manufacturing	
Acetic Acid	CH_3COOH
Acetone	$(CH_3)_2CO$
Ammonium Fluoride	NH_4F
Ammonium Hydroxide	NH_4OH
Buffered Oxide Etchant (BOE)	NH_4F, HF
Chrome Etch	$KMnO_4$, Na_2PO_4
Chromium Trioxide/HF/Water	CrO_3, HF, H_2O
Chromium Trioxide/HF/Water	CrO_3, HF, H_2O
Chromium Trioxide/Phos/Water	CrO_3, H_3PO_4, H_2O
Glass Etch	NH_4F, CH_3COOH
Hydrochloric Acid	HCl
Hydrofluoric Acid	HF
Hydrogen Peroxide	H_2O_2
Isopropyl Alcohol	$CH_3CHOHCH_3$
M-Etch	HF, HNO_3, CH_3COOH
Methyl Alcohol	CH_3OH
Methyl Ethyl Ketone	$CH_3COCH_2CH_3$
Nitric Acid	HNO_3
Phosphoric Acid	H_3PO_4
Poly Etch	HF, HNO_3, NH_4F
Potassium Hydroxide (Solution, Pellets)	KOH
Pre-Evap Etch	NH_4F, $(NH_4)_3PO_4$
Sodium Hydroxide (Solution, Pellets)	NaOH
Sulfuric Acid	H_2SO_4
Xylene	C_8H_{10}

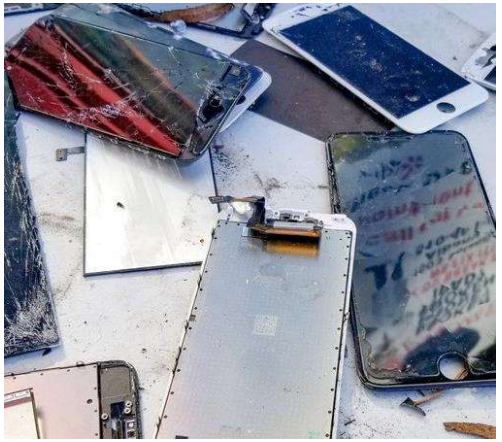
Each 2-gram chip requires at least

- 72 grams of chemicals
  (and not very nice ones)
- 1.6 kg of fossil fuel (oil equivalent)
- 32 kg of water

Dangers of Electronic Components to the Environment

The world produces close to 50 million tonnes of electronic waste (or e-waste for short) every year as consumers and businesses throw out their old **smartphones**, **computers** and **household appliances (such as washing machines and dishwashers)**.

Areas of e-waste are growing as society becomes increasingly electrified: **toys**, **medical equipment**, **furniture** and **most automotive parts** now contain some electronic material that could be harvested and reused.



Dangers of Electronic Components to the Environment

While the **focus has been on collecting products**, not enough effort has gone into building infrastructure for processing the waste or safely recovering used materials.

This has led to a **shortage of facilities where e-waste can be managed safely**.

Instead, e-waste is mixed with residual waste, where it is often placed in landfill etc.

Only 20% of electronics are currently recycled.

Dangers of Electronic Components to the Environment

The current way of handling e-waste is a risk to human health and the environment and has a negative economic impact:

- Some electronic equipment and its components contain substances that are considered dangerous to the environment and human health if they are disposed of carelessly. Although these dangerous substances are usually present in only small amounts, they may leak into the soil, water or air and can cause serious environmental damage.

- If we send electrical and electronic products to landfill sites, we miss the opportunity to recover and reuse millions of tonnes of materials. Recovery of these materials would mean we need to extract less raw material to manufacture new products.

Think about indium (In) in indium tin oxide (ITO), which is used a lot on touchscreens. Its reserve is very low in nature. A recycle programme would be very nice.

RoHS Initiative

Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations (Pronounced Row-Hos)

EU RoHS often referred to as the "lead-free“ directive, but it restricts the use of the following 6 substances in the manufacture of various types of electronic and electrical equipment:

- Lead
- Mercury
- Cadmium
- Chromium VI (Also known as hexavalent chromium)
- PBB (flame retardants used in some plastics)
- PBDE (flame retardants used in some plastics)

China RoHS also regulates the use of certain hazardous substances such as lead, cadmium etc but it is quite different from the EU RoHS.

More Questions

You are helping write some software to control the braking on a Mercedes car. What are the professional implications of how you go about your programming? What could happen if there were a bug?

You are selecting materials for your company's new product. Times are financially tough and you need to make the cheapest product. You have two choices, one slightly cheaper than the other, but it's slightly more toxic (but still within regulations) than the other. Which should you pick?