

18-100 Introduction to Electrical and Computer Engineering

Lecture 06

Identity as an Engineer and Engineering Ethics

Reflection

- Many years ago I sat in a freshmen engineering classroom. The class was ENGR 180, "Engineering Methodology". It was an introduction to all things engineering.
- My professor was Dr. Jose. He was a civil engineer.
- His job that day was to help me, and the other wide-eyed freshmen in the room, to understand the awesome responsibility of engineers, their high station in our society, and help us to begin reflecting upon that responsibility and shaping ourselves into professionals with the values and sense of duty worthy of that responsibility.
- He impressed all of that day (well, at least me, among others) with an understanding of who we are and how the world views us. I hope, today, to do the same for you.

What is a professional identity?

- What is a *professional identity*?
 - From the perspective of the professional?
 - From the perspective of others?
- What do you think?

What is a professional identity?

- What is a *professional identity* from the perspective of the professional?
 - A type of *social identification*, i.e. how one wants others to see them as an example of members of their profession
 - A set of *values* that one possesses that are hallmarks of their profession
 - A sense of *duty* and *responsibility* that one feels as a result of their profession
 - Perhaps a drive to acquire and maintain a core knowledge or core set of skills common to their profession
 - Perhaps, most of all, a set of oneness or fellowship, or camaraderie as a result of one's membership in the profession.

What is a professional identity?

- What is a *professional identity* from the perspective of others?
 - Does how someone introduces themselves tell you something about how they view themselves and how you should understand them?
 - Do you expect that a physician will care about your health? Or a psychologist or therapist will care about your confidentiality? Or a chef will care about the taste and presentation of food? Or a nutritionist will care about healthy eating? Or a trainer will care about healthy body conditioning? Or a financial planner will care about financial security?
 - If physician speaks about a matter of health, do you expect that...?
 - They are qualified to speak about the topic?
 - That they will have your best health in mind?
 - If someone introduces themselves as a general dentist, do you expect that they have the skills needed to diagnose and repair or medically treat teeth, gums, and general oral health?

What does it mean to be an Engineer?

- What do you think?

What does it mean to be an Engineer?

- Engineering is an important and learned profession.
 - As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity.
 - Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare.
 - Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.
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- <https://www.nspe.org/resources/ethics/code-ethics>

What does it mean to be an Engineer?

I. Fundamental Canons

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
 2. Perform services only in areas of their competence.
 3. Issue public statements only in an objective and truthful manner.
 4. Act for each employer or client as faithful agents or trustees.
 5. Avoid deceptive acts.
 6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.
- <https://www.nspe.org/resources/ethics/code-ethics>

What does it mean to be an Engineer?

IEEE Code of Ethics

- <https://www.ieee.org/about/corporate/governance/p7-8.html>

Why is this important?

- **How do other view engineers?**
- **What do you think?**

How Does Identity Impact Trust?

- Do you expect a sales person to provide false information about a product they represent? Or about a competitor's product?
 - No. Sales people are expected to hype what they represent, but not misrepresent anything.
- Do you expect a salesperson to tell you about a competitor's product if it is better suited to your needs?
 - Probably not: Sales people are expected to explain the features and relative benefits of the products they represent.
 - They are not expected to place your interest above their sale.
- Do you expect a physician to tell you about an alternative medical procedure if it may be better for you?
 - Why the difference in expectation?

How Does Identity Impact Trust?

- Do you expect a restaurant server to tell you what ingredients are in their food, w.r.t. allergens and dietary constraints?
 - Yes. To the best of their ability
- Do you expect a restaurant server to tell you that they don't know about food concerns outside of their knowledge, e.g. potential for cross-contamination, source of ingredient, etc.
 - Yes. You don't expect them to make things up.
- Do you expect a restaurant server to recommend that you eat at an other restaurant instead of at their own that evening?
 - Nope. You expect them to help you find the best meal they have for you at that restaurant.

Why is this important?

- **Examples I remember from Dr. Jose's class...**
 - The bridge that one crosses – over the river below
 - The road one drives along, not knowing for sure what is around the next turn
 - The plane one flies in – defying gravity
 - The power grid carrying enough energy to power the city
 - The elevator that takes one to the Nteeth floor
 - The skyscraper reaching to the stars (or even this building)
 - The ship in the middle of the ocean

Why is this important?

- **What do these examples have in common?**
 - We usually trust them, implicitly, without thought
 - When we do ponder their risks and complexities, we merely “marvel” at modern technology (even for century old structures)
 - We use them without even considering the risk
 - They are safe by all reasonable standards
 - We have no idea who designed them
 - We have no idea the qualifications of who designed them
 - We have no idea of the reputation of those who designed them
 - **We know engineers designed them.**

Why is this important?

- What examples might Dr. Jose have offered if he was teaching today (not in 1992)? And, especially if he, himself, were an EE or CompE?
- What do you think?

Why is this important?

- Who is more trusted, a physician or an engineer?
 - What do you think?

Why is this important?

- Who is more trusted, a neurosurgeon or an engineer?
 - Do you know the education of the engineers who built the bridge before you drive over it?
 - Do you know the experience of the engineers who built the building before you go to the top floor?
 - Do you know whether or not the engineers who designed the Web site, App, or eCommerce platform site have considered your privacy before you used it?
 - Do you know the training of those who designed the flight control software of the plane in which you fly?
 - Do you know anything, at all, about those who designed the local electrical distribution system, or who designed the CPU running the system, or the software running upon it.

Why is this important?

- Who is more trusted, a neurosurgeon or an engineer?
 - In my view, the engineer is more trusted!
- Consider this...
 - The patient (most often) has the opportunity to learn about their surgeons credentials, to learn about their experience, to check their reviews, to check with their colleagues for references, to consider the credibility of their employer, and to meet them and make sure they are in tune with their concerns.
 - The surgeon can only impact one patient at a time.
 - A surgeon's work can often be revised if needed.

737 MAX Crashes

- What happened? Who knows?

737 MAX Crashes

What was the sequence of events?

- A computer system received bad information from a single Angle of Attack (AoA), i.e. how high up the nose is pointing, sensor
 - It wasn't programmed to consider the input of the 2nd "redundant" sensor.
- The computer pushed the nose down to "compensate", but actually caused the plane to nose dive.
- Properly trained pilots, or those that could reason about the situation, disconnected the system by hitting two switches that had existed for decades
 - Initially no pilots had been trained, and the ability to reason about the situation varied.
- Pilots who understood the "roller coastering" technique could recover the aircraft
 - 737 pilots hadn't necessarily been required to learn this technique for decades, since it hadn't been needed in practice – until now.

737 MAX Crashes

At a technical level, what happened?

- Redundant sensors were provided for Angle of Attack (AoA), i.e. how high up the nose is pointing.
- Only one of them was used by the software.
 - It was defective
- The software incorrectly thought the plane was too far nose-up and pushed the nose-down
 - It did so repeatedly, even if turned on-and-off again and again.
- The feature that automatically observed a discrepancy between the two sensors and alarmed was sold as an optional feature, not a required one.

737 MAX Crashes

At a human level, what happened?

- Recognition and recovery was within the understanding and skill set of some pilots
 - But, tragically, not all pilots
 - The required technique, “roller coastering” hasn’t been a required part of the 737 series (it is optional)
- Pilots had never been explicitly told about this “feature”
 - Some could reason how to manage the failure as an extension of other aspects of the system, but not all.
- Initial communication about the potential problem, after the first tragedy, provided incomplete information
 - It told pilots how to shut off the defective feature
 - But, it wrongfully assumed all of them would know how to recover.
- The FAA had never been explicitly told about this “feature”
 - It didn’t know to require training or documentation

737 MAX Crashes

How did this happen?

- Business folks put pressure on engineering
 - Airbus was barking at their door
 - Each sale lost isn't just a sale lost
 - It is also decades of support for the aircraft, which is where the money is
 - It is also momentum for the maker for years to come, since the infrastructure and training for Boeing, Airbus, Embraer, etc, are all very different.
- Business folks expected that engineers would work harder and faster not make an unsafe plane
 - No Engineer would ever do that, right?
- Some Engineers had become business people, sort of
 - Confused identities = confused expectations of themselves from themselves and others.
 - How did they view themselves?
 - How did their bosses and colleagues view them?
 - How did more junior engineers view them?

Food for thought...?

- Is it wrong for business people to ensure that engineers understand the financial impact of their work?
- Is it wrong for business people to do so fervently?
- Is it wrong for business people to provide financial incentives to engineers for meeting goals of financial significance?
 - Or should engineers be ineligible for that type of reward, even though others associated with the project may get them?
- Are business people necessarily equipped to understand technical processes, the details of a product's maturity, and the risks to users of the product at different levels of maturity?
 - What obligation do such decision makers have?

Food for thought...?

- How much should Engineers allow such pressure to impact their work?
- Who has the responsibility to ensure that the process guarantees the safety of the product?
- Who has the responsibility to communicate about the status of that process and the product?
- Who has the responsibility to make sure that communication is understood?

What Are The Challenges for Engineers?

- What are the challenges Engineers face in getting these things Right?
 - What do you think?

What Are The Challenges for Engineers?

- What are the challenges Engineers face in getting these things Right? A few ideas...
 - Developing and maintaining their knowledge, understanding and skill
 - Knowing the limits of their own abilities
 - Working effectively with others
 - Communicating effectively with others
 - Supporting others w.r.t. developing their abilities and respecting their limits
 - Developing and respecting a methodological process using well-accepted techniques that guarantee the reasonable safety of their product.
 - Accepting and upholding their responsibility to the safety of others above all else.

Broader Questions

- Today we touched on only the most fundamental aspects of the responsibility of engineers:
 - To be trustable by everyone. Always.
 - To develop and maintain the technical, personal, professional, communication, followership, and leadership skills necessary to achieve this in each role they fill, in each stage of their career.
- There are actually broader, bigger picture questions
 - How do engineers balance the good of their customers vs the good of the broader world?
 - A cheaper safe airplane vs a more expensive safe airplane that is better for the environment
 - A financially successful product, that serves many well, but, at scale, is shown to hurt, oh, I don't know, children?
 - Technology that improves the lives of the tech savvy or wealthy, but at the cost of the livelihood of many more without that positioning.
 - AI/ML that can, I don't know, undress people, impersonate a parent with a fake emergency on scam calls, or offer deep-fake endorsements.

Broader Questions

The broader questions are important ones.

- It is very much worth asking, what is a worthy role?
- And, what responsibility does an Engineer have to shape the world around them?

But these questions all require the same foundation as the more basic ones:

- Engineers must be trustable
 - Even when they won't be known to those who trust them.
 - Even when the pressure is on.
 - And, even when it is against their immediate self-interest.
 - The goal for today's class was to get you to start thinking of yourself as Engineers, with the awesome responsibility that being an Engineer entails.
 - Actions become habits, and habits become character
 - I hope you feel motivated to Rise Above. Starting today.
 - Coming attractions
 - Respectful and effective communication is often one of the greatest challenges to effectively managing ethical challenges
 - We'll do some case-study role playing in recitation this week.
- See you then!

Broader Questions

- The goal for today's class was to get you to start thinking of yourself as Engineers, with the awesome responsibility that being an Engineer entails.
- Actions become habits, and habits become character
 - I hope you'll start reflecting upon your identity as an Engineer and the Responsibility that comes with it.
 - Actions make habits and habits make character.
- Coming attractions
 - Respectful and effective communication is often one of the greatest challenges to effectively managing ethical challenges
 - We'll do some case-study role playing in recitation this week.
 - See you then!