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What is an ethical engineer?

In the advancing world of technology, engineers are faced with ethical dilemmas that stretch further beyond technical problem solving. With the rise of AI and autonomous control systems comes the decisions that could affect a human's life. Autonomous vehicles weigh the risk in real time, considering every millisecond and every inch that comes close to hitting another human. Climate changes on the planet require each design to be sustainable and long lasting. In all of these scenarios, only one question arises: what does it mean to be an ethical engineer? An ethical engineer is not simply someone who follows the book, but an engineer who thinks about the moral impact of their job and anticipates the consequences. While engineers are understood as being the bridge between the future and discovery, an ethical engineer holds the characteristics of responsibility, integrity, and empathy through consequentialism, deontology, and virtue ethics.

Consequentialism defines morality through results. Consequentialism stems from the word consequence, and engineers must consider what the end result of their design choice would lead to before they can act. When looking through the slides, it is understood that “morally right action is the one with best overall consequences,” which some would view as an outcome oriented mindset. One can see the right action as having the best consequence by weighing the potential outcomes that come with making such a decision and whether it brings the best for a group of people from a utilitarianism viewpoint. Engineers on a daily basis will have to analyze

data, model results, make the best decision to ensure that their design is safe and cost, all while being efficient.

In class, we viewed an example of a junior engineer named Aiwa who was placed on a team designing a safety system at one of her company's fabrication labs. Her team consisted of senior engineers and juniors with the goal of improving lab safety without harming "chip quality, process efficiency, or technician morale". Her team came up with multiple designs and other alternatives to help improve safety, but the team was stuck on one option. That option was option 5, which was seen as the best option within her team due to it being the cheapest option and would produce the same quality and process efficiency. The only consequence that came with this option was that it would have fewer options than another choice that Aiwa was focused on. Aiwa wanted to pick option 12, which produced the safest outcomes but suffered from some consequences. A key consequence was that the solution was complex and created more time and demand, meaning that it would be more expensive to implement. From a consequentialist standpoint, Aiwa's reasoning focused on the outcomes of picking each option as she weighed the potential harm versus cost and efficiency. Although her decision conflicted with the company's interest, it highlighted a key aspect of consequentialist ethics, which requires engineers must evaluate the foreseeable future before they make a decision that could maximize benefit but also minimize harm, even when resources are limited.

From a personal standpoint, Consequentialism reflects the essence of engineering judgment. Thinking before we say and thinking before we do. Engineers, in most cases, rarely have the luxury that comes with having perfect data and results, and just have to design or find a solution by interpretation. An activity that comes to mind is "Pizza Time," as no one was given any data or statistics on whether "Wall-E" would be the best option for delivering pizza or any

option in general. Most solutions were more focused on the positives, and the consequences were only given one bullet point when there were many underlying issues. When picking Domino's delivery robot, the main consequence was that it was driverless, but this was hinted at being an improvement. In a general sense, it would be an improvement, but it replaces the pizza delivery job and doesn't help people who have a disability, as how are people who are in a wheelchair going to pick up the pizza from the curb conveniently? Another option was picking a delivery drone to help drop off the pizzas, which has the main drawbacks that it can only pick up two pizzas and does not have a thermal enclosure. Through this activity, we realized that it takes more to be an ethical engineer. Consequentialism is not just finding the design with the best numbers or results, but it is about understanding who is affected by those results. Every choice an engineer makes has winners and losers, benefactors and victims. Ethical engineers must look beyond having efficient designs and consider the human and environmental consequences of their designs. In a sense, consequentialism is tied directly to the virtue of responsibility. Engineers who are responsible must accept that every decision involves a cost and shapes the world in some way.

However, outcome-based thinking has its limitations. Sometimes, the right decision isn't just one that produces the best results but the one that honors a duty or principle. Engineers are often placed in different situations where doing what they feel is right isn't the most profitable or efficient solution. This is where deontological or the ethics of duty comes into play.

Deontological ethics emphasized duty and moral rules over outcomes. The framework of deontology is that the morality of an action should be determined if it's wrong or right by whether it follows a set of rules. An average Joe version of the rules would be the law, as if someone were to cross the road without first walking on the sidewalk, may seem harmless if no

cars are coming, but it still breaks the law, making it non-deontological. Within engineering, these “rules” go beyond laws and extend into professional responsibilities such as honesty, fairness, and respect for human safety. The IEEE code of ethics reflects this mindset, urging engineers to “hold paramount the safety, health, and welfare of the public” and “to be honest and realistic in stating claims or estimates.”

For engineers, deontology means upholding these duties even when it’s difficult or inconvenient. For example, a civil engineer is working on a bridge and finds a design that doesn’t exactly meet safety guidelines. The civil engineer's sole responsibility is to protect the general public and ensure that the bridge doesn’t break, causing an accident. Even if reporting the flaw could delay the project or upset management, the deontological duty is to protect the public, as it comes first. An ethical engineer recognizes that following moral and professional obligations helps preserve both human life and the integrity of the profession. Deontology aligns closely with the virtue of integrity as it calls on engineers to act according to principle, even when no one is watching.

Deontology, in a way, serves as a counterbalance to consequentialism. While consequentialism focuses on achieving the best outcomes, deontology serves as a reminder for the engineer that certain principles, such as honest, fairness, and respect for life, should never be compromised. Even in the pursuit of good results, an engineer must care about another life and understand that efficiency doesn’t mean that the solution is necessarily good. Bringing the engineer to design with integrity. A case mentioned in class was “Airbags,” as Bob Blaines, a worker in a quality control department, was tasked with looking through the designs of airbags. Bob Blaines saw a design that he was unsure of was being pressure to sign off on by his manager. When he investigated the situations, he found them to be ambiguous and potentially

unsafe. Despite his lack of seniority, Bob refused to approve the design as he believed it would violate his professional duty to ensure safety. Even with his manager pressuring him to sign off anyway, he decided to follow his principles rather than compromise his morals and resigned from the company. This case highlights deontology in action as Bob stuck with his conscience rather than submitting to authority, jeopardizing his own job security. Bob's choice reflects the virtue of integrity, acting right even when it comes with a personal cost. As a future engineer in industry, this case tells us that ethics is not only about producing results but also staying true to oneself. Upholding principles, even when under pressure it defines what it means to be an ethical engineer.

Virtue ethics shifts the focus from rules or results to the moral character of the person making the decisions. Instead of asking "what should I do?" or "what would happen if I did this?", virtue ethics asks "what kind of person should I be?" This framework of ethics suggests that ethical behavior comes from developing good character traits known as virtues. Some well-known virtues would be honesty, empathy, courage, humility, and integrity. Within engineering, virtue ethics goes beyond simply following codes or calculating risks, but rather embodies who the engineer is as a person when making decisions.

Within the lecture notes, many arguments for virtue ethics are brought up. One argument is that virtue ethics "responds to the complex and social nature of engineering work and output". Within engineering, it's not just one person working to find a solution or making a decision; it's often a team environment. Every engineering decision involves teamwork, uncertainty, and real human impact. Unlike following rigid rules or outcome-based decisions, virtue ethics prepares engineers to use good character and judgment to make ethical choices in complicated situations.

Virtue ethics also emphasizes practical wisdom, the ability to use moral understanding in conjunction with technical knowledge. In class, we covered Harris's "non-technical excellences," which were cited as basic virtues for engineers, which are "techno-social sensitivity," "respect for nature", and "commitment to the public good". Techno-social sensitivity is being able to foresee how technology affects society, the environment, and the conditions that help influence the evolution of technology. It reminds the engineer that every design has consequences beyond the lab or schematic. Respect for nature pushes the engineer to see themselves as part of a larger system rather than being exempt from it, helping to promote sustainability and environment awareness in every stage of a design. Lastly, Commitment to the public good means designing a solution that goes beyond the guidelines and considers how it can benefit the general public.

These virtues ask engineers to think about not only what can be built but what is essential. As an example, in the design of renewable energy schemes, a techno-social sensitive engineer would put into place the long term environmental and economic effects of the design. They could employ materials that reduce waste or work with local communities to make sure that the solution will help everyone equally. Similarly, showing respect for nature may be shown in design of preserve ecosystems or diminishing carbon emissions. Commitment to the greater good may be shown in advocating for safety improvements, even if they low production or increased cost shown in the Aiwa example.

Virtue ethics calls engineers to bring together moral awareness and technical expertise to view engineering as a human-oriented profession rather than a mechanical one. It is these virtues that transform an engineer from a simple problem solver to one who solves with responsibility, empathy, and conscience.

In the end, being an ethical engineer is not just about solving technical problems; it's about the kind of person you choose to be when making those decisions. Consequentialism, deontology, and virtue ethics all shape what it means to act responsibly, honestly, and with empathy in the face of adversity. Consequentialism keeps engineers mindful of their duty for the effects of what they do and always concerned about who will be affected by what they create. Deontology is a matter of honor and moral duty, and it calls on engineers to do what they ought to do even when it is difficult or not popular. Virtue ethics is centered on sympathy and character, and it calls on engineers to care about people, communities, and the environment in all the decisions they make. Together, these philosophies suggest to us that engineering is not so much the act of making things. It's the act of making trust, safety, and a better world. To me, an ethical engineer isn't just someone who makes things accurately but someone who designs with purpose, balancing knowledge against compassion and using skills to make good happen in the world.

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