Rowan University
DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

# ECE 09.461 Professionalism & Consulting in Engineering

## Lecture 12

## Ethics in Engineering Design & Decision Making

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# This Week in P&C: Ethical Considerations

- Not your typical ethics class
- Ethics vs. morals
  - Some (in)famous examples of engineering disasters
  - Code of ethics, ABET student outcomes
- Four corners approach
  - Capabilities
  - Consequences
  - Duties
  - Virtues
- But wait… what about / what if…?
  - Some exercises
- The headline test
- Putting it all together



Some of the content in this lecture is based upon material in *Technology and Design Ethics*; Morten Rand-Hendricksen, Nov 2019. Available at https://www.linkedin.com/learning/technology-and-design-ethics/

# ETHICS

- Ethics: An understanding to determine and judge what is right or wrong, with respect to virtues such as:
  - Fairness & justness
  - Moral obligations
  - Benefits to society

eth·ics

/ˈeTHiks/

*noun*

1. moral principles that govern a person's behavior or the conducting of an activity.
   "medical ethics also enter into the question"

   Similar: moral code | morals | morality | moral stand | moral principles

2. the branch of knowledge that deals with moral principles.
   "neither metaphysics nor ethics is the home of religion"

*Oxford dictionary*

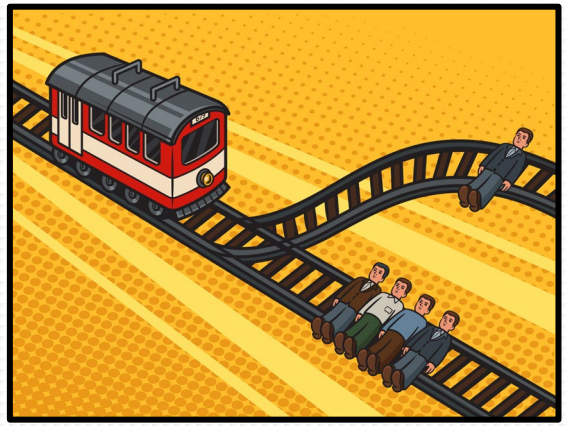
- There is a difference between morals and ethics, however:
  - Morals: personal understanding of what is right / wrong, typically based on culture, religion, politics and own life experience
  - Ethics: societal agreement / understanding of what is right / wrong

# Ethics vs. Morals

- Morals and ethics can be at conflict with each other:
  - During your consultant work for a company, you are provided with some data that can help an underserved community in a significant way.
    - **You signed an NDA with this company, but if you were to release the data, there is no way the company can possibly trace that to you, and the information can help hundreds of underserved people in your community.**
  - Morally, you feel perfectly and completely justified in releasing the data.
  - Is it ethical to do so?
    - **Why / why not?**

# Ethical Dilemmas

- … are rare!
  - In most cases and examples that are presented as ethical dilemmas, the situation is either absurdly hypothetical or the right thing to do is often (but not always*) obvious
    - **There is often an obviously right decision**
    - **…but that decision is ignored due to other, typically financial, factors**
  - An ethically right decision – even when it is obvious after the fact - is not necessarily easy to make, due to competing circumstances:
    - **Clouded judgment**
    - **Miscalculations on risk**
    - **Conflicts of interest**
    - **Greed**
    - **Fear of loss (of money, position, prestige, etc.)**




* We will see some true ethical dilemmas later in this class

# Some (In)Famous Examples of Engineering Disasters

- Titanic (1912)
  - Not only the watertight compartments were not properly designed, but there were not enough lifeboats for everyone. There was enough space for 1200 people, whereas there were 2200+ people on board.
- Ford Pinto (1971-1976)
  - A faulty fuel tank design that could cause a rupture → some engineers pointed out the flaw that would cost $11 to fix (per vehicle), but the company did not follow the recommendations. 30 ~180 people have died as a result.
- Kansas City Hyatt Regency Hotel Walkway (1981)
  - Two walkways suspended in the air were supposed to be held together by a single set of rods connected to the ceiling. During construction, the different sets of rods were used and connected to each other, causing the rods to carry twice the weight. The design change was not properly evaluated/approved. The walkways crashed, killing 114 and wounding 200+.
- New Orleans' Levees (2005 – Katrina)
  - The Army Corps of Engineers did not follow its own design guidelines, designed the levees to withstand only low-speed hurricanes, and did not consider the natural gradual sinking of the levees, leading to insufficient height. The collapse of the levees killed 1800+ people, causing over $100 billion in damage.

# Some (In)Famous Examples of Engineering Disasters

- Space Shuttle Challenge Disaster – NASA 1986
  - The O-rings used in fuel tanks were improperly designed for colder ambient temperatures – and failed in the cold temperatures, leading to the explosion. The issue was known to some engineers, who advised against launching at colder temperatures, but reportedly, NASA went ahead with the launch so as not to miss the launch window. Seven crew members died.
- Space Shuttle Columbia Disaster – NASA 2003
  - Debris from the fuel tank during liftoff struck the left wing of the shuttle. NASA informed the crew that there was no significant damage and it was safe to return. 16 days later, when the shuttle returned to earth, Columbia disintegrated during reentry. Seven crew members died.
- Baltimore Key Bridge Collapse (2024)
  - Container ship MV Dali struck one of the six piers of Baltimore's F.S. Key Bridge, causing it to collapse instantly, killing six crew members on the bridge, and shut down Baltimore harbor for 11 weeks, causing over $2B damage. The bridge, which had previously been hit by another ship (in 1980), had not been upgraded to the current standards to withstand ship collisions (a not-so-uncommon occurrence), while the ship had electromechanical issues before departure, which were not fully addressed, causing it to lose power (and hence propulsion control).

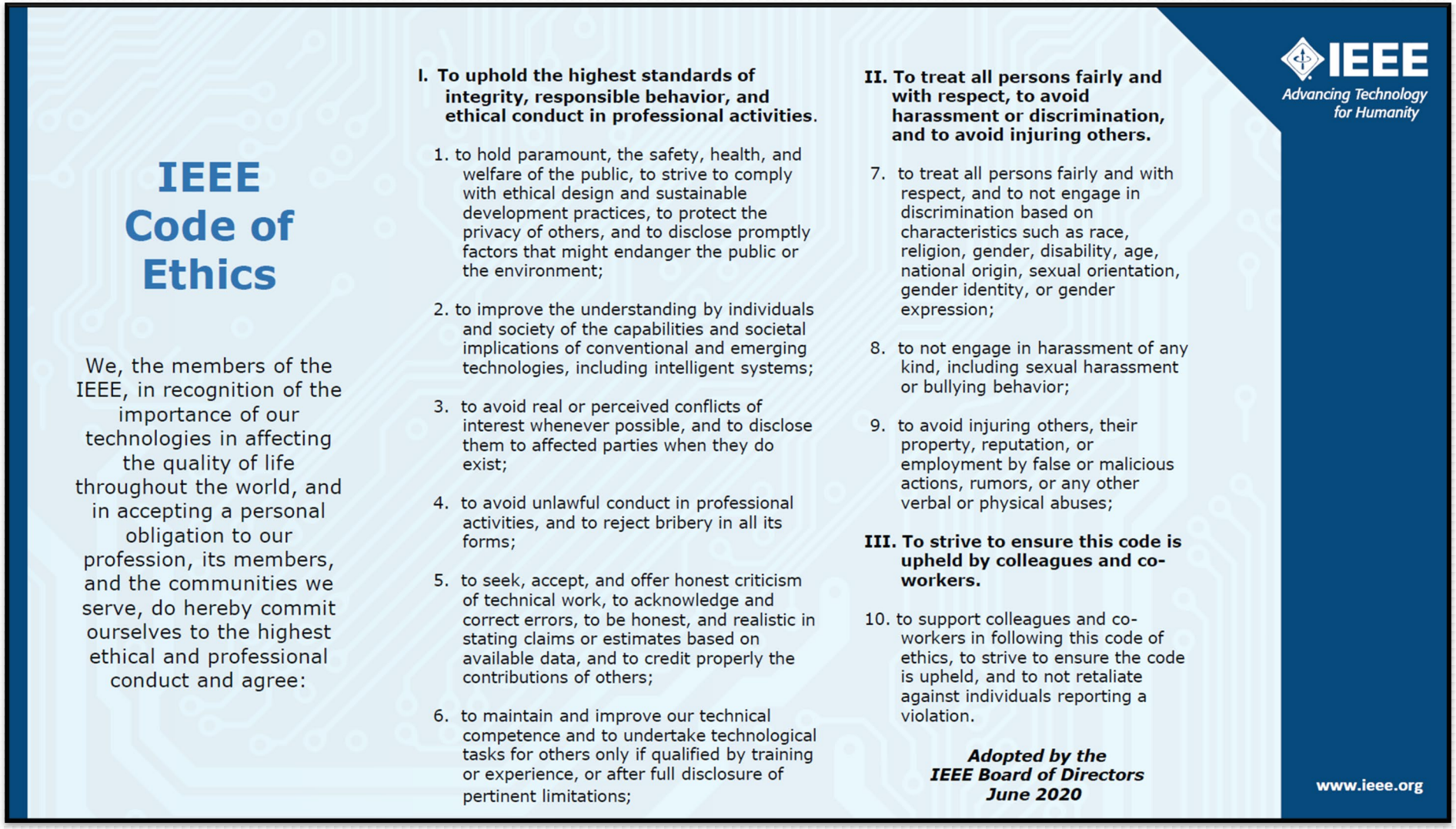
What is the common problem in all of these – and countless other – disasters?

# Ethical Standards

- Many organizations involved in various areas of engineering have issued their own ethical standards
  - AIChE Code of Ethics
  - ASME Code of Ethics
  - ASCE Code of Ethics
  - BMES Code of Ethics, Conduct & Policies
  - ASEE Code of Ethics for Engineering Educators
  - IEEE Code of Ethics


- Looking at them, you will see common threads on insuring health, safety, honest decision making, avoiding conflicts of interest, treating others with respect, etc.

# IEEE Code of Ethics



## IEEE Code of Ethics

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members, and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

**I. To uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities.**

1. to hold paramount, the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment;
2. to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;
3. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
4. to avoid unlawful conduct in professional activities, and to reject bribery in all its forms;
5. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest, and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others;
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

**II. To treat all persons fairly and with respect, to avoid harassment or discrimination, and to avoid injuring others.**

7. to treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;
8. to not engage in harassment of any kind, including sexual harassment or bullying behavior;
9. to avoid injuring others, their property, reputation, or employment by false or malicious actions, rumors, or any other verbal or physical abuses;

**III. To strive to ensure this code is upheld by colleagues and co-workers.**

10. to support colleagues and co-workers in following this code of ethics, to strive to ensure the code is upheld, and to not retaliate against individuals reporting a violation.

***Adopted by the IEEE Board of Directors June 2020***

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https://www.ieee.org/content/dam/ieee-org/ieee/web/org/about/corporate/ieee-code-of-ethics.pdf

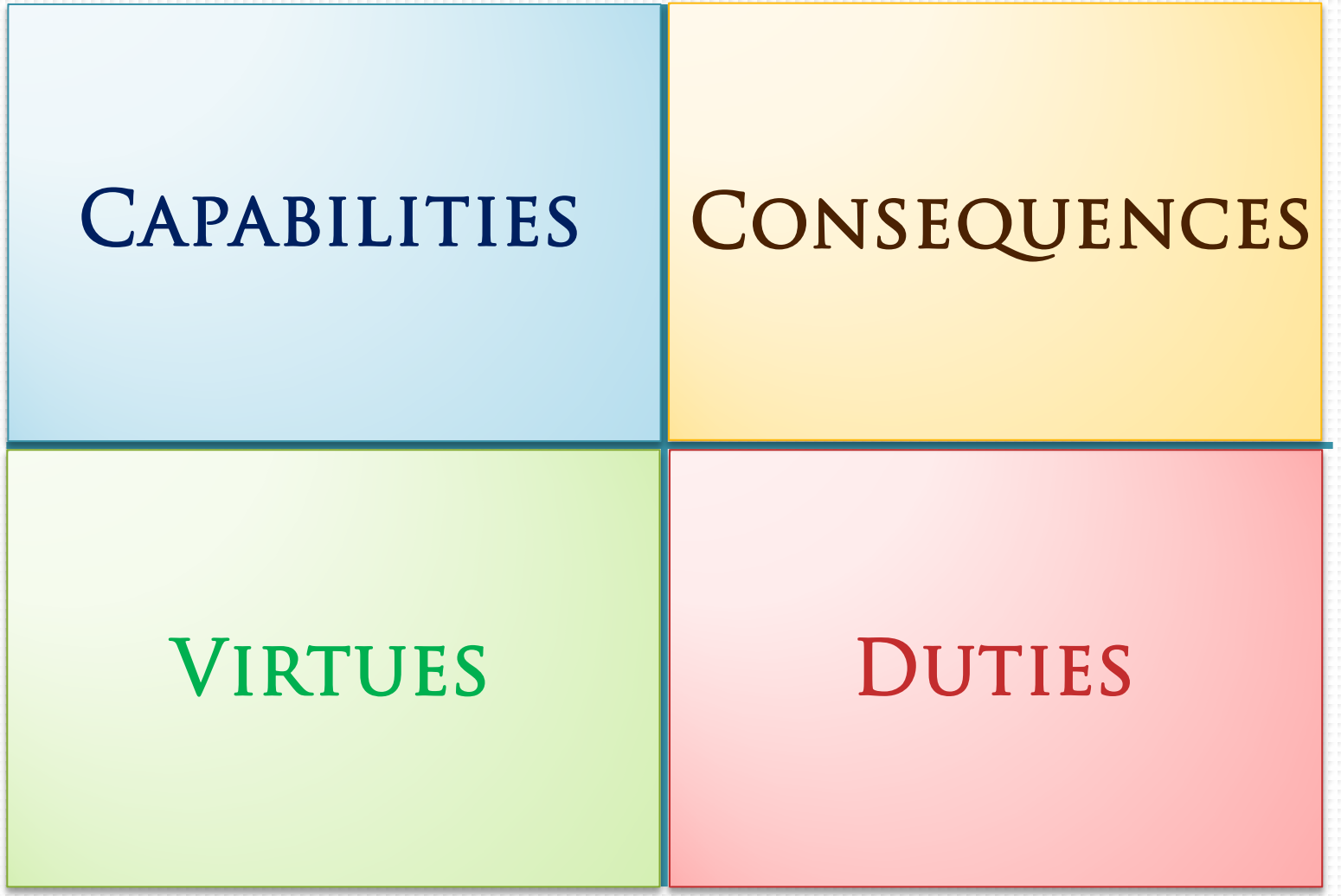
# ABET Student Outcomes

An engineering program – to be accredited - must document the attainment of the following student outcomes that prepare graduates to enter the professional practice of engineering.

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. **an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.**
3. an ability to communicate effectively with a range of audiences.
4. **an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.**
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

# Four Corners Approach

- Ethics is about making the right decision, whether there is a dilemma or not!
- We will use the four corners approach to guide our decision-making process.
- Each corner represents a key consideration to help in ethical decision-making
  - Map to four theories of moral philosophy:
    - **Capability approach**
    - **Consequentialism**
    - **Duty ethics**
    - **Virtue ethics**



# CAPABILITIES

- Every new design introduces / modifies capabilities
  - Granting new capabilities – something new that did not previously exist
  - Enabling capabilities – providing access to a capability
  - Limiting capabilities
  - Removing capabilities
- Using this product / solution, the user now can / cannot _____
  - Discuss, e.g.: e-bicycle, smart-bulb, parental controls, non-fungible tokens, etc.
- The design and the new / modified capabilities must be relevant / useful to the end user → utility ethics, utilitarianism
  - Giving a smart bulb to someone who has no internet access (or power) is not very useful
- Capabilities create a ripple effect beyond the primary end-user, each perhaps with a decreasing but non-zero impact.

# … But Is It Good?

- Evaluate the new / modified capabilities for each stakeholder from two primary perspectives:
  - Equity – does every member of this stakeholder have equal access to these capabilities
  - Does it serve a common good for this stakeholder
- Then, ask yourself: what is the worst that can happen when this stakeholder has this capability.
  - Look at all reasonable scenarios
    - **…but not cases with zero or infinitesimally small chances of happening, e.g., no aliens, dinosaurs, etc.**
    - **E.g. you develop a new [drone / smart bulb / social media platform / Gen AI tool …] → i) who are the stakeholders, and ii) what is the worst they can do with that tool?**
- Add all primary and downstream capabilities to your Capabilities corner, and prepare to consider the reasonable scenarios for the…

# CONSEQUENCES

- What is the impact or utility of this new / modified capability on each of the stakeholders ➔ consequences
  - The client / company for which you provided services / designed something
  - The primary end-user of that design / service
  - All other potential stakeholders / users impacted by your design / service, including those who will not or cannot use your service / design.
- The most ethical design/ decision is the one that provides the most utility (happiness, relief of pain / suffering, improvement in quality of life, etc.) to most people.
  - The utility should be considered not just in the immediate term but also long term.
  - Determining / imagining long-term consequences, particularly negative ones, may be difficult
    - **Intentional or unintentional misuse, negative consequences**
    - **For example: think about the unintended consequences of social media**

# Who Is Left Out?

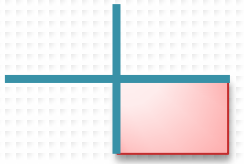
- Consider, in particular, those who are "left out" by your decision / service, and the impact of your decision on those stakeholders.
  - These are typically people who cannot use / benefit from your design / service for some reason or another (typically access, cost, etc.)
- You may find out that your design will benefit some stakeholders (primary stakeholders), and perhaps harm others.
  - Ask yourself if and how you may be able to protect the rights and dignity of all people who may interact with or be impacted (even if indirectly – say by not using it), from your design / service / decision.

# CONSIDER

- Fill this table and add to the Consequences corner.

| Capability | Consequence | Stakeholder | Utility Value |
|---|---|---|---|
| | | | Positive Utility: +1 |
| | | | Neutral Utility: 0 |
| | | | Negative Utility: -1 |
| | | | |

# DUTY



- With every design / service decision, you are not just providing a solution to your immediate stakeholder / client; you are also setting a path – an example – for others to follow.
  - Those "others" include your customers, clients, colleagues, and even competitors.
- When this path / example leads to good things, you become a pioneer, innovator, trend setter, transformer, change maker, etc.
  - How do you know if this path leads to good things?
    - **Ask yourself: Is this the decision I would want others to take if they were in this specific situation?**

# Duty Ethics

- Does your decision set a good precedence for other people to follow?
  - Does your decision uphold your duty of care for other people?
    - **Consequentialism → Consequences of what you have created**
    - **Duty ethics → Your reason for your design / decision**
  - If other people (colleagues, clients, competitors) were to replicate what you have done, is that still in the best interest of most people? (Competitor test)
    - **Mind you, once your solution / decision / design is replicated, both its advantages and disadvantages may amplify → Does that change your decision?**
  - Given the answer to the above question, would you still take the same path / design / decision?
    - **Can your solution / design / decision be considered a best practice?**
    - **If your solution / design / decision sets a precedence – with your name attached to it – would you still make the same decision?**

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# DUTY TRIANGLE

## ASK YOURSELF:

1. Is there a current "best" practice for this design / decision?

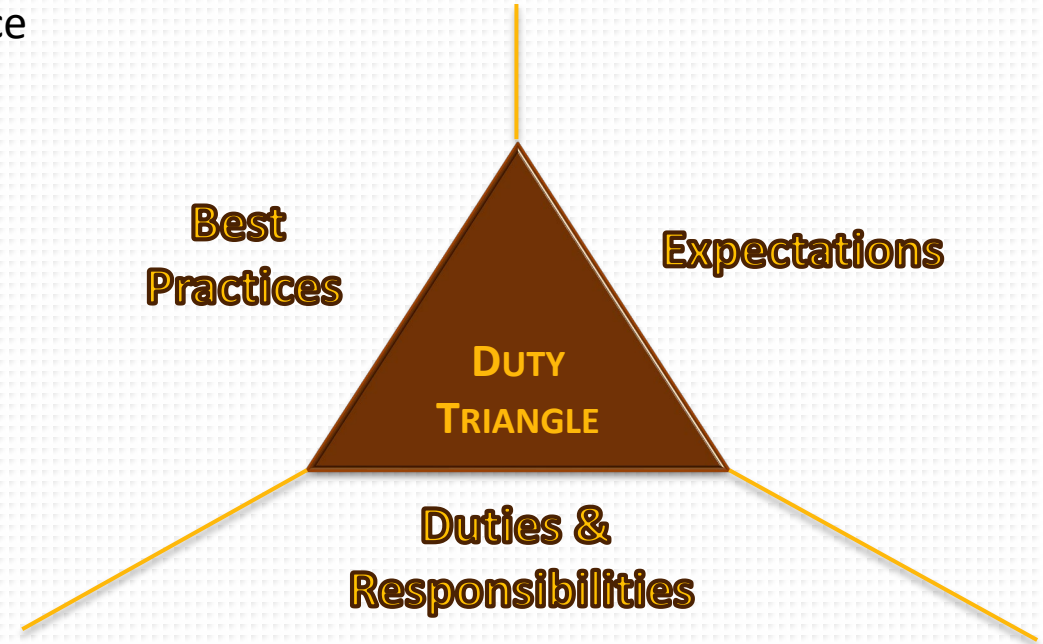
**YES**
What is it?

Why is it a best practice?

Why do you want to create a new one?

**NO**
What is your solution?

Why should that be a best practice?



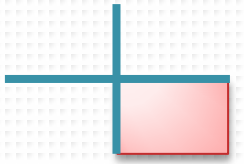

2. What are the users' / client's (or anyone affected by your design) reasonable expectations for your design / service?

Are you meeting them?

3. Can my design / decision possibly harm anyone? If so, what is the harm, how does my design / decision cause the harm, and who does it harm?
(consider – physical safety, security, data safety, privacy, psychological impact, etc.)

*Duty of care: This is a legal obligation requiring adherence to a standard of reasonable care while performing any acts that could foreseeably harm others. It is the first element that must be established to proceed with an action in negligence*

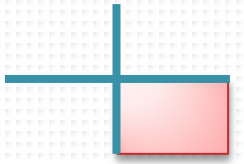
# ...But Wait... (Part I)



- Q: What about:
  - … other people who do unethical things?
  - … who do not care about whether they cause harm?
  - … or intentionally want to cause harm?
  - … aren't there companies/individuals who not only break ethical rules but also legal laws to get an advantage or get what they want?... And get away with them?
- A: Bad actors / apples do not matter – they are irrelevant!
  - Just because someone is doing the wrong thing – and gets away with it – does not make it right. It is still wrong!
  - Being ethical is a conscious decision to do the right thing – because of our commitment to our society, to ourselves – even if there are others who get away with being unethical.

# …But Wait… (Part II)

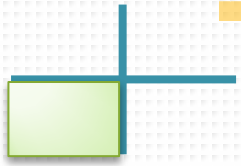
## True Ethical Dilemmas



- Q: What if…
  - … I am forced to do the unethical thing because of peer pressure
  - … or simply because I am ordered to do so by my boss / superior?
  - … doing the right thing causes harm to **me / my family / loved ones** ?
- A. Asking someone to put themselves in a difficult, precarious or dangerous situation over an ethical situation would be unreasonable and, in turn, be unethical – in many circumstances.
  - E.g., if you will lose a job you depend on to care for your dependents.
  - In most consulting jobs, this is unlikely to be the case.
- But, there are some cases where simply refusing to do the wrong thing – and if necessary walking away from that job – is not only the right thing to do, but is also the only thing you should do, if otherwise significant, real and irreparable harm will come to one or more people.

# Solution To The Dilemma

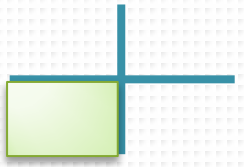
- In most cases, the bad decisions of bad apples / bad people are not because they just want to cause harm, but rather there is bias, ignorance, unawareness, greed, etc. in play.
- Your opportunity: educate them. Tell them that:
  - The path they are following is likely to cause harm – not just to other people, but to our / your / their customers, eventually to the company and to themselves;
  - …and that there are / may be other solutions, that will provide better outcomes (albeit, perhaps in the long run).
  - .. and that you may be able to propose some such solutions.
- A not-so-unlikely scenario for a real dilemma (an in-class exercise):
  - You are offered a job at a company whose business practices you despise because – while legal – the company profits off the misfortune of the most vulnerable population of society, or engages in a line of business that you find very much against your morals.
  - However, you have been out of a job for several months, racking up (say, medical or mortgage) debt, and your family depends on you.



# VIRTUES & VALUES

- We have talked about Capabilities, Consequences, Duty Ethics – all of which are somewhat external concerns.
- We now ask inward pointing question(s):
  - What are our virtues, beliefs and values?
  - Virtue ethics: the goodness of a decision is determined by the impact of that decision on the decision maker him/herself.
    - **This is where ethics and morality overlap considerably.**
- Ask yourself: Is this the design / decision **my ideal self** would make?

# Virtue Ethics



- Virtue ethics help us become the person / company we want to become.
  - Companies / organizations do this through their mission, vision, code of conduct statements.
- For tech-design, consider Shannon Vallor's Technomoral Virtues
  - Honesty
  - Self-control
  - Humility
  - Justice
  - Courage
  - Empathy
  - Care
  - Civility
  - Flexibility
  - Perspective
  - Magnanimity (generosity)
  - And their integration to technomoral wisdom
- What are your virtues? Identify your virtues, and then ask:
  - What decision would be appropriate for someone with [those virtues].
  - Is this the decision a person with [those virtues] would make?
  - Is this the decision a person ***I want to become*** would make?

# Do the Right Thing...

Alphabet
Investor Relations

## Code of Conduct

Preface

Employees of Alphabet and its subsidiaries and controlled affiliates ("Alphabet") should do the right thing – follow the law, act honorably, and treat co-workers with courtesy, support, and respect.

We expect all of our employees and Board members to know and follow this Code of Conduct. Failure to do so can result in disciplinary action, including termination of employment. Any waivers of this Code for directors or executive officers must be approved by our Board.

Never retaliate against anyone who reports or participates in an investigation of a possible violation of the Code.

⋮

V. Conclusion

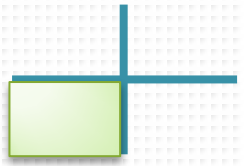
We rely on one another's good judgment to uphold a high standard of integrity for ourselves and our company. Each of us should be guided by both the letter and the spirit of this Code.

Adopted October 2, 2015; amended Sept 21, 2017 (updated with clarifying language regarding conflicts); amended September 25, 2020 (updated with language regarding our Workplace Guiding Principles and applicability of this Code to members of our extended workforce)

See Google Code of Conduct here.

https://abc.xyz/investor/other/code-of-conduct/

# Your Virtues



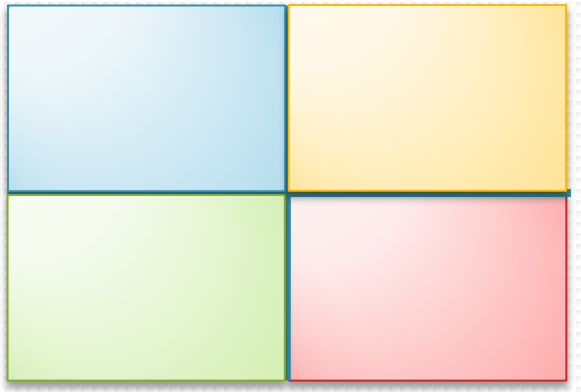
- Once you identify your virtues, decide what those mean to you.
  - If you picked **honest**, **just** and **caring**, ask yourself what these mean to you.
  - By doing this, you are setting an ethical bar – a threshold – for yourself → every design / decision you make, you will be judging yourself against that threshold.

- Ask yourself: With this design / decision:
  - Is this a design / decision an [**honest**] person would make?
  - Is this a design / decision a [**just**] person would make?
  - Is this a design / decision a [**caring**] person would make?

# The Headline Test

- A simple test to determine whether you are holding yourself to these standards:
  - How do you feel about reading the news about your design / decision on a major national / international news headline?
  - Will people reading this headline think you are **honest**, **just** and **caring** ?

# Putting It All Together



- These are not exercises
  - … that you do only one
  - … that must be completed all at once all the time
  - … that need to be completed in a specific order
- Use them holistically to
  - accomplish your goals,
  - evaluate your designs and decisions
  - find hidden issues, flaws, concerns, problems with your design / decision
  - answer your ethical questions or dilemmas
  - find better solutions, develop better designs, make better decisions

# ASSIGNMENT

- Use the four corners approach in evaluating your design / service in the context of global, economic, environmental, and societal factors; and how you address them or how they can be addressed.
  - Identify (by asking and answering the questions mentioned in this lecture) the capabilities, consequences, duties and virtues associated with your design / service / decisions.
- This is Part 3 of your Engineering Design & Impact Statement, and will probably need a separate page to answer thoroughly and properly.
  - Each part of Engineering Design and Impact Statement will be graded separately, and will form part of your grade.

# GRADING

- The final grading will be as follows:
- Project Approval and Evaluation Form: 15 %
- Project 60%
  - Grade given by client:30%
  - Engineering Design & Impact Statement: 30%
    - **Part I: 10 %**
    - **Part II: 10 %**
    - **Part III: 10%**
  - Final Exam covering the most critical aspects of lecture content: 15%
  - Professionalism & attendance: 10%