Engineering Ethics
(Hum 4441)

Lecture 1

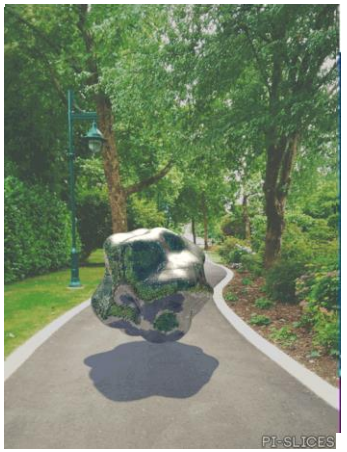
Engineering

- The word "**Engineering**" itself comes from the Latin INGENIUM, meaning "Cleverness", and INGENIARE, meaning "To Design and Devise".
- It's more useful to think **science** as a tool, a tool that engineers use – along with mathematics – to perform their duties.

Science vs Engineering

- ❑ You are a curious person

- Background chemistry
  - want to know the molecular structure and chemical component in it
- Background biology
  - Take a sample from the blob to learn its biology
- Background Physics
  - How it operates in motion
  - May be the glue has special property

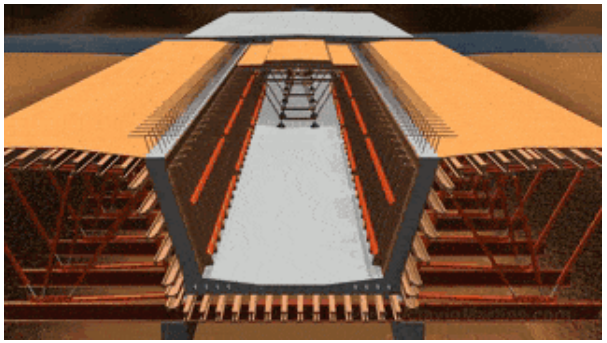


Science vs Engineering

- Science ask questions about the nature of the universe, from our expanding knowledge of space, to the tiniest particle found in the tip of the pencil.
- But **engineers** want to take answers those questions and solve the problems.
- Because in the process of designing clever things, what engineers really does is solve the problems.

Civil Engineering

- **Civil engineering** is used for civilian purposes.
- It deals with the design, construction, and maintenance of the physical and naturally built environment, including public works such as roads, bridges, canals, dams, airports, structural components of buildings, and railways.

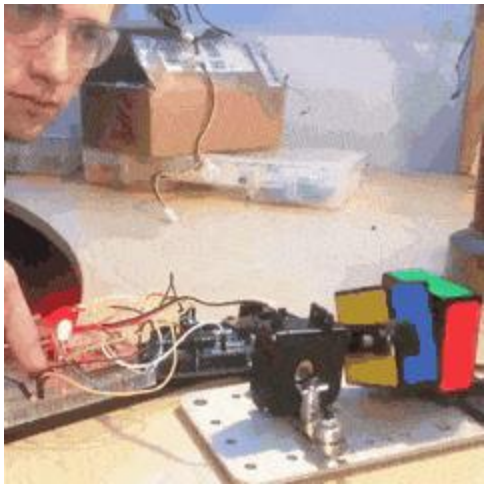


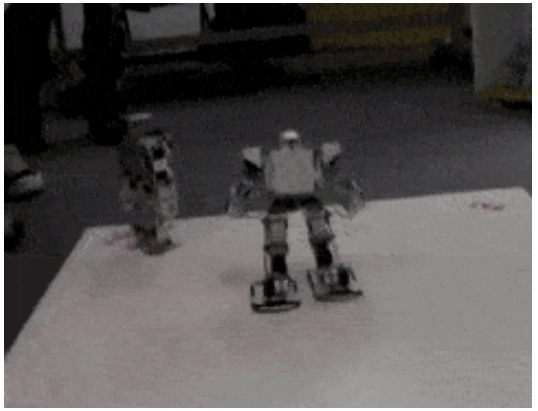
Mechanical Engineering

- **Mechanical engineering** is an **engineering** branch that combines **engineering** physics and mathematics principles with materials science to design, analyze, manufacture, and maintain **mechanical** systems.

Electrical Engineering

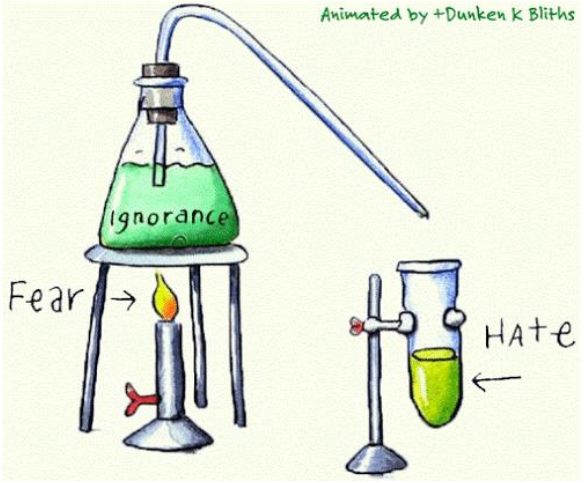
- **Electrical engineering** is an engineering discipline concerned with the study, design and application of equipment, devices and systems which use electricity, electronics, and electromagnetism.



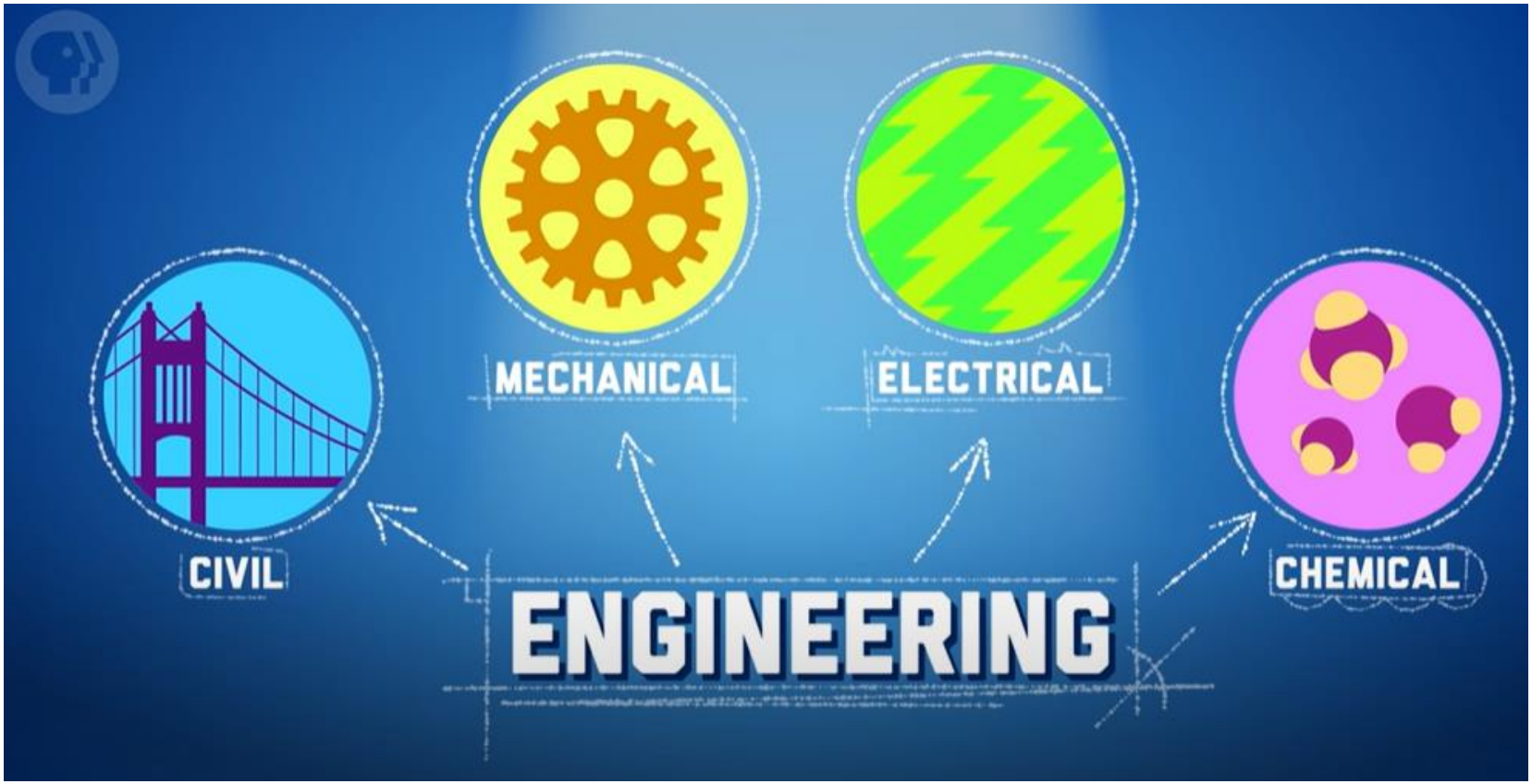


Chemical Engineering

- **Chemical engineering** is the branch of **engineering** that deals with **chemical** production and the manufacture of products through **chemical** processes.
- This includes designing equipment, systems and processes for refining raw materials and for mixing, compounding and processing **chemicals** to make valuable products.



Engineering Branches

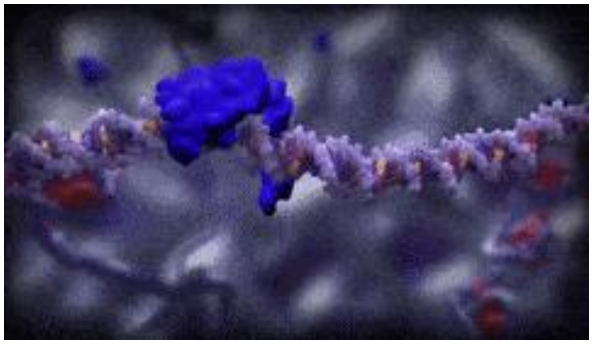


Engineering Branches

Aerospace Engineering

Nuclear Engineering

Biomedical Engineering



Industrial Engineering

- **Industrial engineering** is an **engineering** profession that is concerned with the optimization of complex processes, systems, or organizations by developing, improving and implementing integrated systems of people, money, knowledge, information, equipment, energy and materials.

Herbert Hoover (views on engineering)

- *"The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them. His acts, step by step, are in hard substance. He cannot bury his mistakes in the grave like the doctors. He cannot argue them into thin air or blame the judge like the lawyers….He cannot, like the politician, screen his shortcomings by blaming his opponents and hope that the people will forget. The engineer simply cannot deny that he did it if his works do not work, he is damned forever."*

Herbert Hoover (views on engineering)

- Engineering profession is something
  - where the outcomes are important
  - this outcome is a tangible product where everybody can see and use
  - it affects the life of people.
- It is very important to tone up the responsibility of the outcomes faced by the users of the product, and engineers cannot deny like they have not done it.

The Engineering Profession

- How engineers view themselves:
  - Problem-solvers
  - Engineering is enjoyable;
  - Engineering benefits people, provides a public service
  - Engineering provides the most freedom of all professions (Florman, 1976)
  - Engineering is an honorable profession

- How Public views engineering ?
- The Engineer's Role
  - Engineers as Utilitarian
  - Engineers as Positivists
  - Applied Physical Scientists
- A socialist approach –Engineers are drivers for converting technology to their benefit
- Rational, logical and systematic approaches to problem solving which tend to alienate the engineer from the public because of the technicalities.

The general public at large may not understand the in-depth technical issues involved in it. But it is a great responsibility and challenge for the engineers to translate that technology into something which is usable and which is for the benefit of the public at large.

Why Ethics in engineering?

- The National Society of Professional Engineers (**NSPE**) is most widely recognized governing body of engineers which decides the overall standards and codes of ethics for all the engineering professions in US and serves as a reference point for others bodies in the world.
- The Preamble of the NSPE *Code of Conduct for Engineers* (2007) states
  - *"Engineers shall at all times recognize that their primary obligation is to protect the safety, health, property, and welfare of the public. If their professional judgment is overruled under circumstances where the safety, health, property, or welfare of the public are endangered, they shall notify their employer or client and such other authority as may be appropriate."*

Why Ethics in engineering?

- Engineering occurs at the confluence of *technology*, *social science*, and *business*
  - Engineering is done by people and for people
  - Engineers' decisions have a impact on all three areas in the confluence
  - The public nature of an engineer's work ensures that ethics will always play a role
- Thus, it becomes importance for engineers to make sure that the interest of the groups to be affected prevails over their own interest of profit.
- So, engineers' have to give primary responsibility towards the safety, health, property and welfare of the public as well as protect these 4 pillars for the public is over and above thinking of owns personal profit. If in any case some conflict of interest happens then engineers' need to decide how to solve it.

Personal vs. Professional Ethics

- It is important to make a distinction between personal ethics and professional, or business, ethics, although there isn't always a clear boundary between the two.

- **Personal ethics** deals with
  - how we treat others in our day-to-day lives.
  - Many of these principles are applicable to ethical situations that occur in business and engineering.

- **Professional ethics** often involves
  - choices on an organizational level rather than a personal level.
  - many of the problems will seem different because they involve relationships between two corporations, between a corporation and the government, or between corporations and groups of individuals.
  - it deals personal ethics (own value system virtue) which will help engineers' to find an answer towards how to solve this professional ethics issues dilemmas and to arrive at a balanced solution.

What is Engineering Ethics

- According to Martin and Schinzinger (1996), Engineering ethics relate to;
  - the study of the moral issues and decisions confronting individuals and organizations involved in engineering;
  - the study of related questions about moral conduct, character, policies, and relationships of people and corporations involved in technological activity"

So, it is the guiding principles given by the organization or the professional body, which will guide the engineers to behave in a certain way in a given situation.

Situations of Ethical issues

- **Engineering ethics** is concerned with the question of what are the standards in engineering ethics should be and how to apply these standards to particular situations. (Harris, Pritchard, and Rabins 1995)
- Situations where ethical issues can arise:
  - Conceptualization, Design, Testing, Manufacturing, Sales, Service
  - Supervision and Project Teams
    - Project timelines and budgets
    - Expectations, opinions, or judgments
  - Products: Unsafe or Less than Useful
    - Designed for obsolescence
    - Inferior materials or components
    - Unforeseen harmful effects to society

- Other fields where ethics are critical
  - Medical Ethics
  - Legal Ethics
  - Business Ethics
  - Scientific Ethics

Engineering Tasks and Possible Outcomes

Tasks	A selection of possible problems
Conceptual design	Blind to new concepts. Violation of patents or trade secrets. Product to be used illegally.
Goals; performance specifications	Unrealistic assumptions. Design depends on unavailable or untested materials.
Preliminary analysis	Uneven: Overly detailed in designer's area of expertise, marginal elsewhere.
Detailed analysis	Uncritical use of handbook data and computer programs based on unidentified methodologies.
Simulation, prototyping	Testing of prototype done only under most favorable conditions or not completed.
Design specifications	Too tight for adjustments during manufacture and use. Design changes not carefully checked.

Engineering Tasks and Possible Outcomes

Tasks	A selection of possible problems
Scheduling of tasks	Promise of unrealistic completion date based on insufficient allowance for unexpected events.
Purchasing	Specifications written to favor one vendor. Bribes, kickbacks. Inadequate testing of purchased parts.
Shipping, installation, training	Product too large to ship by land. Installation and training subcontracted out, inadequately supervised.
Safety measures and devices	Reliance on overly complex, failure-prone safety devices. Lack of a simple "safety exit."
Use	Used inappropriately or for illegal applications. Overloaded. Operations manuals not ready.
Maintenance, parts, repairs	Inadequate supply of spare parts. Hesitation to recall the product when found to be faulty.

There could be ethical issues and dilemmas coming up, because number of parties are involved in it and **as an engineer**, based on the professional judgment and the professional conscience, the engineer has to **take a decision** which is in the best interest for the **safety** and **security** of the public at large.

Engineer's ethical decisions have a far reaching impact on :

- The Products and Services (safety and utility)
- The Company and its Stockholders
- The Public and Society (benefits to the people)
- Environment, Earth
- The Profession (how the public views it)
- The Law (how legislation affects the profession and industry)
- Personal Position (job, internal moral conflict)

Mistakes (made by engineers) can be costly

The Therac 25 X-ray machine, a **radiation therapy machine** killed or injured patients at several north American health care facilities between June 1985 and January 87.

When the **technician** operating the Therac 25, he made a typographical error in entering instructions and tried to correct this mistake by using the delete key. The filter on the machine dropped out of position. The result was that the patient undergoing radiation treatment received a massive dose of X ray. Several patients were injured or killed as a result, before it was realized that the machine was dangerously defective.

The Therac 25 had been poorly designed and inadequately tested. In particular, the design and testing of the linking of the hardware and software were totally inadequate.

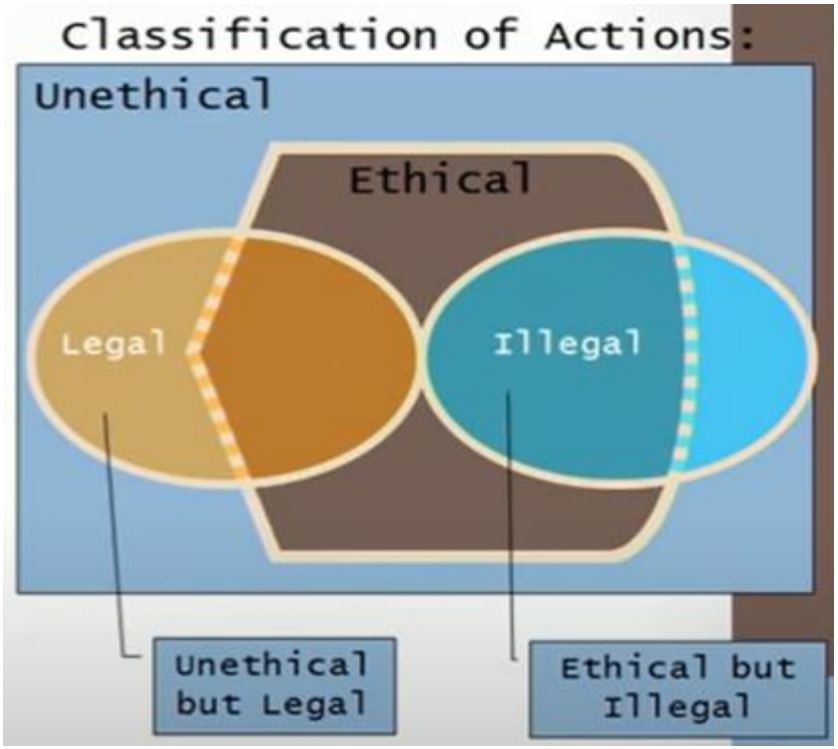
Competitive machines had a shield that would engage with the power were at high level. Furthermore, management decisions in the face of evidence of safety problems varied from short-sighted to negligent. The manufacturer atomic energy of Canada limited had many problems and has since gone bankrupt.

Mistakes (made by engineers) can be costly

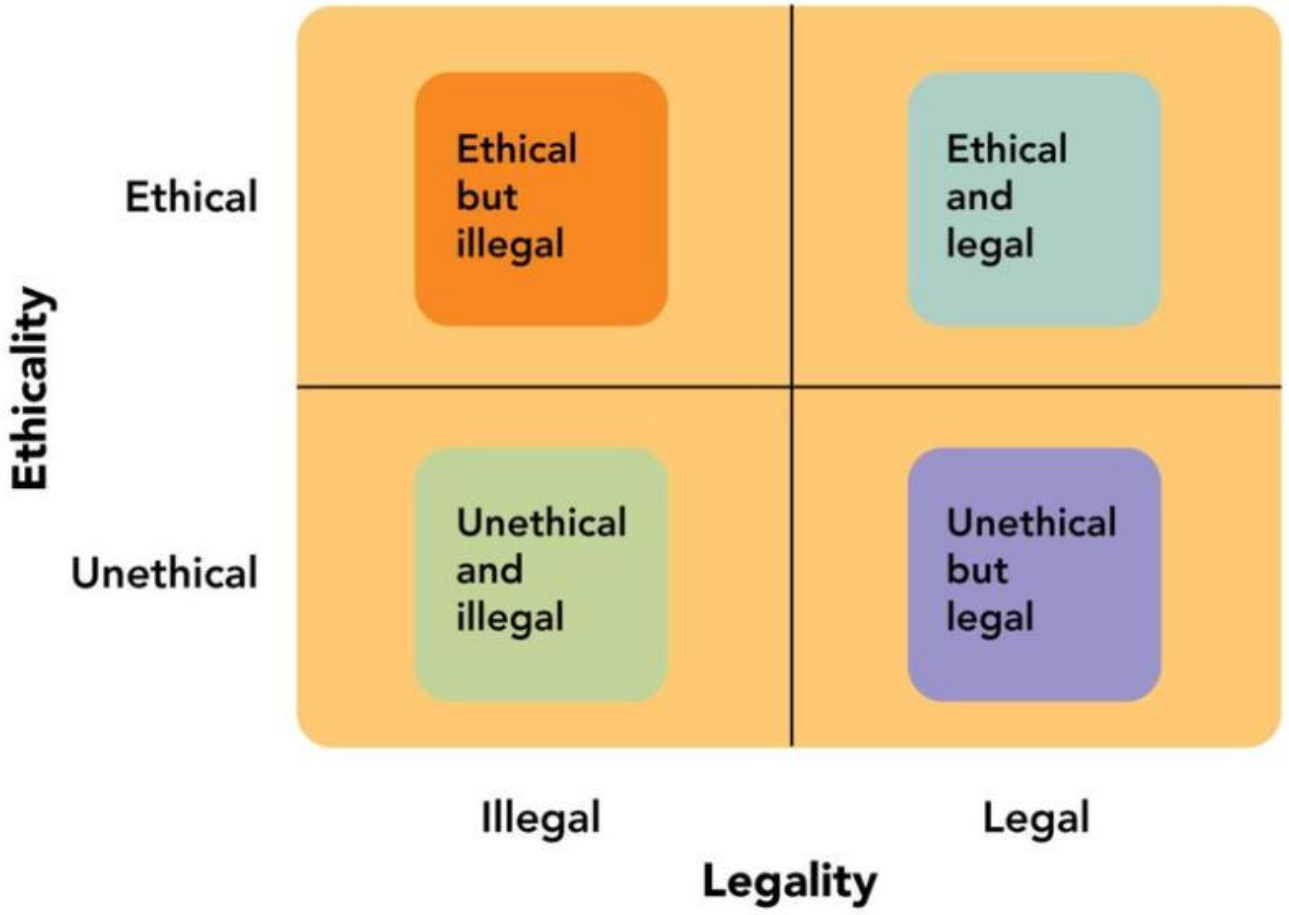
- We see a number of parties are involved
  - The engineers who designed and developed the machine.
  - The technician who is operating and made a particular error.
- Who is majorly responsible for the accidents? To answer, we need to focus on:
  - the design of the machine itself: whether it has been designed properly;
  - whether it has been tested properly;
  - whether the long term consequences of the proper use or misuse of this machine was thought of;
  - whether proactive measures were taken to capture for these type of accidents and harms;

Ethics, Morals, and the Law

- **Morals**
  - Principles of right and wrong
- **Ethics**
  - A set of moral principles guiding behavior and action
- **Laws**
  - *Binding* codes of conduct; formally recognized and enforced Company Policies



Classification of Actions



Example - 01

- I give a person a certain amount of money that is definitely **legal**.
- Later, I ask him for a favor of some kind, I'm one step from being a slug.
- This is totally **legal** but when a person betrays me this **unethical**.

Example - 02

Keeping money that someone dropped is **legal**, but again, many would find it **unethical**.

Example - 03

- Smoking cigarettes in public is **legal** in some places.
- But some may find it disrespectful and **unethical**.

Example - 04

- When a child is hungry and he stole a loaf of bread from a shop to feed.
- This action is **ethical** because a child is hungry and he wants something to eat but this is **illegal** because stealing is illegalized throughout the world.

Example - 05

- It is **illegal** to run a traffic light or speed
- But this can be **Ethical** and also **legal** if someone's life dependent on it…Like if we had to rush them to the hospital.