

Engineering Ethics

***Lec-8: The Concept of Risk in
Engineering***



Risk as the Product of the Probability and Magnitude of Harm



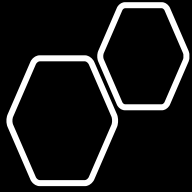
To assess a risk, an engineer must first identify it.



To identify a risk, an engineer must first know what a risk is.



The usual engineering definition of *risk* is “*a compound measure of the probability and magnitude of adverse effect.*”

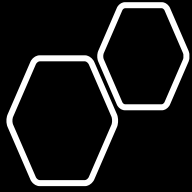


Risk (Contd.)

- According to definition, risk is composed of two elements: the likelihood of an adverse effect or harm and the magnitude of that adverse effect or harm.
- By compound is meant the product.
- Risk, therefore, is the product of the likelihood and the magnitude of harm.
- A relatively slight harm that is highly likely might constitute equal risk to people as a relatively large harm that is far less likely.

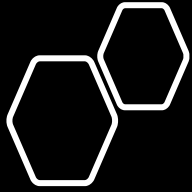
Harm

- We can define a harm as an invasion or limitation of a person's freedom or well being.
- Engineers have traditionally thought of harms in terms of things that can be relatively easily quantified, namely as impairments of our physical and economic well being.



Examples (Harm)

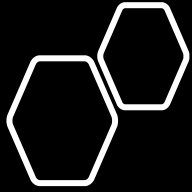
- Faulty design of a building can cause it to collapse, resulting in economic loss to the owner and perhaps death for the inhabitants.
- Faulty design of a chemical plant can cause accidents and economic disaster.
- These harms are then measured in terms of the numbers of lives lost, the cost of rebuilding or repairing buildings and highways, and so forth.



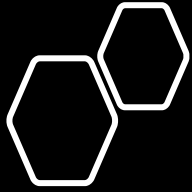
Utilitarianism and Acceptable Risk

- The engineering conception of risk focuses on the factual issues of the probability and magnitude of harm and contains no implicit evaluation of whether a risk is morally acceptable.
- In order to determine whether a risk is morally acceptable, engineers and risk experts usually look to utilitarianism.

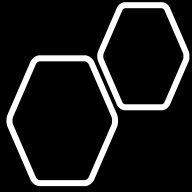
- The answer to any moral question is to be found by determining the course of action that maximizes well-being.
- Given the earlier definition of risk as the product of the probability and the consequences of harm, we can state the risk expert's criterion of acceptable risk in the following way:



- An acceptable risk is one in which the product of the probability and magnitude of the harm is equaled or exceeded by the product of the probability and magnitude of the benefit, and there is no other option where the product of the probability and magnitude of the benefit is substantially greater.

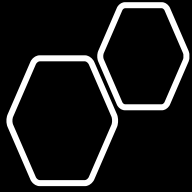


- One way of implementing this account of acceptable risk is by means of an adaptation of cost–benefit analysis.
- Utilitarians sometimes find cost–benefit analysis to be a useful tool in assessing risk.
- In applying this method to risk, the technique is often called risk–benefit analysis because the “cost” is measured in terms of the risk of deaths, injuries, or other harms associated with a given course of action.
- For simplicity, however, we shall use the term cost–benefit analysis.

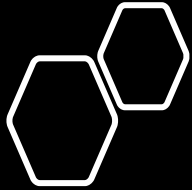


Example: Cost – Benefit Analysis

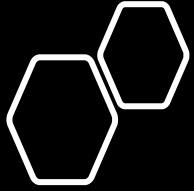
- Consider a case in which a manufacturing process produces fumes that might be a threat to health.
- From the cost–benefit standpoint, is the risk to the workers from the fumes acceptable?



- To calculate the cost of preventing the harms, we would have to include the costs of modifying the process that produces the fumes, the cost of providing protective masks, the cost of providing better ventilation systems, and the cost of any other safety measures necessary to prevent the deaths.
- Then we must calculate the cost of not preventing the deaths caused by the fumes.



- Here, we must include such factors as the cost of additional health care, the cost of possible lawsuits because of the deaths, the cost of bad publicity, the loss of income to the families of the workers, and costs associated with the loss of life.
- If the total cost of preventing the loss of life is greater than the total cost of not preventing the deaths, then the current level of risk is acceptable.



- If the total cost of not preventing the loss of life is greater than the total cost of preventing the loss, then the current level of risk is unacceptable.

Advantage of Utilitarian Approach

- The utilitarian approach to risk embodied in risk–benefit analysis has undoubted advantage in terms of clarity and susceptibility to numerical interpretation.
- Nevertheless, there are some limitations that must be kept in mind.

Limitations of Utilitarian Approach

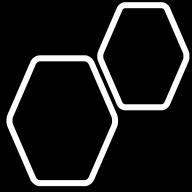
- *First*, it may not be possible to anticipate all of the effects associated with each option. Insofar as this cannot be done, the cost–benefit method will yield an unreliable result.
- *Second*, it is not always easy to translate all of the risks and benefits into monetary terms.

Limitations of Utilitarian Approach (Contd.)

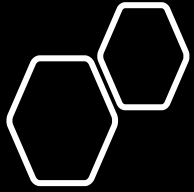
- *Third*, cost–benefit analysis in its usual applications makes no allowance for the distribution of costs and benefits.
- Suppose more overall utility could be produced by exposing workers in a plant to serious risk of sickness and death. As long as the good of the majority outweighs the costs associated with the suffering and death of the workers, the risk is justified. Yet most of us would probably find that an unacceptable account of acceptable risk.

Limitations of Utilitarian Approach (Contd.)

- Fourth, the cost–benefit analysis gives no place for informed consent to the risks imposed by technology.
- Most people think informed consent is one of the most important features of justified risk.

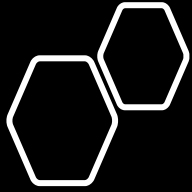


- Despite these limitations, cost–benefit analysis has a legitimate place in risk evaluation.
- When no serious threats to individual rights are involved, cost–benefit analysis may be decisive.
- In addition, cost–benefit analysis is systematic and provides a way of comparing risks, benefits, and cost by the use of a common measure—namely, monetary cost.

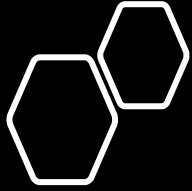


“Risky” Situations and Acceptable Risk

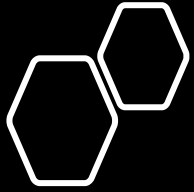
- It does appear to be true that the engineer and risk expert, on the one hand, and the public, on the other hand, differ regarding the probabilities of certain events.
- The major difference, however, is in the conception of risk itself and in beliefs about acceptable risk.
- One of the differences here is that the public often combines the concepts of risk and acceptable risk—concepts that engineers and risk experts separate sharply.



- Laypeople do not evaluate risk strictly in terms of expected deaths or injury.
- They consider other factors as well.
- For example, they are generally willing to take voluntary risks that are 1,000 times as uncertain as involuntary risks.
- Thus, voluntarily assumed risks are more acceptable than risks not voluntarily assumed.

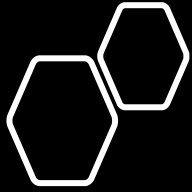


- Another reason for classifying something as risky is that the information about it might come from a questionable source.
- We might say that buying a car from a trusted friend who testifies that the car is in good shape is not risky, whereas buying a car from a used car salesman whom we do not know is risky.



Acceptable Risk by Lay Public

- Even though laypeople often combine the concept of risk with the concept of acceptable risk, we shall formulate a lay criterion of acceptable risk in the following way:
- An acceptable risk is one in which
 - (1) risk is assumed by free and informed consent, or properly compensated, and in which
 - (2) risk is justly distributed, or properly compensated.



- Two issues in the public's conception of risk and acceptable risk have special moral importance: *free and informed consent* and *equity or justice*.
- These two concepts follow more closely the ethics of respect for persons than utilitarianism.

1. Free and Informed Consent

- To give free and informed consent to the risks imposed by technology, three things are necessary.
- *First*, a person must not be coerced.
- *Second*, a person must have the relevant information.
- *Third*, a person must be rational and competent enough to evaluate the information.

- *First*, a person must not be coerced: it is difficult to know when consent is free.
- Have workers given their free consent when they continue to work at a plant with known safety hazards?
- Perhaps they have no alternative form of employment.

- *Second*, a person must have the relevant information: people are often not adequately informed of dangers or do not evaluate them correctly.
- As we have seen, sometimes laypeople err in estimating risk. They underestimate the probability of events that have not occurred before or that do not get their attention, whereas they overestimate the probability of events that are dramatic or catastrophic.

- *Third*, a person must be competent enough to evaluate the information: it is often not possible to obtain meaningful informed consent from individuals who are subject to risks from technology.
- How would a plant manager obtain consent from local residents for his plant to emit a substance into the atmosphere that causes mild respiratory problems in a small percentage of the population?
- Is the fact that the residents do not protest sufficient evidence that they have consented?
- What if they do not know about the substance, do not know what it does, do not understand its effects correctly, or are simply too distracted by other things?

- In light of the problems in getting free and informed consent, we could compensate individuals after the fact for actual harms done to them through technology.

2. Equity or Justice

- The ethics of respect for persons places great emphasis on respecting the moral agency of individuals, regardless of the cost to the larger society.
- Philosopher John Rawls expresses this concern: “Each member of society is thought to have an inviolability founded upon justice...which even the welfare of everyone else cannot override.”

Government's Approach to Risk

- Let us propose the following criterion of acceptable risk from the standpoint of the government regulator:
- An acceptable risk is one in which protecting the public from harm has been weighted more heavily than benefiting the public.