UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

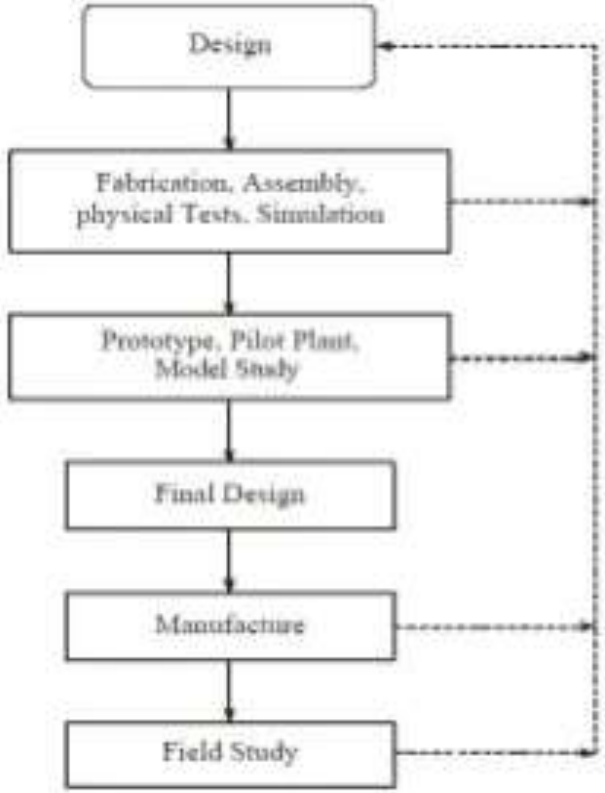
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

ENGINEERING AS EXPERIMENTATION

- Before manufacturing a product or providing a project, we make several assumptions and trials, design and redesign and test several times till the product is observed to be functioning satisfactorily.
- We try different materials and experiments. From the test data obtained we make detailed design and retests.
- Thus, design as well as engineering is iterative process as illustrated in Figure.

Figure - Design as an interactive process

- Several redesigns are made upon the feedback information on the performance or failure in the field or in the factory.
- Besides the tests, each engineering project is modified during execution, based on the periodical feedback on the progress and the lessons from other sources.
- Hence, the development of a product or a project as a whole may be considered as an experiment.



Engineering Projects VS. Standard Experiments

- It is now compare the two activities, and identify

1. the similarities and
2. contrasts.

	Similarities	Contrasts
1	Partial ignorance	Experimental control
2	Uncertainty	Humane touch
3	Continuous monitoring	Informed consent
4	Learning from the past	Knowledge gained

Similarities 1. Partial ignorance

- The project is usually executed in partial ignorance.
- Uncertainties exist in the model assumed. The behavior of materials purchased is uncertain and not constant (that is certain!).
- They may vary with the suppliers, processed lot, time, and the process used in shaping the materials (e.g., sheet or plate, rod or wire, forged or cast or welded).
- There may be variations in the grain structure and its resulting failure stress. It is not possible to collect data on all variations.
- In some cases, extrapolation, interpolation, assumptions of linear behavior over the range of parameters, accelerated testing, simulations, and virtual testing are resorted.

2. Uncertainty

- The final outcomes of projects are also uncertain, as in experiments.
- Sometimes unintended results, side effects (bye-products), and unsafe operation have also occurred.
- Unexpected risks, such as undue seepage in a storage dam, leakage of nuclear radiation from an atomic power plant, presence of pesticides in food or soft drink bottle, an new irrigation canal spreading water-borne diseases, and an unsuspecting hair dryer causing lung cancer on the user from the asbestos gasket used in the product have been reported.

3. Continuous monitoring

- Monitoring continually the progress and gaining new knowledge are needed before, during, and after execution of project as in the case of experimentation.
- The performance is to be monitored even during the use (or wrong use!) of the product by the end user/beneficiary.

4. Learning from the past

- Engineers normally learn from their own prior designs and infer from the analysis of operation and results, and sometimes from the reports of other engineers. But this does not happen frequently.
- The absence of interest and channels of communication, ego in not seeking information, guilty upon the failure, fear of legal actions, and mere negligence have caused many a failure, e.g., the Titanic lacked sufficient number of life boats—it had only 825 boats for the actual passengers of 2227, the capacity of the ship being 3547! In the emergent situation, all the existing life boats could not be launched. Forty years back, another steamship Arctic met with same tragedy due to the same

4. Learning from the past.....

- But the lesson was learned. In most of the hydraulic systems, valves had been the critical components that are least reliable.
- The confusion on knowing whether the valve was open or closed, was the cause of the Three-Mile Island accident in 1979.
- Similar malfunctioning of valves and mis-reading of gauges have been reported to have caused the accidents else where in some power plants. But we have not learnt the lesson from the past.
- The complacency that it will not happen again and will not happen 'to me' has lead to many disasters.

Contrasts 1. Experimental control

- In standard experiments, members for study are selected into two groups namely A and B at random. Group A are given special treatment. The group B is given no treatment and is called the 'controlled group'. But they are placed in the same environment as the other group A.
- This process is called the experimental control. This practice is adopted in the field of medicine. In engineering, this does not happen, except when the project is confined to laboratory experiments. This is because it is the clients or consumers who choose the product, exercise the control. It is not possible to make a random selection of participants from various groups. In engineering, through random sampling, the survey is made from among the users, to assess the results on the product.

2. Humane touch

- Engineering experiments involve human souls, their needs, views, expectations, and creative use as in case of social experimentation.
- This point of view is not agreed by many of the engineers.
- But now the quality engineers and managers have fully realized this humane aspect.

3. Informed consent

- Engineering experimentation is viewed as Societal Experiment since the subject and the beneficiary are human beings. In this respect, it is similar to medical experimentation on human beings.
- In the case of medical practice, moral and legal rights have been recognized while planning for experimentation. Informed consent is practiced in medical experimentation. Such a practice is not there in scientific laboratory experiments.
- Informed consent has two basic elements

3. Informed consent.....

1. Knowledge: The subject should be given all relevant information needed to make the decision to participate.
2. Voluntariness: Subject should take part without force, fraud or deception. Respect for rights of minorities to dissent and compensation for harmful effect are assumed here.

- For a valid consent, the following conditions are to be fulfilled:
- 1. Consent must be voluntary
- 2. All relevant information shall be presented/stated in a clearly understandable form
- 3. Consenter shall be capable of processing the information and make rational decisions.
- 4. The subject's consent may be offered in proxy by a group that represents many subjects of like-interests

4. Knowledge gained.....

- Not much of new knowledge is developed in engineering experiments as in the case of scientific experiments in the laboratory.
- Engineering experiments at the most help us to

a) verify the adequacy of the design,

b) to check the stability of the design parameters, and

c) prepare for the unexpected outcomes, in the actual field environments.

- From the models tested in the laboratory to the pilot plant tested in the field, there are differences in performance as well as other outcomes.

ENGINEERS AS RESPONSIBLE EXPERIMENTERS

- Although the engineers facilitate experiments, they are not alone in the field. Their responsibility is shared with the organizations, people, government, and others. No doubt the engineers share a greater responsibility while monitoring the projects, identifying the risks, and informing the clients and the public with facts. Based on this, they can take decisions to participate or protest or promote. The engineer, as an experimenter, owe several responsibilities to the society, namely,

1. A conscientious commitment to live by moral values.
2. A comprehensive perspective on relevant information. It includes constant awareness of the progress of the experiment and readiness to monitor the side effects, if any.
3. Unrestricted free-personal involvement in all steps of the project/product development (autonomy).
4. Be accountable for the results of the project (accountability).

Conscientiousness

- Conscientious moral commitment means:

a) Being sensitive to full range of moral values and responsibilities relevant to the prevailing situation and

b) the willingness to develop the skill and put efforts needed to reach the best balance possible among those considerations.

- In short, engineers must possess open eyes, open ears, and an open mind (i.e., moral vision, moral listening, and moral reasoning).
- This makes the engineers as social experimenters, respect foremost the safety and health of the affected, while they seek to enrich their knowledge, rush for the profit, follow the rules, or care for only the beneficiary.
- The human rights of the participant should be protected through voluntary and informed consent.

Comprehensive Perspective

Relevant information

- The engineer should grasp the context of his work and ensure that the work involved results in only moral ends.
- One should not ignore his conscience, if the product or project that he is involved will result in damaging the nervous system of the people (or even the enemy, in case of weapon development) A product has a built-in obsolete or redundant component to boost sales with a false claim.
- In possessing of the perspective of factual information, the engineer should exhibit a moral concern and not agree for this design. Sometimes, the guilt is transferred to the government or the competitors. Some organizations think that they will let the government find the fault or let the fraudulent competitor be caught first.
- Finally, a full-scale environmental or social impact study of the product or project by individual engineers is useful but not possible, in practice.

Moral Autonomy

- Viewing engineering as social experimentation, and anticipating unknown consequences should promote an attitude of questioning about the adequacy of the existing economic and safety standards.
- This proves a greater sense of personal involvement in one's work.

Accountability

- The term Accountability means:

1) The capacity to understand and act on moral reasons
2) Willingness to submit one's actions to moral scrutiny and be responsive to the assessment of others. It includes being answerable for meeting specific obligations, i.e., liable to justify (or give reasonable excuses) the decisions, actions or means, and outcomes (sometimes unexpected), when required by the stakeholders or by law. The tug-of-war between of causal influence by the employer and moral responsibility of the employee is quite common in professions. In the engineering practice, the problems are:

a) The fragmentation of work in a project inevitably makes the final products lie away from the immediate work place, and lessens the personal responsibility of the employee.

Accountability.....

a) Further the responsibilities diffuse into various hierarchies and to various people. Nobody gets the real feel of personal responsibility.

b) Often projects are executed one after another. An employee is more interested in adherence of tight schedules rather than giving personal care for the current project.

c) More litigation is to be faced by the engineers (as in the case of medical practitioners). This makes them wary of showing moral concerns beyond what is prescribed by the institutions. In spite of all these shortcomings, engineers are expected to face the risk and show up personal responsibility as the profession demands.

CODES OF ETHICS

- (The 'codes of ethics' exhibit, rights, duties, and obligations of the members of a profession and a professional society. The codes exhibit the following essential roles:

1. Inspiration and guidance. The codes express the collective commitment of the profession to ethical conduct and public good and thus inspire the individuals. They identify primary responsibilities and provide statements and guidelines on interpretations for the professionals and the professional societies.
2. Support to engineers. The codes give positive support to professionals for taking stands on moral issues. Further they serve as potential legal support to discharge professional obligations.

CODES OF ETHICS....

3. Deterrence (discourage to act immorally) and discipline (regulate to act morally). The codes serve as the basis for investigating unethical actions. The professional societies sometimes revoke membership or suspend/expel the members, when proved to have acted unethical. This sanction along with loss of respect from the colleagues and the society are bound to act as deterrent
4. Education and mutual understanding. Codes are used to prompt discussion and reflection on moral issues. They develop a shared understanding by the professionals, public, and the government on the moral responsibilities of the engineers. The Board of Review of the professional societies encourages moral discussion for educational purposes.

CODES OF ETHICS....

5) Create good public image. The codes present positive image of the committed profession to the public, help the engineers to serve the public effectively. They promote more of self regulation and lessen the government regulations. This is bound to raise the reputation of the profession and the organization, in establishing the trust of the public.

6) Protect the status quo. They create minimum level of ethical conduct and promotes agreement within the profession. Primary obligation namely the safety, health, and welfare of the public, declared by the codes serves and protects the public.

7) Promotes business interests. The codes offer inspiration to the entrepreneurs, establish shared standards, healthy competition, and maximize profit to investors, employees, and consumers.

Limitations of codes

- The codes are not remedy for all evils. They have many limitations, namely:

1) General and vague wordings. Many statements are general in nature and hence unable to solve all problems.
2) Not applicable to all situations. Codes are not sacred, and need not be accepted without criticism. Tolerance for criticisms of the codes themselves should be allowed.
3) Often have internal conflicts. Many times, the priorities are clearly spelt out, e.g., codes forbid public remarks critical of colleagues (engineers), but they actually discovered a major bribery, which might have caused a huge loss to the exchequer.
4) They cannot be treated as final moral authority for professional conduct. Codes have flaws by commission and omission. There are still some grey areas undefined by codes. They cannot be equated to laws. After all, even laws have loopholes and they invoke creativity in the legal practitioners.

Limitations of codes....

5) Only a few enroll as members in professional society and non-members cannot be compelled.
6) even as members of the professional society, many are unaware of the codes
7) Different societies have different codes. The codes cannot be uniform or same! Unifying the codes may not necessarily solve the problems prevailing various professions, but attempts are still made towards these unified codes.
8) Codes are said to be coercive. They are sometimes claimed to be threatening and forceful.

A BALANCED OUTLOOK ON LAW

- The 'balanced outlook on law' in engineering practice stresses the necessity of laws and regulations and also their limitations in directing and controlling the engineering practice.
- Laws are necessary because, people are not fully responsible by themselves and because of the competitive nature of the free enterprise, which does not encourage moral initiatives. Laws are needed to provide a minimum level of compliance.
- The following codes are typical examples of how they were enforced in the past:
- Code for Builders by Hammurabi
- Hammurabi the king of Babylon in 1758 framed the following code for the builders:

A BALANCED OUTLOOK ON LAW....

- "If a builder has built a house for a man and has not made his work sound and the house which he has built has fallen down and caused the death of the householder, that builder shall be put to death.
- If it causes the death of the householder's son, they shall put that builder's son to death. If it causes the death of the householder's slave, he shall give slave for slave to the householder. If it destroys property, he shall replace anything it has destroyed; and because he has not made the house sound which he has built and it has fallen down, he shall rebuild the house which has fallen down from his own property.
- If a builder has built a house for a man and does not make his work perfect and the wall bulges, that builder shall put that wall in sound condition at his own cost" This code was expected to put in self-regulation seriously in those years

A BALANCED OUTLOOK ON LAW....

- Steam Boat Code in USA
- Whenever there is crisis we claim that there ought to be law to control this. Whenever there is a fire accident in a factory or fire cracker's store house or boat capsize we make this claim, and soon forget. Laws are meant to be interpreted for minimal compliance. On the other hand, laws when amended or updated continuously would be counterproductive. Laws will always lag behind the technological development. The regulatory or inspection agencies such as Environmental authority of India can play a major role by framing rules and enforcing compliance.
- In the early 19th century, a law was passed in USA to provide for inspection of the safety of boilers and engines in ships. It was amended many times and now the standards formulated by the American Society of Mechanical Engineers are followed.

Collegiality and loyalty – respect for authority in industry – collective bargaining – Confidentiality – conflicts of interest and conflicting interest

- Collegiality is the tendency to support and cooperate with the colleagues. It is virtue essential for the team work to be effective. This consists of various aspects.
- 1. Respect to ideas and work of others
- 2.Commitment to moral principles
- 3.Connectedness
- Loyalty
- Loyalty is exhibited in two senses.
- 1. Agency Loyalty: It is an obligation to fulfil hi/her duties to the employer.
- 2. Attitude Loyalty (or identification Loyalty): It is concerned with the attitude, emotions, and a sense of personal identity. It includes willingness to meet moral duties, with attachment, conviction, trust with employers.

- Authority
- Decisions can be taken by a few people, but putting into action requires larger participation from different groups of people, such as operation, purchase, sales, accounts, maintenance, finance etc. In effectively-and efficiently-transferring decisions to actions, the authority comes into play a great role. Otherwise the individual discretions may ruin the activities. Further the authority fixes the personal responsibility and accountability uniquely on each person. This is necessary to ensure progress in action.
- Institutional Authority
- Expert Authority

- COLLECTIVE BARGAINING
- It is the bargain by the trade union for improving the economic interests of the worker members. The process includes negotiation, threatening verbally, and declaration of ‘strike’. It is impossible to endorse fully the collective bargaining of unions or to condemn. There exist always conflicting views between the professionalism and unionism.
- Faithful Agent or Trustee?
- Service to the public?
- CONFIDENTIALITY
- Confidentiality means keeping the information on the employer and clients, as secrets. It is one of the important aspects of team work.

- Justification for Confidentiality:
- Confidentiality can be justified by various ethical theories. According to Rights-based theory, rights of the stakeholders, right to the intellectual property of the company are protected by this practice. Based on Duty theory, employees and employers have duty to keep up mutual trust. The Utilitarian theory holds good, only when confidentiality produce most good to most people. Act utilitarian theory focuses on each situation, when the employer decides on some matters as confidential.
- Further, the following moral principles also justify the concept of ‘confidentiality’:
- 1. Respect for Autonomy
- It means respecting the freedom and self-determination of individuals and organizations to identify their legitimate control over the personal information of themselves. In the absence of this, they cannot keep their privacy and protect their self-interest

- 2. Respect for Promises: This means giving respect for the promises made between the employers and the employees. Employees should not disclose the promises given to the employers. This information may be considered as sensitive by the employer. But promises do not establish complete obligations.
- 3. Trustworthiness: Maintaining confidentiality by lawyers, accountants, and attorneys are necessary to develop confidence and welfare of the individuals and the organizations. It does not mean however that theses professionals collude with them unethically.
- 4. Respect for Public Welfare: This moral consideration is important in identifying relationships in professional transactions, for the benefit of public welfare, for example, if the medical practitioners keep confidentiality on the problems of patients, patients develop confidence and trust in them, they feel free to reveal their problems and personal information, without being shy. This is likely to increase their chances of being cured.

- Types of confidential information
- Privileged Information: It is information that is available and accessed, by virtue of a privilege, i.e., privilege of being employed on that assignment. An engineer working on defense project may know that the missile he has developed is to be tested against the terrorists across the border.
- Proprietary Information: It is the information owned by the organization. It refers to the knowledge and procedures established by and in the organization. Some internal communication in an organization is marked as proprietary. It is protected legally by the organization from use by others, including the employees.
- Is Switching Job Ethical?
- When persons change jobs (employers), what happens to their moral obligation? The obligation to protect the information does not cease, when one shifts to another employee. Otherwise, the former employee will reveal this information to the new employer or sell it to a competitor of the former employer. The integrity of the employee, even upon switching the employer demands that he maintains confidentiality and does not to divulge the information.

- The professional integrity of engineers is more valuable than the loyalty to the current employer.
- Many engineers value professional advancement than long-term tie and loyalty to a single employer. The engineers involved in research and development and expert contribution change jobs. Normally they are familiar with the innovative developments in the parent organizations.
- For example, one manufacturing expert along with his colleagues as well as with some secret documents left General Motors and joined Volkswagen. This violation of trade secret, lead the V W to pay huge compensation to GM in cash and compulsion to buy parts from GM for seven subsequent years. Employees, who change jobs, will not able to withhold their knowledge and expertise. They are sought after only for their expertise. They may not carry the papers and but their active brain always carry memories.

- Although some organizations hold that this is unethical, the individuals can not be prevented from divulging the facts to benefit the current employer. The courts have held a moral verdict. Even though the previous employers had the right to maintain their trade secrets confidential, the personal rights of the employees, who switched job in pursuit of career advancement, had to be honored and balanced.
- Management Policies
- How can we protect the rights of the employers and at the same time recognize the genuine personal rights and other rights of the engineers/employees?
- Some of the management practices and their limitations are discussed here under:
- 1. One way is to restrict the future employment of employees, by using employment contracts at the time of their exit. Details such as the restriction on geographical location, time gap between the departure from one place and engagement with the other employer, and on the type of jobs that one can perform with future employer, are entered in to contracts. But such contracts have not been given legal sanction.

- 2. An incentive instead of threatening their rights by the employment contract, may offer some positive benefits in exchange for the restrictions listed. A lump sum post-employment payment or compensation over a specific period may offered as incentive to restrict him.
- 3. Another approach by the management is to effect tighter controls on internal information flow on trade secrets and other vital features. But this is likely to create a mutual distrust in the organization and to throttle the creativity of engineers involved in the research and development.
- A better understanding between the ethical management and the professional responsibility of the engineers will fulfill both professional concerns and employee loyalty
- Conflict of Interest
- A conflict of interest occurs when the employee has more than one interest. A professional conflict of interest is the situation where the professional has an interest that, if pursued, might prevent him from meeting his obligations to his employers or clients.

- A conflict of interest is different from conflicting interests,
- Types of Conflicts of Interests:
- 1. Actual Conflict of Interest
- 2. Apparent Conflict of Interest
- Potential Conflict of Interest

- SAFETY AND RISK
- Safety was defined as the risk that is known and judged as acceptable (William W. Lawrence). But, risk is a potential that something unwanted and harmful may occur. It is the result of an unsafe situation, sometime unanticipated.
- Different methods are available to determine the risk (testing for safety)
- 1. Testing on the functions of the safety-system components.
- 2. Destructive testing: In this approach, testing is done till the component fails. It is too expensive, but very realistic and useful.
- 3. Prototype testing: In this approach, the testing is done on a proportional scale model with all vital components fixed in the system. Dimensional analysis could be used to project the results at the actual conditions.
- 4. Simulation testing: With the help of computer, the simulations are done. The safe boundary may be obtained. The effects of some controlled input variables on the outcomes can be predicted in a better way.

- Analytical Methods
- Several analytical methods are adopted in testing for safety of a product/project.
- 1. Scenario Analysis
- This is the most common method of analysis. Starting from an event, different consequences are studied. This is more a qualitative method.
- Steps for Risk Assessment
- 1. What can go wrong that could lead to an outcome of hazard exposure? (identification and characterization of risk)
- 2. How likely is this to happen? (quantification of risk, likelihood, and magnitude)
- 3. If it happens, what are the consequences? Scenarios are constructed and the ways and means of facing the consequences are designed.
- 2. Failure Mode and Effect Analysis
- In this mood various parts or components of the system and their modes of failure are studied

- The causes of failure or the interrelationships between the components are not studied.
- It is one of the qualitative tools, which support proactive quality strategies.
- Successful implementation of FMEA requires relevant knowledge and insight as well as engineering judgment.
- FMEA concept was introduced in 1960s by aerospace companies. Then the use of FMEA was extended to automobile industries and other types of industries, understanding the value of this approach.
- In the last decade, it has undergone metamorphosis where focus was on severity, occurrence and detection rating.

- Thus, FMEA is defined as a systematic tool to
- (a) identify possible failure modes in the products/process,
- (b) to understand failure mechanism (process that leads to failure),
- (c) risk analysis, and
- (d) plan for action on elimination or reduction of failure modes.
- A. STEPS TO CONDUCT FMEA
- 1. Product/process and its function must be understood first. This is the most fundamental concept to be adopted in this methodology. This understanding helps the engineer to identify product/process function that fall with the intended and unintended users.
- 2. Block diagram of product/process is created and developed. The diagram shows the major components or process steps as blocks, identifies their relations namely, input, function and output of the design. The diagram shows logical relationship of components and establishes a structure for FMEA. The block diagram should always be included in the FMEA form.

- 3. Header on FMEA form is completed. FMEA form includes part/process name, model date, revision date, and responsibility.
- 4. The items/functions are listed logically in the FMEA form, based on the block diagram.
- 5. Then failure modes are identified. A failure mode is defined wherein a component, subsystem, system, and process could potentially fail to meet the design intent.
- 6. A failure mode in one component can cause failure in another. Each failure should be listed in technical terms. Listing should be done component- or process-wise.
- 7. Then the effects of each risk/failure mode are described. This is done as perceived by both internal and external customers. The examples of risk/failure effect may include injury to the user, environment, equipment, and degraded performance. Then a numerical ranking is assigned to each risk or failure. It depends upon the severity of the effect. Commonly, in the scale, No.1 is used to represent no effect and 10 to indicate very severe failure, affecting system of operation and user. By this, the failures can be prioritized and real critical risks can be addressed first.

- 8. Then the causes of each failure mode have to be identified. A cause is defined as a design weakness that results in a failure. The potential causes for each failure mode are identified. The potential causes, for example, may be improper torque or contamination or excessive loading or external vibration.
- Stages
- Stage 1:Identifying possibilities and defining the scope
- Stage 2: Measuring the volume of risk involved from the failure modes identified.
- Stage 3: Classification of severity of effects and the solution for the causes of high risk.
- Stage 4: Revalidation of the above Procedure.

- The major reasons for the analysis of the risk benefit are:
- To know risks and benefits and weigh them each.
- To decide on designs, advisability of product/project.
- To suggest and modify the design so that the risks are eliminated or reduced.
- There are some limitations that exist in the risk-benefit analysis.
- The ethical and economic limitations are presented as follows:
- 1. Primarily the benefits may go to one group and risks may go to another group. Is it ethically correct?
- 2. Is an individual or government empowered to impose a risk on some one else on behalf of supposed benefit to some body else? Sometimes, people who are exposed to maximum risks may get only the minimum benefits. In such cases, there is even violation of rights.

- 3. The units for comparison are not the same, e.g., commissioning the express highways may add a few highway deaths versus faster and comfortable travel for several commuters. The benefits may be in terms of fuel, money and time saved, but lives of human being sacrificed. How do we then compare properly?
- Both risks and benefits lie in the future. Both have related uncertainties but difficult to arrive at expected values.
- Projects, which are highly beneficial to the public, must be safe also. Therefore, these projects can be justified using RISK-BENEFIT analysis. Withing this analysis they should be able to find out answers to the following question

- i) What are the risks involved?
- ii) What are the benefits that would accrue?
- iii) When would benefits be derived and when risks have to be faced?

- Public Risk
- Reducing Risk (Improving safety)
- Voluntary Risk
- Govt. Regulator’s approach to risks-
- The two major approaches of the government are −
- Lay person − Wants to protect himself or herself from risk.
- The government regulator − Wants as much assurance as possible that the public is not being exposed to unexpected harm.
- The engineers are required to give their view on the future such as in planning, policy-making, which involves the technology. For example, should India expand nuclear power options or support traditional energy sources such as fossil fuels or alternative forms like solar and wind energy? In the recent past, this topic has created lot of fireworks, in the national media.

- Occupational crime: Wrong actions of a person through one's lawful employment, Crime committed by employee to promote his interest, and theft by the employee.
- White-collared crime- violation of laws regulating work activities, when committed by office workers or professionals occupational crime is called a white-collared crime. Antonym: blue-collared crime.
- Examples of occupational crimes:
- Price fixing: fixing the bidding rate by companies, in collusion with other companies, for the contract / services. It is an occupational crime, prevalent in electrical industries.
- Bootlegging: Manufacturing selling or transporting liquor and narcotics that are prohibited by law. In engineering practice, it refers to working on projects which are not properly authorized.

- Employee Right: Professional Rights, Basic Human Rights, Institutional Rights or Contractual Employee Rights, Non-Contractual Employee Rights.
- Whistle-blowing – process by which an employee conveys information about a significant moral problem to a person in a position to take action on the problem, outside the approved organizational channel.
- There are four aspects of whistle blowing:
- 1. Basis of disclosure: The basis for disclosure may be intentional, or under pressure from superiors or others not to disclose.
- 2. Relevance of topic: The whistle blower believes that the information is about a significant problem for the organization or its business ally. It can be a threat to the public or employees' health, safety and welfare or a criminal activity, or unethical policies or practices, or an injustice to the workers within the organization.

- 3. Agent: The person disclosing the information may be a current or former employee or a person having a close link to the organization.
- 4. Recipient: The person or organization, who receives the information, is in a position to remedy the problem or alert the affected parties. Usually, the recipients are not aware of the information fully or even partially.
- Based on the destination (recipient), whistle blowing is classified into types, as:
- (a) Internal: In this case, the information is conveyed to a person within the organization, but beyond the approved channels.
- (b) External: This happens when the information is transmitted outside the organization. The recipient may be a municipal chairman or member of legislature or minister. It becomes severe if the information reaches the press and through them the public. The damage is maximum and sometimes poses difficulty in remedying the situation.

- Based on the origin or source (agent), this can be divided into three types, as follows:
- (a) Open: The originator reveals his identity as he conveys the information. This information is reliable and true, but sometimes partially true.
- (b) Anonymous: The identity is concealed. The information may or may not be true. But the agent anticipates perhaps some repression or threat, if identity is revealed.
- (c) Partly anonymous (or partly open): Such a situation exists when the individual reveals his identity to the journalist, but insists that the name be withheld from others.
- When can we justify whistle blowing?
- Conditions

- Intellectual Property Rights (IPR):
- The use of computers have raised a host of moral concerns such as free speech, privacy, intellectual property right, and physical as well as mental harm.
- Definition: information and original expression that derives its original value from creative ideas, and has commercial value. It is an intangible asset
- Patent and Trade secret: Patents protect legally specific products from being manufactured or sold by others, without permission of the patent holder. Trade Secret are on designs, technical processes, plant facilities, and methods. Limited legal protection, against abuse by the employee or contractor.
- The validity and territory for the patents- 20 years from the date filing the application for the patent. It is territorial right and needs registration.
- utility patent- granted to one who invents or discovers any new and useful process, machine, manufacture or chemical composition of any manner or any useful improvement. Utility time is 20 years.

- Industrial design patent- idea or conception regarding features of shape, configuration, and pattern, ornamental with lines or colors applied to any article, two or three dimensional, made by industrial process. Patent has a term of 14 years from the date of filing the application, e.g., design applied to shoes, T.V., textiles.
- Copyright- specific and exclusive right for reproduction of original work, i.e., literary material, music, film, sound recording, broadcasting, software and multimedia. No need for registration and no need to seek lawyer's help for settlement. Life of copyright protection is the life of author plus 50 years.
- Trademark- identity of specific good and services. It is a territorial right, which needs registration, but without any time limit. It may be registered in the form of words, designs, sounds, and symbols.

- UNIT V:
- Ethics in Present Scenario and Engineers Role Multinational corporations – Business ethics – Environmental ethics – computer ethics
- MULTINATIONAL CORPORATIONS
- Organizations who have established business in more than one country, are called multinational corporation.
- The headquarters are in the home country and the business is extended in many host countries.
- A multinational corporation is known by various names such as: global enterprise, international enterprise, world enterprise, transnational corporation etc.
- Features of Multinational Corporations (MNCs): 1. Huge Assets and Turnover 2. International Operations Through a Network of Branches 3. Unity of Control 4. Mighty Economic Power 5. Professional Management 6. Better Quality of Products 7. Aggressive Advertising and Marketing.

- Advantages of MNCs from the Viewpoint of Host Country
- 1. Employment Generation.
- 2. Automatic Inflow of Foreign Capital.
- 3. Proper Use of Idle Resources.
- 4. Improvement in Balance of Payment Position.
- 5. Technical Development.
- 6. Managerial Development.
- 7. End of Local Monopolies.
- 8. Improvement in Standard of Living.
- 9. Promotion of international brotherhood and culture.

- Limitations of MNCs from the Viewpoint of Host Country
- 1. Danger for Domestic Industries:
- 2. Repatriation of Profits.
- 3. No Benefit to Poor People.
- 4. Danger to Independence.
- 5. Disregard of the National Interests of the Host Country.
- 6. Misuse of Mighty Status.
- 7. Careless Exploitation of Natural Resources.
- 8. Selfish Promotion of Alien Culture.
- 9. Exploitation of People, in a Systematic Manner.

- International Human Rights
- To know what are the moral responsibilities and obligations of the multinational corporations operating in the host countries, let us discuss with the framework of rights ethics.
- Common minimal rights are tobe followed to smoothen the transactions when the engineers and employers of MNCs have to interact at official, social, economic and sometimes political levels.
- At international level, the organizations are expected to adopt the minimum levels of (a) values, such as mutual support, loyalty, and reciprocity, (b) the negative duty of refraining from harmful actions such as violence and fraud, and (c) basic fairness and practical justice in case of conflicts.

- MNCs and Morality
- The economic and environmental conditions of the home and host countries may vary. But the multinational institutions have to adopt appropriate measures not to disturb or dislocate the social and living conditions and cultures of the home countries. A few principles are enlisted here:
- 1. MNC should respect the basic human rights of the people of the host countries.
- 2. The activities of the MNC should give economic and transfer technical benefits, and implement welfare measures of the workers of the host countries.
- 3. The business practices of the multinational organisations should improve and promote morally justified institutions in the host countries.
- 4. The multinationals must respect the laws and political set up, besides cultures and promote the cultures of the host countries.
- 5. The multinational organisations should provide a fair remuneration to the employees of the host countries. If the remuneration is high as that of home country, this may create tensions and if it is too low it will lead to exploitation.

- 6. Multinational institutions should provide necessary safety for the workers when they are engaged in hazardous activities and ‘informed consent’ should be obtained from them. Adequate compensation should be paid to them for the additional risks undertaken.
- Ethical Balance
- ENVIRONMENTAL ETHICS
- Environmental ethics is the study of
- (a) moral issues concerning the environment, and
- (b) moral perspectives, beliefs, or attitudes concerning those issues. Engineers in the past are known for their negligence of environment, in their activities. It has become important now that engineers design eco-friendly tools, machines, sustainable products, processes, and projects.
- These are essential now to (a) ensure protection (safety) of environment (b) prevent the degradation of environment, and (c) slow down the exploitation of the natural resources, so that the future generation can survive.

- Engineers as experimenters have certain duties towards environmental ethics, namely:
- 1. Environmental impact assessment: One major but sure and unintended effect of technology is wastage and the resulting pollution of land, water, air and even space. Study how the industry and technology affects the environment.
- 2. Establish standards: Study and to fix the tolerable and actual pollution levels.
- 3. Counter measures: Study what the protective or eliminating measures are available for immediate implementation.
- 4. Environmental awareness: Study on how to educate the people on environmental practices, issues, and possible remedies.
- Disasters: 1. Plastic Waste Disposal, 2. e-Waste Disposal, 3. Industrial Waste Disposal, 4. Depletion of Ozone Layer, 5. Global Warming, 6. Acid Rain.

- COMPUTER ETHICS
- Computer ethics is defined as (a) study and analysis of nature and social impact of computer technology, (b) formulation and justification of policies, for ethical use of computers.
- This subject has become relevant to the professionals such as designers of computers, programmers, system analysts, system managers, and operators.
- The use of computers have raised a host of moral concerns such as free speech, privacy, intellectual property right, and physical as well as mental harm. There appears to be no conceptual framework available on ethics, to study and understand and resolve the problems in computer technology.

- UNIT V:
- Ethics in Present Scenario and Engineers Role Multinational corporations – Business ethics – Environmental ethics – computer ethics
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- WEAPONS DEVELOPMENT
- Engineers involve in weapons development because of the following reasons:
- 1. It gives one job with high salary.
- 2. One takes pride and honor in participating in the activities towards the defense of the nation (patriotic fervor).
- 3. One believes the he fights a war on terrorism and thereby contribute to peace and stability of the country. Ironically, the wars have never won peace, only peace can win peace!
- 4. By research and development, the engineer is reducing or eliminating the risk from enemy weapons, and saving one's country from disaster.
- 5. By building-up arsenals and show of force, a country can force the rogue country, towards regulation. Engineers can participate effectively in arms control negotiations for surrender or peace, e.g., bombing of Nagasaki and Hiroshima led to surrender by the Japanese in 1945.

- ENGINEERS AS MANAGERS
- The characteristics of engineers as managers are:
- 1. Promote an ethical climate, through framing organization policies, responsibilities and by
- personal attitudes and obligations.
- 2. Resolving conflicts, by evolving priority, developing mutual understanding, generating various alternative solutions to problems.
- 3. Managers have the ethical responsibility to produce safe and good products (or useful service), while showing respect for the human beings who include the employees, customers and the public. Hence, the objective for the managers and engineers is to produce valuable products that are also profitable.

- CONSULTING ENGINEERS
- The consulting engineers work in private. There is no salary from the employers. But they charge fees from the sponsor and they have more freedom to decide on their projects. Still they have no absolute freedom, because they need to earn for their living. The consulting engineers have ethical responsibilities different from the salaried engineers.
- For instance, 1. Advertising: The consulting engineers are directly responsible for advertising their services, even if they employ other consultants to assist them. But in many organizations, this responsibility is with the advertising executives and the personnel department.
- 2. Competitive Bidding It means offering a price, and get something in return for the service offered. The organizations have a pool of engineers. The expertise can be shared and the bidding is made more realistic. But the individual consultants have to develop creative designs and build their reputation steadily and carefully, over a period of time.

- 3. Contingency Fee: This is the fee or commission paid to the consultant, when one is successful in saving the expenses for the client.
- 4. Safety and Client's Needs: The greater freedom for the consulting engineers in decision making on safety aspects, and difficulties concerning truthfulness are the matters to be given attention.
- ENGINEERS AS ADVISORS IN PLANNING AND POLICY MAKING:
- 1. Objectivity, 2. Study All Aspects, 3. Values, 4. Technical Complexity, 5. National Security
- MORAL LEADERSHIP: Engineers provide many types of leadership in the development and implementation of technology, as managers, entrepreneurs, consultants, academics and officials of the government. Moral leadership is not merely the dominance by a group. It means adopting reasonable means to motivate the groups to achieve morally desirable goals. This leadership presents the engineers with many challenges to their moral principles.

- SAMPLE CODE OF ETHICS
- ASME (American Society of Mechanical Engineers) Code of Ethics of Engineers
- ASME requires ethical practice by each of its members and has adopted the following Code of Ethics of Engineers as referenced in the ASME Constitution.
- The Fundamental Principles:
- Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:
- 1. Using their knowledge and skill for the enhancement of human welfare.
- 2. Being honest and impartial, and serving with fidelity the public, their employers and clients.
- 3. Striving to increase the competence and prestige of the engineering profession,

- The Fundamental Canons
- • Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
- • Engineers shall perform services only in the areas of their competence.
- • Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional and ethical development of those engineers under their supervision.
- • Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest or the appearance of conflicts of interest.
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- ARTICLE I
- Engineers shall maintain high standards of diligence, creativity and productivity, and shall: 1. Accept responsibility for their actions.
- 2. Be honest and realistic in stating claims or estimates from available data.
- 3. Undertake engineering tasks and accept responsibility only if qualified by training or experience, or after full disclosure to their employers or clients of pertinent qualifications.

- 4. Maintain their professional skills at the level of the state of the art, and recognize the importance of current events in their work; 5. Advance the integrity and prestige of the engineering profession by practicing in a dignified manner and for adequate compensation.
- ARTICLE II
- Engineers shall, in their work: 1. Treat fairly all colleagues and coworkers, regardless of race, religion, sex, age or national origin.
- 2. Report, publish and disseminate freely information to others, subject to legal and proprietary restraints.
- 3. Encourage colleagues and co-workers to act in accord with this Code and support them when they do so.
- 4. Seek, accept and offer honest criticism of work, and properly credit the contributions of others.
- 5. Support and participate in the activities of their professional societies.
- 6. Assist colleagues and co-workers in their professional development.

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- Engineers shall, in their relations with employers and clients: 1. Act as faithful agents or trustees for their employers or clients in professional and business matters, provided such actions conform with other parts of this Code.
- 2. Keep information on the business affairs or technical process of an employer or client in confidence while employed, and later, until such information is properly released, provided such actions conform with other parts of this Code.
- 3. Inform their employers, clients, professional societies or public agencies or private agencies of which they are members or to which they may make presentations, of any circumstance that could lead to a conflict of interest.
- 4. Neither give nor accept, directly or indirectly, any gift, payment or service of more than nominal value to or from those having business relationships with their employers or clients.

- 5. Assist and advise their employers or clients in anticipating the possible consequences, direct and indirect, immediate or remote, of the projects, work or plans of which they have knowledge.
- ARTICLE IV Engineers shall, in fulfilling their responsibilities to the community: 1. Protect the safety, health and welfare of the public and speak out against abuses in these areas affecting the public interest.
- 2. Contribute professional advice, as appropriate, to civic, charitable or other non-profit organizations.
- 3. Seek to extend public knowledge and appreciation of the engineering profession and its achievements.
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- 6. Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession and shall act with zero tolerance for bribery, fraud, and corruption.
- 7. Engineers shall continue their professional development throughout their careers, and shall provide opportunities for the professional development of those engineers under their supervision.

- INSTITUTION OF ENGINEERS(INDIA) CODE OF ETHICS
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- 1. To consider first the total interest of one's organization in all transactions without impairing the dignity and responsibility to one's office.
- 2. To buy without prejudice seeking to obtain the maximum ultimate value for each rupee of expenditure.
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- 5. To respect one's obligations and those of one's organization consistent with good business practice

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- 5. avoid deceptive acts.
- 6. conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

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- Responsibility for research integrity
- You are a graduate student working as part of a group on a large project. The results from your group experiments are used for other experimental work. Your faculty supervisor, the principal investigator (PI) for the project, wants you to use a new procedure in your experimental work.
- She expects the new procedure to yield results that are better suited to the conditions of the other experimental work. The other members of your group do not want to change the procedure they have been using; the new one requires significantly more work.
- They believe the PI will not notice if the old procedure is used. You rely on the group for assistance in your own thesis work, but if you go along with the decision to use the old procedure, the quality of the data will most likely be inferior; you will mislead the PI and perhaps the whole scientific community. You argue for using the new procedure and informing the PI that the work will just have to take longer-information which she is not likely to receive well. The rest of the group is not persuaded. What should you do and how can you go about it?

- The responsibility for research integrity has several major components: ensuring the integrity of research results; dealing fairly with others, especially by appropriately acknowledging their contributions; and protecting the welfare of research subjects. Other professional responsibilities of research investigators include laboratory safety and protection of health and safety of the public in the conduct of research.
- honest mistakes in scientific research are controlled through such mechanisms as peer review of scientific work prior to publication and the requirement for replication of results. The prevention of honest errors is not generally considered to be part of the subject matter of research ethics.
- The focus on serious wrongdoing in research runs the danger of conveying the impression that concern for a high standard of research ethics is merely an attempt to hold the line against deliberate deception, rather than a concern to develop, maintain, and transmit standards of research integrity in a context of increasing complexity in research practice. The literature on research ethics is so heavily focused on research misconduct, however, that misconduct and the terms used to describe it provide a convenient starting point.

- Line drawing and Flow chart method
- A flowchart is a graphical representations of steps
- 1. 
- 2. 
- 3. 
- 4. 
- 5. 
- 6.