UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

SOCIAL EXPERIMENTATION

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

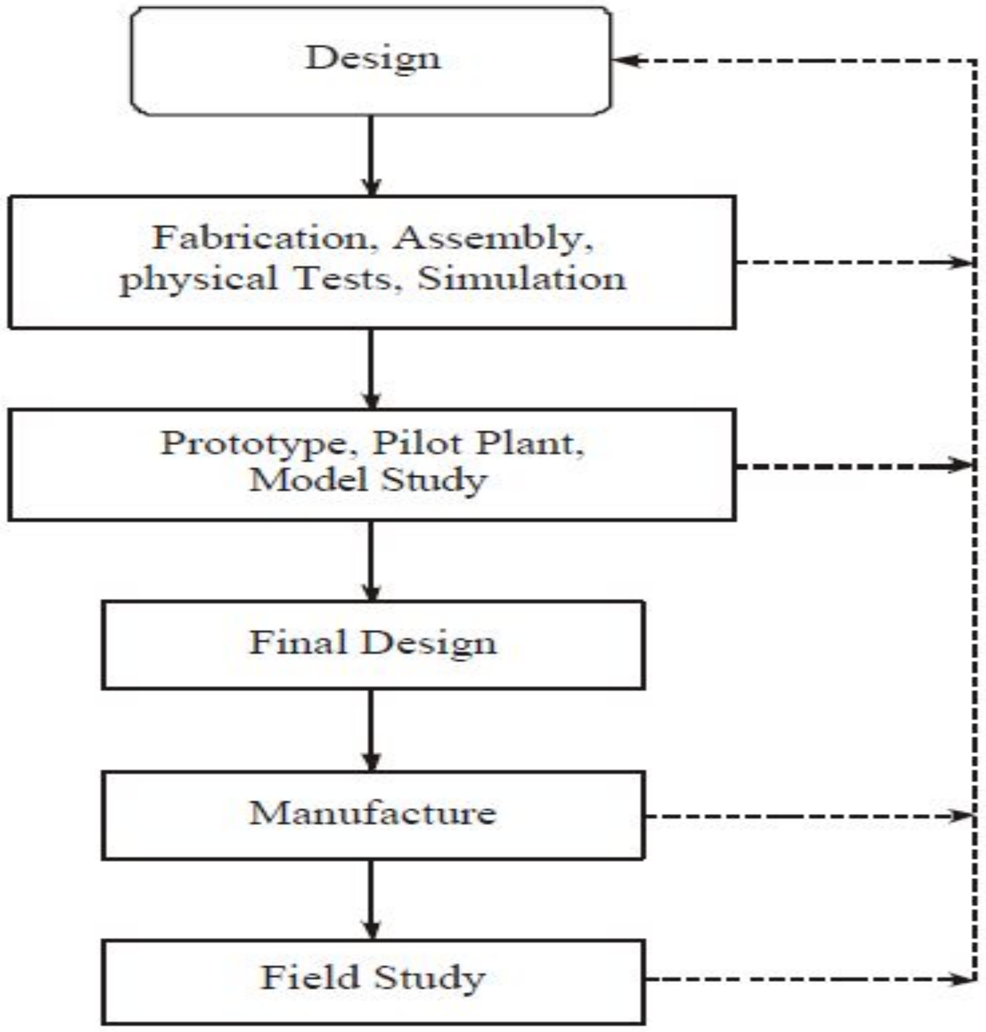
ENGINEERING AS EXPERIMENTATION

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.
- When 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

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

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 shortcoming s, engineers are expected to face the risk

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.

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2.Support to engineers

The codes give positive support to professionals for taking stands on moral issues. Further they serve as potential legal support

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

CODES OF ETHICS….

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.

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.

CODES OF ETHICS….

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

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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.

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….

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.