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DEPARTMENT OF FOOD TECHNOLOGY

19GET201 Professional Ethics and Human Values

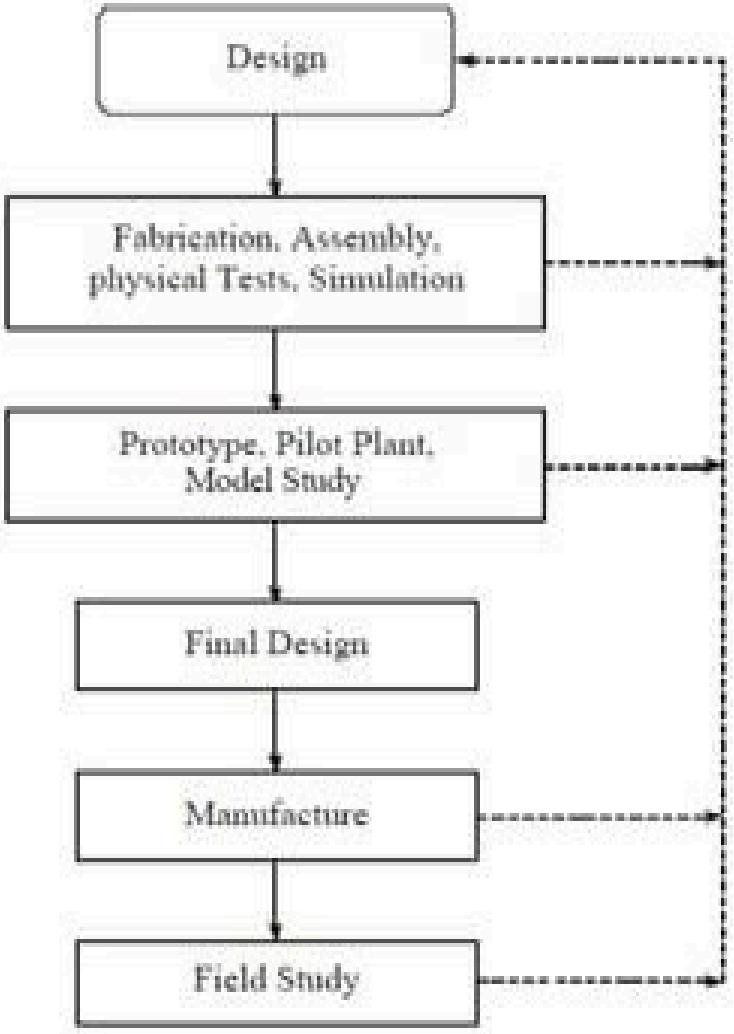
Engineering as Experimentation

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

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

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.