Unit-2
Chapter-3

FMEA & FTA

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Failure Modes and Effects Analysis and Fault Tree Analysis

Failure modes and effects analysis

- Failure modes and effects analysis (FMEA) is a thorough analysis of the malfunctions that can be produced in the components of an engineering system.
- The thrust is on how to redesign the components to improve system reliability.

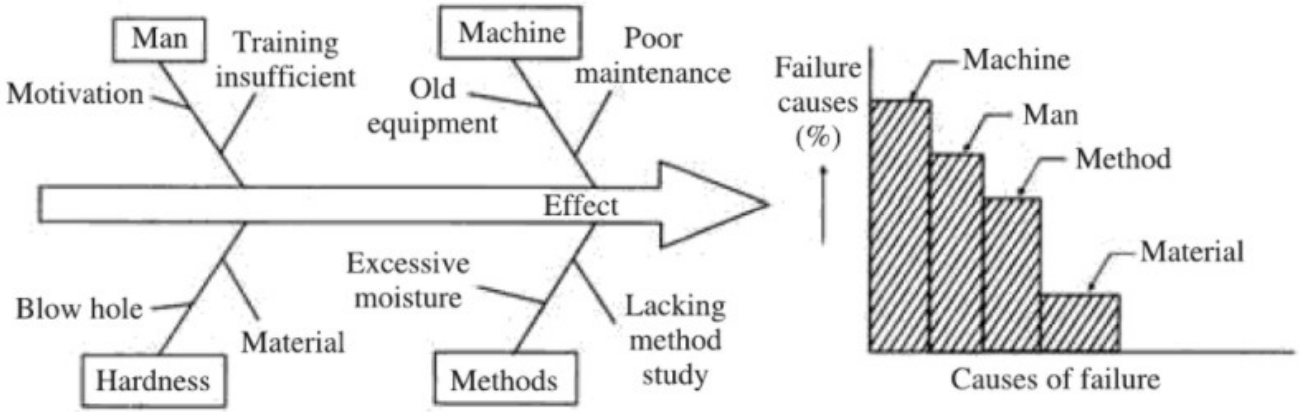
- To carry out an FMEA, the system is broken into assemblies.
- Engineering design data is appraised for each subassembly.
- This is done by making block diagrams of system, subsystem and components to enable analysis.
- A complete list of the components of each assembly and the function of each component are prepared.
- From an analysis of the operating and environmental conditions, the failure mechanisms that could affect each component are identified.
- Then the failure modes of all components are researched.
- Some components may have more than one failure mode.
- Each failure mode is analyzed as to ascertain whether it has an effect on the next higher item in the assembly and whether it has an effect on the entire system or product.
- The preventive measures or corrective actions that have been taken to control or eliminate the hazard are listed.

- The probability of failure of each component, based on published data or company experience, is listed, and the probabilities of failure of the subassemblies, assemblies, and the complete system are calculated from reliability theory.
- Often, FMEA is used in conjunction with fault tree analysis which pinpoints the areas in a complex system where FMEA is needed.

Failure Modes and Effects Criticality Analysis (FMECA)

- In an extension of FMEA, the criticality of each assembly is examined and the components and assemblies to which special attention should be given are identified.
- A component that can give rise to a unique failure is one example.
- A unique point failure is one in which an accident could result from the failure of a single component, a single human error, or any other single undesirable event.
- This extended version of FMEA is known as *failure modes and effects criticality analysis (FMECA).*

- The cause and effect diagram, called *Ishikawa diagram*, is often used for pictorial understanding of failure modes. Referring to Fig. (a). It will be seen that the malfunction is represented by the large Fish bone whereas likely causes are listed on small side bones and their branches.
- If a Pareto diagram Fig. (b) is used in conjunction with a Fishbone diagram (Fig. a) it reveals defects in terms of criticality in a more effective way. A combination of the two tools mentioned above is highly effective in FMEA.



(a) Fishbone diagram

(b) Pareto diagram

Fault tree analysis

- Fault trees are diagrams that show how the data developed by FMEA should be interlinked to lead to a specific event.
- FMEA is very effective when applied to a single unit or single failure.
- When it is applied to a complex system, its effectiveness decreases to a large extent.
- Fault tree analysis (FTA) provides a graphic description of the possible combinations in a system that can result in failure or accidents.
- In FTA, the emphasis is on “how things can fail to work” rather than on “design performance”.
- Basically, fault tree is a logic diagram in which logic gates are used to determine the relations between input events and output events.
- A full quantitative FTA uses probabilities of failure computed for each event.
- The present discussion of FTA will be restricted to qualitative level.

- Each fault tree deals with a specific event, e.g. failure to start an engine.
- FTA is a "top-down approach" that starts with the top event and then determines the contributory events that would lead to the failure event.
- Failures can be either component failures or ergonomic failures.
- Figure shows a *fault tree diagram* which depicts inability of an engine to start.

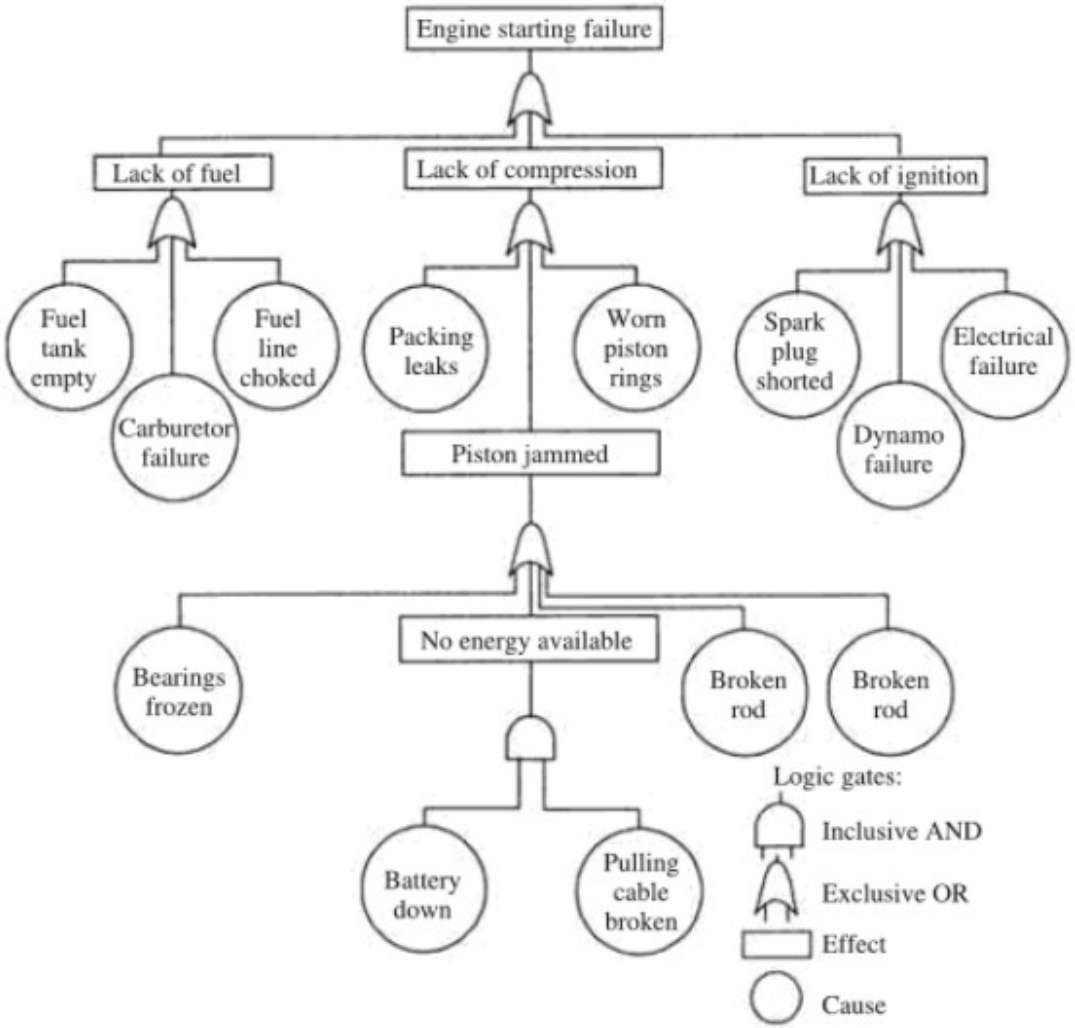


Fig. Failure of an engine – Fault tree diagram