LECTURE 9

LIFE CYCLE ENGINEERING

Working for the environment

KINGSTON • ONTARIO • CANADA

FMEA and its potential for application in LCE; by Jae Lee

Queen's UNIVERSITY

FAILURE MODES AND EFFECTS ANALYSIS (FMEA)

Jason Lee
Mechanical Engineering Graduate Student
Queen's University

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- **What is FMEA?**
- **What does FMEA achieve?**
  - **Greater safety and environmental integrity**
- **What are the main elements of an FMEA?**
  - **Function and Performance Standards**
  - **Functional Failures**
  - **Failure Modes**
  - **Failure Effects**
  - **Failure Consequences**
- **What does this mean as a graduating engineer?**

WHAT IS FMEA?

- **FMEA is a integrated component of Reliability-centered Maintenance**

Reliability-centered Maintenance (RCM) is a process used to determine the maintenance requirements of any physical asset in its operating context

- **RCM process entails asking seven questions!**
  - **What are the functions and associated performance standards of the asset in its present operating context?**
  - **In what ways does it fail to fulfil its functions?**
  - **What causes each functional failure?**
  - **What happens when each failure occurs?**
  - **In what way does each failure matter?**
  - **What can be done to predict or prevent each failure?**
  - **What should be done if a suitable proactive task cannot be found?**

- **SO WHAT DOES THIS HAVE TO DO WITH BEING ENVIRONMENTALLY CONSCIOUS ?**

WHAT DOES FMEA ACHIEVE?

First Generation (B)

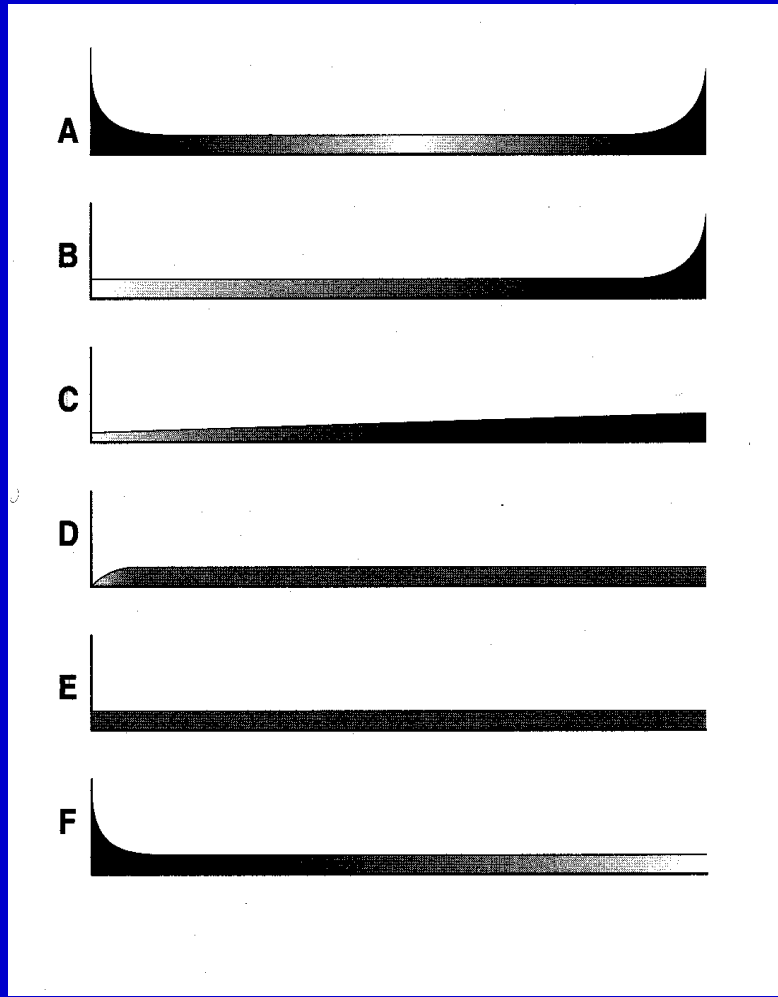
- Fix it when it broke

Second Generation (A)

- Higher plant availability
- Longer equipment life
- Lower Costs

Third Generation (E, F)

- Higher plant availability and reliability
- Greater safety
- Better product quality
- No damage to the environment
- Longer equipment life
- Greater cost effectiveness



- **Greater safety and environmental integrity: RCM considers the safety and environmental implications of every failure mode before considering its effects on operation. This means that steps are taken to minimize all identifiable equipment-related safety and environmental hazards, if not eliminate them altogether. By integrating safety into the mainstream of maintenance decision-making, RCM also improves attitudes to safety.**

- **Improved operating performance (output, product quality and customer service)**

- **Greater maintenance cost-effectiveness**

- **Longer useful life of equipment**

FUNCTIONS and FUNCTIONAL FAILURES

- **Understand the Asset's Operating Context**
  - **Environmental Standards**
  - **Quality Standards**
  - **Batch and Flow Processes**
  - **Redundancy**
  - **Shift arrangements**
  - **Repair Time**

- **Function**
  - **Determine what its users want it to do**
  - **Ensure that it is capable of doing what its users want to start with**

- **Primary Function –** summarizes why the asset was acquired in the first place

  For instance – a primary function of a car exhaust system might be to draw out no less than X micrograms of a specified vaporous waste material, from an engine at a rate of Y cubic meter / second.

- **Secondary Function –** which recognize that every asset is expected to do more than simply fulfil its primary functions. These functions are in areas of environmental integrity, safety/structural integrity, control/containments/comfort, appearance, protection etc…

  For instance – a secondary function of a car exhaust system might also be the subject of environmental restrictions dealing with noise.

  "to emit no more than X dB measured at a distance of Y meters behind the exhaust outlet"

- Functional Failure is defined as the inability of any asset to fulfil a function to a standard of performance which is acceptable to the user

- It is accurate to define failure in terms of the loss of specific functions rather than the failure of an asset as a whole.

  For instance – the car exhaust can drawing out its vaporous waste material but not its exceeds its specified noise level.

FAILURE MODES AND EFFECTS ANALYSIS

- Failure mode is any event which causes a function failure
  - Description should contain enough detail for it to be possible to select an appropriate failure management strategy

- Failure effects describes what happens when a failure mode occurs
  - “what happen” not “how does it matter?”
  - What evidence (if any) that the failure has occurred
  - In what ways (if any) it poses a threat to safety of the environment
  - In what ways (if any) it affects production or operations
  - What physical damage (if any) is caused by the failure
  - What must be done to repair the failure

- EXAMPLE OF FMEA – See Handout

SAFETY AND ENVIRONMENTAL HAZARDS

- Some environmental failure effects are
  - Increase risk of fire or explosion
  - The escape of hazardous chemicals (gases, liquids or solids)
  - Pressure bursts (vessels and hydraulic systems)
  - The growth of bacteria
  - Ingress of dirt into food or pharmaceutical products

- FMEA can help eliminate or minimize these effects

WHAT DOES THIS MEAN TO THE ENGINEER?

- Methods in predicting failures
  - Vibration analysis
  - Infrared analysis
  - Developing real-time diagnostic system
- Determining the asset's functions and performance standards
- Providing sources of Information about Modes and Effects
  - Designer, Manufacturer, vendors of the assest
- Bring Environmental Issues to the Forefront!!

Finally the end of the lecture

Thank you for your attention,

REFERENCES

- Reliability-centered Maintenacne II – John Moubray
- FMEA Info Centre - http://www.fmeainfocentre.com/index.htm
- FMEA Methodology - http://www.fmeca.com/