UNDERSTAND THE FMEA PROCESS

WHO? -> Reliability, Design, SME, Testing, Quality, Manufacturing, Maintenance, Service

WHAT? -> Bottom-up (inductive) study of a design / process’s failure modes, and their effects

WHEN? -> From absolute beginning of the design process, and continuing through project lifetime

WHY? -> Improve safety and reliability, Identify and remove single point failures, decrease cost. *Changes throughout the project lifecycle.*
### NOTIONAL FMEA

<table>
<thead>
<tr>
<th>Hardware Item, Process, or Service under study</th>
<th>Failure Modes</th>
<th>Failure Causes</th>
<th>Failure Effects (Integrated)</th>
<th>Severity (Criticality)</th>
<th>Detection Methods</th>
<th>System Response / Action</th>
<th>Controls / Mitigation</th>
<th>(RPN)</th>
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<tbody>
<tr>
<td>Sensor</td>
<td>Erroneous Output (on scale)</td>
<td>Component failures, loss of power, physical stress, etc</td>
<td>Depends on integration - effect from loss of (reliable) information</td>
<td>Depends on scale and vehicle effects</td>
<td>None</td>
<td>None</td>
<td>Tests or inspections, other</td>
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<tr>
<td></td>
<td>Erroneous Output (off scale)</td>
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<td>Sense off-scale reading</td>
<td>Disqualify Sensor</td>
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<td>Individual Pin Failures</td>
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<td></td>
<td>Depending on effects</td>
<td>Depending on effects</td>
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NOTIONAL, DOES NOT REPRESENT REAL HARDWARE OR FAILURE EFFECTS
Outcomes by Project Phase

Concept  -> Influence the design architecture
Preliminary Design  -> Influence the design at a functional level
                   -> Train engineers on systems, for integration @ later stage
Detail Design  -> Influence the design at a detailed level
                   -> Create test + inspection plans
                   -> Prepare for Troubleshooting & RCA
Produce + Operate  -> Generate ‘lessons learned’ for design
                   -> Add data for Troubleshooting & RCA
Outcome $\propto$ Resources Invested

And we need 100% of the outcome! Often, 1 failure is too many!

- Analyze lower levels of assembly
get more design influences,
get more safety improvement,
price -> more work

- Don’t under-analyze!
FMEA only protects from
failures when it is comprehensive
LEVEL OF ANALYSIS: VEHICLE EXAMPLE (E.ENG)

System broken out into increasing levels of detail, exploring one of many paths.

The FMEA is a “Bottom-Up” Analysis – where is the bottom?

Need to identify the lowest level to perform analysis, to create useful work.

Rule of Thumb: Seek to ‘analyze out’ uncertainty.

Vehicle
Controls System
Sensor
Circuit
Component
Terminal
Concept, Preliminary -> Analyze available data (system to hardware)
Influences Architecture, Functional Design, and prepares RE’s to integrate analysis in later phase

Detail Design -> Analyze from bottom up ("hardware level")
Influences Detailed Design, Test/Inspection Plan and prepares for maintenance & RCA

Produce + Operate -> Further analysis generates lessons learned (variable)
Influences Future Design, R&M Models