1 Tasks and Requirements
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AutoSteve (*FirstEarth Limited*): Supporting FMEA

Failure-Modes-and-Effects Analysis (FMEA)
- Assessment of potential effects of component failure
- Performed *during design*
- Variant problem
  - versions of subsystems
- Safety critical application
  - completeness of results

- component centred model-based reasoning
- engineering tasks on electrical systems
  - Simulation
  - Failure modes and effects analysis (FMEA)
  - Sneak circuit analysis
- Commercially available product
  - Adopted by Ford world wide as part of product development process
Example: Airbag System
Performing FMEA with AutoSteve

1. Airbag circuit drawn in engineer’s normal ECAD tool
2. Check all components have AutoSteve definitions (behavior, failures)
3. Set up functions of circuit
4. Link functions to schematic
5. Set up scenario for testing the circuit
6. Run scenario for all failures, to generate FMEA report
7. Check FMEA report

- Simulation: state of each component at any point in time
  - too much detail.
- Important: function
  - characteristic overall behavior
- E.g. for airbag system:
  - Horn activated
  - Front airbags activated
  - Side airbags activated ...
- Recognised by circuit activity
  - current flow
<table>
<thead>
<tr>
<th>Name</th>
<th>Failure</th>
<th>Potential Failure Mode</th>
<th>Potential Failure Effect</th>
<th>Potential Failure Cause</th>
<th>Sev</th>
<th>Dst</th>
<th>Occ</th>
<th>RPN</th>
</tr>
</thead>
<tbody>
<tr>
<td>HORN_H</td>
<td>Horn fails to sound</td>
<td>Regardless of any event change, the &quot;Horn sounds&quot; function was never achieved.</td>
<td>Horn fails to sound continuously.</td>
<td>The component HORN_H has failure horn fails to sound.</td>
<td>2</td>
<td>10</td>
<td>4</td>
<td>80</td>
</tr>
<tr>
<td>HORN_RELAY_J4</td>
<td>switch stuck closed</td>
<td>When IGNITION SWITCH_D was set to Off (5) the &quot;Horn sounds&quot;, &quot;Warning Lamp illuminates&quot; and &quot;Frontal Bag &amp; Belts fired&quot; functions were achieved unexpectedly.</td>
<td>Horn sounds unexpectedly. Lamp illuminates unexpectedly. Possible death of occupants if seated incorrectly.</td>
<td>The component HORN_RELAY_J4 has failure switch stuck closed.</td>
<td>10</td>
<td>10</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>HORN_RELAY_J4</td>
<td>switch stuck open</td>
<td>When MAIN_CRASH_SENSOR was set to detected (4) the &quot;Horn sounds&quot; function was not achieved. Finally, regardless of any event change, the &quot;Warning Lamp illuminates&quot; and &quot;Frontal Bag &amp; Belts fired&quot; functions were never achieved.</td>
<td>Lamp fails to illuminate. Possible death of occupants.</td>
<td>The component HORN_RELAY_J4 has failure switch stuck open.</td>
<td>10</td>
<td>10</td>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>HORN_RELAY_J4</td>
<td>coil burned out</td>
<td>When MAIN_CRASH_SENSOR was set to detected (4) the &quot;Horn sounds&quot; function was not achieved.</td>
<td>Lamp fails to illuminate. Possible death of occupants.</td>
<td>The component HORN_RELAY_J4 has failure coil burned out.</td>
<td>10</td>
<td>10</td>
<td>3</td>
<td>300</td>
</tr>
</tbody>
</table>
Example: Sneak Circuit

- Two systems
  - Ignition-switched radio cassette
  - Interior lamps:
    - lit when
      1 door open
      2 ignition on and interior switch closed
  - Radio on when
    ignition not on!
Performing Senak Circuit Analysis with AutoSteve

- Detects unintended interaction
- Needed: intended input conditions for functions
- Simulation for all switch settings
  - no failures
- Sneak condition: functions
  - occurring when they should not
  - not occurring when they should

1. Airbag circuit drawn in engineer’s normal ECAD tool
2. Check all components have AutoSteve definitions (behavior, failures)
3. Set up functions of circuit
4. Link functions to schematic
5. Declare correct activation of functions
6. Run sneak circuit tool
7. Look at sneak results
Benefits of AutoSteve

- **Rapid** production of FMEA reports
- **Timely** production of FMEA reports
  - Much earlier than is possible without qualitative reasoning
- **Consistent, complete** production of FMEA reports
- Use of results for incremental FMEA, diagnosis