Solutions to Reliability Analysis of Very Large Equipment/System Designs

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Reliability analyses such as FMEA and Bent Pin Analysis (which is a subset of a FMEA) take on new and unique challenges when they are to be performed on very large equipment or systems with numerous modules or circuit card assemblies. Whereas a single analyst can often perform these analyses in an efficient manner that is schedule sensitive on small and medium size equipment and systems, a team of analysts is often required for equipment or systems that may have over 100,000 failure modes.

Unfortunately, increasing staff size doesn't necessarily translate to a proportional increase in productivity. The following list summarizes just a few of the pitfalls associated with performing an analysis using a team approach:

- A manager with a good track record may not be an effective leader for a large-scale reliability analysis. You will need to identify a leader that can work well with all team members, encourage teamwork, promote enthusiasm, and understand details of technical issues. The leader needs to manage and control the entire technical activity including: developing a streamlined process/procedure for the analysis, responding to process/procedure questions, quoting the analysis and estimating the time to complete the analysis, reporting completion metrics, performing in-process reviews of team member analyses, and ensuring all team members are operating efficiently with no overlap in their work.

- Different analysts often describe the exact same event (failure effect, detection method, etc.) using different words. This results in confusion to the reader, possible analysis errors, and a less cohesive analysis and report.

- Shrink wrap CAE software designed to support reliability analyses is not developed to reflect your company's analysis workflow, it does not assist in managing the analysis, it does not provide meaningful metrics of progress and work to be completed, and although often available in network- or internet-based versions, it is not developed to efficiently support a team approach.

Size and complexity alone often makes complex system analysis difficult, and to make matters worse many of them should have been started months before to meet the delivery schedule. Listed below are a few guidelines developed to efficiently perform these very large analyses:

- Assess whether your existing analysis process/procedure is a reasonable starting point for a team analysis approach. You are trying to:
    - Minimize knowledge sharing among team members
    - Develop clearly defined work packages
    - Develop methods to automate the analysis
    - Define ways to link analyst data developed independently
    - Streamline the process
    - Define a common database
    - Develop methods to quantify progress and manage workflow

If you've never performed a very large analysis before, chances are that your existing process/procedure is mostly inappropriate and you must now think what is best for a team. Do not be scared to discard prior approaches and start fresh with something new.

- Develop a phrase generator. This is a standardized method to describe all events (failure effects, fault detection methods, etc.) This allows us to produce an analysis/report that reads as if one person wrote the entire volume. It also provides an easy means to assure that descriptions are neither overly complex nor inadequate. The number of unique descriptions is minimized and summary tables are more complete and clear to the reader. An automated phrase generator may provide the utmost in flexibility and consistency.

- Develop a CAE tool where one never existed before. Subcontractors may be a source of such valuable tools to improve analysis processes. Such tools can help improve analysis quality while decreasing analysis time – sometimes drastically. For example, after performing several Bent Pin Analyses with commercial FMEA tools we knew we needed a better way. We were analyzing subsystems and systems consisting of numerous "black boxes" where each box had eight or more connectors with over 100 pins each. Just developing the list of potential failure modes took forever. And then, the complete list of failure modes needed to be analyzed for their consequences. To accelerate and improve the process, a CAE tool was developed that automates the bent pin analysis process.

  As with other processes, it is worthwhile to improve CAE tools as you gain experience with them. New versions often provide more realistic and accurate results than the previous version. The new version of the bent pin analysis tool recognizes that a bent pin in a real-world connector often curves when flattened against the opposite mating surface, and that in many real-world connectors, a bent pin may short to not just one pin but to two, or to another pin and the shell. New algorithms, now available, greatly improve the accuracy and thoroughness of predicted failure modes and failure rates, and increased use of automation means faster turnaround with fewer possibilities of human error. Additional improvements include visual feedback to assure correctness of data entry, no restriction on connector size, effects of different pin diameters in the same connector, and mathematically correct analysis of all types of connectors such as those containing bendable pins along with non-bending coaxial or optical contacts. Newer algorithms also compute precise failure rates for pins shorting to connector shells of any shape. The tool also composes English descriptions of failure modes and low-level failure effects so analysts can focus on circuits and systems without looking at pins and wires.

To summarize, the largest error companies make when first trying to perform very large analysis efforts is using existing processes/procedures that are typically not up to the task. By taking a fresh look at your existing approach you will be able to determine what changes are needed or whether a complete new approach must be developed.