Guide 3

TASK GUIDANCE FOR BRIDGING MES MATRIX GAPS WITH MES-TREES

For Use During MES-Based Investigations

Table of Contents

Go to Guide: 0 1 2 3 4 5 6 7 8 9 10

BRIDGING MATRIX GAPS

An investtigator's next challenge is to bridge any gaps in the Matrix description of the process being investigated.
This gap bridging challenge generally stated is to:

1. identify EB on the Matrix that are not linked to one or more other EBs
2. Hypothesize event scenarios that might describe what happened in MES-

trees
3. Apply logic tests to the hypothesize actions displayed
4. Seek data to confirm the hypothesized EBs to find the most likely bridging EB
5. Modify Matrix to show

Procedures for this task are contained in this Guide. They cover manual and software-supported procedures.

OVERVIEW OF MES-TREES

During the development of MES-based Matrixes, gaps in the flow of the investigator's analytical building blocks - the Event Blocks or EBs - are always encountered. Investigators can bridge these gaps by generating hypothesized EBs and scenarios. Hypothesized EBs can be developed using MES-based bounded logic trees. **MES-Tree displays** help investigators discover possible scenarios, and discipline their definition. MES-Tree displays also provide a way to enlist the knowledge and experiences of experts or others familiar with the system operation in an efficient, focused, intellectually challenging and rewarding procedure.

The hypothesized EBs displayed on MES-Trees then point investigators to data needed to *confirm or refute* each candidate EB and scenario. When a hypothesized scenario is confirmed with data from additional observations or other means, it can be considered a feasible "gap filler" and added directly to the MES Matrix, efficiently and quickly. If one can not be confirmed, the effort expended to develop the MES-Tree can demonstrate a "best efforts" attempt to resolve uncertainties. Additionally, the work will prepare the investigator to deal with the "second guessers" and "experienced experts" who always seem to be around to challenge investigator's work products.

The objective of this Guide is to provide a congruent procedure for bridging gaps in MES-based matrixes with logically reasoned hypothetical event blocks, using a structured method to facilitate and organize the development of hypothesized scenario segments on the matrixes.

APPLICABILITY

Use MES-Trees during investigations to develop hypothesized EB sequences that might describe what occurred during a gap in an MES Matrix. MES-Trees thus developed should be subjected to further data acquisition or testing, to determine the most likely EB sequence during a specific occurrence.

As a general rule, deductively reasoned logic trees do not lend themselves well to the display of known EBs during an investigation. Their greatest value is in structuring the search for different ways occurrences can happen. Known EBs, with a certainty of 1, can be displayed more advantageously in MES-based

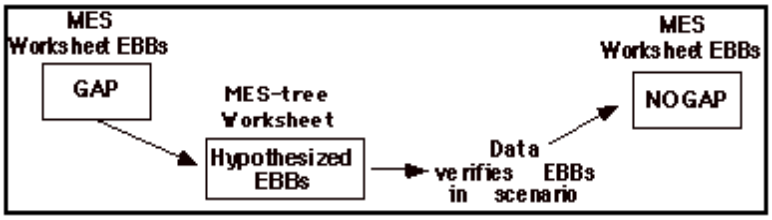
matrices.

Additionally, EBs usually can not be recast adequately into the failure logic structure required for a conventional logic tree without introducing major biases into an investigation. Additionally, it is very difficult to cope with actions by people in investigation fault trees. Finally, except for MES-based matrices, the relative timing of EBs can not be displayed efficiently in conventional fault trees. See the back page for an illustration of the difference between MES-Tree and Fault Tree approach to matrix gaps.

GENERAL GUIDANCE

MES-based logic trees in general provide a structured way to organize speculations about possible EBs to bridge a specific gap in an MES Matrix. The difference between an MES-Tree used during an investigation, and a logic tree used during other functions is the horizontal configuration and the actor/action format for all entries in the blocks constituting the tree. An MES-based logic tree is a logic tree displayed on its side, with the specified starting and ending points derived from the MES Matrix.

Figure 3-1. Work flow to bridge gaps in MES Worksheets.



DATA REQUIRED

Data required to produce MES-Trees includes:

- Known EBs on each side of a gap in a MES-based matrix.
- An understanding of the way the system involved in the occurrence is expected to function.
- Procedures for constructing and confirming hypotheses with the MES-Tree.
- Candidate EB sequences or scenarios to enter into the MES-tree during its construction.

DATA SOURCES

1. An MES- tree is dependent on the investigator's or experts' knowledge and background for data that can be used to develop candidate EBs displayed in the tree.

2. New data are generated as the tree is developed, by repeatedly asking the questions:
    - What prior EBs must have occurred to make this EB occur (necessary logic)? and
    - Were any of the EBs sufficient to cause the next EB by themselves (sufficient logic)?
    - Were all the EBs necessary and sufficient to produce the next EB?
    - (The answers determine the configuration of the MES- tree.)
3. After the MES-Tree is completed, the tree entries dictate the additional data that need to be gathered, and the possible sources for such data.

DATA PRESENTATION

For investigations, a modified logic tree format is used to display hypotheses on an MES-Tree matrix. The EB on the left end of the gap becomes the anchor EB on the left end of the tree matrix, and the EB on the right of the gap becomes the anchor on the right end of the tree. Typically, the flow of the EBs in an MES-Tree diverge from the left EB toward the center, and then converge again from the center toward the right EB.

MES -TREE DEVELOPMENT PROCEDURE

Developing MES-Trees Using **Investigation Catalyst**

- *With **Investigation Catalyst**, the MES-Tree can be created on a new matrix, which can be merged into the main file when completed.*

- *Create the EBs to the right and left of the gap on a new matrix. Manually move the right EB to the right edge of the matrix.*

- *Then begin adding tentative EBs between these two EBs to establish a continuously linked flow of EBs from the begging to the ending EB, as described below.*

- *When completed, find data to support any or all of the EBs between the begin and end EBs*

- *After confirming one of the potential EB pathways, the matrix can be merged into the main file.*

Manual Development of an MES-Tree

Large pieces of paper, at least 2x3 feet, are usually adequate for MES-Trees. 3M "POST-IT" notes can be used to record the hypothesized EBs. Erasures and correction of entries are encouraged until the tree defines EBs precisely. All EBs on a tree should be in the same "actor/action" format as used in MES-based matrixes. The tree development procedure follows.

1. Select a gap on an MES Matrix to analyze.

2. Duplicate the EBs on the right and left of the gap on the Matrix.

3. Prepare an MES-Tree workspace, such as a 24 x 36 inch sheet of paper from a classroom easel. Place the two EBs from the gap along the right and left margins of the MES-Tree matrix.

4. Starting with the right EB, postulate what EBs might have led to the occurrence of that EB. Remember the "change maker" concept, and keep the initial speculation within the bounds of the known system and its operation. Display the first "tier" of EBs on the MES-Tree matrixes as shown in Figure 3-1a, which has 3 hypothesized EBs leading to the right EB of the gap.

5. Note how the MES-Tree builds up from the right to the left. A1-C1 are the "first tier" EBs. In this example, either A1, B1 or C1 could have produced the right EB. This represents an "OR" gate array in an MES-Tree. See Figure 3-1b EB C2 and D1 for an example of an "AND" gate array in an MES-Tree. Necessary and sufficient tests for EB pairs are useful as each tier is added to the MES-Tree

Figure 3-1a. MES-Tree Development

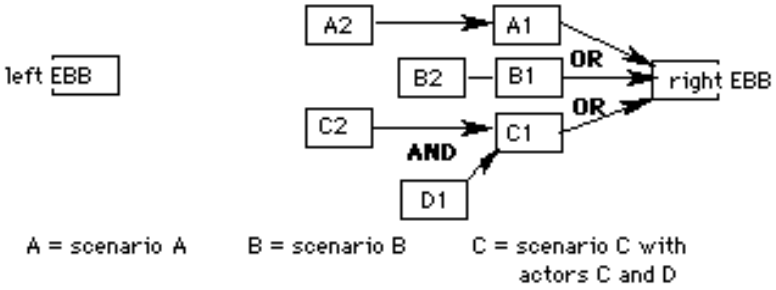
6. Next, try to hypothesize at least one and preferably two or more EBs that could have led to the EBs in the first tier to the left of the right end EB. Remember, use the actor/action format for every EB. At this time do not ignore any possibilities that you can reasonably visualize from your knowledge or other experts' knowledge of your system. Sometimes it is helpful to use the Change Tracking method, or the Energy Trace and Barrier Analysis method to help stimulate hypothesis development. These are both "paper" methods and thus relatively economical to use, when compared to simulations, tests, tear downs or other commonly used investigation techniques. Another convenient way to develop

hypotheses is to try to picture the EBs that you think might have occurred, using the mental movie technique.

7. When you get the second tier of EBs, add them to your MES-Tree matrix as shown in Figure 3-1b.

8. Note that in the sample scenario C has two EBs leading into the first tier EB C1 (C2 and D1.) If both had to occur before C1 occurred, you have an "AND" gate logical relationship. This kind of array arises from testing the links with necessary and sufficient logic as EBs are added to the tree.

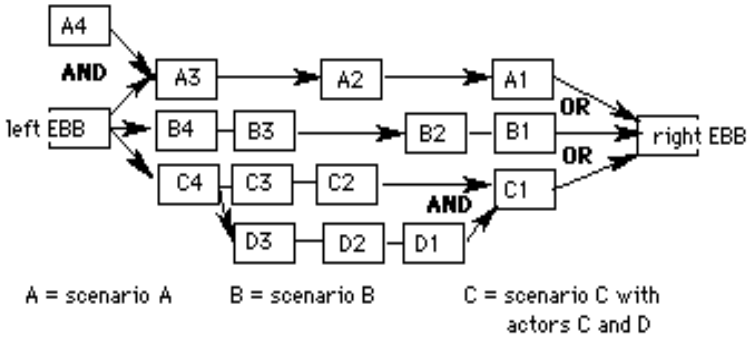
Figure 3-1b. MES-Tree Development



9. Proceed step-by-step with your speculations sideways to the left through each EB until you have reached the left-most EB, i.e., the EB on the left side of the MES Matrix gap. This is where a major deviation from the conventional fault tree procedure occurs: the hypothesized scenario must tie into the EBs on BOTH ends of the tree. It is permissible to tie a scenario into other EBs such as EB A4 in Figure 3-1c below, to satisfy the necessary and sufficient tests. However, each scenario MUST tie into both end EBs to be a credible candidate "gap filler" scenario.

   Figure 3-1c shows the various forms a tentative MES-Tree with three hypothetical scenarios might display. (Insert 3.1c here)

Figure 3-1c. MES-Tree Display



10. In Figure 3-1c, scenario A would require both the left EB and EB A4 to produce A3, after which the scenario progresses to the right EB linearly through A2 and A1. Scenario B is all linear as often occurs when only

one or a few EBs are required to bridge a gap. Scenario C branches after C4 (because it involves actions by two actors) and then converges again at C1 before reaching the right EB, as might be experienced with a more complex "gap filler" scenario.

11. Remember, this is a MATRIX and should be regarded as a work-in-process document until one or more of the scenarios displayed are confirmed with additional data from the investigation. It is OK to make changes and refinements to the matrix as often as necessary as the work progresses.

12. When a scenario uses more than one pathway, it is permissible to prepare that scenario on another MES-Tree matrix, and use transfer symbols (a "copy here" sign post) to move one matrix to another, so all the scenarios are indicated on a single matrix for investigation administrative purposes.

13. Check your EB flows for their logic, for consistency with the system design or operation, and for their cause-effect links before proceeding to the next task.

CONFIRMING THE MES-TREE

When you have completed your hypothesized scenarios and checked your draft MES-Tree, you are ready to use it to identify and confirm the most likely EB scenario.

1. Review the EBs in each path through the tree and try to determine how that EB might have been observed or how it changed something. Look for data to confirm each EB as well as data that would rule out the EB. Continue this process until

    - only one path has only supporting data and no contradicting data, and

    - all the other paths have no evidence or evidence showing they could not have happened.

2. By a process of elimination, identify the most likely path through the tree, if one can be found.

3. Alternatively, if data are lost or destroyed, or no data can be found to support any EBs along any path from the left EB to the right EB, three choices are available. Either

    - acknowledge that data needed to support a choice are not available, and report the gap,

- perform a simulation of the occurrence, bounded by the EBs already on the MES Matrix, or

- subjectively identify the most likely path(s) using expert judgments, the "Delphi" method or some similar rationale to arrive at your conclusion.

4. If a reasonably likely scenario is found, take the most likely path and transfer those EBs from the MES-Tree onto your MES Matrix.

- *With **Investigation Catalyst**, the MES-Tree file can be merged into the main file.*

As an intermediate quality assurance step, check the logic against other EBs on the Matrix after the new EBs have been added. If no contradictory evidence or illogical, non-sequential relationships can be identified, you have probably done as much as can reasonably be expected to bridge the gap in your understanding of the occurrence.

QUALITY CONTROL

MES-Tree quality control is exercised during the development process by insisting on the use of EB development quality controls and on the use of linked EBs as the tree develops. The final QC check occurs after the placement of the most likely scenario on the Matrix, and the subsequent QC testing of the Matrix in the area of the former gap.

COMMENTS

The MES-Tree should be viewed at first only as a "best guess" about what happened. It should not be relied on as the most likely scenario without substantiating data or testing. While the method will indicate the most likely scenario for that portion of the occurrence, the most rigorous validating method is the MES Matrix. Recommendations based on these speculations should not be given great credence without further verification, using the MES Matrix. Possible exceptions: where no other information can be obtained or data didn't survive the occurrence.

Go to Guide: 0 1 2 3 4 5 6 7 8 9 10

Contact Starline | Starline Software Ltd. home page