FIGHTING FAILURE WITH THE INTERNET

Web-based collaborative methods   *facilitate the FMEA process*

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FAILURE MODE AND EFFECTS ANALYSIS (FMEA) methods typically require assembling a team in an isolated environment to brainstorm and discuss candidate items. This physical assembly of a team has several aspects that can limit performance and feasibility. Furthermore, today's globalization of new product development makes assembling key team members logistically difficult due to location and time-zone considerations. Internet technology can solve that problem and limit the negative effects that come with creating a team that must meet in one location. A set of guidelines, illustrated with a case study of an international FMEA project facilitated with a Google Groups website, can help organizations optimize their use of Web-based collaborative environments.

The value of working online

An FMEA team assembled in a physical location has drawbacks that can hamper performance and feasibility. The social influences of group sessions may produce negative effects that include groupthink, hierarchical pressure to understate project risks, and obvious failure modes overlooked as the team focuses on the most obscure possibilities. In addition to the social influences on the project results, global organizations may find it difficult to gather key team members at one site in a timely manner.

The need for inter-enterprise collaboration is becoming more prominent. The world is getting smaller, and corporations with international reach are now the rule rather than the exception. The value of an FMEA rests on the team's ability to identify all potential failures, effects and causes. This information rarely is housed within a single plant or corporation, particularly when FMEAs are used in developing new products and processes. For instance, a supplier may have the best quality information on potential failures for its products, while the company being supplied may have better information on how that failure affects adjoining components and processes. Provision of an online venue for FMEAs enables collaboration with external entities, thus improving the quality of the information developed.

Even when the subject experts are available locally, they may not be able to participate in traditional brainstorming sessions due to conflicts with other project responsibilities. If consultant experts are used, their participation may be costly when considering time for travel to the team meeting place and the cost of allocating specific time blocks to the project. The flexibility of online FMEA participation enables these experts to participate in the process without major disruptions to other project work or incurring non-value-added costs such as travel time.

Team dynamics change when using Web-based collaboration. Unlike traditional FMEA meetings where team members influence each others' contributions directly, online participation is more isolated. In a traditional FMEA scenario, team members sit around a conference room table. Members are aware of their position in the hierarchy, and this creates tension. In brainstorming, team members are encouraged to be open in their contributions and constructive in their responses. If a member of the team is particularly high in rank, team members may be reluctant to voice issues with that person. If they do voice issues, lower ranking members may be conservative in estimating the severity of the effect. This situation is particularly damaging when the high-ranking person is also the process owner. The "arms-length" participation provided in Web-based FMEAs fosters more candid contributions from the team members since they have no visual contact with the other members. This is also an advantage in the rating process as members complete their work individually and are not as susceptible to the pressures of the group. When an online FMEA is managed properly, it may prevent team excursions into unrelated topics during the process.

Another common pitfall associated with traditional FMEA approaches is inadequate definition of the rating scales. The rating scales must have meaning for the product or process being evaluated. The use of database tools enables ratings to be selected based on descriptive choice fields; this results in more consistent ratings and less time to reach consensus. Finally, the use of Web-based tools has the ability to reduce the amount of time spent on documentation. Instead of transcribing hand-written notes and conference room and board work to properly formatted FMEA worksheets, team members enter data directly into the system. If a database is used, the results may be in a more usable form for future reference and improvements. Modification of the worksheets becomes faster when the information is stored in database fields.

Thus, Web-based FMEAs might overcome many of the problems with traditional FMEA methods. However, pay careful attention so that Web-based FMEAs don't suffer from lack of

concentration and instantaneous follow-up discussions. These issues can be mitigated through proper planning, follow-up strategies, and interactive and easily accessible systems.

Recently we had the opportunity to use a Web-based approach for a concept FMEA to develop a new inspection process for an automobile assembly plant. The inspection methodology involved some new technology that was unfamiliar to the manufacturer. The concept FMEA process was used to provide early identification of the risks associated with the performance of the equipment and the process in which the equipment was used. Since our team had busy schedules and one member was in Germany, we used a nontraditional approach.

Computer support cooperative work is the study of how to facilitate collaborative work using computer systems. These studies divide groupware applications into four categories based on time and location of the group members, as shown in Figure 1. In this situation, we were dealing with asynchronous collaboration, where the workspaces were in different locations. Thus our solution required the use of groupware, which enabled information sharing using a common base. We also needed a collaborative system that could be accessed easily by team members from different companies and countries, all while maintaining data security. We decided on a Google Groups groupware application to support our FMEA project. The website's home page is shown in Figure 2.

Picking the players

The purpose of the FMEA process is to bring together people with unique experiences and perspectives to generate information that no one person could visualize alone. The ideal FMEA team would consist of about five people, each with a different perspective of the product or process being analyzed. Types of

TIME-SPACE TYPOLOGY

Figure 1. Groupware has four different dimensions based on time and location.

Source: *Groupware: Computer Support for Business Teams*, published by Free PR in 1988

A VIRTUAL HOME

Figure 2: This was the home page of the FMEA team's website.

Image courtesy of Lawrence Technological University IT Services

fighting failure with the Internet

diverse roles might include part suppliers, design engineers, manufacturing engineers, service providers and customer advocate personnel. These people may work for the company conducting the FMEA, or they may be external players. The roles to include on an FMEA team depend on the focus of the FMEA. A process FMEA must have manufacturing engineers or people involved directly with the process, whereas a design FMEA may have a manufacturing representative to provide additional perspective.

The access and flexibility of Web-based systems enable team members to be selected from a much larger population of experts both internal and external to the company. People with limited time may find the 24-hour access to the process manageable, whereas defined and lengthy conference room sessions make their participation less feasible. The Web-based process allows the team to consider other participants from around the world, not just those local to the team leader. In our case study, this approach allowed us to include two supplier representatives (one in Germany) to participate actively from their offices.

An important consideration in the construction of the team is the level of familiarity each member has with the product or process being evaluated. While people most familiar with the system may have the most complete information, they also may have an emotional investment in the product that may cause them to be inflexible when considering alternate points of view. The most familiar person would be the owner of the design or process. Since the FMEA is a critical analysis of the owner's work, it is difficult for that person to be objective. The process may lead to situations where the owner's self-esteem is hurt, resulting in defensiveness and anger. Thus the owner only is tapped as a team member if no other options are available.

Develop the website

Before assembling the team to kick off a new project, construct the website. Our website contained the following key components:

- *Home page:* This is the point of entry to the website. It contains the project charter information such as the problem description, project scope, upcoming events and site navigational information.
- *Worksheet area:* Place for formal submission and review of the FMEA documents. This area also contains the standardized rating choices and their descriptions. We used spreadsheets for formal submission of data. The spreadsheet submissions were used as input to the "team" FMEA

worksheet, which represented the summary of the inputs and the formal project document. The team worksheet was posted for immediate visual access, whereas the input information could be accessed with links. This method may be improved on by using Web-database applications.

- *Discussion area:* Be sure to provide a location separate from worksheet input for discussion. This keeps the worksheet area clean and focused and encourages less structured and more open communication between team members. We used discussion threads for this communication.
- *Project administration area:* Contains contact information for the members, which may include email tools, the calendar of events for the project, and budget data, if applicable.

A nod to tradition

Similar to a traditional FMEA, our team had a leader who was responsible for keeping the team on track and reporting the results. The difference in working with an online group is that roles and responsibilities must be handled up front because the team leader cannot directly oversee the communication between members and provide procedural guidance as situations arise. We began our project with a kickoff meeting held in a traditional conference room with teleconference inputs from team members outside the local area. This meeting let the team members meet each other and understand each other's background area of expertise. In addition, this meeting was used to establish the project charter and the responsibilities of the team members. Experience has shown that direct communication at this point is important to gauge team understanding of key project requirements.

The kickoff meeting included the following key elements:

1. Introduction of team members
2. Project objectives
3. Project scope
4. Review of the part/process being analyzed
5. Responsibilities of the team members

The information from this meeting was to design the Google Groups home page shown in Figure 2. It acted as a constant focus for the team's efforts. The first four elements in the kickoff meeting are consistent with the kickoff of any FMEA project. But because team members will not have direct contact with the leader for long periods of time during the project, the genesis of an online collaborative project requires putting particular emphasis on the responsibilities of the team members.

To ensure team member responsibilities and proper interaction between participants:

- **Establish a limited period of time for completing team tasks.** We limited our online discussion period to three business days. This provided a definite end to the time for inputs and reduced the probability that procrastinators could hold up the process.
- **Emphasize etiquette.** Keep in mind that this is a brainstorming exercise for the purpose of developing as much information as possible, information that will be evaluated later in the rating process. Team members must respect all inputs in their responses.
- **Confirm website availability.** Advise members on how to access the website and on precautions for keeping the work secure, such as using password protection.
- **Establish the worksheet area.** The team members should know how to submit information to the FMEA worksheets. In our case, the members uploaded spreadsheet files with their submissions, but this could be made much more Web-friendly with a formal online application.
- **Handling consensus.** In our project, the team leader reviewed all the incoming information and installed it to the "team" FMEA worksheet. The team worksheet was used to summarize individual contributions and acted as the document of record for the project; therefore, team members were asked to approve the team worksheets as they were completed. In this case, consensus was handled through a posting to the consensus discussion thread on the website.
- **Proper documentation of input.** Team members should provide the source for any information they contribute to support their points.
- **Encourage discussion among team members.** Show them the discussion area of the website.
- **Provide standardized rating scales.** The rating scales for severity, detection and occurrence should be developed specifically for the project at hand and agreed to by all team members at the kickoff meeting. Each rating value should describe example situations worthy of that level. For example, a severe part failure with a value of five on a five-point scale might be described as "creates a safety or regulatory hazard when it occurs." In our case, we were evaluating an inspection device, so a severe failure would be one where "the inspection data was corrupted or not provided."

The FMEA project process

Once the kickoff meeting has taken place, team members must have immediate access to the website in order to confirm the information provided and develop familiarity. We approached our project by establishing focus modules. Each module represented a specific subsystem in the equipment we were analyzing, as shown in Figure 3.

By using modules, the team was able to focus its efforts on one system at a time. Our process was iterative, one module at a time, in seven steps:

1. **Establish the FMEA worksheet structure for the module.** The team leader lists the subsystems and components for the focus module in a spreadsheet. This provides organization to the inputs from the team members into standard FMEA worksheet format.
2. **Failure modes identification.** FMEA worksheets are made available to team members on the website. Team
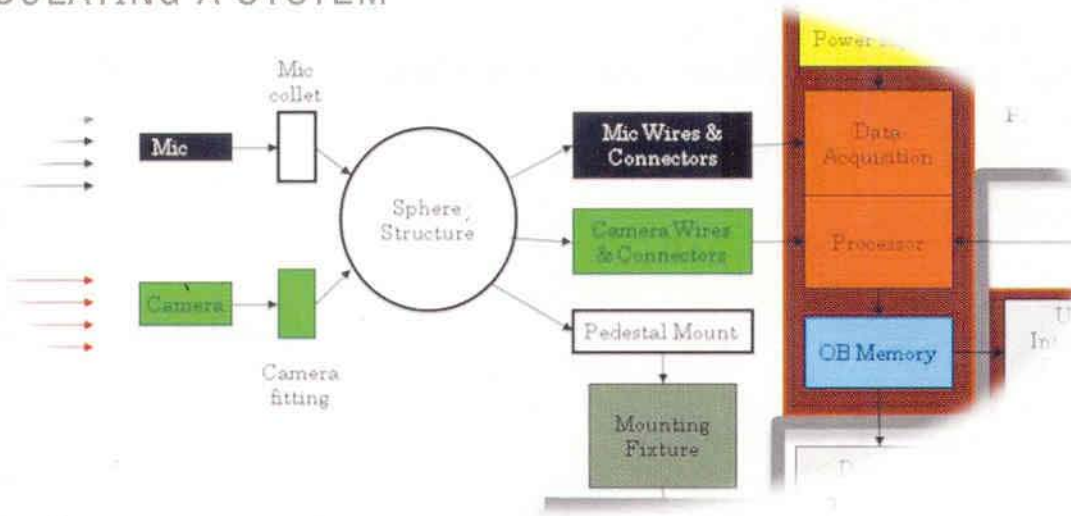
MODULATING A SYSTEM

Figure 3: The team used modules to approach complex FMEA topics.

ONLINE IMPROVEMENTS

Web-based FMEA might overcome many of the problems associated with traditional FMEA methods. Benefits include:

- Flexibility of time and location for meetings and team input to the process
- Ability to involve external entities in the process
- Improved quality of team members
- Reduction of social effects on team efficiency and results
- Standardization of response data
- Reduced documentation time

mine that a face-to-face meeting is required. If not, the finalized worksheet is posted and the team members indicate their approval for consensus.

6. **Ratings.** Team members are given a set period of time (in our case two business days) to post their severity, occurrence and detection ratings for the line items in the finalized worksheet.

7. **Risk analysis.** The team leader completes a risk priority number risk analysis based on the submitted ratings and posts the worksheets with the final scores. A Pareto chart works well as a tool to present the relative risks of the line items.

With today's busy schedules and globally reaching enterprises, more and more collaborative work must be done online. Web-based FMEA processes provide the ability to assemble people remotely and effectively gather team inputs, resulting in substantial cost savings and greater efficiency. Successful deployment of Web-based FMEA analysis requires well-structured rules of engagement and pre-defined roles and response time requirements. The availability of improved Web-based FMEA groupware tools and the increasing power of hand-held devices have the potential to make groupware collaborative work the new standard practice in industry. ⌁

members work on their own to identify the potential failure modes for each line item. There is a defined length of time for team members to submit potential failures to the leader. After the submissions are received, the team leader consolidates the results into a single worksheet.

3. **Effects and causes.** The team has a brainstorming meeting to review the consolidated failure modes and to discuss effects and causes. For those not able to attend the meeting in person, Internet video conferencing may be used. We used Skype.

4. **Review period.** The leader updates the consolidated worksheet based on the results of the brainstorming meeting and posts it to the website. Team members are given a set period of time to discuss the document and suggest modifications. During this time, the discussion area of the website is active as team members discuss issues in detail and provide support data for their assessments.

5. **Consensus.** The team leader assembles all discussion results and adjusts the consolidated worksheet as required. If there are unresolved issues, the team leader may deter-

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Engineering & management solutions at work

THE MISSING INGREDIENT?

Unjumbling value streams
could make Boeing's impressive
lean gains even better

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