Employee Involvement

Proactive Safety

Engage employees in failure modes and effects analysis to improve safety

By Cliff Welborn and Carol Boraiko

ACCIDENT INVESTIGATION AND REPORTING is a critical technique used to identify the root causes of an industrial incident or near-hit. However, it is a reactive procedure performed after the incident. Truly effective safety programs have both reactive and proactive components. Proactive processes seek to prevent incidents before they occur.

Since a workplace accident can be viewed as a failure of the work system to keep an employee safe, techniques associated with failure reduction can be applied to a safety program. Failure modes and effects analysis (FMEA) is a common technique used to manage risks associated with potential failures and root causes. It is a proactive technique that can be used before a product or process is introduced to users. A modified FMEA can be used to evaluate potential risks to employees in industrial settings.

FMEA: History, Process & Applications

FMEA is an analytical technique used to identify, quantify and prioritize risks. In 1949, the U.S. military first used FMEA to improve the probability of successful strategic missions. Later, in the 1960s, NASA used FMEA to reduce the risks associated with manned space flight. In the 1970s and 1980s, the automotive industry used the technique to evaluate health risks to passengers from driving vehicles, and later to minimize the occurrence and effect of quality defects.

The methodology has been beneficial in many different applications. One specialized version, design FMEA, is used during the engineering design phase in product development. FMEA can also target product function (functional FMEAs), address the interface between products (interface FMEA) or focus on components of a product (detailed FMEA).

A traditional FMEA quantifies risk in terms of three categories: severity, occurrence and detection (George, 2002). Each category is rated on a scale of 1 to 5 (or 1 to 10), with a lower rating representing a lower risk. The severity rating typically represents the effect of a failure on the product/process user. FMEA developers quantify the effect on the user if the failure occurs.

The occurrence category is the probability that the failure will occur. The rating may be based on historical data or may be a subjective estimate of the FMEA developers (Cheng, Yen, Wong, et al., 2008). The detection category is a rating of the current system's process controls to prevent or detect a failure.

Once severity, occurrence and detection ratings are developed, the scores are multiplied to provide a risk priority number (RPN). RPN value is calculated as: severity x occurrence x detection (Pyzdek, 2003). A higher RPN number for a potential failure represents a higher overall risk.

RPN values should be used to guide process improvement efforts. Potential failures with higher RPN values are given a higher priority for risk mitigation efforts. Action plans are developed to reduce the risks from potential failures. Such plans may attempt to reduce the severity, occurrence and/or detection rating. After action plans are developed, those ratings are rescored, and a new RPN value is calculated. Figure 1 (p. 38) depicts a typical FMEA form.

The FMEA process can be modified to satisfy unique applications (McCain, 2006). For example, a project FMEA uses only two criteria for risk assessment: probability that a project risk will occur and impact on the project if the risk materializes (Buthmann, 2008).

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Abstract: *One way to prevent workplace incidents is to identify the risks found in the work environment. Failure modes and effects analysis (FMEA) is a well-established process used in product design to prevent or mitigate risks associated with potential product failures. It can be adapted to fit workplace safety applications. A case study is provided to demonstrate how the FMEA process encourages employee involvement in safety efforts.*

Frequency, likelihood and severity are terms that can be used to quantify safety risks in an occupational setting. The severity category is defined the same as in the traditional FMEA. It represents how the employee will be affected if a failure occurs in the safety system. How much damage will the employee incur if an incident occurs?

The likelihood category is similar to the occurrence category in a traditional FMEA. It represents the probability that a failure will occur. The probability score may be developed by examining previous accident investigation data, or may be based on subjective judgment if no data are available.

The traditional detection criteria are replaced with frequency criteria. The frequency criteria represent a rating of how often an employee is exposed to an activity where a risk may occur. If an employee performs a daily task that involves exposure to a risk, the frequency criteria is rated as high. If an employee performs a task less than once per month, the frequency rating is low. The frequency criterion is a rating of how often the employee performs the work task, not a rating of how often the risk actually occurs. Just as a traditional FMEA process multiplies the values of severity, occurrence and detection to compute an overall RPN, this process multiplies the values of severity, occurrence and frequency to calculate an overall RPN value.

Employee Involvement in Safety Programs

Currently, few U.S. government regulations require employee involvement in safety programs. One exception is the OSHA Process Safety Management regulation [29 CFR 1910.119(c)]. The employee participation section of the regulation states, "Employers shall consult with employees on the conduct and development of process hazard analyses and on the development of other elements of process safety management."

Many companies have used this requirement to incorporate employee involvement into facility-wide safety programs, including risk assessments. According to OSHA (2008), the best work protection occurs when all employees, management plus workers, share responsibility for the safety program:

> The more that employees are involved in a variety of safety-related activities, the more that they will appreciate the potential hazards that exist at the worksite, the more likely that they will avoid unsafe behaviors, and the more likely that the overall safety culture of the organization will strengthen.

Common activities of a joint employer/worker safety committee include hazard assessments, workplace inspections, accident investigations, record review, audits of chemicals and PPE use, and safety training (State of New Jersey, 2006). In particular, conducting hazard or risk assessments allows employees to use their extensive knowledge of the work processes in their jobs.

According to OSHA (2007), involving employees in worksite safety produces many benefits, including the following:

- Individuals who are the most exposed to the hazards have the highest level of interest in reducing those hazards. This ensures that risk assessments are completed by the most-concerned workers.
- Expanding the number of individuals involved in a hazard assessment program to include workers increases the field of experience.
- People are more willing to support programs in which their contributions are accepted as part of those programs. This increases buy-in.
- Involvement in safety programs increases workers' knowledge of safety, the causes of injuries and preventive measures.

Another benefit of active employee involvement in safety is the presence of a broad knowledge base, from both management and workers. According to Tolbert (2005), the knowledge contributed by employees ensures that important facts, such as the true operation of work processes, are not omitted. Karasek and Theorell (1990) found that allowing employees to make meaningful contributions in their workplace, such as within the safety program, increases their well-being. Other areas that use a model of employee involvement in workplace programs include medical, employee assistance and child care. These programs, along with management/employee joint safety programs, create an atmosphere of trust (Xiao & Pu, 2005).

The Canada Labor Code [Part II (R.S.C. 1985, C.L-2, Section 135 to 137)] requires workplaces to have joint management/worker safety and health commit-

Figure 1: FMEA is an analytical technique used to identify, quantify and prioritize risks. It can be modified to satisfy unique applications.

Figure 1

Excerpt: FMEA Form

Process step/input	Potential failure mode	Potential failure effects	SEVERITY	Potential causes	OCCURRENCE	Current controls	DETECTION	RPN	Actions recommended	Resp.	Actions taken	SEVERITY	OCCURRENCE	DETECTION	RPN
What is the process step and input under investigation?	In what ways does the key input go wrong?	What is the impact on the key output variables (customer requirements)?		What causes the key input to go wrong?		What are the existing controls and procedures (inspection and test) that prevent either the cause or the failure mode?			What are the actions for reducing the occurrence of the cause or improving detection?		What are the completed actions taken with the recalculated RPN?				
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tees. To facilitate this, the Canadian Center for Occupational Health and Safety recommends following specific guidelines (see sidebar at right).

Mechanisms to involve employees in safety programs include (OSHA, 2007’ 2008):

•participating on joint labor-management committees and other advisory or specific purpose committees in the workplace;

•conducting site inspections;

•analyzing routine hazards in each step of a job or process, and preparing safe work practices or controls to eliminate or reduce exposure;

•developing and revising site safety and health rules;

•training current and newly hired employees;

•providing programs and presentations at safety and health meetings;

•conducting and participating in incident investigations;

•reporting hazards;

•fixing hazards within employee control;

•supporting coworkers by providing feedback on risks and helping them to eliminate hazards;

•performing a preuse or change analysis for new equipment or processes in order to identify hazards before use.

Involved Employees: Improved Attitudes Toward Safety

Employee attitudes toward workplace safety are affected by how they perceive the program. According to Barrett (2000), a major contributor to these perceptions is how management supports accountability for the completion of safety-related issues. Workers must believe the responsibility for all aspects of the safety program is fair and equitable.

For example, suppose an employee identifies a potential safety hazard during a risk assessment, such as the repeated use of a substandard ladder, and requests a replacement. If management denies or postpones the acquisition, the employee will feel that management is not following its own safety rules. In addition to distrusting management’s commitment to safety, the employee believes his/her opinion is not valued. However, a safety program with strong employee involvement can provide a mechanism for ensuring that the employee’s improvement suggestion is implemented where feasible.

Hurst and Palya (2003) state that an effective behavior-based safety (BBS) process should include “actionable plans for involving all employee levels.” BBS philosophy also includes positive reinforcement to encourage desirable safe behavior. However, if rewards are given without regard to the origin of the suggested improvement or level of hazards, workers’ attitudes toward the program can be adversely affected. Claims of favoritism or prejudice can be levied against management.

An effective, active safety program requires support from both management and employees (Bose, 2008). Ensuring that employees are included in all aspects of the facility’s safety culture works to prevent problems before they arise. This can be seen when workers are more willing to follow safety rules they helped to create. Allowing employees to help direct the safety culture will also increase their motivation (Barretta, 2008). This has an added benefit of attracting the most competent employees to work within a participatory environment.

Safety FMEA: A Case Study Highlighting Employee Involvement

RadioShack Store Fixtures (RSSF), a division of RadioShack Corp. in Fort Worth, TX, provides distribution support of furniture and fixtures to all RadioShack retail stores. A store fixture can be as small as a plastic price-tag holder or as large as a cash counter or a 2 x 4 ft section of a steel wall system. RSSF receives fixtures from domestic suppliers by tractor trailer or from international suppliers by intermodal shipping containers.

These fixtures are stored at the RSSF warehouse until needed for new store construction, store remodels, or individual store repair and maintenance. Large fixture orders are loaded onto dedicated outgoing trailers, while small fixture orders are shipped via small package carriers. The distribution center employs full-time employees as well as temporary employees during peak business periods.

As with many industrial distribution operations, employee safety is a key strategic objective for the RSSF operation. The facility has an employee safety committee to encourage employee involvement in developing and enforcing safety policies and procedures. The committee is led by a salaried manager, while all other committee members are hourly employees from various departments within the distribution center.

The Role of FMEA

At the beginning of each calendar year, the committee selects project objectives for the coming year. These objectives establish goals for the safety committee. The RSSF safety committee uses FMEA to priori-

Is Your Joint Safety & Health Committee Effective?

Canadian Center for Occupational Health and Safety suggests these parameters be used to judge a joint safety and health committee’s success.

•Post the committee members’ names to ensure access to the committee by all workers.

•Make the duties and authority of the committee members readily available to all workers.

•Poll the workers as to whether the committee is viewed as providing safety leadership.

•Ensure that workers do not view the committee as a mechanism to reduce management’s responsibility for maintaining a safe workplace.

•Track worker suggestions to committee members. Establish a program for the timely response to all suggestions.

•Choose a senior manager to be a committee member, providing credibility to management’s commitment to safety.

•Provide adequate support to committee members to accomplish their assigned duties. This support must include sufficient time (paid), funds, information (accident reports, audits) and training.

•Track committee recommendations implemented.

•Record committee meeting minutes, recommend actions and status and make this available to all workers.

In addition to private industries involving workers in safety committees, governmental agencies and universities are implementing joint management/worker safety committees (e.g., State of New Jersey, 2006; Concordia University, 2008). Some universities have expanded the concept of using all levels of experience to include students in their safety programs as well (Concordia University).

Table 1

Safety FMEA

Frequency x likelihood x severity = RPN score

Task	Risk	Freq	Likelihood	Severity	RPN	Priority
Truck loading/unloading	Trailer moves	5	3	5	75	1
Manual material handling/QC	Product falls off skid onto employee	5	3	3	45	2
Truck loading/unloading	Slip on wet/icy dock plate	5	2	3	30	3
Manual material handling/QC	Hit by forklift	5	1	4	20	4
Truck loading/unloading	Dock plate breaks	5	1	3	15	5

Table 1: Once all rating scores are calculated, an overall RPN is determined by multiplying the frequency by likelihood by severity rating. Each risk then has an RPN value representing the overall risk assessment. The risks are ranked based on the RPN values, with a higher RPN value posing a higher overall risk to employees.

tize its project activities. The committee begins by holding a brainstorming session to develop a list of potential failures/risks encountered at the site. Along with each risk, the team identifies the task an employee would be performing when exposed to the risk.

Next, each risk is evaluated in terms of frequency, likelihood and severity. All committee members are actively involved in determining the FMEA evaluation scores. Various forms of group discussion and multivoting are used to establish ratings. The frequency rating represents the exposure opportunity or how often the task is performed. Ratings are made on a scale of 1 to 5, with 5 being the highest exposure opportunity or a task that is performed repeatedly throughout the day.

The likelihood of the risk materializing is determined next. Often, this involves a subjective evaluation, although historical records can be used to help define the probability of a particular incident. A rating scale of 1 to 5 is used, with 5 representing a risk that is highly likely to occur.

Finally, the severity of risk is evaluated. The severity rating represents an evaluation of how severely the employee is harmed if the risk occurs. Again, a scale of 1 to 5 is used, with 5 representing a risk that would result in a major permanent disability or fatality.

Once all rating scores are calculated, an overall RPN is determined by multiplying the frequency by likelihood by severity rating. Each risk now has an RPN value representing the overall risk assessment. The risks are ranked based on the RPN values, with a higher RPN value posing a higher overall risk to employees. The results of the initial safety FMEA process are shown in Table 1.

In this case, since the risk with the highest RPN value was a trailer moving while being loaded or unloaded, the safety committee selected this risk as its first process improvement objective. Although all risks should be addressed in a continuous process improvement methodology, prioritization is a reality of business. Projects must be prioritized and pursued in a systematic manner.

Determining Root Causes

The next step is to determine the risk's possible root causes. Again, committee members met to define the root causes of a trailer moving unexpectedly. The results of this analysis are shown in Figure 2.

Two root causes for unexpected trailer movement were identified. The first cause was created by a trailer jack sinking into the asphalt pavement. RSSF is located in Fort Worth, TX, where summer temperatures regularly surpass 100 ºF. At this temperature, asphalt becomes soft and the concentrated weight of a trailer jack begins to displace the asphalt, allowing the jack to sink into the ground.

When the distribution center was originally built, trailers were shorter than the 53-ft. trailer that is common today. At that time, concrete pads were installed in front of the loading dock doors to allow trailer wheels and jacks to rest on a more stable surface. As trailer lengths expanded over time, they have outgrown the concrete pads, causing trailer jacks to rest on soft asphalt.

The second root cause was created by a driver connecting a truck to the trailer and pulling forward. The committee identified three system deficiencies that allowed this to occur. Once a trailer is parked at a loading dock it is disconnected from the truck while being loaded/unloaded. However, no visible signal alerts the driver when s/he can reconnect the truck to the trailer. Under current procedures, the signal was being delivered verbally from a warehouse employee to the truck driver.

During a walkthrough inspection, the committee noted another system deficiency: Wheel chocks were not available at all dock doors.

The final system deficiency identified involved the process for releasing a load to a truck driver. Under current procedures, the bill of lading and other necessary paperwork could be signed by a RadioShack representative and given to the driver at any time during the loading/unloading process. As a result, a driver, possessing the completed paperwork, could attempt to leave while a trailer was still being loaded. The physical movement of material into or out of the trailer was viewed as separate from processing paperwork. The team identified the need to hold the driver's paperwork until the trailer was completely loaded or unloaded. Figure 2 also shows the identified system deficiencies.

Solutions Proposed & Implemented

The committee used the FMEA process to identify problems, which led to the next step: Develop action plans to eliminate or minimize the system deficiencies associated with the risk of a trailer moving unexpectedly. The identified corrective actions are shown in Figure 2.

To prevent trailer jacks from sinking into the soft asphalt, steel plates were installed in the ground at the point where the trailer jacks normally rest. This provided a firm, stable footing for the jacks.

To ensure that truck drivers know when it is okay to back a truck under a trailer, the committee developed a new operating procedure. Traffic cones are now placed in front of the trailer to signal that movement is not permitted. The warehouse operator loading/unloading a trailer is responsible for placing the cones as well as for removing them once work in the trailer is complete. This procedure allows the operator, the person ultimately at risk, to have some influence over the process controls. Photo 1 shows the traffic cone and steel plate in use.

The committee also took steps to ensure that each dock door has a set of wheel chocks. The chocks are chained to the building next to the door to prevent them from being removed or misplaced.

Finally, to address the timing of the release of paperwork, an operating procedure was established to define when paperwork is signed and returned to a truck driver. Under this procedure, the bill of lading and other documents are given to the truck driver only after the loading/unloading process is complete.

Following a continuous process improvement methodology, the risk assessment would begin again. The values of severity, occurrence and frequency would be rescored based on the process improvements implemented. The risk with the highest RPN value is then targeted and the committee will continue project activities to make the work environment safer.

Figure 2

Root-Cause Analysis & Corrective Action Matrix

Risk: Trailer moves while loading/unloading

Root cause	System deficiency	Corrective action
Trailer jacks sink into ground	Trailer jacks resting on soft asphalt	Installed steel plates
Driver moves trailer	No visible signal to prevent trailer hook up	Use cones to prevent early hook up
	Chocks not available at all loading dock doors	Made sure chocks are available and used
	Paperwork is given to driver before trailer is ready	Bill of lading not signed until loaded

Figure 2: In this case, the committee identified root causes of several hazards, determined what system deficiencies contributed to them, then implemented corrective solutions.

Conclusion

Although no safety system can guarantee a risk-free workplace, the RSSF safety committee made significant improvements in the work environment. Using FMEA to guide its efforts, the committee mitigated the risk of a trailer moving unexpectedly while being loaded or unloaded. As important as the facility and procedural changes were, the key to success was the process of involving warehouse employees as members of the safety committee. Because the operators were involved in selecting the project and identifying corrective actions, implementation of and adherence to operating procedures was not a problem.

Safety programs must seek to prevent incidents. Additionally, operator involvement in selecting projects and developing process improvements is critical for acceptance and workplace morale. FMEA is a well-established analytical technique used to quantify, prioritize and reduce risks, and it can be used in an industrial safety setting to minimize employee risk exposure. The FMEA process lends itself to team involvement through various brainstorming exercises and idea evaluations. ■

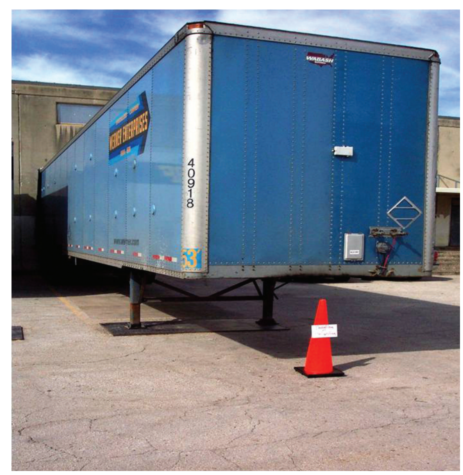

Photo 1: The committee used the FMEA process to identify problems, which led to the next step: Develop action plans to eliminate or minimize the system deficiencies associated with the risk of a trailer moving unexpectedly. In this case, a steel plate was installed and a cone is used to signal whether trailer movement is permitted.

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