Visual Solutions for Management System Processes: Part III—Analytical Approaches Using Process Maps

This is the third and final installment in a series of articles on the development and use of visual tools, in particular, processing mapping, to support environmental and/or health and safety management system activities. In this article, we will detail some special applications and discuss how the process map tool can be augmented to support the International Organization of Standardization's (ISO) 14001 and the Occupational Health and Safety Assessment Series' (OHSAS) 18001 management system elements. We will also detail different process map tools and how existing mapping tools can be leveraged, both to provide support to an organization's management system and to communicate management system elements to associates to ensure that they understand and follow the procedures that greatly minimize the likelihood of accidents.

Establishing "Freedom to Act" and Defining Activity Control Barriers

A Recap of Principles

We will continue to promote the use of the key principles used in developing work processes and process mapping that were discussed in the first two articles, and we will add one new key principle. Key principles include:

- *Engaging stakeholders*: The actual process operator(s) or owner(s) need to participate in designing the approach to and mapping of these processes.
- Allowing the team the flexibility to design their process and tools to fit their activities, personalities, and cultures while not losing focus on the actual deliverable.
- Using layering processes to provide sufficient detail to understand the workings or gaps within a process.
- Using Kaizan or Lean Events to implement the process.
- Using dynamic mapping processes to address highly variable activities.

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The new key principle that should be added to those already listed is as follows:

- Leveraging existing process mapping tools that are already in place within the organization.

Process Mapping Recap and Additional Types of Process Maps

The concept of process mapping comes in many forms, but all of them deal with a logical, sequential diagramming of activities. We can apply any mapping tool we desire that will accomplish our objectives. There is no reason to adopt a fixed form of mapping that is not currently in use unless there is an organizational need to do so to accomplish one's objectives.

Value Stream Mapping

If processes within the organization have been subjected to value stream mapping, and this process is well developed and understood, it can easily be adapted to provide the visual tool to support a "process map." Sequential activities are presented and analyzed for their contributions to product or service value through the eyes of the customer. When formatting, the value stream map modifications can be layered in using an environmental, health, and/or safety (EHS) layer that defines the "EHS" risk potential and applicable control factors.

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Project Networks

A logical development from the Program Evaluation and Review Technique (PERT) map process is to show activities related to the completion of a project and to assess such key factors as early and late start and stop times, project "float" times, and the critical path or paths for completing the project. This type of process flow map or diagram should be developed using a layering process, and during the implementation phase, progress regarding or the status of activity or task elements can be updated to daily flow maps or process maps through brief, preshift meetings managed by stakeholders.

A number of software programs are available to help document the project network. These programs include the types of resources needed, the risk levels of control levels (through color coding and filtering), and dependencies on other tasks. The dependencies can be used to identify points of control and systems of control necessary to minimize risk, especially when there is a very complex set of dependent tasks that must be performed during the project in question.

Flow Maps

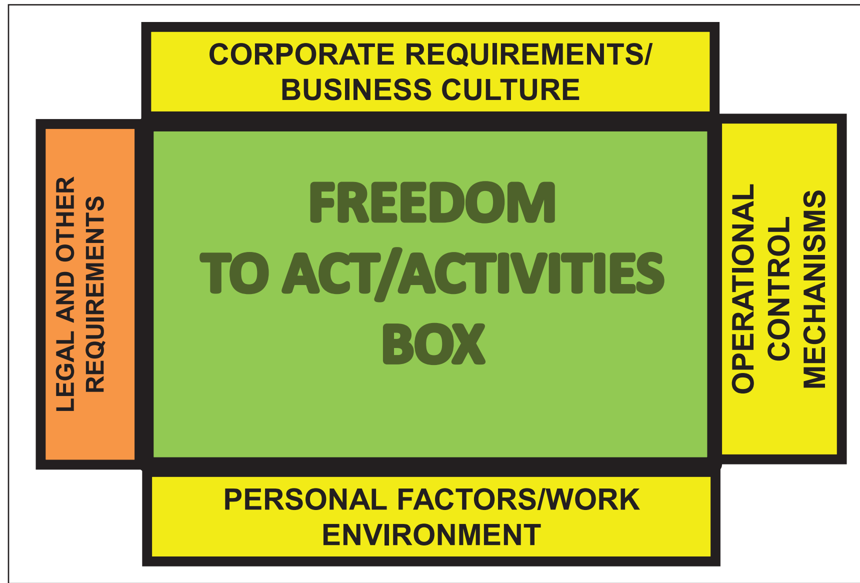
Flow maps offer additional information regarding decision points. Decision points within the flow of an operation or activity are, in fact, integrated places within a process where "checks and balances" occur as well as key points of control.

Freedom to Act Diagramming

Whatever visual process mapping tool we use provides a core operational control. Each activity block within a process map is governed by four general control families, or barriers, which define those elements or mechanisms that guide an activity and show the limits within which an associate performing that activity must function (e.g., he or she must adhere to operating controls, legal requirements, company policies, etc.). **Exhibit 1** shows an activity block in which those performing the task have "Freedom to Act" and perform the activity within the parameters described within the four control families' boxes.

The Freedom to Act area is bordered by four control families, which provide the parameters, boundaries, or requirements that must be adhered to within the Freedom to Act zone (e.g., the center box in Exhibit 1). The control families act

Exhibit 1. Control Box—Freedom to Act Barriers



as "barriers" to the Freedom to Act. They include requirements, operating procedures, and policies, and associates must adhere to them during the conduct of the activity in the Freedom to Act zone. Decisions to deviate from the parameters set by the control families for a given activity can only be made by an expert resource, such as a supervisor, manager, director, or specialist, who is empowered to make that decision.

The control families forming the barriers surrounding the Freedom to Act or activity zone are:

- Corporate requirements/business culture,
- Operational control mechanisms,
- Personal factors/work environment, and
- Legal and other requirements.

These control families are described in greater detail in the following sections.

Freedom to Act diagrams can be developed for standard or repetitive tasks in the form of a database using visual diagrams, or they can be developed during prejob briefings, stop work briefings (e.g., when a task has been halted because of unsafe or nonroutine conditions), or associate on-the-job interactions such as "take five" analyses, which occur on a dynamic basis during the performance of a task.

Freedom to Act/Activity Box

As we have already discussed, the Freedom to Act or activity zone is the space in which an associate can make decisions while performing the activity without conferring with supervisors or experts about changing the parameters within any of the four control families that define allowable activities. (It should be noted that high-level analyses of control family parameters can form an excellent basis for defining an organization's management system policy(ies).)

Corporate Requirements/Business Culture

Corporate requirements need to be evaluated for viability and applicability to the organization and then clearly communicated to define this parameter for Freedom to Act activities. EHS and quality (Q) policies are clearly high-level, management-driven control processes that define the philosophical values of the organization. EHS and Q policies are defined by management

system standards and have several mandatory requirements. Questions that need to be asked and answers articulated in this control box include:

- Who is empowered organizationally to interpret corporate and management requirements?
- Who is empowered organizationally to implement corporate and management requirements? Responsibilities and accountabilities need to be defined.

Business cultural elements should also be considered and evaluated. Those business cultural elements that affect discipline and the effectiveness of operational controls should be included in this box. In the second article in this series (Winter, 2014), we discussed how top management's messaging on organizational cost reductions set off a series of inappropriate decisions, which contributed to a nonconforming incident.

One of the objectives of the operational control process should be to ensure that standard operating procedures for the activity in question are used to minimize as much risk as possible.

Thus, individual management and supervisory behaviors at all levels of the organization should be evaluated to determine how they influence outcomes on a risk-based basis. Areas that should be evaluated in this regard include:

- Management style;
- Human resource availability;
- Technical resource availability; and
- Financial analysis tools and understanding how conformance and nonconformance financially affect the enterprise.

Make sure that you have evaluation tools available to determine how "porous" this control family or barrier is. The more porous and indistinct the elements within the barrier, the more oversight is required. This oversight may include such things as using more stringent operational controls and audit and assessment tools.

Operational Control Mechanisms Box

One of the objectives of the operational control process should be to ensure that standard operating procedures for the activity in question are used to minimize as much risk as possible. Examples of procedures and mechanisms that can be used to ensure that activities carried out within the activity box are safe and productive include:

- Engineering controls that do not permit "human" decisions, and thus restrict business and associate cultural practices that are not acceptable. When engineering controls are not possible, audit and assessment tools should be implemented to verify and reinforce conformance.
- Provision of training and/or evaluation of associates' competency to perform the tasks in question.
- Teamwork can be harnessed as a control tool via mechanisms such as "tool box" meetings, "stop work" audits, "take five" analyses, and the like on a routine and regular basis to ensure that personal factors are minimized.

In addition, as part of the incident prevention process, the operational controls for a given task should clearly define standard and nonstandard activities. Only standard activities are permitted within the Freedom to Act/activities box. It should also be noted that nonstandard activities can be defined and should include factors such as potential risks, the frequency of the event (last time accomplished), incident reviews from previous activities, and the appropriate level of "expert resource" (supervisor, manager, director, specialist) must be sought out to make the "go/no-go" decision.

Exhibit 2 Case: Failure to Report Spills

A work site had a written requirement for reporting all spills, regardless of size. The site experienced a reportable spill, and because there was no history of previous spills, the investigators assumed that there had been none before this particular incident. However, upon inquiry, the operators admitted that spills had been occurring at the site constantly over a long period of time. When the operators were asked why these spills were not reported, it turned out that the operators had, in turn, assumed that because spills had been occurring prior to the reporting procedure, and most spills were only of a few gallons, the spills simply were not required to be reported.

How does this happen? The reporting procedure was clear and the workers had received training. In this case we had:

- Operators who were not following a procedure;
- Supervisors who were not monitoring activities;
- Insufficient manager oversight,
- No verification that training had been understood;
- No auditing of the process;
- No visual aids on spill reporting located at the potential spill point; and
- No routine or remedial training conducted after the initial session when the procedure was set into place.

This case shows how the entire management system failed not only to prevent the original spill that investigators were called in to investigate but to affect positive change in the system and look for other areas where the "cultural practices" within the workplace (e.g., not reporting spills and assuming that this was acceptable) were not in accordance with the legal and corporate/managerial requirements.

Personal Factors/Work Environment

Personal factors are a highly variable parameter, and they should be evaluated on an individual basis because of the difficulty of controlling what people actually do in their jobs on a daily basis. By looking at the other three control families, one can determine the areas within this parameter that could be open to operator interpretation and personal control. The case included in **Exhibit 2** provides an example of how operator interpretation and personal control led to a failure to comply with a procedure on the reporting of spills.

Organizations that manage this parameter effectively understand the importance of dynamic review processes, management of change, and the value of ongoing, interemployee communication and evaluations.

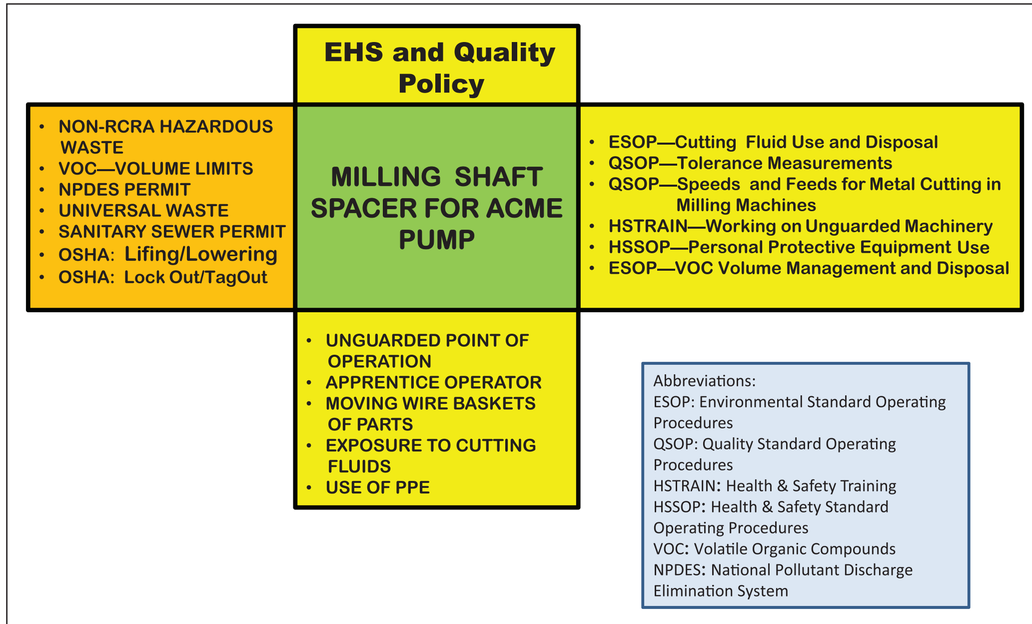
The work environment includes factors such as time of day, day of week, business practices that encourage short cutting, bonuses and incentive practices, management/labor force pressures, financial pressures, communication styles, physical factors (e.g., weather, lighting, temperature, noise, distractions, such as construction activities), changes in normal work location, and the like.

Legal and Other Requirements

The fourth control family or barrier shown in Exhibit 1 is legal and other such requirements. The contents of this box are neither open to negotiation nor open to interpretation by associates. Work sites or organizations have policies that commit them to comply with legal and other requirements. In some cases, the details of these requirements may need to be communicated directly to associates through licensing and permitting actions (e.g., the need to obtain a hot work permit before welding). Ensuring compliance with other items within this box will require the development of a process for implementation by a subject matter expert. In all cases, it is necessary to:

- Clearly define who is responsible for the interpretation and implementation of legal requirements;
- Ensure that the responsible person has the technical background or support resources necessary to support those activities to ensure compliance;
- Deliver the process requirements through the operational control process, when appropriate, if associates do not need specific knowledge of

Exhibit 3. Sample Control Box—"Freedom to Act"/Activities Box Diagram for Milling Shaft Spacer for Acme Pump



the legal requirements, but instead simply need to operate within it. Examples of activity areas in which training and actual certification to perform certain functions that are subject to legal requirements—and that require those performing such activities to understand the actual legal requirements—include:

- ◦ Persons working in Hazardous Waste Operations and Emergency Response (HAZWOPER) capacities and Department of Transportation Hazardous Materials associates working in the chain of "shipment of hazardous materials" must possess detailed legal knowledge and receive certifications obtained through approved training programs—no matter what organizational operational controls exist.

- Activities requiring compliance with legal requirements, but without workers necessarily possessing an understanding of the laws themselves, include:

  - ◦ Persons who are tasked with throwing away a universal waste, such as batteries or aerosol cans, but who are not legally required to understand the actual laws and regulations behind the steps they much take to handle such wastes. Instead, the legal requirements can be interpreted and passed on to them through the operational control process.

Example of an Activity Block for Milling a Shaft Spacer

Exhibit 3 shows an example of how an activity block in a process map could be analyzed using our concept of Freedom to Act. Note that this exhibit includes much more detail within the families of control boxes than would be the case in real life. We have spelled out certain major components within these boxes so that readers can better understand the considerations that would otherwise be listed in much more abbreviated forms.

Corporate Requirements/Business Culture

We list the EHS and Q policies as high-level decision-making guidance for associates during the activity. In the example in Exhibit 3, we may have an additional requirement from a "customer probation issue" (e.g., an associate may not be competent or may not have adequate oversight until qualified or competent in the activity), which could lead to potential enterprise or financial risk.

Operational Controls

We list the actual documented procedures, training programs, and engineering controls that define the control of activities to accomplish the work and minimize or eliminate risk in the Freedom to Act/activity zone. These operational controls should include all EHS and Q operational controls, as there is an interrelationship between these areas that may present opportunities for variation from the specifications that the shaft spacer must meet (quality issues) or opportunities for an incident resulting in injuries, illnesses (from exposures), or environmental damage (EHS issues).

Personal Factors/Work Environment

We list the points at which personal judgment, past practices, or cultural factors may create a risk of exposure. This list should also function to spark discussion regarding corporate responsibility/business culture and operational control mechanisms families of control to minimize possible risk exposures. Based on potential risk, temporary control strategies such as prejob meetings, pretask meetings, interactions, such as "take fives," and/or additional audits and assessments can be developed to minimize exposures.

Legal and Other Requirements

All appropriate legal requirements are listed for the activity, regardless of whether or not they have been integrated into the operational controls.

Finally, it must be noted that all four of our "barriers" in the Freedom to Act diagram interact significantly and heavily influence each other. We can easily identify the perceived gaps in these processes as targets to improve our EHS and Q programs and then set objectives to do so. For example, when using a manual milling machine, it has been a long-standing tradition not to guard the point of exposure for the tooling. This has been considered necessary because of the wide variety of parts that are being made and the short runs in which many parts are made.

What is the answer? We will create an objective and target to minimize that exposure with engineering controls. Note that we have also listed "pedestrian exposure" for bystanders, who may be hit by hot chips flying from the metal during the machining process. In this case, we can create an objective and a target to resolve this issue through engineering controls with an easily installed, interlocked deflector on the machine.

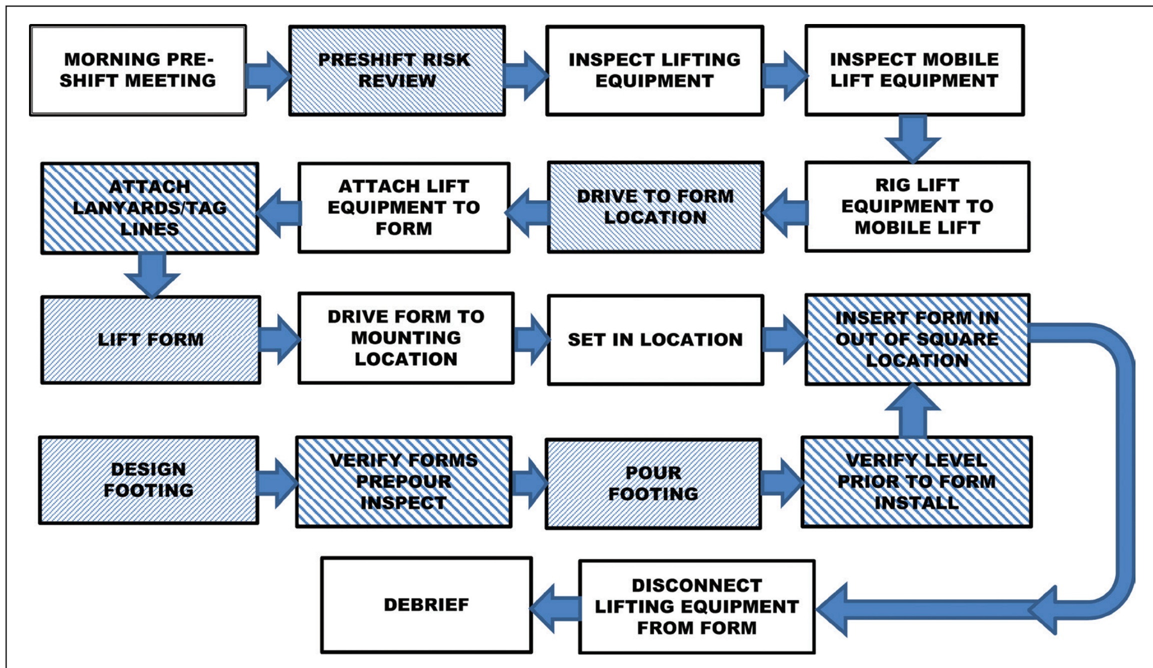
Based on potential risk, temporary control strategies such as prejob meetings, pretask meetings, interactions, such as "take fives," and/or additional audits and assessments can be developed to minimize exposures.

Case Study: Near Miss Fatality, Serious Injury Incident

Exhibit 4 shows a flow diagram of the activities involved in this case study. The following paragraphs describe what happened in this case.

Workers at the site were moving a large section of concrete form with a mobile crane within a very confined working area. The form had to be moved about 200 yards along a rough, unpaved construction roadway. Three people were involved in moving the form itself, and approximately eight people were involved in setting the form on the footing.

Exhibit 4. Flow Chart—Setting Form at Bridge Abutment



Near Miss Number One

The form had two taglines for controlling its swing. One of the lines was about 20 feet long and one was about six feet long. The form began to swing while moving, and the associate working with the short tagline went to the side of the form to prevent the swing. This created an exposure for this associate. He could have been knocked down by the form, or if the form had fallen, it would likely had crushed the associate. In addition, the associate with the short tagline was consistently very close to the swinging form.

Near Miss Number Two

When the team was trying to set the form, it would not square up with the adjacent forms because the footing on which it was to be set was not level. This was due to errors in the footing pouring process. The crane operator tried to push the form horizontally while it was suspended to force it into position. Several associates were on the adjacent form in the direct path of the suspended form, exposing them to harm should a lifting device fail or the suspended form "pop out" from where it was jammed.

Observed Positive Practices

A debriefing was performed after the task was completed. This debriefing took 20 minutes and involved the team: four people and the team leader. Following are a list of activities that were proper and within standard operating procedures or were completed successfully:

- A prelift inspection of the slings and clevises was conducted.
- The crane operator was highly trained and experienced and displayed very good control of all crane movements.
- All associates who were on top of the forms used fall protection.
- None of the associates placed a hand, foot, or tool in the gap between the forms.

- The form was ultimately moved into place with pry bars and secured.
- Excellent responses were provided by all of the associates during the postincident debriefing, including associates making very comprehensive suggestions regarding preventive actions.

By examining the flow diagram in Exhibit 4, we can spot the following control point failures:

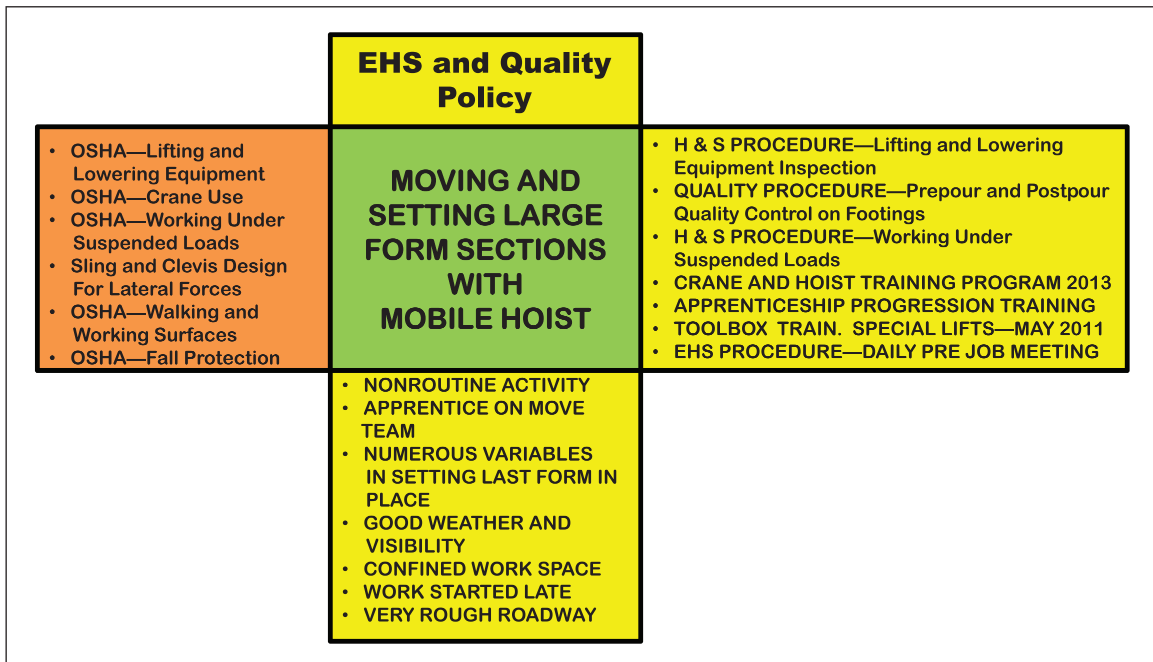
1. The morning preshift meeting did not discuss this nonstandard operation in detail or evaluate EHS risks.
2. The tagline team did not ensure adequate length on the tagline at the rear of the form. This task item should have been cause for a STOP WORK (stop work activities are shown in bold, shaded boxes in Exhibit 4). STOP WORK means that the job is immediately stopped by any person who observes an unsafe or abnormal condition.
3. The crane operator should have dropped the form to the ground to stop the swing, and the tagline associates should have stayed clear. The occurrence of the form swinging and the observed unsafe act of the associate operating the short tagline should have been grounds for an immediate STOP WORK (bold, shaded blocks).
4. The crane operator should not have attempted to "push" the form into place. When the misalignment occurred, it should have triggered a STOP WORK (bold shaded blocks).
5. Associates atop the adjacent forms along the trajectory path of the form that was being set into place should have relocated when the misalignment of the form with the footing was observed.
6. The prepour inspection should have revealed an issue with the levelness of the footing. This should have been grounds for a STOP WORK for the form setting (bold shaded blocks).
7. The postpour, preforming inspection should have revealed the issue with the footing, and this should have been grounds for a STOP WORK (bold shaded blocks).
8. There were a total of nine control points that would have prevented one or the other near miss situations. These are shown in the lightest shaded blocks in Exhibit 4.

Upon review of these findings, the team involved in the two near miss situations came up with the following preventive actions and observations:

1. Ensure that high-risk operations are discussed in detail at the morning prejob meeting.
2. In this case, the short tagline could have been attached to the mobile crane, eliminating associate exposure.
3. Although the team reviewed the possibility of using a fixed crane, doing so was not feasible because of local conditions (e.g., work environment). Contributing conditions included too long a boom length for a fixed crane, a narrow work zone, and high traffic in the vicinity of the site.
4. The crane operator was aware that he should not have attempted to push the form into place and understood the risk involved with this action.
5. The importance of recognizing that when things do not go according to plan, the job should be stopped was discussed.
6. Options for making improvements to the prejob morning meetings, including conducting specific discussions on tasks and risks, and increasing the amount of associate involvement in the discussion (there was none) were considered.

How did our Freedom to Act diagram, which is shown in **Exhibit 5**, work? A review of the

Exhibit 5. Control Box—"Freedom to Act"/Activities Box Diagram Moving and Setting Large Form Sections with Mobile Hoist



control families or barriers to the Freedom to Act revealed the following violations:

1. Corporate commitment to accident prevention was not followed.
2. Crane operating practices, legal, and manufacturer's safety requirements were not followed.
3. The morning preshift meeting was never audited or evaluated for effectiveness.
4. The need to "get the job done" forced inappropriate actions by the crane operator and the form setters. The job should have been stopped and evaluated when the form did not fit.
5. One tagline member failed to follow operational controls and legal requirements by entering the "fall zone" for the form.
6. Quality control procedures for the footing were inadequate and created the original form setting issue.

Summary

Throughout this series of articles, different clauses of the current ISO 14001 and OHSAS 18001 standards have been visually linked and integrated together. As we moved through the process mapping activities and analyzed their individual strengths and weaknesses, we provided a list of "gaps" that can be used to define objectives and targets for our program and/or places that need additional oversight or vigilance through audits, assessments, inspections, and interactions to ensure that the "human variables" are controlled and managed by the people doing the job. In this way, we also minimized the opportunity for cultural or past practices, driven by business or personal practices, to somehow supersede what an associate or manager has received as a practice through training and documented procedures. Using the visual aid toolbox, we can design a management system that is effective, easy to maintain, and

easy to understand both by internal and external stakeholders.

Presenting the key elements of one's management system through visual tools can break down institutional and cultural barriers that often surface through associates' own interpretation or filtering of written documents. In addition, when written documents are not prepared in a format that is clear and concise and show only the information that the audience requires, that audience will not actually use the written document.

A good example of this is an arc fault procedure, which was written by a physicist. Including equations, this procedure was more than 100 pages long. No electrician cares one iota about all of that background information; they want to know what to do and what the risks are. In this case, an actual near miss fatality incident occurred, and part of the cause was that the electricians were required to read the procedure and then take an "open book" test at the end that asked all kinds of detailed technical questions. No one field-verified that they had, in fact, read the procedure. The new procedure developed after the near miss fatality incident is one-page long and is appropriate for the audience.

Especially when one is working in an environment where multiple languages are spoken or used, visual tools can help minimize issues that could be mistranslated or communicated inefficiently through words, and again, cause errors and mistakes.

Engagement of the actual people working within the process or activity is key to the success of developing effective operational controls, as it ensures that useful information gathering will take place based on facts and not suppositions. Also note that when we discussed the crane incident earlier in this article, we discussed the positive practices that took place during the operation, in part, as a reinforcement tool and to get buy-in and cooperation from the team.

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