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There Is No Glory in Fighting a Fire That Could Have Been Prevented

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Introduction

Since its introduction by NIOSH in 2006, the concept of Prevention Through Design (PtD) has now taken root within the safety profession. Recently, the American Society of Safety Engineers (ASSE) has held seminars and webinars covering the topic and numerous articles in their Professional Safety Journal have been written. Several sessions of the current ASSE Professional Development Conference in Las Vegas are devoted entirely to the topic and explore it in great detail. And while some of these programs may lead the average safety professional shaking their heads believing that the concept is an *all or nothing* proposition, or that it is far to complicated for them to introduce into their organizations, it is not.

This article will provide an overview of the basic concepts of the PtD process. In reviewing the concepts of PtD, a list of several key elements of the process will be identified. An understanding and application of these key elements will make it easier for the safety professional or design engineer to have use the PtD process as they design, redesign, or make adjustments to processes, operations, and systems.

Background

In looking back at my past career in the fire service, I am reminded of a sign that was on my wall when I worked in the fire prevention bureau. The sign simply stated: "There is no glory in fighting a fire that could have been prevented." The "bureau", as it was called, was the place where most fire personnel, including myself, did not want to work. The real work of the fire service was out in the streets, battling fires that were the cause of the devastation, injuries, and even lost lives; and in responding to other types of incidents with similar consequences. For most firefighters, the reason that they joined the fire service was to work in that response mode and to make a difference in those areas. The sign on the wall was in stark contrast to the work that I had done previously, the work that I had trained for, that I had trained others to do, and work that I did quite well. The focus of my work in the fire service had always been about response, about reacting after the fact.

But it was in reading that sign that I began to realize that prevention of the event in the first place was the only way to really help the people that I ultimately wanted to help. It occurred to me that you can't "unburn" something, that dealing with burned bodies most often has limited success because the scars remained, and that the thousands of people who die every year in the United States might have been better served had more thought and resources been devoted to preventing the very things that caused their pain and suffering. That thought was one that changed the way that I approached my job from that day on.

As I began exploring the topic of prevention in more depth, it became clear that there was a rational process that was used in the fire service to actually prevent fires. As my experience in the bureau increased and as my education in the area of fire prevention expanded, I began to see that the process worked because of its use of two Codes to do what needed to be done. The Codes were the Building and Fire Codes that together helped to both to prevent the occurrence of the fire, and also to reduce the devastating consequences that resulted once a fire started. The Codes, starting with the Building Code and expanding into the Fire Code, worked in harmony to design a building with some degree of inherent safety already built in, and in effect to prevent the two types of "fires" that occur. The first fire was the initial one, the actual flames which with their smoke and heat caused devastation to a building. That fire was started when excess heat ignited combustible or flammable materials. The Codes helped to prevent this fire from starting. The second "fire" was the consequences of the first. When we failed at preventing the first, the Codes had a backup plan, one to deal with the results of the fire that had not been prevented by the first level of Codes. The methods prescribed by the Codes required systems to sound an alarm and quickly bring the fire department to the now-burning building, to close doors and prevent the spread of fire and smoke into other non-involved parts of the structure, to prevent people from being trapped by ensuring adequate and sometimes redundant exiting systems, and even to begin early control of the fire with the placement of automatic fire suppressions systems such as fire sprinkler systems.

Now as a working safety professional I realize that we have similar challenges in the areas of our prevention work. However, it seems that the safety profession, in some ways is similar to my old version fire service and has historically been one of reaction to past events. However, unlike the fire service, my observations are that much of the safety profession continues to be bogged down in a rut, living in a response mode. Consider that many safety professional still gauge the effectiveness of their employee safety and health programs by the use of quantifying past failures by the number of fatalities, OSHA recordables, overall injury and incident rates, or numbers of days away from work. Lagging indicators are used to show those failures and regulations are then introduced to help prevent incidents that have already occurred from reoccurring. In many cases, we remark in our safety training classes that the OSHA regulations are "written in blood" without really understanding that this is all so unnecessary and that we have tools available to us to deal with those. The safety profession must become proactive in anticipating the next accident before it happens and in implementing systems to protect employees from hazards that do not need to be present in the first place.

When we do review the overall safety statistics we find that they seem to indicate that the safety profession has done a fair job overall and has in fact cut injury rates. However the statistics also show that our efforts to prevent serious injuries and fatalities have not been as effective and that rates in these areas have not continued to decrease and have now plateaued (Manuele 51). This shows that there is clearly more to do and as the complexity of the workplace continues to get even more complex, we find that the ability of our employees to adapt to those complexities has also reached a plateau. The safety profession must look for new and better tools that will take our safety programs to the level of safety systems, where all aspects of the system, including our employees, are factored into the mix.

What is now apparent to me based on my dual backgrounds in the fire service and now as a safety professional is that we might need to do something similar to what I saw with the use of the combination of the Building and Fire Codes, and what they do to design fire and life safety systems into a facility. They provide a systematic approach to protection that incorporates the design of the building including its structural components, fire resistive nature of the materials of construction, height limitations, etc., along with the integration of people into that structure. They interface people into the design of the system and expand on the overall fire and life safety systems to protect those people from themselves and their actions, actions that are largely predictable when studied.

For example, the Building Codes mandate the height and overall structural design of the building. It provides details that will keep the building from falling down in high winds or seismic activity. Once those factors are set in motion in the design process, the Fire Code requirements add in the fact that people will use the building for various things. That the human being will interface with that building fire and life safety systems. Since humans will use the building, they become part of the overall system that needs to be taken into account. Take the following two situations as examples of this concept:

- The Building Code requires that some exit corridors be protected with fire resistive construction and that all openings into that corridor be also fire resistive. To maintain this, there is a requirement that all doors that open into that corridor must have self-closing hardware, that they be fire rated, that they have smoke gaskets, and that they are kept closed except when being used to enter or leave. But humans often like to keep their doors open and want to block them open and defeat the fire protection afforded by the required self-closing doors and assemblies. To help with this, the Fire Code provides a system to allow doors to be left open and to accommodate the human interface through the use of alarm actuated self-closing hardware. The use of this allows people to be protected from their own actions of blocking the door open, actions which are predicable.
- The use of hazardous materials, especially flammable or combustible liquids, in buildings can significantly increase both the likelihood that a fire will occur and that the fire will rapidly spread. Since we know that people will want the use of these materials inside some buildings, the Fire Codes provide additional systems to allow these materials to be used safely inside buildings by ensuring adequate protection to prevent both the initial fire from occurring (reduction or elimination of electrical sources through the use of explosion-proof wiring system, increasing ventilation to dilute the concentration of vapors present, and the use of special techniques for transfer materials such as bonding and grounding of vessels). Further, the Fire Codes also reduce the consequences of that fire were it to occur by requiring additional exiting, shorter exit distances, vapor detection systems that sound alarms, and higher efficient automatic fire sprinkler systems. Again, people are protected through the use of built-in safety design features.

Finding the Solution

As safety professionals, we may now have a system for practicing safety that is similar to the integration of the Building and Fire Code model that incorporates the human interface into the overall design of the system. It is the Prevention through Design (PtD) system. While the overall PtD process may seem daunting to many, the concepts included in the PtD process are actually relatively simple when they are studied. At its core, PtD, like the fire service Codes, takes the current process of designing a new system at a facility, modifying some components within that facility or operation, or even changing procedures at the facility; and adds into the engineering and design of that system the human element. PtD integrates employees into the system as a separate component, and requires the system to take all of the aspects of that human element into account in the design of that system from its initial development, into the construction phase, through its operational element including maintenance of the system, and even into decommissioning. However, if done early enough, the integration of that human element, the employee in the case of occupational safety, can be done on paper in the design process, while the actual risk is still theoretical. Once identified, the safety professional or design engineer can then apply solid concepts of safety to deal with the risks created by the hazards that are identified. In the end, it acts much like the fire service model of basic design with the addition of people and the anticipation of what they will need to do, likely do, and even possibly do. It thinks of the unthinkable before it happens, and looks ahead to identify when and where the next accident will occur before it has the opportunity to occur. It fights the fire before the fire starts and prevents the inevitable consequences that would occur if they were not identified and controlled early.

The Required Concepts of PtD

When one looks at the ANSI/ASSE Z590.3-2011 standard, or listens to some of the speakers who provide very in-depth information on how to implement PtD programs, many safety professionals or design engineers quickly get confused and throw up their hands. The standard is quite complex and is designed to provide a comprehensive approach to safety design. However, much like other complicated systems, if one digs deep into the standards, it is easy to identify some key concepts that can be used and adapted for use. These are the essential elements that are at the core of the PtD process. And following is a listing of the five key elements of the PtD process that can be easily understood and implemented.

1. **Begin with the regulatory requirements, but don’t end there. Think about people and what people will likely do once the system or operation is being used by them.**

   Prevention through design must start with designing a system that is compliant with the applicable regulatory requirements. In the fire service examples, the Building and Fire Codes provide the initial design criteria but are simply that, the initial ones. They should not be the only considerations that are used in designing safety into our programs. PtD goes further than the regulatory requirements and looks at the risk, what happens when people are placed in proximity to the hazards that might be present. Consider the following picture (Exhibit 1) as an example.

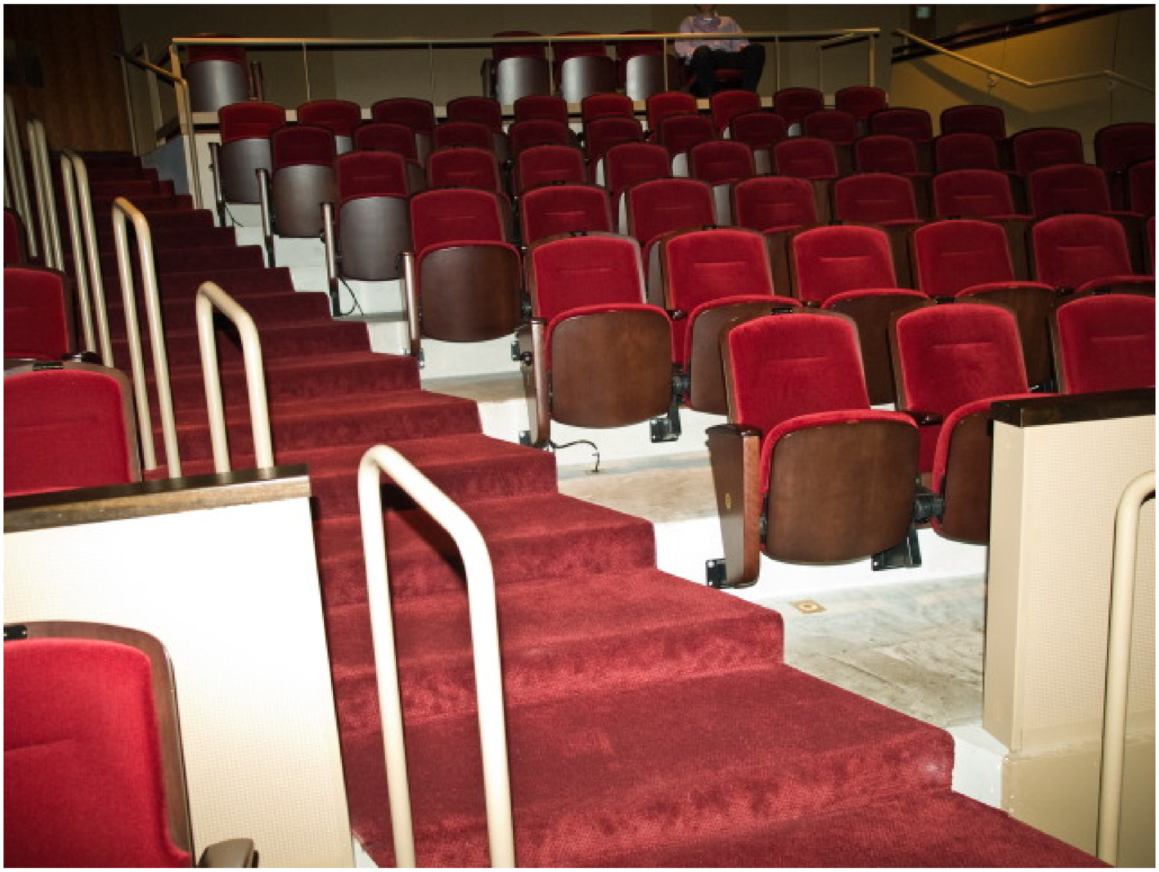

Exhibit 1. Theater with required trails along stairway.

Exhibit 1 shows a regulatory compliant theater with the required rails along the stairway. But note that the rails are on only one side of the stairway. While compliant with the regulations, does this design adequately address the risk that is present? Obviously the answer to that is a resounding “no.” If you put people into that environment, they will be exposed to the hazard created by the lack of adequate rails to stabilize people who walk up and down the stairs. Consider that the theater will likely also have lower lighting during performances and that some of the occupants might be elderly requiring more stability walking up or down the stairway. Clearly this is a recipe for an accident to happen even though it complies with the Codes.

In fact, in this case an accident did happen when an elderly woman fell and suffered serious injury as a result of the poor design. That injury led to a lawsuit being filed seeking damages for the injuries suffered. In this case, neither the injury nor the resulting lawsuit was necessary had simple concepts of PtD been implemented. Clearly simple compliance with regulations is only the starting point. The design must be looked at in light of the inclusion of people in the equation. So begin the PtD process with the regulations and then add the human element into the mix.

2. **Think about what people could do to the system once it is operational. Always consider that people will attempt to develop workarounds – bricolage.**

Once the design, redesign, or development process begins, it is important to consider that people will be involved in operating, maintaining, or in some other way, interfacing with the new system or operation. Most of the time, the engineer who is responsible for designing the system may never have done the tasks that are involved in operating or maintaining the system. For this reason it is important to involve those who will work in those capacities in the design process. The PtD standard says that the knowledge, skills, experience, insight, and creativity of employees close to the hazards and risks should be used in the design process (ANSI/ASSE Z590.3-2011, section 4.1). Consider that operations staff who will use the system or process may know what is realistic and what is not when it comes to procedural items including the placement of gauges or valves. Even the look and design of the gauges can be evaluated by the operations staff who will know the circumstances of how those gauges will be read. And mechanics have a good insight into how they will need to work on the system. Their involvement at this stage can both reduce costs and eliminate hazards that might be present and unseen by someone without the same level of field experience. This involvement will also help to gain buy in by the groups who will ultimately own the system or operations involved and who will accept it as their own.

If you don't involve those who will use the system in the design process you will likely open up the potential for them to develop alternatives to what was specified in the design process once they take over the system from the design process. This is sometimes referred to as bricolage, which simply means developing alternatives to standard operations or workarounds to those procedures. If they are not involved, they might end up inventing creative methods for doing something to do their job that was not part of the original design and thereby introduce higher risk. If they are involved, they can often make suggestions to reduce risk and even the costs of operation.

An example of employee involvement occurred in a water distribution facility. The design of the system was such that a valve that was required to be periodically activated that was located inside a vault inside the facility. Because entry into the vault was necessary to operate the valve, the process involved using the Permit Required Confined Space program for the site requiring multiple personnel to be present and to introduce one or more employees to the hazards of entering the vault and operating the valve in a tight area. Multiple hazards were present in the final design. After the system was operational, both operations and maintenance staff pointed out the issues during a site visit. They noted that all that was needed to reduce the hazards would be to extend the valve up above the grating. This would eliminate the confined space requirements, reduce the risk when working in the confined space, reduce the number of personnel required to operate the valve with resulting lower costs of operation, and allow the valve to be operated in an open area where the risk of a back injury was reduced. This was done in the redesign process, resulting in lowering the continued cost of operating this element of the system.

3. **In designing everything, make it easy for people to do the right thing and make it hard for them to do the wrong things.**

This concept is similar to the last but expands on it by going one extra step. A good example of this involves the use of portable ladders. Safety professionals know full well the hazards associated with the use of ladders and the statistics of injuries involving falls remain high. There are simply too many variables involved when selecting or using portable ladders. Employees will often fail to get the proper type or length of ladder and will often find ways to make the ladder work. Again, it is too easy to make a mistake and sometimes difficult to do the right thing. Bricolage will become the process used by employees who are very good at getting the job done. Their salaries depend on getting the job done so they will do whatever is needed, even if it means that they will cut some corners or violate some rules. How common is it to see something similar to the following picture (Exhibit 2)?

Exhibit 2. Making ladder work though not the proper length

While it is difficult to design out the use of all portable ladders, it is important to look for those opportunities when designing or redesigning a system or operation. The use of fixed ladders is a good first step (no pun intended) to reducing the potential for falls. Another opportunity is to consider the installation of a stairway in lieu of building in fixed ladders. Considerable savings in time, money, and a subsequent reduction of risk can be realized when you substitute a compliant stairway in lieu of a fixed ladder in an underground vault that would be classified as a permit required confined space using the ladder.

Other considerations that should be taken into account in this is when designing the system or process, ensure that valves and gauges are easy to read to keep employees from having to interpret complex readings and in those areas where there is a lot going on, try to limit the amount of non-essential items in the area so employees will not become distracted by them. Consider that distractions make it easier for someone to make a mistake without even knowing it at the time. Also, distractions including noise can add to stress in employees leading them to make mistakes. Making it easier for them to do their jobs correctly can be helped by designing work areas that are low in noise and distractions.

4. **Systems will be dynamic and there will be issues that come up even in the best designed ones. It is vital to build resilience into the system so that it can adapt as the changes occur so that failures do not always happen when minor deviations occur.**

The concept of system resilience is critical when it comes to effectively designing or developing safety systems. While it can be described in a number of ways, resilience is defined in terms of the ability of the system or organization to continue operations or recover a stable state following a mishap. It also encompasses, "the ability of systems to prevent or adapt to changing conditions in order to maintain (control over) a system property. To ensure safety, the system or organization must be resilient in terms of avoiding failures and losses, as well as responding after the fact" (Hollnagel, Woods, & Leveson 95). In other words, this is the last leg of protection within the system that must be present to keep the system from failing.

In terms of PtD, this concept will include looking ahead into the system use and recognizing that the system or operation will be subject to adaptations and changes over time despite efforts to prevent them. Systems are not static and need to adjust. The design should not only establish and enforce constraints by those who will operate or maintain it, but also should the safe operations continue as minor changes or adaptations occur during the course of the operation (Hollnagel, Woods, & Leveson 96).

One good example of this concept is to try to review the system and determine if there are single-point failures in it. When there are, the system lacks resilience and would be subject to failure from a single event. Consider that even with a good mechanical integrity program, piping systems can fail. And when they do suffer a failure, serious consequences could result. To prevent a single failure in the system from creating a hazard, some systems design in excess flow valves to monitor the system flow and react in a positive manner when a failure occurs. While not required, these valves do provide more resiliency in the system with a subsequent decrease in overall risk.

5. **Have a Plan B for when things do fail.**

The final concept of the PtD process is to develop a way to provide protection when things do fail. Even the best-designed system, the one that incorporates all of the concepts that have been discussed including building in system resilience, may experience a failure. In the fire service discussion, it was noted that when a fire occurs, there must to be a system to prevent the second fire, the unnecessary damages that result from the first. The best example of this is the design and maintenance of proper exiting so that employees or the public can safely exit the building when a failure in our protection occurs. So PtD processes must ensure that if there is a system failure, the consequences are mitigated to a point where risk is still maintained at an acceptable level and safeguards are in place to prevent catastrophic failures that would result in a serious injury or fatality.

Summary and Conclusion

Finally, there is a way for the safety profession to become fully proactive in their approach to safety system implementation. The use of the PtD concepts discussed in this paper, or the utilization of the full process as found in the standard will go a long way at preventing accidents. The key to successful safety design is to find something that works and which is simple and easy for an organization to implement. The system used should at a minimum incorporate the concepts presented in this paper. It should factor in the fact that people are an important component of the system and that sometimes the system is more complicated than they are able to effectively manage. For this reason, people need to be involved in the front-end design and provide input into how to make their jobs easier to do while doing that. Further, the process of design should also include a discussion of potential diversions from what is in the original design. That design should incorporate some resilience to ensure that a single small deviation does not lead to an upset. Elimination of single-point failures and the building in of redundancy can help in this area. And finally, the PtD process should always include looking at preventing or reducing the serious consequences that could occur if a serious failure or mishap were to occur. Prevention of the second fire should always be a consideration in the design of the system or operation.

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