Causal data from fatal and serious injury events suggest the decisions arising from the prevention through design (PTD) process play a central role in avoidance of catastrophic (life-ending or life-altering) events. Numerous studies and research reveal 20% to 50% of all mishaps reported indicate a design gap finding. From the author’s first-hand experience and study, fatal and serious events are at the high end of this percentage range.

The central question is, What is holding back organizations from addressing design-related events head-on? The author believes a critical organizational and cultural blind spot exists. Through benchmarking with other SH&E professionals, he has found that most injury/illness data management systems used by organizations do not ask for, capture or highlight design-related causal factors. This data gap has caused latent, design-related conditions to go uncontrolled and undetected in most organizations. As a direct result, both existing and new designs continue to be operated or procured with inherent uncontrolled hazards and risks that can potentially cause serious mishaps.

To avoid such design-related incidents, the author strongly suggests that SH&E professionals personally dive deep into their own organizations’ injury/loss experience if they have not done so already. By critically examining previous incidents, startling answers can be uncovered.

The author has gained new insight from his own experiences by drilling deeper into causal data from past mishaps. Other SH&E professionals can also discover compelling information that can be used to generate a stronger focus on PTD in their organizations.

One key outcome of the author’s work has been the development of a design safety checklist centered on fatal and serious mishap prevention controls related to past events. This design-focused checklist has been a game changer for designing out fatal and serious mishap-related risks.

PTD Skill-Building
To enhance their skill level and efforts around PTD, SH&E professionals should first obtain and read ANSI/ASSE Z590.3-2011, Prevention Through Design: Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes.

Section 1.3 of the standard, which is focused on application, states the PTD standard applies to four main stages of occupational risk management:

1) preoperational;
2) operational;
3) postincident;
4) postoperational.

The author believes for PTD to come to the forefront of business decision making, the SH&E community must begin to spend more time in the preoperational stage. SH&E professionals must shift and even depart from traditional safety roles and daily job duties, such as compliance program writing, training, inspections and claims management, and must transition into risk avoidance and risk mitigation activities related to organizational planning, design, specifications, safety procurement specifications, design safety reviews, proven solution development and risk assessment.

Based on the author’s informal research and discussion with many global SH&E professionals over the past 5 years, the SH&E community roughly spends its time as follows:

1) preoperational, 10% (avoidance and elimination focus);
2) operational, 70% (compliance and retrofit focus);
3) postincident, 20% (claims management, litigation, regulatory issues);
4) postoperational, <1% (decommissioning, demolition).

Today’s best organizations seek out innovative and creative SH&E professionals, but the SH&E job description of tomorrow will likely look much different. Progressive employers will look for SH&E professionals who possess these key core competencies (working in the preoperational risk management stage):

1) PTD;
2) risk assessment;
3) management of change;
4) fatal and serious injury prevention;
5) operational risk management system;
6) contractor risk management;
7) safety specifications for procurement;
8) human error and human performance.

These core competencies are highlighted in ANSI/AIHA/ASSE Z10-2012, Occupational Health and Safety Management Systems, another document SH&E professionals should obtain, read, fully understand and adopt.

SH&E professionals who possess these core competencies will bring the required leadership and creativity to their organizations and facilities by identifying, establishing and driving proven solutions into new designs and processes. The author believes future SH&E professionals should establish a career target (both time and skill set) to work 70% in the preoperational stage of risk management. In this stage, the business world sees the SH&E professional as a leader, valued business partner and risk mitigation advisor. Personal recognition and reward come with this new role.

According to the author’s observations, SH&E professionals spend most of their time in a firefighting and/or compliance mode while making these common mistakes:
1) Assume their business leaders know what they should be doing next in SH&E (such as PTD).
2) Believe nothing can be done in PTD without a corporate edict or standard.
3) Think that PTD is to be left only to engineers and designers.
4) Fear that they will not perfectly implement PTD when starting out.
5) Wait for others to engage them in the PTD process.

SAFE DESIGN MYTHS & BAD DESIGN HURT ORGANIZATIONS

Five common myths must be dispelled and overcome to move an organization forward:
1) The design meets minimum compliance; therefore, it is safe.
2) PTD is cost-prohibitive. High-level controls are too costly.
3) PTD will slow down the project. We do not have time for design reviews and risk assessment.
4) The current/old design is safe enough. We have always done it this way. Our injury experience does not prove otherwise.
5) Low-level controls on the hazard-control hierarchy greatly reduce severity of harm.

Bad designs can negatively influence an entire organization in the following ways:
1) serious mishaps;
2) low employee morale;
3) elevated risk levels;
4) human performance barriers;
5) product quality issues;
6) losses impacting profitability;
7) poor operating efficiency;
8) equipment and process reliability issues;
9) litigation;
10) poor public image;
11) higher labor costs;
12) compliance gaps;
13) waste and scrap;
14) business interruption;
15) customer expectations not being fulfilled.

PROVEN SOLUTIONS:

PTD CULTURE REVOLUTION

Risk avoidance and hazard elimination are proven solutions for designing out causal factors. These solutions directly remove high-potential risk factors often faced by exposed groups, such as operations and maintenance personnel, construction workers and the public.

PTD decision makers and stakeholders are responsible for risk control, and these entities include business owners, customers, capital project delivery teams, construction managers, design/build firms, engineers, designers, machine builders/fabricators, operations and maintenance personnel and SH&E professionals. Proven solutions provide a visible means to remove traditional cultural barriers in the form of false beliefs from design-for-safety efforts.

Proven solutions are myth-busters that address causal factors surrounding catastrophic events and have these key attributes:
1) risk avoidance;
2) hazard elimination;
3) severity reduction;
4) high level of control (control effectiveness);
5) remove barriers to safe work;
6) reduce burden costs (e.g., costly retrofitting, claims, compliance programs);
7) address both normal and abnormal conditions;
8) widely accepted by users;
9) positive impact on operating efficiency and maintenance;
10) easily incorporated into engineered designs and procurement specifications.

Such solutions should be incorporated into a project at the earliest stage of the design process as performance objectives and design criteria and can be used to provide a tangible view of what achieving acceptable risk looks like.

Proven solutions originate from the hierarchy of controls. As presented in Z590.3, this approach is the preferred method of achieving acceptable risk in design through risk avoidance. Avoidance has the greatest net positive impact on safe design because it prevents hazards from entering the workplace through design. When avoidance strategies are used, no hazards need to be eliminated or controlled.

A good risk avoidance statement begins with a “no” statement. Each no statement bears a proven solution. Taking this approach may seem strange to many SH&E professionals because avoiding risk can rarely be accomplished. Most SH&E professionals tend to work in the reactive or costly retrofit world and never
live in the risk avoidance mindset or workspace.

During the conceptual design stage, risk avoidance and hazard elimination allow SH&E professionals to work and participate with design and project teams. Proven solutions offer the rare opportunity to design out or to avoid entire hazard/exposure categories.

Proven solutions create and shape the bond between the SH&E community and engineering and design communities by allowing engineers and designers to do what they do best—incorporate risk control measures into their designs and redesigns with confidence.

From 2009 to 2011, the author worked on a large capital project in China, a multimillion-dollar manufacturing facility. He worked with the design/build firm to incorporate proven solutions into the plant design by placing each of the performance objectives into a no statement. The result of this effort came with a no-exposure outcome. Examples of no statements included:

1. No portable ladders.
2. No powered forklift trucks used in the manufacturing space.
3. No elevated work.
4. No energized electrical work.
5. No manual handling/lifting of manufactured products exceeding 45 lb by production employees.
6. No elevated or remote energy isolation points used for lockout/tagout/try tasks.
7. No open chemical processing and mixing systems.
8. No unsecured trailers while loading.
9. No open electrical panels to perform diagnostics or thermography.
10. No fall hazards during building construction.
11. No congested or restricted workspace regarding people, equipment, maintenance and emergencies.
12. No direct interface between employees and powered machinery and equipment (during either normal or abnormal conditions).

Upon completion of this project, many of the 350 employees at this new facility found their new work environment to be world-class and worker-friendly.

Sustainable, proven solutions are now used on all projects based on these no statements. The author established for the China project. For example:

1. Typical portable ladder tasks are designed out by
   a) relocating work at ground level;
   b) work made accessible by fixed stairways/platforms;
   c) establishing a proper accessway for work-lifts.
2. An automated guided vehicle system eliminates forklift operations.
3. Electrical energy isolation, arc-preventive switchgear/motor control centers and diagnostic ports are used.
4. Piping system isolation valves are used at ground level, as are gauges and filters.
5. A trailer restraint system and dock door barrier guards are used.
6. Automated product conveyance and lifting systems are used.
7. Fully-enclosed chemical process and mixing systems are used.
8. Fall prevention, including perimeter guarding, skylight guarding and aerial lifts, is used 100% of the time during construction.
9. Employees wear less PPE, not more.
10. Devices are enabled under the exclusive control of maintenance workers for approved troubleshooting tasks.
11. All hazardous energy isolation points are at floor level within 3 m of need.
12. Employees are removed from directly interfacing with powered machinery and equipment using barrier guarding and automated jam-clearing systems.

**PTD Influence on Exposure & Human Performance**

The only opportunity SH&E professionals and designers have to impact severity of harm is during the avoidance and elimination stage. In some cases, substitution can also affect the severity of harm. Other levels of control can only impact likelihood, not severity.

The author highly recommends that SH&E professionals obtain and read ANSI B11.0-2010, Safety of Machinery: General Requirements and Risk Assessment. Table 3 in this standard, the hazard control hierarchy,
outlines the influence each level of control has on risk factors, such as severity and likelihood. The table indicates that the greatest influence on eliminating or reducing severity of harm is at the elimination or substitution level.

Based on the author’s experience, many SH&E professionals, engineers, and others hold a false belief that low-level controls have a great impact on severity when they do not. Guarding and engineering controls are excellent risk control measures, but their primary purpose is to reduce likelihood, not severity. That is why control effectiveness and control maintainability are so important for sustainable protection. To prevent fatal and serious loss events, the focus on design must begin with avoidance and elimination because these highest-control levels relate directly to severity reduction.

Proven solutions also support safe behaviors and eliminate many common human error factors. SH&E leaders begin to understand the affect of PTD in their organizations when they overhear project managers, business leaders and others make these statements:

1) “Design the work so it is easy to do it safely and difficult to do it wrong.”

2) “Severe injuries will have a greater impact on the organization than will stopping production to improve safety.”

3) “Someone who wants to do well never underestimates a bad outcome.”

4) “Administrative and PPE controls will never replace appropriate safeguarding.”

5) “We could be world-class if this process were not so poorly designed to begin with.”

Proven solutions can significantly enhance human performance through avoidance and elimination of the following human error influencers:

1) high ambient noise;

2) poor ergonomics (e.g., layout, job setup, workspace);

3) PPE loading and barrier to job completion;

4) working in high ambient temperatures or poor lighting;

5) responding to routine process upsets and abnormal conditions;

6) performing complex work;

7) physically demanding work that leads to fatigue;

8) use of hand tools that draw a worker close to the hazard.

The only opportunity SH&E professionals and designers have to impact severity of harm is during the avoidance and elimination stage.

Proven Solutions
Reduce Burden Costs

A key PTD selling point often overlooked by the SH&E community and during design reviews is the long-term burden costs the organization will incur when hazards are not eliminated in the design or redesign phase. The SH&E community can identify and communicate burden costs when low-level controls are selected over one-time, high-level controls designed to avoid or eliminate hazards and risks.

Most SH&E professionals spend the majority of their time in the operational and postincident phase due to:

1) burdensome oversight of regulatory-driven programs and claims management;

2) almost daily efforts to find scarce resources for retrofitting uncontrolled hazards associated with design gaps.

Of special significance is the fact that burden costs, which can be extreme, must be maintained during the facility’s life expectancy.

One example of how burden cost can add up over time is using portable ladders in a typical manufacturing setting. Based on the author’s experience, the burden cost for a new 500,000-sq-ft facility that has a planned lifespan of 50 years with intent to use portable ladders can run as much as $9.3 million.

As an alternative, proven solutions to design out the 17 defined routine ladder tasks (for 175 ladder users) in the concept stage would require a one-time capital investment of $500,000. This is a noteworthy net positive capital investment and can prevent the facility from ever having a serious portable ladder-related mishap.

Any capital project always has two monetary spends. The first spend (pay now) is the cost of the new design, and the second spend (pay later) is the long-term burden costs. Long-term burden costs often far exceed the cost of an original design solution that would have eliminated the entire hazard category.

The most commonly seen burden costs linked to a facility’s life expectancy are injury claim costs, compliance maintenance costs, retrofit costs, business interruption, operating inefficiencies, resource management and manpower costs.

Many organizations continue to report falls from portable and fixed ladders, which are reflected in past and current data reported by OSHA and the Bureau of Labor Statistics. Often, falls from ladders can become life-ending or life-altering. Portable ladders also continue to appear on OSHA’s top 10 violations list.

When looking at portable ladder use, the ladder and its user are both considered lower-level controls. A safe ladder and safe ladder user do not mean low severity, which is why ladder-related fatalities continue to be a commonly reported mishap.

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When looking at portable ladder use, the ladder and its user are both considered lower-level controls. A safe ladder and safe ladder user do not mean low severity, which is why ladder-related fatalities continue to be a commonly reported mishap. In
fact, portable ladder use is a high-risk task. Our focus must shift from ladder compliance programs to ladder avoidance through design.

The author uncovered a significant risk factor when performing an in-depth review of previously unseen causal factors related to poor design. The key risk factor discovered was the impact a congested or restricted access workspace has on worker safety. As most organizations and businesses attempt to cut project costs, a common approach is to reduce floor space or the facility’s footprint. This approach generally results in less workspace and/or restricted access to equipment for maintenance activities. It forces the facility’s operations management to purchase portable ladders because no workspace or access was provided for alternative safer designs, such as stairways, personal lifts and hoisting equipment.

**Business Value & Benefits Gained from PTD**

A second key selling point for PTD is the benefits derived from safe project delivery. Safe designs offer organizations many benefits. For example, the new plant built in China incorporated many proven solutions into its design and saw these additional benefits:

1. Project came in $10 million under budget.
2. Reduced energy consumption.
3. Zero waste to landfill and overall net positive impact on the environment.
4. Plant sold out of its product line and achieved full production capacity ahead of plan.
5. High worker morale.
6. Operating efficiency targets achieved well ahead of plan.
7. Fifty innovative proven solutions incorporated into design (many hazard categories avoided or eliminated).
8. Plant design and all job tasks achieved an acceptable risk rating.
9. No reported serious mishaps or near-miss events since plant startup in 2011.
10. CEO and business leadership-level recognition given to the design team and project champion.

The China project team is proud of the new facility, the project teamwork displayed and the outcome achieved. Proven solutions that avoid risk and eliminate hazards in design must be our legacy, not programs and firefighting. Knowing that 350 employees of a new facility can go home to their families at the end of each workday injury- and illness-free is the true reward.

As SH&E professionals, walking into a new facility or operation during a ribbon-cutting event with the customer and other leaders and professionals reinforces the long-term impact our efforts have on those who will be working with the new design for years to come. SH&E professionals can showcase their overall value to organizations by designing to acceptable risk through sustainable high-level controls.

**Building a Proven Solutions Library**

PTD is a culmination of proven solutions (safe designs) to avoid risk and to eliminate hazards in new designs/redesigns. When the SH&E community works in partnership with engineers and designers over the next decade to incorporate proven solutions into designs, the net positive results will be the prevention of life-ending and life-altering mishaps globally. Establishing proven solutions is critical work that places SH&E professionals in the preoperational stage of risk management.

Many resources are available to help SH&E professionals develop a proven solutions library. These include:

1. Internal organizational data analysis related to design;
2. NIOSH;
3. ASSE’s Body of Knowledge;
4. ANSI/ASSE Z590.3-2011;
5. ASSE Risk Assessment Institute;
6. Design for Construction Safety;
7. Construction Industry Institute;
8. ASSE’s PTD Symposium;
9. OSHA;
10. Lessons learned from completed design projects;
11) engineering and design community;  
12) vendors and suppliers;  
13) hourly workers;  
14) benchmarking;  
15. Safety in Design.

PTD Action Steps for SH&E Professionals
The SH&E community should take these actions to drive a cultural revolution around PTD. The rewards and benefits will be many, but the most noteworthy outcome will be the prevention of life-ending and life-altering mishaps. SH&E professionals should follow these steps:

1) Create a design safety checklist from organizational incident data linked to design gaps.  
2) Establish a personal goal to spend more time in the preoperational stage of occupational risk management.  
3) Develop a critical skill set around PTD and risk assessment.  
4) Apply a high level of control decision making in the design process with special focus on severity reduction.  
5) Develop and use a proven solutions library that achieves risk avoidance or hazard elimination in design.  
6) Identify and share long-term burden costs related to poor design decision making with leaders and design teams.  
7) Work to dispel common PTD myths.  
8) Eliminate barriers to safe work through design.  
9) Capture and communicate the benefits of safe design.  
10) Make your legacy one that leaves a lasting net positive impact on the organization.

Conclusion
Incorporating proven solutions into design is critical to the prevention of life-ending and life-altering mishaps. Proven solutions have global application and bring demonstrated value on many fronts when such an approach is adapted as part of an organization’s PTD culture and process.

The pace of injury/illness prevention improvement during one’s lifetime is directly linked to the speed of change led and driven by the SH&E profession. Risk assessment and PTD must be at the forefront of these efforts. The SH&E community has the responsibility, creativity and power to support injury-free lives around the world.

References

David Walline, CSP, is a global safety leader for Owens Corning in Toledo, OH. Walline is a 35-year professional member of ASSE. Prevention through design (PTD), fatal and serious injury prevention and risk assessment have been his primary career focus. He has developed and implemented global risk assessment, PTD processes and training programs within organizations and also influenced the design and risk mitigation levels of projects worldwide. In June 2012, Walline received the CSP Award of Excellence from the Board of Certified Safety Professionals. He was a contributor to and served on the review committee for ANSI/ASSE Z590.3-2011, Prevention Through Design: Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes. He is chair of ASSE’s Risk Assessment Committee, which manages ASSE’s Risk Assessment Institute. He also served on the planning committee for and presented at ASSE’s PTD Virtual Symposium in February 2013.

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