Policy Development

A Key Factor in Promoting PTD

By T. Michael Toole, Pamela Heckel and Matthew Hallowell

In August 2011, NIOSH hosted "Prevention Through Design: A New Way of Doing Business," a conference attended by 175 stakeholders that focused on applying prevention through design (PTD) principles within multiple industry sectors. Conference tracks focused on education, research, practice and policy. All presentations are available on ASSE's website (**www.asse.org/professionalaffairs_new/ptd.php**). Although no presentations specifically addressed policy, this article provides an opportunity to identify policies that relate to PTD and influence its advancement and diffusion throughout multiple industries.

The term *policy* is vague and has many meanings. A common thread across definitions is that policies dictate a proposed course of action and are typically set by organizations or institutions, rather than by individuals. Safety professionals can help their organizations establish and enforce safety-related policies, many of which may be borrowed from or reference policies established by national trade associations or consensus standards on this topic. Policies and standards together effect change in safety culture.

This article summarizes PTD-related policies associated with federal agencies and national organizations. Many SH&E professionals and researchers regard this concept as a highly promising means for reducing occupational hazards by engineering out hazards faced by users, manufacturers, constructors and maintenance workers.

SH&E professionals and design engineers have different roles in PTD. Typically, safety professionals develop, enforce and monitor

IN BRIEF

- **Diffusion of major innovations in organizational contexts, such as prevention through design (PTD), often requires a multifaceted implementation strategy.**
- **A policy statement that reflects a commitment to protecting worker safety and health is an effective means to communicate support for PTD initiatives.**
- **This article summarizes PTD-related policies and consensus standards.**
- **Safety professionals can use this information to support their efforts to adopt PTD within their organizations.**

T. Michael Toole, Ph.D., P.E., is a professor of civil and environmental engineering, associate dean of engineering, and director of the Institute for Leadership and Technology at Bucknell University in Lewisburg, PA. He has a B.S. in Civil Engineering from Bucknell University, and an M.S. in Civil Engineering and a Ph.D. in Technology Strategy from the Massachusetts Institute of Technology. Toole initiated and maintains **www.designforconstructionsafety.org**. He has been vice chair of the ASCE Construction Institute Prevention Through Design Committee and cochair of the NIOSH/NORA Construction Sector Council Construction Hazards Prevention Through Design workgroup. Toole is a professional member of ASSE's Central Pennsylvania Chapter and a member of the Construction Practice Specialty.

Pamela Heckel, Ph.D., P.E., is a senior service fellow at NIOSH, where she develops educational outreach materials for the Prevention Through Design initiative. Heckel holds a B.S. in Engineering from Vanderbilt University, a B.S. in Civil Engineering from Purdue University, and an M.S. in Architecture and a Ph.D. in Environmental Engineering from the University of Cincinnati. Her work experience includes design and manufacturing of nuclear reactors and construction of nuclear containment facilities.

Matthew Hallowell, Ph.D., is an assistant professor at the University of Colorado, Boulder. He holds a Ph.D. with a dual focus in Construction Engineering and Management, and Occupational Safety and Health from Oregon State University. Hallowell conducts research in construction safety specializing in injury prevention strategies, risk management and cost modeling. Before moving to academia, Hallowell worked as a laborer for Fenderson-Howe Builders, project engineer for Pine Tree Engineering, engineering and construction manager for Penn Lyon Homes and president of Modular Design Solutions.

safety-related policies, while design engineers address technical details of project design and execution, and comply with project specifications, building codes and regulations. Therefore, the owner may influence adoption of PTD policies by including an SH&E professional on project design teams, beginning with the kickoff team that meets at the conceptual design stage.

PTD policy influences the development of consensus standards when such standards are adopted by many different organizations. This assumption is explicitly recognized in "Prevention Through Design: Plan for the National Initiative" (NIOSH, 2010a), which identifies goals relating to research, practice, education and policy. As reported in that document:

> 4) Policy: Business leaders, labor, academics, government entities, and standard-developing and -setting organizations endorse a culture that includes PTD principles in all designs affecting workers. Policy focuses on creating demand for safe designs for workers and incorporating these safety and health considerations into guidance, regulations, recommendations, operating procedures and standards.

Most urgent to PTD implementation is the development of a broad, overarching policy that will guide the effort to establish processes and programs for enterprises of all sizes, across all industrial sectors. Outcome-based guidance for the implementation of industry- or activity-specific standards also is needed. As a fundamental element of developing such a policy, relevant recommendations from various authoritative and advisory organizations should reflect PTD principles. The ultimate goal is to include these principles in all design standards that affect workers.

As NIOSH (2010a) notes, no singular policy related to PTD has yet been developed. Rather, various organizations and institutions across multiple industries have taken explicit or implicit positions with respect to designers' role in occupational safety and health. These positions and related policies are reviewed, and recommendations for policy development are provided.

Federal Government Policy

In 1970, Congress passed the OSH Act, creating OSHA to establish and enforce regulations and NIOSH to conduct research. Thus, the government's commitment to protecting workers was promulgated.

OSHA

In the construction industry, in which design engineers and architects are typically not employed by firms with field construction workers

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no regulations or policies are directly related to PTD, nor is it mentioned in OSHA's Field Inspection Resources Manual. However, OSHA (a) has actively promoted the concept by convening a Design for Construction Safety (DFCS) workgroup within the Construction Alliance Roundtable since 2005. Presentations and products associated with this workgroup have promoted PTD.

Although the agency promotes this concept as a potentially effective injury reduction tool on its website, OSHA has yet to formalize a policy related to these efforts. One might contend that OSHA has developed an open and supportive position for PTD despite the fact that the General Duty Clause places no responsibility for worker safety and health on the designer unless workers are the designer's employees. This implies that SH&E professionals should be proactive and not wait for OSHA to require PTD. Safety professionals must recognize the opportunity that this concept presents and voluntarily implement a program within their organizations.

It has been suggested that OSHA could increase its promotion of PTD by initiating a program to provide consultation to private firms, similar to the way that consultation is provided through the voluntary partnership programs and other outreach/alliance activities [OSHA(c)]. This initiative would require a substantial investment to educate OSHA employees on this concept and process. Another potential policy action would be to target

OSHA-funded training grants (i.e., Susan Harwood grants) for outside organizations to train design engineers and architects.

NIOSH

Beyond the national initiative document, PTD-related priorities are communicated through the National Occupational Research Agenda (NORA).

"NORA is a partnership program to stimulate innovative research and improved workplace practices. Unveiled in 1996, NORA has become a research framework for NIOSH and the nation. Diverse parties collaborate to identify the most critical issues in workplace safety and health. Partners then work together to develop goals and objectives for addressing these needs (NIOSH)."

In 2006, NIOSH began organizing NORA-setting activities by sector. Each of the 10 current sectors has its own sector council, which establishes the research agenda for that sector. The first set of sector agendas was established in late 2008 and early 2009. They are organized by strategic goals, intermediate goals and activity output goals, the latter being associated with NIOSH's emphasis on translating research to practice.

Five sector agendas explicitly refer to PTD or to using engineering design to improve safety and health.

1) National Manufacturing Agenda includes text that focuses on using design to reduce injuries to manufacturing workers. For example, Intermediate Goal 1.3 states, "Adopt design recommendations for reducing worker injuries and fatalities that occur while operating equipment and/or machinery" (NIOSH, 2010b).

2) National Healthcare and Social Assistance Agenda includes text that focuses on using design to improve the safety and health of healthcare workers and facility occupants. For example, Intermediate Goal 4.2 states, "Promote the development of new and reengineering of safe sharps with device manufacturers, with a priority on sharps-free alternatives wherever feasible." Intermediate Goal 5.11 states, "Designing facilities to facilitate appropriate work practices and incorporate protective engineering controls. Investigators/industry will focus on ways to design facilities that reduce infectious disease acquired through airborne, contact, waterborne and multiroute transmission by facilitating appropriate work practices and incorporating protective engineering controls" (NIOSH, 2009a).

3) National Transportation, Warehousing and Utilities Agenda includes some provisions on truck driver safety. Intermediate Goal 1.12 states, "Truck manufacturers will modify cab designs based on updated anthropometric data, results of ergonomic workspace evaluations and updated design standards" (NIOSH, 2009b).

4) National Services Sector Agenda includes text that focuses on the safety of workers associated with solid waste. Intermediate Goal 15.4 states, "Identify, develop and incorporate engineering solutions to eliminate hazards for solid waste collection and disposal operations through partnerships with federal and state regulators, vehicle manufacturers and equipment manufacturers" (NIOSH, 2009c).

5) National Construction Agenda is the only sector that includes PTD as a strategic goal rather than merely as an intermediate goal or activity. Strategic Goal 13 states, "Increase the use of prevention through design approaches to prevent or reduce safety and health hazards in construction." The five intermediate goals to this strategic goal address obstacles to, incentives for, and tangible products and methods related to construction hazards. Unlike other agendas, this sector agenda explicitly focuses on the safety and health of design implementers (construction workers), rather than on users of the work product of a design (NIOSH, 2008).

In addition, NIOSH is working with industry stakeholders, government agencies and nongovernmental organizations to develop a system to categorize chemicals based on the hazards they pose. This initiative aims to identify and conservatively group together chemicals of similar risk so designers, manufacturers and consumers can use this information. As with OSHA, NIOSH has acted to promote PTD understanding and use. Through these initiatives, the federal government has set the foundation for future policy by supporting actions to promote PTD. In other countries, government policies have been more aggressive. For example, U.K. (HSE) regulations give designers explicit responsibility for worker safety and health.

Most engineering education programs fail to teach PTD tools and techniques, which is a long-term barrier to mainstreaming these principles in practice (Mann, 2008). Stakeholders recognize the need to develop content for required engineering courses rather than to add more safety courses to the curricula. As a result, the NIOSH (2010b) plan includes this strategic goal:

> 2) Designers, engineers, machinery and equipment manufacturers, health and safety professionals, business leaders, and workers understand PTD methods and apply this knowledge and skills to the design and rede-

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> sign of new and existing facilities, processes, equipment, tools and organization of work.

NIOSH has actively pursued this goal by developing textbook content such as case studies and homework problems. As a result, four textbooks and two booklets have been published, and several more are being written. University partners have developed four 3-hour education modules for use in undergraduate engineering classes to cover these topics: structural steel design, reinforced concrete design, architectural design and construction, and mechanical-electrical systems.

Future modules will cover agricultural engineering; bioengineering and biomedical engineering; chemical process safety and chemical engineering; manufacturing and industrial engineering; mechanics; and nanotechnology and materials science engineering. NIOSH is working with 22 universities to incorporate PTD principles and educational modules into their allied science, engineering, construction, or occupational safety and health curricula.

The practical implication is that NIOSH's embrace of PTD provides safety professionals with a potentially useful tool for encouraging their organizations to adopt this approach. Specifically, safety professionals can initiate programs that help achieve one or more specific industry sector goals; this establishes an organization as a progressive safety leader and helps it reap the associated financial benefits of lower injury and illness rates, reduced absenteeism, lower employee compensation expenses, improved employee morale and increased productivity.

Professional Societies

Professional societies, often not-for-profit organizations, that represent a specific profession or industry may establish and disseminate policy relevant to their membership in the form of policy statements, position papers or white papers. Some societies communicate their policy through documents that are less explicitly related to policy, such as standards and model contract documents.

Professional societies have taken several influential steps to promote PTD. For example, BCSP has included PTD-related questions on its CSP exam since 2009, which reflects safety community support for the concepts.

Second, NIOSH is working with the National Council of Examiners for Engineers and Surveyors to add PTD content to the questions on the fundamentals examination for engineers. Third, various societies have created or revised standards explicitly or implicitly related to PTD principles:

- ASSE Prevention Through Design Technical Report (2010);
- ANSI/ASSE Z590.3-2011, Prevention Through Design Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes;
- ANSI/AIHA/ASSE Z10-2012, Occupational Health and Safety Management Systems.
- SAE J2194, Rollover Protective Structures for Wheeled Agricultural Tractors (2011);
- ANSI B11.0-2010, Safety Standards for Machine Tools;
- ANSI B11.19-2010, Performance Requirements for Safeguarding;
- ISO 12100:2010, Safety of Machinery: General Principles for Design—Risk Assessment and Risk Reduction;
- ANSI/PMMI B155.1-2011, Safety Requirements for Packaging Machinery and Packaging-Related Converting Machinery;
- ASHRAE Technical Committee 9.11, Clean Spaces;
- ANSI B11, Safety Standards for Machine Tools;
- ISA 12, Electrical Equipment for Hazardous Locations;
- UL 2201, Portable Engine—Generator Assemblies;
- ANSI Z87, Safety Standards for Eye Protection;
- ANSI/AIHA Z9, Health and Safety Standards for Ventilation Systems;
- ANSI/ASSE A10 Accredited Standards Committee for Safety in Construction and Demolition Operations;
- ANSI/ASHRAE 161-2009, Air Quality Within Commercial Aircraft.

Let's review the specific activities of several key professional societies.

ASSE

ASSE represents more than 34,000 SH&E professionals who work across all industries worldwide protecting people, improving business and safeguarding the environment [ASSE(a)]. Through their efforts, ASSE members help employees stay safe, healthy and productive, which delivers positive bottom-line results to employers and helps enhance corporate image. ASSE posts its position papers online [ASSE(b)], including "Designing for Safety." Consider these excerpts:

> Designing for Safety (DFS) is a principle for design planning for new facilities, equipment, and operations (public and private) to conserve human and natural resources, and thereby protect people, property and the environment. DFS advocates systematic processes to ensure state-of-the-art engineering and management principles are used and incorporated into the design of facilities and overall operations to ensure safety and health of workers. . . .
>
> DFS includes the following parameters:
>
> - Observance of safe containment or substitution of materials and/or equipment, which may adversely affect the health and well-being of the public and the worker, or may impact the environment.
> - Designing out hazards and minimizing risks of injury through properly selected safeguards, controls and barriers most appropriate for the operation, process or activity involved.
> - Architects, engineers, designers, code officials, and safety and health professionals

play a major role in DFS. Managers must be informed of their responsibilities in maintaining programs that ensure safe design and systems to protect the worker, the public and the environment.

•When appropriate, both existing and new laws and regulations should be structured to incorporate the philosophy of DFS and recognize its benefits.

ASSE's approach to PTD also is reflected in the groundbreaking ANSI/ASSE Z590.3-2011, Prevention Through Design Guidelines for Addressing Occupational Hazards and Risks in Design and Redesign Processes. Industry professionals considering initiating a PTD program within their organizations would do well to review this voluntary consensus standard.

American Society of Civil Engineers

American Society of Civil Engineers (ASCE) represents more than 140,000 members of the civil engineering profession worldwide. Its stated mission is to "provide essential value to members and partners, advance civil engineering and serve the public good" [ASCE(a)]. One of its five primary goals is to "advocate infrastructure and environmental stewardship to protect the public health and safety and improve the quality of life."

ASCE communicates its policy through 171 formal policy statements [ASCE(b)]. For example, Policy Statement 350, "Construction Site Safety" [ASCE(c)], includes this language that seems to explicitly encourage PTD.

> The American Society of Civil Engineers (ASCE) believes improving construction site safety requires attention and commitment from all parties involved.
>
> Design engineers have responsibility for:
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> •Recognizing that safety and constructability are important considerations when preparing construction plans and specifications.
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> Educators are encouraged to:
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> •Incorporate project site safety and constructability concepts in design and construction curricula;
>
> •Emphasize engineers' role in providing a safe and healthy environment for personnel engaged in project activities through proper planning and design;
>
> •Conduct basic and applied research to advance the knowledge and practice of safe design and construction.

Although these excerpts imply that ASCE embraces the PTD concept, Toole (2011) reports that increased liability concerns prompted dissolution of ASCE's Prevention Through Design Committee in 2009. The fear of liability likely has led to the inclusion of specific text in the model contract between an owner and a design professional by Engineers Joint Contract Document Committee (EJCDC, 2002), which includes representatives of ASCE, National Society of Professional Engineers and Associated General Contractors. For example, the following content likely hinders PTD in construction:

> Engineer shall not at any time supervise, direct, or have control over Contractor's work, nor shall Engineer have authority over or responsibility for the means, methods, techniques, sequences, or procedures of construction selected or used by Contractor, for security or safety at the Site, for safety precautions and programs incident to the Contractor's work in progress, nor for any failure of Contractor to comply with Laws and Regulations applicable to Contractor's furnishing and performing the Work.

Similar language affirming that a designer is not responsible for site safety during construction can be found in the EJCDC (2007) model general conditions document that is typically part of the contract between the owner and the general contractor. For example, paragraph 9.09 ("Limitations on Engineer's Authority and Responsibilities") states:

> Engineer will not supervise, direct, control or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto.

In addition, this general conditions document specifically addresses the contractor relying on the drawings for safety management.

> Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:
>
> 1) the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or
>
> 2) other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings. . . .

Another document that could be seen as communicating policy is ASCE's Code of Ethics, which includes fundamental principles and fundamental canons. One principle that would seem to be related to PTD is that engineers are to use "their knowledge and skill for the enhancement of human welfare and the environment," the connection being that human welfare can be enhanced by designing out unnecessary risk in a facility's design. Also arguably relevant is the first canon:

> Engineers shall hold paramount the safety,

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> health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties. Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering judgments, decisions and practices incorporated into structures, machines, products, processes and devices.

As many researchers have noted, the key concern is whether construction and maintenance workers are considered part of the general public. The public could be considered to include all people using the facility or affected by it upon completion. Conversely, the public could be considered to be all individuals who lack engineering expertise in forces, stresses, flows, etc., and, therefore, cannot fully understand the risks associated with the facility, both during and after completion. The first concept of the public would exclude construction workers while the second concept would not.

In the authors' opinion, regulations that require design professionals to perform PTD would be problematic for many reasons, especially with regard to the increased risk of inappropriate lawsuits. However, it seems appropriate to enable designers to perform PTD on a voluntary basis by revising the model contract/general conditions. Specifically, these documents could acknowledge that a designer may attempt to increase a design's safety constructability, yet neither warrants that all avoidable risks will be designed out, nor that the designer possesses knowledge about the hazards that may be present during construction or how the contractor may elect to manage those exposures.

Therefore, SH&E professionals considering initiating PTD should investigate their organizations' use of standard contract terms that may explicitly or implicitly prevent designers from performing PTD. Practitioners also should confirm that professional society policies for the designers they hire do not explicitly or implicitly state that those designers should never be associated with the safety of operators, constructors or maintenance workers.

Education-Related Institutions

For academic engineering programs in the U.S., ABET establishes the policy that most directly affects each program, since that organization evaluates and accredits university curricula in engineering and technology. While ABET accreditation determines whether graduates can become registered professional engineers, it has less direct implications for graduate school admission and employment.

Beginning in 2000, ABET shifted from an approach that dictated what courses students in a specified program were required to complete to an approach that delineated the learning outcomes of a program (i.e., capabilities graduates possessed upon graduation). Two sets of required outcomes are established for each type of program (e.g., chemical engineering, civil engineering). One set includes the 13 outcomes required of all engineering and technology programs (ABET, 2011). The only outcome directly relevant to PTD is Criterion 3(c): "an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, *health and safety* (emphasis added), manufacturability and sustainability."

Reportedly, no engineering program to date has interpreted this text to mean that it must ensure that its graduates can perform PTD—that is, design out unnecessary hazards to which implementers of the design (e.g., manufacturing and construction workers) will be exposed. However, NIOSH is actively working with ABET to increase awareness of PTD concepts.

ABET also specifies that a lead professional society for the specific program establishes a second set of required outcomes. For example, program outcomes for electrical engineering are established by the Institute of Electrical and Electronics Engineers. Currently, only two of 28 programs include the word *safety* in their lead professional society outcomes. The professional society program criterion for construction engineering programs (which are distinct from civil engineering programs yet still are established by ASCE) includes the following:

> 1) Curriculum. The program must prepare graduates to apply knowledge of mathematics through differential and integral calculus, probability and statistics, general chemistry and calculus-based physics; to analyze and design construction processes and systems in a construction engineering specialty field, applying knowledge of methods, materials, equipment, planning, scheduling, *safety* (emphasis added).

The professional society program criterion for mining engineering (established by Society for Mining, Metallurgy and Exploration) includes these criteria:

> 1) Curriculum. The program must prepare graduates . . . to be proficient in engineering topics related to both surface and underground mining, including: mining methods, planning and design, ground control and rock mechanics, *health and safety* (emphasis added).

One potential strategy is to incorporate knowledge and convey importance early in the careers of designers and engineers. This approach can help designers/engineers recognize the magnitude of the occupational safety and health issues; enhance students' knowledge of safety and health hazards; demonstrate PTD tools; and provide concrete examples of how designers can influence worker safety and health. If students embrace these concepts early on, they may be less influenced by traditional culture that in some cases is not supportive of PTD. Additionally, providing educational experiences that demonstrate strategies which are cost-effective or cost-neutral, and also improve occupational safety, would be particularly impactful. Thus, safety

professionals should not assume that designers can perform PTD because key information was likely not included in their formal education. Instead, it is best to hire designers with documented PTD abilities or to provide fundamental training and tools, such as software programs that provide related checklists or design suggestions.

Conclusion

PTD policy is a complex topic because it is controlled by a multitude of stakeholders and may significantly affect hundreds of thousands of individuals and organizations across many industries. To date, federal government efforts to establish PTD policy have been fragmented. In fact, as noted, some policies conflict with the PTD progression, which hinders the generation and enforcement of an overarching policy. Fortunately the federal government, academic institutions and professional societies have taken important steps, such as allocating resources for research, launching educational initiatives, and pursuing agreements and standards.

Perhaps the greatest challenge is fairly distributing responsibility and compensation for implementation costs. To set aggressive policy where economic incentives are currently inadequate (e.g., for designers on traditional design-bid-build construction projects), stakeholders must create cohesive industry standards. Policies are difficult to implement and disseminate when the suggested actions are perceived to cause an economic disadvantage to one or more stakeholders.

For policies to become accepted standard practice, such disadvantages must be recognized and equitable compensation must be designed and incorporated into the policy. For example, for PTD policy to become accepted practice in construction, industry stakeholders must acknowledge that the process requires additional time, knowledge and tools than does traditional practice. Since OSHA's General Duty Clause places no legal responsibility on the designer for contractors' employees, the policy must include a compensation system for the designer. Without such a provision, it is unrealistic to require the designer to implement PTD strategies until designers recognize that mastering PTD will provide a competitive advantage. This responsibility-compensation imbalance is not unique to construction.

For SH&E professionals, the practical implications are that they must demonstrate exceptional initiative and persistence when implementing PTD programs. At this point, they cannot point to OSHA policies or requirements mandating PTD, but they may find that designers hired to perform PTD cannot do so and/or resist the concept due to industry traditions, boilerplate contracts and liability concerns. The lure of fewer lost-time incidents and lower workers' compensation claims may not overcome fears of liability and the inherent resistance to change. However, SH&E professionals must persist in implementing PTD because the potential improvement in employee safety and health is too promising to ignore. **PS**

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