Rapporteur's Report

Education Issues in Prevention through Design

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1. Introduction

Education, identified as one of the primary activities of the Prevention through Design (PtD) initiative, is a major factor needed to make PtD successful. The educational requirements vary within each sector. Therefore, an education strategy should be developed with an overall approach and set of resources, which is then tailored to each sector.

The key themes of the PtD Education Functional Area are:

- Classify every education action as developing awareness or capability
- Develop education resource materials that are available to all
- Tailor approach and resources to each of the constituents in a sector
- Incorporate elements for all size companies
- Conduct assessment and continuous improvement efforts
- Identify drivers of education change and work with them

Discussion in the Education Functional Area included significant input by representatives from the safety engineering field, where there has been extensive work done on PtD. The American Society of Safety Engineers (ASSE) has extensive expertise not only in PtD, but also in the processes of educating people. Certification, seminars, text books, webinars, and many other activities offered or sponsored by the ASSE, may be considered as a model for many approaches to the Education Functional Area of the PtD initiative. Additional discussions revealed that some effective PtD education is available. Though there seems to be some success, extensive education on PtD is needed. These successes should be identified and leveraged in the development of a fully developed PtD educational program.

Although professional organizations, such as the ASSE, have offered educational programs on safety through design

principles, developing the products and services to reach more professional disciplines are needed. For example, people in fields outside of safety engineering need to learn how to access the skills and expertise of safety engineers. This education can focus on basic issues of identifying and posing the proper questions and problems for safety engineers. Further, there is a need for the education of safety engineers to learn how to develop safety engineering solutions that meet the requirements of each of the sectors and to work with those on the front line of product or process use.

One broad area of consensus was that formal education can most effectively include segments on PtD in existing courses, rather than generating whole courses on PtD, and that these should be implemented in training programs in all sectors. This effort can be effectively supported by developing and maintaining a database of educational tools and modules for all levels and sectors. There are several examples of such material, but developing and maintaining this in a central database, possibly by the National Institute for Occupational Safety and Health (NIOSH), will greatly enhance the impact of the already existing educational materials, as well as those still to be developed.

It was also clear from the sectors that more education is needed in all aspects of PtD so that PtD can be addressed from every angle. For example, in a hospital, safe medical devices are developed based on good engineering and collaboration with all those working in that environment. Further, to have an immediate impact, the educational challenge is not only to educate those preparing for the work world, but also those already in it. There are common aspects to both, therefore the tools and education designed for undergraduate students can also be used for continuing education.

Assessment was also clearly identified as a critical process in the PtD educational program. Assessment is a common practice at universities, and should be used to ensure that PtD educational practices are evaluated and modified to increase their effectiveness.

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Finally, it is clear that the drivers for education must be understood and assessed. These drivers, such as the certification of educational institutions and certification for individuals, can be allies in getting PtD into the educational norm.

2. Capability and Awareness

During the design stage of any educational effort, it is critical to first establish if the goal of an activity is to create capability or awareness. This will impact the materials and approach. As examples, capability includes:

- Engineers using tools to apply PtD in the early stages of design
- Nurses and engineers knowing how to effectively communicate each other's ideas
- Safety officers being able to develop the business case for safety
- Small machine shop owners being able to assess the business cases for purchasing old equipment without proper safety guards, or purchasing more expensive equipment with all the recommended safety features
- Owners of a two or three person home repair company being able to assess the required equipment and cost for safely completing a job.

Awareness includes:

- CEO's knowing that there is a business case for safety and setting an expectation that it will always be evaluated
- Engineers knowing that they need to communicate with people using products, in order to understand safety and gather potential solutions
- Consumers knowing how to obtain safety certifications created for home repair companies
- Prospective employees understanding the risk of taking a job in a small business that has not met minimum safety requirements on equipment.

Education is considered to include the formal education at the primary, secondary, and post-secondary level, information workshops, as well as a variety of communication mechanisms, such as professional journals, that have the goal of educating the various people needed to implement PtD.

It is recommended that a rating system be developed for awareness and capability, and that all tools and materials, developed for the PtD initiative, be rated on these scales. Such a system can greatly help educators quickly identify tools and materials that are designed for their intended educational outcome.

3. Educate the Whole Product or Process Team

It was noted that for workforce training in PtD to be most effective, all contributors to the design of a product or process need to be schooled in PtD concepts. Not only does the same educational message for a given sector need to be adapted to the different contributors, but also the list of those considered to be contributors should be expanded.

As an example, it was discussed in the Construction Sector breakout session that more of the construction industry needs to be educated. In particular, construction company owners and financiers need to be educated in PtD concepts. Another example is in the health care setting, in which a wide range of hospital staff, including physicians, nurses, administrative staff, and housekeeping staff, should be represented in the design process and trained in the principles of PtD.

PtD education programs aimed at the current working population should be designed to provide a consistent message to all on the team, while providing each member with the specific capabilities, tools, and awareness that they will need. In addition to developing PtD training just for engineers designing a product or process, PtD educational programs should be developed to include those involved in implementing the process or as end users.

4. Executive Education

Several speakers from large corporations described how PtD principles were implemented throughout a company once the leadership understood PtD and the positive impact it had on business profits. The challenge is reaching these company leaders to educate them about PtD.

There was skepticism expressed in the group about leadership taking the time to learn PtD principles. However, there was discussion of a CEO education model in Ontario, Canada, called the "CEO Health & Safety Charter." It was reported that meetings are attended by CEOs from roughly 200 companies, showing potential for success in training CEOs to understand the connection between PtD and company prosperity. The education group suggests that creating a CEO safety education program, to include PtD, after the "CEO Health & Safety Charter" be explored.

Other approaches that should be pursued, include getting articles printed in trade journals and business-oriented publications, such as the Wall Street Journal, which are read by company executives. Newsletters from Masters of Business Administration programs can also provide unique access to company leaders. Such articles should focus on successes of PtD approaches, and be written from the executive's perspective in language that will appeal to them.

Educating leaders in companies is critical to the success of PtD, not only because they can drive the adoption of PtD into all parts of a company's operation, but also because they can be a key proponent for change in how universities educate students. Many university and college presidents, provosts, deans, and faculty are actively talking to leaders in industry to ensure that education will be focused on areas critical to the success of their students. Recently, the author of this report noted that an engineering department chair changed from relegating design education to one senior design course staffed only by graduate students, to developing a team of faculty to incorporate design principles throughout the curriculum. This change was described as being driven by an alumnus, a CEO of a multi-billion dollar company, who requested more emphasis on design education. CEOs can drive the culture within companies and also universities.

5. Secondary and Post-Secondary Education

Within secondary and graduate education, the disciplines of engineering, architecture, and business most frequently are identified as prime opportunities for PtD education. However, many other fields, including health care, hotel and restaurant management, industrial technology, and food science, are examples of additional targets for PtD educational efforts. Some of these were identified during the sector group meetings at the PtD workshop.

There was a clear consensus in the education group that PtD will be best introduced in educational curricula through modules, rather than in complete courses. Departments and faculty, in most disciplines, already are making hard choices about core curriculum and materials; changing required courses to electives, or removing them entirely. Therefore, providing ready-made modules, case studies, and other lessons that can be incorporated into existing courses provides the greatest likelihood that PtD concepts will be covered.

It was recommended that, where possible, PtD concepts be tied to other similar course content, such as sustainability and environmental issues. This will allow PtD to be connected to other design concerns, rather than being addressed as an isolated issue. Similarly for the business arena, PtD can be included in courses such as corporate social responsibility, to insure its connection to other matters of corporate good citizenship.

Within engineering curricula, PtD concepts can easily be incorporated into stand-alone courses on safety and health, bio-materials, and materials. Design courses easily lend themselves to the teaching of PtD. In business schools, lessons involving the principles of PtD can be used to teach subjects such as finance, human resource management, and organizational behavior.

A critical issue that needs to be better understood is the pedagogy for teaching PtD at the undergraduate and graduate levels. During the PtD workshop, most of the examples of successful PtD work were experience-based decision making. This is very difficult material to ask typical 18 to 22 year old college students to learn and apply. PtD education at the undergraduate level may need to be limited to problems that can be clearly solved using analysis tools, rather than experience-based approaches. It is recommended that the issues relative to pedagogy be studied and addressed.

Two important drivers for universities are accreditation and rankings. Means to take advantage of these drivers should be explored. In engineering, for example, the Accreditation Board for Engineering and Technology (ABET) is the accrediting body, and input regarding curricular requirements comes from discipline-specific professional societies. Therefore, for engineering education, it would be important to find appropriate avenues for approaching ABET, and the professional societies that help drive PtD into all curricula.

Universities, colleges, and professional schools should also look to companies for training. Companies are willing to train faculty, and even see some of their training materials incorporated into the PtD modules that are taught at universities, colleges, and professional schools. Using the environment and training already available in companies can provide faculty with clear motivation and applications for PtD in their own curricula. It is recommended that universities, colleges, and professional schools partner with companies. An example could be a summer internship for faculty that is sponsored by several companies. This industry lobbying could be facilitated by NIOSH.

6. Continuing Education

Continuing education is being considered here as formal education provided to people who are no longer full-time undergraduate or graduate students. The training may lead to post-secondary degrees or certificates, or may be needed for maintenance of existing certification or licensure. Such training programs can be geared toward advancing PtD through structures in which employees can participate. Many universities have very active distance education programs, including course work that is offered through the Internet. Other continuing education programs include those offered by companies and union training centers.

Course work for continuing education can be the best opportunity for multi-disciplinary approaches to PtD. Further, at the typical age and experience of people involved in continuing education, the willingness for, and at times preference of, experience-based approaches to PtD, compared to analysis tools, should be understood. This distinction, compared to typical undergraduate students, could require different teaching approaches and educational resources than those developed for undergraduate education. Understanding this issue is critical to the success of the educational approaches and materials developed, for both the typical undergraduate and continuing education student.

Training opportunities, other than traditional distance course work, should be developed. For example, one idea presented was in the area of health care. Engineers need to better understand how health equipment is used, while nurses need to better understand what engineers can do in the design stage to make equipment more useful. Engineers and nurses need to effectively communicate their ideas to each other. A training program can provide opportunities for engineers to shadow nurses in their hospital work, so that they can see first hand how equipment is used. This will provide a forum for nurses to comment on equipment and communicate their ideas, and engineers to explain potential design alternatives. These training programs can be set-up to include formal lectures and unscripted time with the engineer shadowing the nurse. Care will be needed to keep the engineer's employer confidential, so that the training does not become a means for specific companies to market their equipment. This effort can be offered as a stand alone program, providing Continuing Education Unit credits, or coupled with formal course work in a university.

As the state-of-the-art includes PtD, increasing the awareness of engineers will actually reduce exposure to liability lawsuits. However, liability can be a limiting force for some companies to discuss PtD issues, or even advocating for training at professional meetings or through distance education. This needs to be considered in designing the educational opportunities, but also indicates the need to address the beliefs that even discussing safety can create liability exposure. Educating those in power as

to the value of safety is therefore a critical need. It is proposed that this issue be looked at more carefully to see if there is training that can assist with reducing liability exposure, which would lift the barrier to companies and employees receiving PtD training.

7. Community Education

The community is one of the potential drivers for seeing PtD implemented by small businesses and in consumer products. Notes from the Wholesale and Retail Trade sector state that the "customer has to say that it is important," thus creating the demand for PtD. For example, when a consumer hires a contractor to perform house maintenance or remodeling, if they have information about PtD, they can ask the right questions to assure that safety principles are being incorporated in the job and that the contractor is PtD qualified.

It is recommended that a rating system for PtD be developed for products and processes that an individual or small group in a community would be concerned with. Such a rating system could be modeled after the Carolina STAR program. The PtD rating system would need to accompany a community-level education program to ensure that it is understood and all questions are answered.

As a companion to a PtD rating system, a means for small businesses to be trained on the system must be developed. These issues are addressed in the Small Business section of the report.

8. Small Business

Addressing PtD issues for small businesses was identified as a challenge with no easy solution. While PtD does require significant resources for large- and mid-size corporations to implement, the cost savings can make it financially viable. Further, in comparison to small businesses, large organizations can use a smaller percentage of total resources to focus on education and implementation of PtD efforts. In small businesses, however, the financial and staff resources for executives or their employees to become educated about the potential, tools, and methods of PtD, may not be available. For example, it may be near impossible for the owner of a three-person machine shop to attend a week-long PtD training course, much less send employees. Required PtD certification or compliance was suggested as one of the drivers for small businesses to become educated in and implement PtD.

There are reports, however, of training programs that have been successful at attracting small business owners. One of the participants in the PtD education group discussion indicated that safety education efforts in Ontario, Canada, have provided training that has been attended by significant numbers of small business owners. Similar programs should be studied and replicated here if possible.

It is proposed that small businesses be given incentives to implement PtD training and practices. Funded training programs for the employees and owners can be developed, perhaps through low-interest business loans.

Further, it is recommended that a separate educational effort be developed for customers, so that they seek out small businesses that practice PtD methodologies. Customer demand has great potential to influence the practices and priorities of small businesses in the areas of construction, remodeling, repair, house maintenance, house cleaning, automotive repair, and so forth. Training programs will need to be tailored to each type of business. Also, tools will need to be developed for a small business to identify the PtD training opportunities in their business sector and geographic area, and to help them implement the principles tailored to their business.

9. Resource Development

A critical component of creating an educational foundation for PtD is to develop and maintain a database of resources for PtD education. The database would include lecture modules, case studies, and lesson plans that can be used at both the secondary and continuing education levels. The content should be tailored for courses ranging, for example, from engineering, to architecture, to business, to the service sector. Educational materials should be, to the maximum extent possible, "turn-key" and easy to integrate into existing courses.

While many resources currently exist, it is recommended that they be identified and collected into a central database that is available to all. A gap analysis then needs to be performed to recognize additional modules that should be developed. Incentives, such as grants, may need to be given for their development, but free access to the modules may be incentive enough for individuals to donate their materials. The education group suggests that NIOSH could add the development of PtD training materials, as a requirement for ERC Training Grants.

The criteria for any material maintained in the database, is that it: (1) have effective content, (2) is sector-specific, (3) is well produced, and (4) is "turn-key" and easy to integrate into existing courses and training.

10. Drivers for Education Change

Education is currently taking place at many levels of every economic sector. The education is either mandatory to gain entrance to the job market, advance in the job market, or to maintain access to the job market. Education is taking place at many trade and professional meetings and is often considered vital or essential to maintaining a license. License boards can drive PtD education by requiring that some portion of the training include PtD concepts.

At universities, change can be generated from the top down, but often more permanent changes are generated from the faculty. From the top down, change agents can be alumni, company CEO's, and accreditation organizations, such as the Accreditation Board for Engineering and Technology. One of the strongest change agents is an alumnus who is a CEO of a large corporation. These individuals can generate swift change. Accreditation organizations, such as ABET, generate a gradual change cycle. For example, an ABET accreditation visit is only every 6 years, and change in the criteria is a deliberate process, in large part driven by faculty

members from many institutions. It is recommended that NIOSH establish industry groups to lobby universities and accreditation organizations.

Faculty members represent the best potential for long-term change that will permeate the education and research in an institution. While commitment to PtD is a primary driver for many faculty members, the incentive structure for faculty is to leverage teaching of new topics from their research. Therefore, PtD can be driven into the classroom by increasing the research funding available for faculty. Then including an evaluation of the plan to add PtD concepts from the research to course work, can be criteria when evaluating a proposal for funding. Providing more research funding will allow faculty members to include the PtD work in their promotion and tenure credentials. Once PtD is in the classroom, and the students are subsequently hired with this knowledge, then it has a high probability of becoming permanent.

It was also noted that members of industry need to be better educated on how to influence universities, colleges, and professional schools.

Companies, through their hiring, represent key change agents. If companies make it clear that specific material is making some students more attractive for internship or permanent hiring, then many university faculty will include the material in their curriculum. An example is the current demand for change in MBA programs, throughout the county, to include more course work on social responsibility.

Licensure and certification was identified as an essential driver in all of the economic sectors. For example, the engineering license could contain PtD content. This will not only drive individuals to learn PtD, but it will also generate a greater need for training.

Professional associations are also potential drivers. These organizations contain many people who are passionate about their field and are willing to contribute to educating others about their trade. As an example, the ASSE is implementing training beyond its own members. One motivation appears to be that this allows more hiring of safety engineers, and that their capabilities are better appreciated.

Further analysis is needed to identify all drivers for PtD education to ensure that all approaches are being considered.

11. Summary of Sector-Specific Comments

The following contains sector-specific comments that were not included in the above discussion:

Healthcare and Social Assistance
- Include toxicity in material science courses
- Be aware that the Center for Health Care design is developing an evidence-based design certification for projects and designers
- Develop a certification for clinicians

Agriculture, Forestry, and Fishing
- Incorporate PtD into training provided by AMSEA (Alaska Marine Safety Education Association), NPFVOA (North Pacific Fishing Vessel Owners' Association) and other organizations
- Incorporate PtD into programs for future farm owners

Construction
- Determine whether the American Institute of Architects (AIA) and Professional Engineer (PE) licensing organizations can influence education
- Coordinate course content with the Occupational Safety and Health Administration (OSHA) training
- Develop an American National Standards Institute (ANSI) committee on PtD
- Incorporate PtD into technology, such as computer aided design (CAD)
- Institute a constructability review standard
- Look at the success process used in Leadership in Energy and Environmental Design (LEED)
- PtD should be branded like LEED
- Educate insurance industry and attorneys
- All states require licensed professionals to protect the "health, safety, and welfare of the public." Educate the industry to consider construction workers to be the public, so that PtD concepts are applied to the construction process. If legal precedence for construction workers to be considered part of the public is established, then PtD will have to be applied to them.
- Synchronize training materials by following the path of constructability
- Develop case studies from bog companies to validate processes and share best practices

Services
- Educate the public on hazards of housekeeping
- NIOSH should partner with NSWMA (National Solid Wastes Management Association) to access non-members
- To access small haulers, target insurance carriers who insure them
- Create incentives for safety in municipal contracts

Mining
- Peer reviewed journals do not get to the mining industry. Publish more about PtD in technical news.

12. Discussion

There was broad consensus that PtD Education Functional Area should include instruction at the secondary school level, as well as work force education, and that all types of teaching, both formal and informal, classroom teaching, and practical training, be included.

As a start, a complete study of all current PtD training be undertaken to ascertain current capabilities and define best practices. Examples include training by the ASSE, the CEO Health and Safety Charter in Ontario Canada, and educational efforts in Australia. Identifying all sources of education is critical.

For now, undergraduate and graduate school education in PtD should be accomplished largely through teaching modules and case studies added to existing curricula, rather than through entire new courses.

Further, a repository or database of such teaching modules should be developed and made available to all. The training

materials need to be well produced and proven to be effective. As a start, the database should be populated with available materials, and then a gap analysis performed to identify additional needs. Grant money, and other incentives, can be used to support the development of additional modules and case studies.

To encourage schools to incorporate PtD into their curriculum, PtD should be linked to other similar course content, such as sustainability, environmentalism, and other matters of corporate good citizenship. Accreditation bodies and professional societies that help drive curriculum content should be approached and educated about the importance of teaching PtD. There is consensus among the sectors that there are significant barriers to improving education of PtD, and that taking advantage of the drivers, such as CEO's influencing universities, research funding influencing faculty, and certification influencing companies, is needed.

In the area of work force and continuing education, practical opportunities for training at the worksite should be developed, and all employees involved in the creation of products and implementation of processes should be included in PtD training.

Development of CEO training in PtD should be explored. To reach small businesses and have them offer PtD training, incentives should be developed. It was further urged that community education be used to raise awareness of PtD among consumers, so that they will be able to assess the qualifications of contractors in terms of their implementation of safety principles.

Finally, to enhance the likelihood that PtD education and training will be integrated into school curricula and made a part of work force training, it was recommended that drivers of change, as well as barriers to change, be identified at all levels and across various industry sectors.