



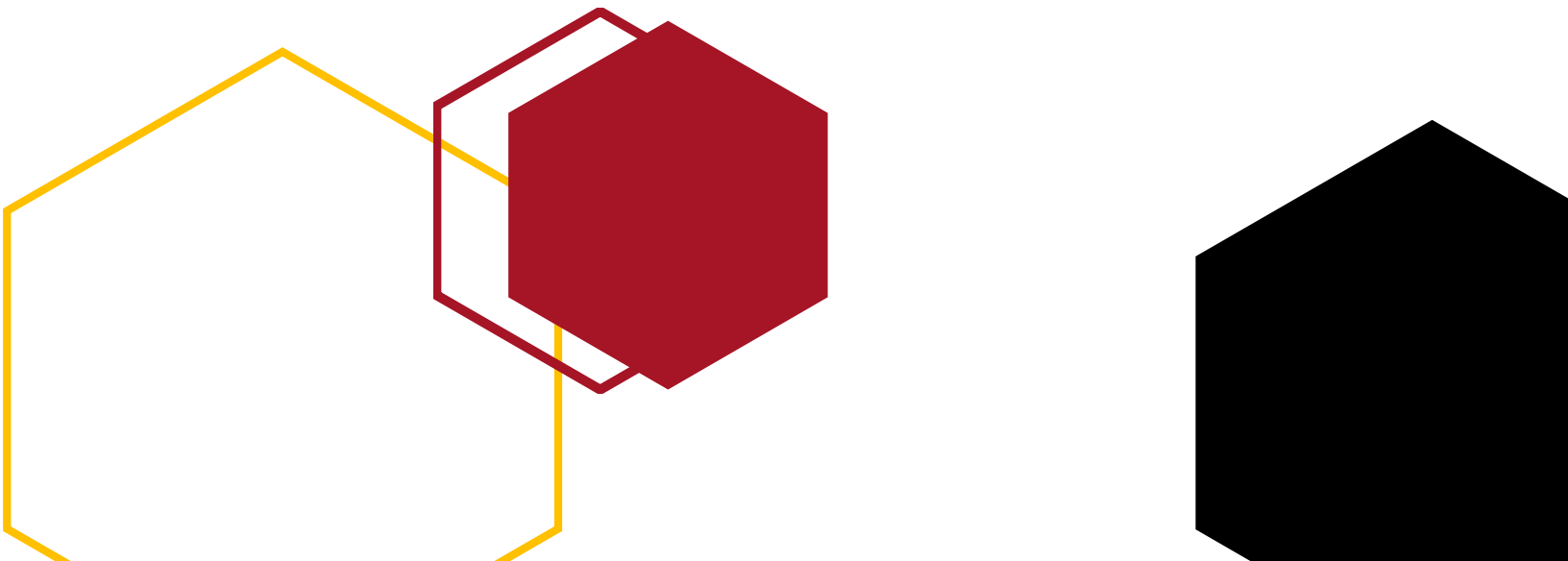
Prevention through Design 2020: Current and Future State-of-the-Art on Research, Practice and Education

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Arizona State University, NIOSH award R13OH011707-01-00

Report No.1, June 2020

Arizona State University, Tempe, AZ 85281



Executive Summary

Arizona State University hosted the first Prevention Through Design (PtD) Workshop 2020 in Tempe, AZ on March 11, 2020. The event brought together representatives from 20 construction industry organizations as well as nine universities, to work on improvement of PtD efforts in research, implementation and education. This first Workshop was designed to identify, exchange, and leverage experiences and expertise on PtD research, practice, and education efforts at engineering, design, contractor, client and owner organizations, insurers, US colleges and universities, and agencies. During the Workshop, 45 participants were actively engaged in review of the best practices of PtD including where designs have failed and succeeded. With subject matter expert (SME) feedback, a baseline of the current PtD state-of-the-art was established. Past, current, and potential PtD research efforts were discussed. High payoff research topics were identified. Synergistic and collaborative opportunities were sought among SMEs, researchers, and academics. Keynote videos and details of this workshop can be found at <https://ptd.engineering.asu.edu/ptd-workshop-2020-neu/>.

Funded by NIOSH and hosted by Arizona State University, this workshop was the first of what is planned to be a five-year Prevention through Design (PtD) Initiative aimed at engaging compelling stakeholders from agencies, industry, and academia in order to advance PtD. PtD holds the promise to substantially reduce exposure of construction workers to safety and health hazards and minimize the rate of accidents, morbidity, and fatalities. It also can improve efficiency and thus profitability for project participants. When properly implemented, PtD facilitates the identification and mitigation of exposure from early project stages (i.e., from conceptual design), in contrast with the prevalent practice of waiting for construction to start. However, to date, PtD knowledge and implementation are still scarce. Such lack of PtD awareness negatively impacts the wellbeing of construction workers. Safety records in Australia and the UK (where PtD is more widely practiced and required by law) point to a disparity between their results and the US, indicating that PtD may play a significant role in reducing fatalities in the US construction sector in the future if adopted more widely. With a series of annual workshops starting in Spring of 2020, this NIOSH-funded effort aims at: 1) advancing PtD knowledge; 2) promoting the implementation of PtD through the engagement of agencies, industry, and academia; and, 3) promoting the instruction of PtD in construction management and construction engineering programs at US colleges and universities.

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Acknowledgements:

Thanks to NIOSH and the Del E. Webb School of Construction for their financial help in making this Workshop a reality. We want to thank our keynote speakers for their work in putting together a wonderful set of markers for future workshops. Thanks to the National Academy of Construction (NAC) for sponsoring Mike Flower's trip to Tempe. We want to thank our Steering Committee for their excellent guidance in this first year. Also, much thanks to Mark Grushka, Zia Ud Din, Charles Hoes, and Rob Berryman for facilitating the breakout sessions during the workshop. Also, thanks to our ASU graduate students for their support during the event and to Hanisha Chava for her work in setting up the details of the Workshop. Finally, thanks to Lisa Hogle and her staff for their "behind the scenes" work in making the Workshop possible.

Citation:

Gibson, G., Grau, D. and Chava, H. (2020). *Prevention through Design 2020: Current and Future State-of-the-Art on Research, Practice and Education, Report 1*, School of Sustainable Engineering and the Built Environment, Ira A. Fulton Schools of Engineering, Arizona State University. DOI: 10.13140/RG.2.2.32031.59049

Available at: <https://ptd.engineering.asu.edu/ptd-workshop-2020-neu/>

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1. Introduction

This document describes the first Prevention Through Design (PtD) Workshop 2020 hosted by Arizona State University at the College Avenue Commons building in Tempe, AZ on March 11, 2020. The theme of this workshop was “Current and Future State-of-the-Art on Research, Practice and Education.” The event brought together representatives from 20 construction industry organizations as well as nine universities, to work together on improvement of PtD efforts in research, implementation and education. Participants represented organizations in North America and several international countries. This first Workshop was designed to identify, exchange, and leverage experiences and expertise on PtD research, practice, and education efforts at engineering, design, contractor, client and owner organizations, insurers, US colleges and universities, and agencies. Keynote videos and details of this workshop can be found at <https://ptd.engineering.asu.edu/ptd-workshop-2020-neu/>.

The Purpose of this PtD Workshop Initiative was to facilitate information exchange and foster momentum toward better awareness, implementation and education of PtD in the work place and higher education, ultimately helping drive positive change.



Dr. David Grau introducing the workshop agenda (photo courtesy of Pedram Esmailzadeh)

During the Workshop, the 45 participants¹ were actively engaged throughout the day. With subject matter expert (SME) feedback, a baseline on the current PtD state-of-the-art was established. Past, current, and potential PtD research efforts were discussed. High payoff research topics were identified. Synergistic and collaborative opportunities were sought among SMEs, researchers, and academics. The agenda for this first Workshop is provided in Appendix B.

The Workshop was envisioned as the first of at least five, focused on PtD and funded by the National Institute of Occupational Safety and Health (NIOSH). This initiative is described in Appendix C and its aims are:

- To drive the implementation of PtD at large industry organizations.

¹ The list of participants can be found in Appendix A

- To advance knowledge in PtD through collection of implementation guidelines, tools, and identify case studies and business case models for the effective demonstration of concepts and strategies.
- To promote the instruction of PtD in construction management, construction engineering, architecture and other engineering programs at US colleges and universities.

The vision for this first Workshop and additional workshops within the five-year PtD Initiative is that they become a significant linchpin for enhancing the dialog about PtD, inspiring and fostering research into PtD, improving implementation of PtD concepts, helping to build momentum in education and training, and ultimately leading to improved safety performance in the workplace



Workshop Venue and Participants (photo courtesy of Pedram Esmailzadeh)

and saving lives. The Steering Team² sees this effort as facilitating the formation and execution of work streams to enhance safety.

Mr. Jonathan Bach³ from the National Institute of Occupational Safety and Health (NIOSH) was the initial keynote presenter, setting the stage for the rest of the Workshop. His presentation provided a relevant history of PtD, highlighted work by NIOSH and others, outlined no-cost PtD educational resources covering key construction features and trades, and summarized both the “Priority” and the “Process” of PtD. In addition, he demonstrated by means of hard numbers the powerful advantages of PtD methods and their ability to amplify the impact by construction professionals⁴. Overall, the presentation provided a very good kickoff to the workshop.

² The Steering Team is listed in Appendix D.

³ Presenter bios can be found in Appendix E.

⁴ Keynote video and presentation can be found at: <https://ptd.engineering.asu.edu>.

2. Prevention through Design Research

As mentioned previously, the morning working session of the Workshop consisted of two keynote speakers, followed by two facilitated breakout tracks. One of the tracks focused on the current state of PtD Research, while the other on PtD Implementation. This Chapter describes the Research track.



Dr. John Gambatese (photo courtesy of Pedram Esmailzadeh)

Dr. John Gambatese⁵ of Oregon State University provided a key note presentation describing research that supports selecting PtD as a means to efficiently and effectively address safety on projects. He outlined multiple research studies that have been conducted to explore the benefits of PtD, best practices for its implementation, and factors that inhibit its implementation in the design and construction industry. His presentation explained the results of PtD research, demonstrating the value of addressing and mitigating construction site safety in the design of a project.⁶ The presentation set the stage for a breakout, focused on a research path forward as described below.

Approximately half of the attendees participated in two facilitated breakout groups focused on PtD research. Mr. Mark Grushka and Dr. Zia Ud Din facilitated these breakouts. After deliberation, the plenary session reconvened and each group presented their results. This breakout specifically addressed the following topics:

- 1) Identify and discuss opportunities for creating synergies and leveraging efforts in PtD research, including research needs or topics;
- 2) Identify and discuss challenges to conducting PtD research; and
- 3) Prioritize top opportunities and challenges for conducting PtD research; briefly discuss strategies to overcome challenges or strengthen opportunities and paths forward.

⁵ Speaker bios provided in Appendix E

⁶ Keynote video and presentation can be found at: <https://ptd.engineering.asu.edu>.

The breakout groups provided the following overarching guidance and thoughts. Researchers should work closely with industry participants and industry-oversight teams, enabling connectivity and effective communication between researchers and owners/contractors. They also should target industry sectors with high ownership input and influence



Breakout Group (photo courtesy of Pedram Esmailzadeh)

(universities, hospitals, industrial) or insurance companies for research funding. Researchers should consider identifying high performing organizations using PtD as test cases (i.e., those with existing business processes, such as electrical transmission, Integrated Project Delivery (IPD) implementers, or the prefabrication industry). Also, researchers should leverage existing knowledge of organizations such as NIOSH and CPWR—The Center for Construction Research and Training. The need for increasing investment in PtD research was a recurring theme. Among the key opportunities identified for study are:

- Improving ways to implement technology impacting PtD, including use of big data analytics, virtual/augmented reality training, artificial intelligence (AI), sensing and so forth.
- Demonstrating positive cost/benefit of implementation of PtD
- Improving training of designers, including pedagogical research
- Investigating impact of accreditation standards and education on PtD outcomes
- Comparing PtD in the United States against that in countries such as the UK and Australia with existing regulations mandating PtD

Among the key challenges identified are:

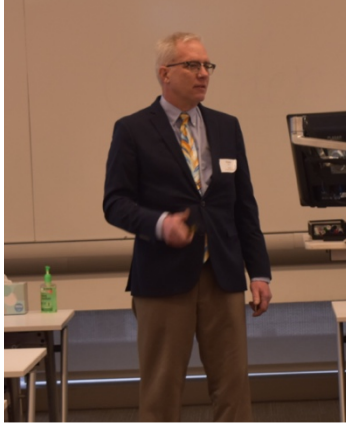
- Availability of research funding
- Communication across diverse spectrum of users (engineers/designers/owners and other key stakeholders), which requires improving “language” relating to PtD
- Collaboration between researchers and industry practitioners including sharing of information by industry participants and data availability on safety implementation and how to measure it

- Contract methods, perhaps biggest influence, as many contracts are not collaborative in terms of sharing responsibility for safety
- The right tools and technology may not be available to support PtD
- Social norms/cultural issues, including lack of understanding by designers/engineers that PtD is and should be part of their responsibility

Overall, the breakout participants agreed that a significant amount of research has been done, but much more is yet needed. Engagement of facility owner groups, access to data, and utilization of proper research methodology are all challenges, but need to be pursued to help push PtD in the United States. Areas of research inquiry should be focused on performance (looking backward), PtD practice, technology effect on PtD, and education effectiveness.

3. Prevention through Design Implementation

As noted, the morning session of the Workshop consisted of two topic-specific keynote speakers, followed by two facilitated breakout tracks. One of the tracks focused on the current state of PtD research, while the other PtD Implementation. This Chapter describes the Implementation Track.



Mr. T.J. Lyons (photo courtesy of Pedram Esmailzadeh)

Mr. T.J. Lyons⁷ from Total Facility Solutions gave an engaging presentation on the value of PtD, including case histories in the U.S. and overseas. Examples of how several current practices provide “killing conditions” to workers and owners long after construction is complete were discussed. How firms can use PtD to increase efficiency, and indeed profit, while realizing a safer project by default were demonstrated. The presentation emphasized how PtD not only supports a “safety thing” but also becomes “good business”. The presentation was supported with numerous examples of PtD applications that firms routinely incorporate, leveraging the need for their competitors to step up and embrace this philosophy to succeed.⁸ Mr. Lyons provided the attendees with several tangible examples/handouts, including safe-installation modular electrical outlets, rolled-edge steel studs, no-blind spot fork lifts, emission-controlled asphalt equipment, and other designs than can enhance both safety and productivity.

Approximately half of the attendees participated in two facilitated, implementation breakout groups addressing the following statements:

- 1) Identify and discuss opportunities for creating synergies and leveraging efforts in PtD implementation, including strategies or developments needed;
- 2) Identify and discuss challenges to conducting PtD in application; and
- 3) Prioritize top opportunities and top challenges for implementing PtD; briefly discuss strategies to overcome challenges or strengthen opportunities and paths forward including key organizations to leverage with.

⁷ Speaker bios provided in Appendix E.

⁸ Keynote video and presentation can be found at: <https://ptd.engineering.asu.edu>



Breakout Group (photo courtesy of Pedram Esmailzadeh)

These two breakout sessions were facilitated by Mr. Charles Hoes and Mr. Rob Berryman. After deliberation, the plenary session reconvened and each group presented their results. One overarching theme included the need to educate practitioners such that capacity can be created for safety (failing safely) not

only in terms of how the building or facility is designed, but also the tools, methods, knowledge, and abilities of workers who are using those tools to build. Stakeholders/owners should be educated to the value and financial return that PtD provides, including guidance on how they should direct architects/engineers to design safe environments. Emphasis should be put on eliminating silos, creating implementation education models to share with industry, developing an implementation body of knowledge (BOK), and capturing the influence of prefabrication on PtD.

Among the key opportunities identified are:

- Focus on social norms, such that engineers/architects understand PtD is part of their job
- Provide an index of SME resources (i.e., videos, web sites, publications, consultants)
- Enhance and supplement design processes and influence building code legislation to push PtD adoption
- Use AI and big data analytics to assist designers
- Address the “buckets of complexity” in the design process, and how to focus on the end state of having a safe design
- Break down communication barriers, so that everyone shares a common PtD language
- Communicate the processes that have fail-safe means
- Communicate ROI of PtD savings
- Create a model of how to enhance the Body of Knowledge (BOK) and training needs for PtD
- Get a large number of universities to buy in to the promotion of PtD principles and practice
- Embed PtD into the curriculum of university design programs

- Develop a certification process in PtD for practitioners (e.g., similar to LEED AP)
- Encourage designers to take “construction” internships in college or early in their careers to expose them to hazard recognition

Among the key challenges identified are:

- Fragmentation of the industry and higher education
- Language and communication barriers
- Mindset and culture of the industry at this time (e.g., lack of system safety thinking)
- Shifting of risk through contracts (e.g., from owner to contractor(s))
- Blaming the wrong, or other parties, for safety issues, and not taking responsibility

Overall, the breakout participants agreed that much is known about prevention through design concepts and processes, but knowledge is not used widely. Engagement of all relevant parties, including owners, designers, contractors, and educators, is important to ensure the practices can be widely adopted. Perhaps a push for legislation, similar to the UK, is needed to provide the impetus to make this happen. At the same time, accreditation requirements in higher education design programs should include and be more explicit in requirements for evaluation of learning in PtD. A clearinghouse of PtD knowledge and also certification program(s) to assess and qualify SME’s would provide value.

4. Prevention through Design Education

This Chapter describes the afternoon working session of the Workshop, which consisted of two keynote speakers on the themes of PtD education in practice and PtD in higher education, followed by one facilitated breakout track focused on the current state of PtD education.



Mr. Mike Flowers (photo courtesy of Pedram Esmailzadeh)

Mr. Mike Flowers⁹ gave a presentation that emphasized the synergistic relationship between PtD education (or lack thereof) and safety conditions during project execution. Based on a critique of current state-of-the-art design and construction practices, PtD opportunities were identified, exemplified, and discussed. Structural stability concepts and practices were outlined to highlight the opportunity that sophisticated owner, design, and contractor organizations can leverage to integrate prevention analysis in the design process.¹⁰

Dr. Mike Toole lead his presentation with the following question, “If designing out hazards is a powerful way of making our construction sites and other workplaces safer, shouldn’t all engineers receive training on occupational safety and on preventing injuries through design?” The presentation focused on how PtD can be an excellent channel to address topics included in engineering program criteria that are frequently not given sufficient attention, including

⁹ Speaker bios on this page provided in Appendix E.

¹⁰ Keynote videos and presentations can be found at: <https://ptd.engineering.asu.edu>

engineering ethics, social sustainability, integrated design and construction, life-cycle perspectives, public policy and leadership.

All Workshop attendees participated in four, facilitated education-focused breakout groups addressing the following statements:

- 1) Identify and discuss opportunities for creating synergies and leveraging efforts in PtD education, including developments, programs, technology;
- 2) Identify and discuss challenges to educating PtD at the university and practitioner level; and
- 3) Prioritize opportunities and challenges for PtD education; briefly discuss strategies to overcome challenges or strengthen opportunities and paths forward.



Dr. Mike Toole (photo courtesy of Pedram Esmailzadeh)

The four breakout groups were facilitated by the same group of facilitators from the morning sessions. After deliberation, the plenary session reconvened and each group presented their results. Overarching themes that became evident in the breakouts included: the need to require PtD education as part of accreditation at the university level; the opportunity for more structured continuing education efforts in PtD, including the possibility of certification; the difficulty of teaching PtD, both logistically and pedagogically; and again the need for information/research on ROI and benefits of PtD. Emphasis should focus on eliminating barriers through curricula development, identifying PtD SMEs who can help in the class room, and leveraging information that is already available.

Opportunities for creating synergies and leveraging efforts in PtD education are:

- Identify and influence stakeholders (accreditors, associations, industry professionals, etc.) to ensure universities are producing PtD-educated students.
- Tie ABET/or other accreditation board's criteria to PtD
- Integrate PtD into curriculum (instead of classes); including content/modules and teaching methods across all disciplines of engineering and design
- Include a PtD focus in student competitions/ASCE/awards/scholarships
- Leverage guest lectures (sharing knowledge through case studies, lessons learned); develop clearing house of SMEs willing to serve as guest lecturers across the country and as industry-focused experts, based on discipline
- Promote collaboration between different engineering disciplines to enforce the application of PtD
- Promote outlets for additional trainings / professional development / certification; perhaps a text book and continuing education opportunities (perhaps through OSHA training centers)
- Train and educate professors on PtD (“train the trainer”)
- Offer degree programs specifically focused on safety and safety design in higher education
- Set PtD as a topic across all design disciplines (architecture, engineering (including a number of disciplines such as civil, mechanical, electrical, chemical, etc.) and construction)
- Provide field trip opportunities to demonstrate PtD design principles



Charles Hoes presenting breakout group results (photo courtesy of Pedram Esmailzadeh)

Top challenges to educating PtD at the university and practitioner level are:

- Lack of academia leadership support and buy-in. Curricula are not easy to change

- Unclear nature of what curricula are needed and how to develop them
- PtD competency/capability is not clear and not defined; for example, what other expertise areas complementary to PtD
- Limited time for inclusion of new subjects in university programs (e.g. integrating safety, PtD, and constructability into the coursework as opposed to other subjects and requirements)
- Assess effective PtD application in education; it is unclear what the criteria should be
- ABET and other accreditation organization's influence on curricula improvement, and the relationship of change with industry practitioners and academia.
- Lack of interest by decision makers in PtD education and training

The breakout participants felt that the following enablers could immediately help with PtD education at universities on a class by class basis. Instructors can

- 1) facilitate student involvement in job activities (course project, practical project) where they have to go to a project site and analyze safety;
- 2) give hands-on opportunities to identify hazards on project sites as part of course work;
- 3) teach students to understand the difference between risks and hazards;
- 4) improve safety thinking by teaching safety from all facility participant's perspectives (owner, designer, contractor, user);
- 5) encourage field trips to understand safety aspects of projects, and devise/explore safety solutions and design options; and
- 6) create virtual/ augmented workspaces to teach students about the safety aspects of design.



Student volunteers interacting with Dr. Ud Din (photo courtesy of Pedram Esmailzadeh)

The more-broader influence to higher education and continuing education will require much more effort. Developing certifications and changes to accreditation requirements require long term campaigns, perhaps influenced by regulatory and/or accreditation governing body involvement.

5. Summary

The day wrapped up with a summary of key thoughts and learnings from this first PtD Workshop. It was clear from the enthusiasm generated during the event that gatherings of informed and interested safety professionals and academics, such as this Workshop, are important to help move the goal of improving PtD on projects and products forward. Details of the presentations and breakout sessions are provided in previous chapters. Some of the key issues to consider across research, implementation and education include:



Active participation from attendees (photo courtesy of Pedram Esmailzadeh)

- Work or lobby to increase investment in research around PtD
- Research opportunities:
 - Improving ways to implement technology impacting PtD
 - Demonstrate positive cost/benefit of implementation of PtD
 - Improving training of designers, including pedagogical research
 - Comparisons of PtD in the United States against countries such as the UK and Australia with existing regulations mandating PtD
- Develop an index of SME resources (i.e., videos, web sites, publications, consultants)
- Focus on a campaign to influence social norms, such that engineers/architects understand PtD as part of their job
- Enhance and supplement design processes and influence building code legislation
- Identify and influence stakeholders (accreditors, associations, industry professionals, etc.) so that universities produce PtD-educated students.
- Work to change and tie ABET/or other accreditation board's criteria to PtD
- Focus on integrating PtD into curriculum (instead of classes); include content/modules and teaching methods across all disciplines of engineering and design

- Develop options for additional training / professional development and PtD certification for professionals through continuing education opportunities (maybe through OSHA training centers)

Among the key challenges identified:

- Availability of research funding
- Communication across diverse spectrum of users (engineers/designers/owners and other key stakeholders), which requires improving and sharing “language” relating to PtD
- Collaboration challenges between researchers and industry practitioners including sharing of information by industry participants and data availability on safety implementation and how to measure
- Contract method challenges, perhaps one of the biggest influences, as many contracts are not collaborative in terms of sharing responsibility for safety
- Fragmentation of the industry and higher education
- Language and communication issues
- Mindset and culture of the industry at this time; lack of system safety thinking
- Lack of academia leadership support and buy-in. Curricula are not easy to change
- Unclear nature of what curricula are needed and how to develop
- PtD competency/capability is not clear and not defined

The Steering Committee will take these recommendations and craft future workshops and programs to start addressing these issues. The success and improvement of the Workshop itself is explored in the section below.

Efficacy of the Workshop

Workshop participants were asked to fill out an evaluation survey at the end of the day giving their perspective of the Workshop and were asked for suggestions for improvement. A number of questions were asked using a Likert Scale of 1 to 5, with 1 relating to poor and 5 relating to excellent. The weighted average of each questions is given in Table 1. The five keynote speakers had excellent ratings, ranging from 4.44 to 4.75 on this 5-point scale (not shown).

Table 1. Workshop Participant Subject Evaluation of Contents (n=29)

Question	Average Rating
Workshop content overall	4.55
Applicability to your present and future assignments	4.27
Format and organization	4.62
Time allotted to each topic	4.51
Time allotted to breakouts	4.55
Overall workshop rating	4.57

Overall the Workshop was well-received by the participants. As one of the participants stated, “This was a very well-designed workshop. The speakers were incredible and covered a broad spectrum of professional experiences.” As another said, “It was very interesting to have the breakout sessions. The discussions were very good at identifying common needs across differing disciplines. I found the discussions helped expand my thinking for how to apply this in my daily work.”

A number of yes/no questions were asked to gage the overall value of the workshop. The percentage of yes/no answers for each of the questions is given in Table 2.

Table 2. Workshop Participant Subject Evaluation of Overall Value (n=28)

Questions	Yes %	No %
Did the workshop improve your overall understanding of PtD?	92.8	7.2
Did the workshop improve your understanding of how to implement PtD?	78.5	21.5
Did the workshop improve your understanding of PtD education?	86.2	13.8
Did the workshop improve your understanding of PtD research?	87.5	12.5
Was the venue and food service adequate?	92.8	7.2
Would you recommend a future similar workshop to others?	92.8	7.2
Was the workshop worth the time that you spent attending?	92.8	7.2

Overall, the Workshop was very well received and met its goals. There were some comments for future improvement. Among the comments included “Workshop was very informative. The breakouts need better leads and directs. The evidence or background for breakout discussions can be improved. I would like to volunteer for further workshops.” Another interesting comment

stated, “Good presentations from very knowledgeable presenters. Include more designers and not just safety focused individuals for the next workshop.”

A number of additional suggestions for future content were also received and these will be used as a basis for crafting the next Workshop. The Steering Committee will take these and additional comments received in the survey answers to improve the next workshop, which is tentatively scheduled for the first half of 2021.

Appendix A. First PtD Workshop Attendees

Name	Organization
Ali Abbas	Hong Kong Polytechnic University, Graduate Student
Casey Ambrose	Town of Gilbert, AZ
Vartenie Aramali	Arizona State University, Graduate Student
Jonathan Bach (via ZOOM)	National Institute of Occupational Safety and Health (NIOSH)
Robbie Berryman	American Contractors Insurance Group
Rita Bottesch	Arizona State University, Research Laboratory Mgr.
Guy Boyd	Arizona State University, Laboratory and Safety Mgr.
Bob Bracken	Hub International
Hanisha Chava	Arizona State University, Graduate Student
Namho Cho	Arizona State University, Graduate Student
Toby Crooks	Town of Gilbert, AZ
Hongtao Dang	Central Washington University
Zia Din	University of Houston
Kevin Dunn	Southland Industries
Behzad Esmaeili	George Mason University
Liam Pedram Esmailzadeh	Arizona State University, Graduate Student
Chase Farnsworth	M.A. Mortenson Company
Michael Flowers	American Bridge Company (ret.)/National Academy of Construction
John Gambatese	Oregon State University
Steve Gauthier	OSHA Training Institute Education Center, Keene State College
G. Edward Gibson, Jr.	Arizona State University, Professor
David Grau	Arizona State University, Associate Professor
Mark Grushka	MJGrushka Consulting
Chad Halmrast	Southland Industries
Charles Hoes	Hoes Engineering, Inc; International Systems Safety Society
John Hogan	DPR Construction, Inc.
Stan Klonowski	Arizona State University, Research Laboratory Mgr.
Bruce Lyon	Hays Companies
Thomas J. Lyons	Total Facility Solutions, Inc.
Joshuah Mason	Arizona State University, Shop Mgr.
Babak Memarian	CPWR—The Center for Construction Research and Training
Francisco Mendoza	Arizona Division of Occupational Safety and Health (ADOSH)
Laketta Neumann	Total Facility Solutions, Inc.
Bala Sai Krishna Paladugu	Arizona State University, Graduate Student
Khandakar Rashid	Oregon State University, Graduate Student
Rick Rinehart	CPWR—The Center for Construction Research and Training
Nazila Roofigari-Esfahan	Virginia Tech
Ruben Rodriguez	Arizona Division of Occupational Safety and Health (ADOSH)
Sidney Ruiz	Southland Industries
Melissa Schmaltz	Sompo International
Verena Schneider	Arizona State University, Graduate Student
Jochen Teizer	Aarhus University
T. Michael Toole	University of Toledo
Nicholas Tymvios	Bucknell University
Tim Van Wieren	SNC Lavalin, LLC
Marc Wetter	Parsons Corporation

Appendix B. First PtD Workshop Agenda

Agenda

**March 11, 2020 Prevention Through Design Workshop
Theme: Current and Future State of Art Research and Practices
College Avenue Commons, Room 351
Tempe, AZ**

- 7:30-8:00 Gather and Check In
Light refreshments, coffee
- 8:00-8:15 Welcome and Introduction (Grau and Gibson)
- 8:15-8:35 NIOSH and PtD (Jonathon Bach)
- State of Art Research**
- 8:35-9:10 PtD Research: Why Implement Prevention Through Design
(John Gambatese)
- 9:10-9:45 Moving from Risk Management to Risk Elimination (TJ Lyons)
- 9:45-10:05 Networking Break
- 10:05-11:30 Facilitated Breakout on Research and PtD Practice (with report outs)
- 11:30-12:30 Networking Lunch
- State of Art Practice**
- 12:30 -1:00 Engineering Education and Project Execution (Mike Flowers)
- 1:00 -1:30 Opportunities and Challenges for PtD Education (Mike Toole)
- 1:30 - 2:50 Facilitated Breakouts Education and Practice (with report outs)
- 2:50 - 3:10 Networking Break
- 3:10 - 3:30 Summary and wrap-up, path forward (Grau and Gibson)

Appendix C. Prevention Through Design Workshop Initiative

Construction hazard PtD holds the promise to eventually reduce exposure of construction workers to safety and health hazards, and hence minimize accidents, morbidity, and fatalities. PtD aims at the proactive identification and mitigation of hazard exposure(s) through the design function, i.e. conceptual and detailed design, in contrast to the prevalent industry practice of waiting for construction in order to assess hazards. Hence, there is a critical need to 1) advance PtD knowledge and 2) disseminate and engage influencing stakeholders who are in the position to lead and advocate for the implementation of a holistic PtD approach. In order to address these gaps, highly influencing stakeholders at client / owner, designer, and contractor organizations will be engaged with this PtD Workshop Initiative.

The proposed sequence of workshop themes includes this initial Kickoff workshop in March 2020, followed by four more workshops focused on: 1) current and future state of the art research and practice; 2) training and education; 3) incentives, barriers, and liability; 4) benefits, costs, and lifecycle costs; and, 5) advanced design technologies and PtD.

The aims of this initiative include:

Aim 1: To drive the implementation of PtD at large industry organizations. We will inform and engage highly influential stakeholders at large client / owner, designer, and contractor organizations. We will measure the cumulative engagement of these organizations with PtD during the 5-year effort.

Aim 2: To advance knowledge in PtD. We will collect implementation guidelines, tools, and identify case studies and business case models for the effective demonstration of concepts and strategies. We will query stakeholder participants, for example on PtD drivers, benefits, and barriers. We will also identify and analyze information gaps, and propose a high payoff research agenda. We will evaluate the number, quality, and broader impacts of knowledge contributions.

Aim 3: To promote the instruction of PtD in construction management and construction engineering programs at US colleges and universities. We will design and proactively disseminate six graduate instruction modules around PtD workshop themes. We will cumulatively track academics and programs including the PtD approach in their curriculum.

Appendix D. PtD Steering Team, 2019-20

Name	Organization
Rob Berryman	American Contractors Insurance Group (ACIG)
Scott Earnest	National Institute of Occupational Safety and Health (NIOSH)
Mike Flowers	American Bridge Company (ret)
John Gambatese	Oregon State University
Edd Gibson	Arizona State University
David Grau	Arizona State University
Mark Grushka	MJGrushka Consulting
Charlie Hoes	Hoes Engineering, Inc
TJ Lyons	Total Facility Solutions
Babak Memarian	CPWR—The Center for Construction Research and Training
Jack Toellner	Toellner Consulting, LLC
Mike Toole	University of Toledo
Zia Ud Din	University of Houston

Appendix E. Keynote Bios

Jonathan Bach is a professional engineer serving at the National Institute for Occupational Safety and Health, NIOSH, as the coordinator for the Prevention through Design (PtD) program. He is certified in industrial hygiene and safety. After gaining his engineering degree at Syracuse University, Mr. Bach served as an active duty Bioenvironmental Engineering officer with the U.S. Air Force in Colorado, Turkey, Italy, and Pennsylvania. In 2002 he became a regional industrial hygiene manager for Naval Healthcare New England. In 2004 Mr. Bach moved to Germany to serve with the U.S. Army Corps of Engineers as an environmental project manager and the industrial hygienist for European operations. In 2007, Mr. Bach became the overall Health and Safety Manager for the Army Corps of Engineers in Europe. From 2014 to this date, Mr. Bach's work has focused on PtD with NIOSH.

John Gambatese is a Professor at Oregon State University. His educational background includes Bachelor and Master of Science degrees in Civil Engineering from the University of California at Berkeley, and a PhD in Civil Engineering from the University of Washington. He has worked in industry for six years as a structural engineer in San Francisco and for one year as a project engineer for a construction management firm in Seattle. Dr. Gambatese's expertise is in the broad areas of construction engineering and management, and structural engineering. He has performed research and published numerous articles on construction worker safety, work zone design and safety, prevention through design, risk management, sustainability, constructability, innovation, and construction contracting. He is a member of the American Society of Civil Engineers (ASCE) and American Society of Safety Professionals (ASSP). He is a licensed Professional Civil Engineer in California.

T.J. Lyons is the Regional Environmental, Health, and Safety Manager for Total Facility Solutions, a company of the Exyte Group. For many years, he has worked for some of the largest construction firms in the US and with substantial experience working with Department of Defense. He is Board certified as an Occupational Health and Safety Technologist and Certified Safety Professional. As a result of his long-term advocacy and advancement of health and safety in the design and construction industry, Mr. Lyons is the recipient of multiple awards, including the 2018 IRMI Words of Wisdom (WOW) Award and 2001 IRMI Gary E. Bird Horizon Award. Mr. Lyons was a past chapter writer for the American Society of Testing of Materials and for the recent American Society of Safety Professionals' Construction Safety Management and Engineering. He is Past president of the Hudson River Valley Chapter of the American Society of Safety Engineers. His current focus aside from PtD is helping bring awareness to suicide in the construction industry.

Michael D. Flowers is the retired President and CEO of American Bridge Company. He received his Bachelor of Science in Civil Engineering from West Virginia University and his Master of Science Degree from the University of Pittsburgh. Flower's has worked over 44 years in the engineering and construction of high-rise buildings and complex bridges. He oversaw several notable bridge projects in his career including the rehabilitation of the Williamsburg Bridge in New York City, the Lions Gate Bridge in Vancouver, the historic Wheeling Suspension Bridge in West Virginia, the retrofit of the Tagus River Bridge in Lisbon, Portugal, and the Woodrow Wilson Bridge in Alexandria, VA. Mike is the recipient of multiple awards including the prestigious

Golden Beaver Award for his work on the new Bay Bridge, and ASCE's Roebling Award for outstanding leadership in construction of the most challenging bridge projects ever attempted in the modern era. Mike is an active member of the National Academy of Construction, ASCE, the West Virginia Academy of Civil Engineers, serves with an advisory capacity at both West Virginia University and University of Pittsburgh, and is a trustee at Berea College in Kentucky.

T. Michael Toole is the Dean of the College of Engineering at the University of Toledo. Previous employment includes serving as an officer in the U.S. Navy Civil Engineer Corps, management positions with a publicly traded homebuilder and a multidisciplinary engineering firm, and Associate Dean of Engineering and Professor of Civil and Environmental Engineering at Bucknell University. Mike received his B.S. from Bucknell and his Masters and Ph.D. from M.I.T. He is a professional civil engineer, a member of NSPE, a Fellow in ASCE, the Chair of the Ohio Engineering Deans Council, and hosts www.designforconstructionsafety.org.