



2024 Prevention through Design Workshop

Education, Training, & Legislation – Where do we go from here?

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Workshop Summary

This document provides a summary of the 2024 Workshop, the final annual event in a five-year PtD initiative funded by NIOSH. Held on August 27, 2024, at the ASU Barrett and O'Connor Washington Center in Washington, D.C., the workshop focused on the theme "Education, Training, & Legislation – Where do we go from here?" Featuring distinguished keynote speakers from academia, industry, and government, the event offered insights, knowledge, and experiences from various sectors and perspectives. The workshop also included networking opportunities, interactive sessions, case studies, and collaborative discussions, uniting educators, design and construction professionals, insurance experts, union and worker representatives, and policymakers. The overarching goal was to align research, practice, and policy to advance construction safety through design.

The workshop emphasized aligning research, practice, and legislation to advance construction safety through design

The workshop featured a robust lineup of speakers and interactive sessions. Eight keynote speakers presented insights from diverse perspectives spanning academia, industry, and government. Additionally, an expert panel discussion engaged participants in a debate on whether regulation or self-regulation would promote PtD effectively, further emphasizing the workshop's focus on collaboration and cross-industry sharing. The event also included two facilitated breakout sessions: the first focused on strategies for leveraging PtD practices, while the second explored the implications of legislation versus self-regulation. These elements combined to provide attendees with a comprehensive understanding of PtD and its implementation around the workshop theme.

1. Welcome and Introduction



Figure 1. Dr. Zia Ud Din during his introduction

The workshop began with a welcoming introduction by Dr. Zia Ud Din, co-chair of the workshop and Assistant Professor in the Department of Construction Management at the Cullen College of Engineering, University of Houston (see Figure 1). Dr. Ud Din emphasized the critical role of PtD in proactively addressing safety risks in the construction industry. He highlighted

PtD's potential to reduce workplace hazards and noted its importance in minimizing injuries and fatalities by embedding safety directly into the design process.

Dr. Ud Din's opening remarks underscored the collaborative spirit of the event, which aimed to unite industry stakeholders, academia, and policymakers in developing safer construction practices. His introduction set the stage for a workshop centered around exploring effective strategies to integrate PtD within large organizations, advancing education in PtD principles, contrasting self-regulation and legislation, and promoting the industry-wide adoption of PtD.

2. Opening Remarks



Figure 2. James Frederick during his presentation

James Frederick, Deputy Assistant Secretary of Labor for the Occupational Safety and Health Administration (OSHA), delivered an insightful keynote speech (see Figure 2) on workplace safety, historical fatality trends, and OSHA's strategic insights. His talk highlighted significant achievements, challenges, and future initiatives to advance workers' health and safety. Frederick emphasized the progress that OSHA has made in

reducing workplace fatalities since the OSHA Act was enacted in 1970. However, he cautioned that while improvements have been made, the challenge remains ongoing, exemplified by the slight increase in fatalities during the 2020s.

Frederick discussed trends in OSHA inspections, noting a temporary decline in inspection numbers a few years ago, which has since reversed, bringing inspection activity back on track. An inspection aims to ensure compliance with safety regulations and prevent workplace incidents. "A Good Job is a Safe and Healthy Job" Frederick reaffirmed OSHA's core vision of ensuring safety and health in every workplace. He emphasized that health and safety should be integral values for any organization, highlighting OSHA's role in enforcing them through regulations, standards, and guidance.

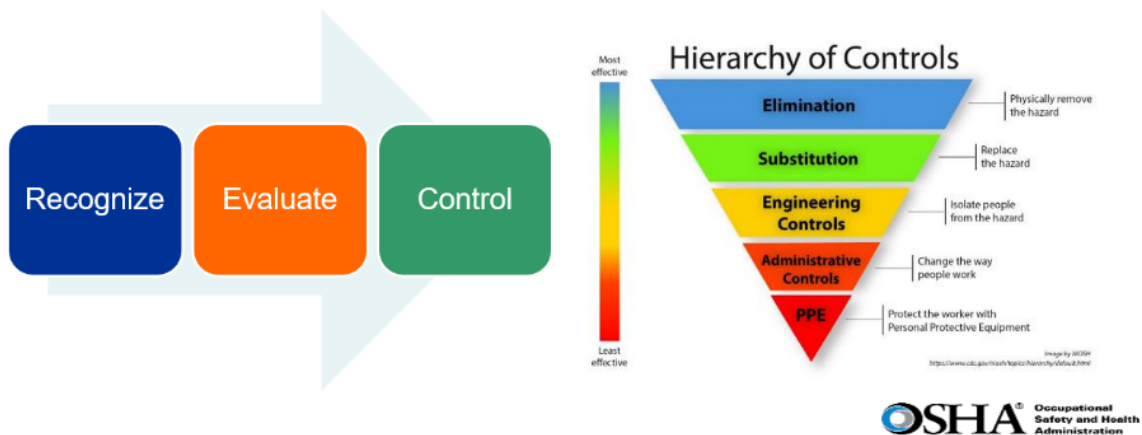


Figure 3. Hazard Control (extracted from James Frederick Presentation)

Frederick spoke about the importance of integrating safety and health management systems. These systems aim to recognize hazards, evaluate risks, and control dangers through the hierarchy of controls, which Figure 3 illustrates. The hierarchy includes elimination, substitution, engineering controls, administrative controls, and the use of personal protective equipment (PPE) as the last resource.

Also, OSHA is actively working to address inequities in workplace safety, particularly for underserved and vulnerable worker populations. Frederick highlighted the ongoing inequities in fatality rates, particularly among vulnerable populations. To address these disparities, OSHA has implemented key initiatives, including over 200 alliances with organizations aimed at protecting at-risk workers. OSHA is also enhancing language learning access to ensure that all workers have access to and can understand safety information. Strengthening whistleblower protections is another priority, allowing employees to report without fear of retaliation. Additionally, OSHA supports immigrant workers through visa certifications. Finally, OSHA exercises enforcement discretion to prioritize cases involving vulnerable workers and severe safety violations.

Dr. Scott Earnest, Associate Director for Construction at NIOSH, moderated an engaging question-and-answer (Q&A) session (see Figure 4) during which attendees delved deeper into OSHA and its impact on industry sectors. Participants explored the following key issues.



Figure 4. Dr. Scott Earnest moderating the Q&A session

- A discussion emerged around the link between worker vulnerability and accident rates, highlighting that such a relationship is still under investigation.
- OSHA's consultative programs were explained, particularly how they provide free, voluntary consultation services to employers to help identify workplace hazards and improve safety practices without penalties.
- A discussion emerged around the recent increase in workplace fatality rates. Causes include factors such as work-related motor vehicle accidents and workplace violence, especially in the retail sector.

- Frederick discussed OSHA's alliances and partnerships. OSHA has formed numerous partnerships, particularly at regional and local levels, focusing on large construction projects. Through these partnerships, OSHA emphasizes PtD, encouraging safety considerations early in the design process. The goal is to elevate conversations about health and safety while encouraging workshops and coordination with safety boards to share information and improve safety outcomes.

3. What did we Learn during the Last Five Years?



Figure 5. Dr. George Edward Gibson during his presentation

Dr. George Edward Gibson, President and CEO of the NAC, provided an insightful overview of the PtD Initiative, reflecting on its progress over the past five years (see Figure 5). Since its launch in 2020, the Initiative has aimed to improve safety in the construction industry by bringing together the design and construction communities. Despite challenges posed by the COVID-19 pandemic, the series of annual workshops continued its mission to disseminate PtD practices, enhance the momentum towards PtD, increase awareness and knowledge, and bring together design, construction, and safety experts.

The Initiative's first event was an in-person workshop in Tempe, Arizona, in 2020. As the pandemic unfolded, PtD transitioned to virtual workshops in 2021 and 2022. This shift to virtual events enabled global participation with attendees from multiple continents. In 2023, PtD returned to an in-person format, which was also adopted for the 2024 workshop described in this report. Over the five years, such a hybrid and flexible approach showed that conversations about safety are meaningful and important and thus can take place, regardless of format. A significant outcome of the 5-year Initiative has been the improved accessibility to PtD information. Before the Initiative, knowledge about proactive safety design was scattered around the Internet, and thus unclear. Today, resources such as reports, presentations, and case studies from the series of workshops are available on the [PtD website](#), offering valuable information and resources. Videos are also available on the dedicated [YouTube channel](#).

Dr. Gibson emphasized that although PtD is gaining wider recognition, its application remains inconsistent. Several case studies have demonstrated PtD's potential to prevent accidents, yet its practice varies across regions, sectors, and organizations. More effort is needed to ensure PtD is consistently integrated into design and construction practices.

Dr. Gibson highlighted the success of PtD in the United Kingdom (UK) and Australia, where legislation has been key to improving safety. UK's Construction Design and Management

(CDM) regulations, implemented in the 1990s, have significantly reduced construction fatalities, resulting in a fatality rate approximately one-fifth of that in the U.S. Similarly, Australia's Work Health and Safety (WHS) strategy, launched in 2012, has led to a fatality rate about one-fourth of the U.S. rate. Such evidence underscores the transformative impact of legislative frameworks in promoting the adoption of PtD principles. Dr. Gibson also shared data showing PtD's life-saving potential. Between 1990 and 2003, 42% of U.S. construction fatalities were linked to design flaws, while a 1991 European study revealed that 60% of fatal accidents were rooted in design decisions. Such large percentages underscore the importance of addressing hazards early in the design phase to prevent injuries and fatalities.

Technologies such as Building Information Modeling (BIM) and wearables promise to enhance PtD by helping designers and construction managers identify and mitigate risks. However, the fragmented construction industry and lack of PtD inclusion in higher education remain major challenges. Dr. Gibson emphasized the need for comprehensive training and legislation, underscoring that PtD is essential for making construction activities safer.

Dr. David Grau, Chair of the workshop and Sundt Construction Professor at ASU, moderated a Q&A session (see Figure 6) that explored insights from the PtD Initiative. Participants discussed the following key issues.



Figure 6. Dr. Grau moderating the Q&A session

- Integrating PtD into an already packed undergraduate curricula for architecture, engineering, and design was identified as a challenge.
- The lack of national PtD training standards is regarded as a barrier to consistent industry adoption. The fragmented construction industry makes transferring lessons between projects and organizations difficult, limiting PtD's broader applicability.
- Early client involvement from project inception in hazard identification was observed as key to enhancing safety.
- PtD design solutions can save costs, but designers need effective strategies to communicate these benefits to clients.

- The discussion on a case resulting in legal liability arising from construction fatalities underscored the critical role of PtD implementation in mitigating risks, preventing accidents, and minimizing legal repercussions.
- Design-build projects, where designers and constructors collaborate closely, were observed to improve safety by increasing shared responsibility and enhancing communication.

4. Review of UK Developments on PtD

Dr. Billy Hare, Professor at Glasgow Caledonian University, Deputy Director of the Built Environment Asset Management (BEAM) Research Center at the same university, and



Figure 7. Dr. Hare during his presentation

International Director of the Working Commission on Safety, Health, Well-being and Construction for the International Council for Research and Innovation in Building and Construction (CIB), delivered an insightful presentation (see Figure 7) focusing on developments in PtD, particularly from the UK's perspective, and explored how

similar principles are being applied in other regions like Australia. One of the central themes of his presentation was the comparison between traditional enforcement mechanisms, such as fines, and more progressive approaches like positive reinforcement through incentives and recognition. Dr. Hare emphasized that positive reinforcement, supported by incentives and recognition, leads to superior performance compared to fines, which, at best, results in compliance. This stance was reinforced by findings from the Health and Safety Executive (HSE) public body, which show that fines, while effective, need to be complemented by sustained cultural changes driven by positive reinforcement.

In the UK, CDM regulations are crucial in embedding safety into the early design stages of construction projects. Dr. Hare highlighted the rise in fines over the years, noting that the total penalties imposed increased from £15.6 million in 2011/12 to £69.9 million in 2016/17, although they stabilized at around £35.8 million in 2022/23. See Figure 8. However, there is an ongoing debate about whether such a punitive approach alone can deliver sustained safety improvements.

Dr. Hare contrasted the UK's approach with Australia's enforceable undertakings, where offenders enter legally binding agreements with the government to commit to long-term improvements in safety practices. This alternative focuses on restitution for affected personnel and promoting social justice by requiring offenders to contribute to safety research and

education programs. He suggested that restitution and social justice create a more sustained cultural change than fines alone.

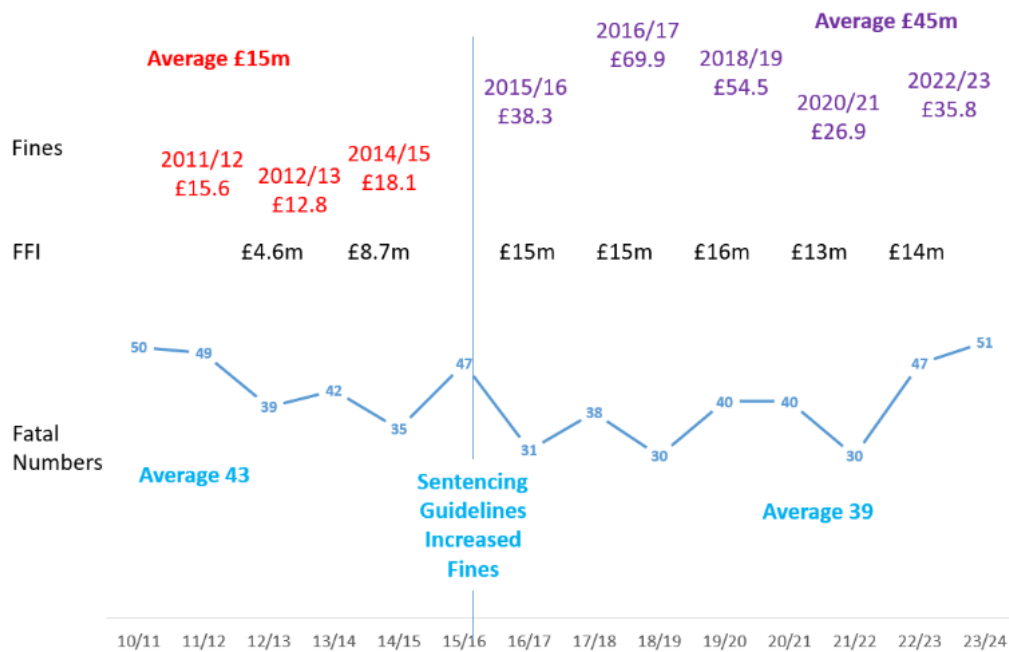


Figure 8: Fatality Numbers and Fines from 2010 to 2023 (extracted from Dr. Hare’s presentation)

Dr. Hare highlighted findings from a review for the UK’s HSE, focusing on the role of CDM regulations in advancing PtD. The review highlighted the role of CDM advisors, who, though not legally required, are increasingly engaged by stakeholders. According to the review, 43% of clients, 24% of principal designers, and 24% of contractors have effectively leveraged advisors’ expertise to meet PtD responsibilities. He further emphasized the importance of empowering key roles, particularly during pre-construction. Roles such as lead designers and project managers were identified as key influencers of safety and design decisions. Conversely, roles like quantity surveyors or cost consultants often deprioritize PtD due to cost-focused responsibilities, underscoring the need for influencing and engaging roles with clear authority to coordinate PtD activities.

The presentation also identified gaps in PtD execution. While activities such as design risk management and health and safety file reviews are often well-performed, critical tasks like obtaining pre-construction information and managing the integration of temporary and permanent works are frequently overlooked, highlighting the need for improved early-stage risk management.

Sector analysis revealed that infrastructure projects, particularly in civil engineering, achieve higher PtD implementation with 71% than building construction, which shows an uneven implementation rate. He also addressed the challenges posed by the Building Safety Act, including overlaps with CDM regulations. He suggested solutions such as integration or appointing a compliance manager to improve continuity and efficiency. Dr. Hare highlighted digital innovations like BIM, which enhances PtD through tools like risk libraries embedded in BIM tools. He also highlighted that digitization and technology integration can significantly improve PtD practices across the construction industry, fostering safer and more efficient projects.

5. PtD in the Australian Construction Industry: Legislation, Knowledge and Opportunities

Dr. Helen Lingard, Distinguished Professor at Royal Melbourne Institute of Technology (RMIT), and Dr. Payam Pirzadeh, Researcher at RMIT, delivered a combined presentation (see Figure 9) on key legislative aspects of the Australian construction industry and their relationship to PtD. They discussed WHS performance, its legislative framework, and the importance of education and knowledge in making informed decisions.

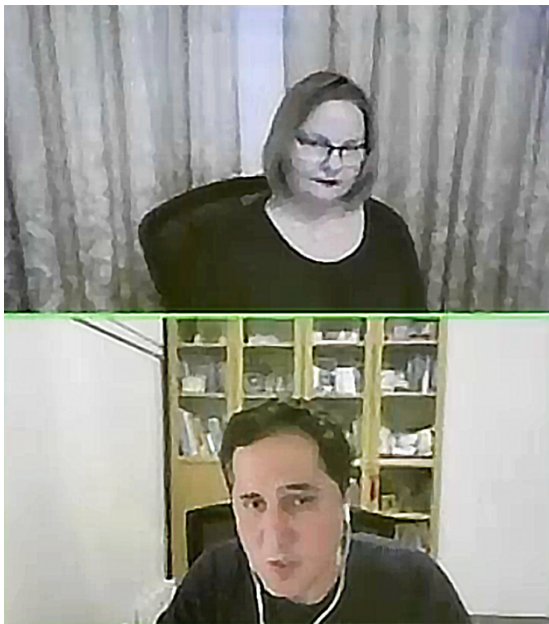


Figure 9. Drs. Lingard and Pirzadeh's during their presentation

Dr. Lingard began by reviewing Australia's construction industry performance, noting that although fatality rates have declined since 2003, they have plateaued in recent years. Such a trend indicates that while progress has been made, there is still room for improvement. Dr. Lingard introduced the concept of "healthy and safe by design," which is part of Australia's national WHS strategy. This approach emphasizes eliminating risks throughout the entire lifecycle of structures, plants, and systems, from design to decommissioning.

The legislative framework for WHS in Australia is state and territory-based, but in 2011, efforts were made to harmonize the regulatory body by creating model WHS laws. Model laws introduced PtD provisions, requiring designers to ensure their designs are, as far as reasonably practicable, free from risks to the health and safety of anyone involved in construction, use, or demolition. Dr. Lingard also discussed the principle of "reasonable practicability," a key tenet of Australian WHS law. This principle requires designers to assess risks based on factors such as the likelihood of an incident, potential harm, and available knowledge. Designers must stay informed of the latest safety standards and regulations to meet their duty of care.

Dr. Pirzadeh continued the presentation with insights into a research project aimed at helping designers better understand hazards and risks through the use of infographics. Such infographics were the result of industry interviews and literature reviews and were generated

to visually prompt designers to consider risks at various levels, such as façade systems. As Figure 10 illustrates, when tested in workshops, these tools significantly improved the designers' ability to identify and mitigate risks, highlighting the importance of visual aids in enhancing PtD.

Dr. Pirzadeh also presented two prosecution cases under PtD laws, underscoring the importance of accountability. In the first case, a stadium roof collapsed due to inadequate bolting systems, injuring two apprentices. The investigation revealed failures in the design review process, leading to fines for both the designer and the certifier. In the second case, a steel beam in a sub-ground carpark collapsed, causing two workers to fall. The designer, who had miscalculated the load-bearing requirements for the beam, was fined AUD 100,000. These legal cases illustrate designers' critical role in ensuring safety through proper planning and execution.

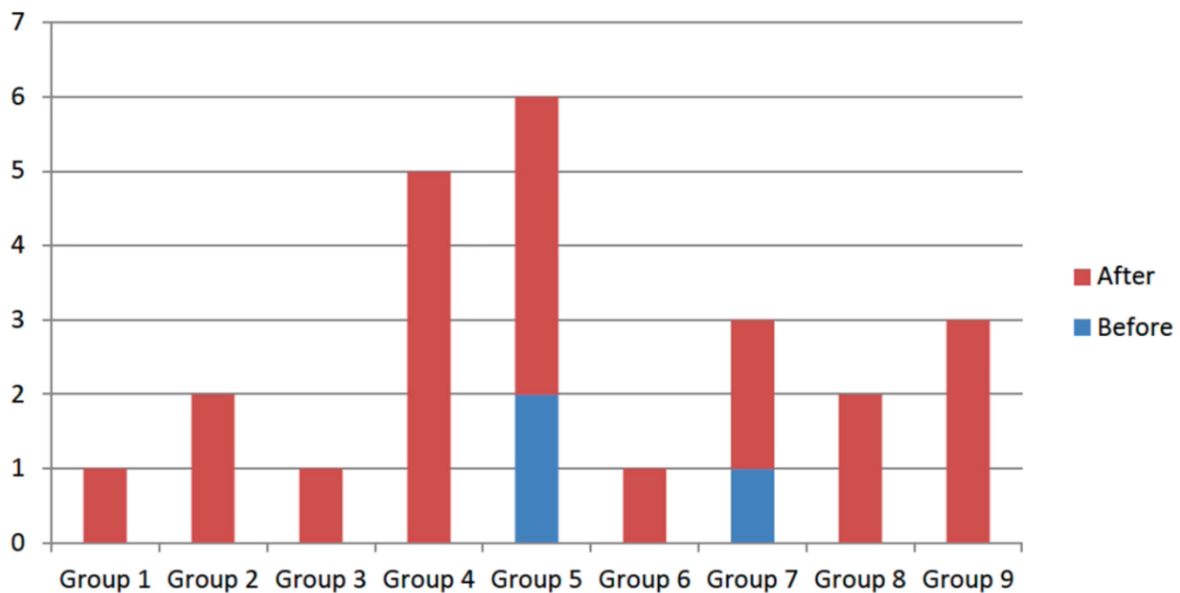


Figure 10: Ability to identify safety hazards (by count, on the vertical axis) by different groups (horizontal axis) before and after leveraging infographic representation (extracted from Drs. Lingard & Pirzadeh's presentation)

Then, Dr. Lingard introduced the National Coronial Information System, a national database of coronial information on every death reported by a coroner in Australia and New Zealand. It aims to assist public agencies and researchers in obtaining coronial data to inform death and assess injury prevention. She shared a case study of a worker's death involving a scissor lift, where poor control design led to the fatality. The coronial findings resulted in recommendations to standardize scissor lift controls and introduce secondary crush protection mechanisms.

Finally, Dr. Lingard discussed enforceable undertakings (EUs), an alternative to prosecution for WHS breaches. EUs are legally binding agreements where violators commit to significant, ongoing improvements in safety practices. These agreements benefit the workplace, the broader industry, and the community. Dr. Lingard emphasized the importance of EUs in fostering sustained cultural changes and promoting restorative justice.

Dr. John Gambatese, Professor at Oregon State University, moderated an engaging Q&A session (see Figure 11) with Drs. Hare, Lingard, and Pirzadeh. Participants explored the following key issues.

- The role of EUs in improving company performance and their broader impact on industry safety standards through targeted initiatives was discussed.
- Discussions also emphasized how evidence-based practices not only reduce risks but also enhance design quality and organizational performance in design and contractor companies.
- PtD legislation was highlighted to foster communication between design and contractor teams, improving safety dialogue and project outcomes.



Figure 11. Dr. John Gambatese moderating the Q&A session

6. Facilitated Breakout – Strategies for Leveraging PtD Practices

The above presentations were followed by an interactive breakout session facilitated by Mark Grushka, Principal at MJGrushka Consulting, Dr. John Gambatese, Dr. Siyuan Song, Associate Professor at ASU, and Dr. Daniel Mehrabi, Faculty Associate at ASU. The breakout session focused on strategies for leveraging PtD practices. Participants were divided into four groups to discuss strategies, drivers for adoption, and barriers against adoption. After the breakout discussions, each group shared its insights and proposed approaches aimed at improving PtD implementation (see Figure 12). The plenary discussion and corresponding insights are summarized below.

A. Strategies for Leveraging PtD Practices:

- *Engaging Leadership.* Involving upper management and executives to champion PtD practices and set industry best practices.
- *Recognition of Best Practices.* Highlighting and rewarding companies that have successfully implemented PtD and thus motivate others to follow.
- *Cost-Benefit Analysis.* Emphasizing the long-term benefits of PtD, including improved safety and potential financial savings.
- *Education and Training.* Integrating PtD into academic programs, thus ensuring that future professionals are knowledgeable in PtD principles and practices.
- *Collaborative Risk Assessment.* Holding regular meetings to document, track, and review risks, ensuring that all team members are aligned.
- *Standardized Contracts.* Embedding PtD requirements into project contracts to make safety considerations mandatory.

B. Drivers for PtD Adoption:

- *Owner and Client Influence.* Owners' safety expectations and requirements drive contractors and designers to prioritize PtD.
- *Formal Communications.* Clear communication within companies and with stakeholders ensures alignment around PtD expectations and goals.

- *Collaboration across Teams.* Since the early project phases, bringing together pre-construction, safety, and operations teams enables the integration of PtD into workflows.
- *Industry Standards and Certifications.* Establishing PtD certifications encourages companies to adopt PtD practices through recognition and compliance.
- *Educational Outreach.* Increasing PtD awareness among students and future professionals creates a foundation for industry-wide adoption.
- *Peer Recognition Programs.* Implementing peer awards to acknowledge and promote innovative PtD efforts.



Figure 12: Participants from each group reporting during the plenary discussion

C. Barriers to PtD Adoption:

- *Cost and Financial Concerns.* High initial costs make some companies hesitant to invest in PtD without clear short-term returns.
- *Lack of Communication and Training.* Insufficient communication and training on PtD principles across organizational levels and roles hinder adoption.
- *Legal and Regulatory Challenges.* Uncertainty around legal liabilities and compliance deters companies from embracing PtD.
- *Technology Resistance.* Smaller companies may be reluctant or unable to adopt advanced technologies like BIM and Virtual Design and Construction (VDC) to support PtD.
- *Short-Term Focus.* Prioritizing immediate profits over long-term benefits discourages investments in PtD.
- *Resistance to Change.* Companies may resist adopting new practices due to comfort with established methods and fear of potential risks or unknowns.

The breakout session highlighted the importance of a comprehensive approach to PtD adoption, emphasizing leadership engagement, education, long-term cost benefits, and clear

communication. Addressing barriers such as financial concerns, communication gaps, and legal uncertainties is essential to broader PtD adoption.

7. Structural Collapses During Construction: Lessons Learned

Dr. Alan Lu, Director of the Office of Engineering Services for the Directorate of Construction at OSHA, provided insights (see Figure 13) into recent structural collapses and the critical lessons learned for improving safety through design. The presentation highlighted notable incidents, emphasizing the impact of structural design deficiencies and the need for enhanced training and collaboration.



Figure 13: Dr. Lu during his presentation

Dr. Lu began by outlining OSHA's role in investigating construction and engineering incidents across various temporary and permanent structures, including bridges, cranes, scaffolds, and communication towers. The presentation focused on high-profile structural collapse incidents during construction between 2018 and 2024, including the Florida International University pedestrian bridge collapse, a tower crane collapse, and long-span wood truss collapses.

In 2018, the bridge collapse resulted in six fatalities when a pedestrian bridge under construction collapsed in Miami, Florida. Dr. Lu detailed the timeline of events, noting that cracks had been observed and documented days before the collapse. The OSHA investigation identified several critical design deficiencies as contributing factors, such as a lack of structural redundancy, design calculation errors, and inadequate peer review. The presentation underscored the importance of a thorough design review process and the need for redundancy in structural components.

A tower crane collapse in 2023 in Florida that injured four people was also discussed. The 116-foot-tall crane toppled during the erection process due to its insufficient isolated footing. This failure highlighted the importance of adequate structural support and foundational stability, especially for tall structures, and the need to adhere to design and safety standards.

Then, Dr. Lu reviewed multiple long-span wood truss collapses, which resulted in multiple injuries and fatalities. Most incidents stemmed from inadequate temporary cross-bracing during truss installation, which is a requirement by the International Building Code (IBC) and the American National Standard Institute/Truss Plate Institute (ANSI/TPI) 1 standards. The collapses highlighted gaps in compliance with building codes, particularly in spans over 60 feet. They reveal limited involvement and awareness among stakeholders, including project owners, engineers of record, truss designers, and contractors. Dr. Lu emphasized the need for enhanced training on code requirements, as accelerating project schedules, increased complexity, and limited expertise contribute to safety hazards.

In his conclusions, Dr. Lu reiterated OSHA's commitment to promoting construction safety through PtD by advocating for better training, thorough design reviews, and increased collaboration. He encouraged attendees to view safety as a core component of the design process and avoid shortcuts, highlighting the importance of proactive safety measures to prevent incidents and protect lives.

Dr. Scott Earnest moderated (see Figure 14) the Q&A session. A summary of the discussion follows.

- Attendees inquired about other structural failures, including communication tower collapses, train derailments, and excavation operations, seeking clarification on the review and investigation processes.
- Participants questioned the decision-making process for determining which construction incidents are investigated and documented. It was clarified that OSHA reviews all incidents occurring during construction and extracts lessons learned.
- Concerns were raised regarding the inadequate peer review that contributed to the bridge collapse case, highlighting the importance of robust design validation procedures.
- Attendees discussed how to prevent errors when documents are signed by professional engineers, highlighting the need for accountability.



Figure 14: Dr. Scott Earnest moderating the Q&A session

- It was emphasized that construction errors often result from either design deficiencies or construction flaws, partially driven by the complex nature of construction.

8. PtD in Practice: Influencing Positive Designer Behavior Through ‘de5ign’

Ray Coleman, Senior Associate Director of Health, Safety and Environment (HSE) in Design at Jacobs, outlined during his presentation (see Figure 15) Jacobs’ approach to integrating PtD



Figure 15. Ray Coleman during his presentation

practices through their internal global process known as de5ign (pronounced "five in design"), which aims to influence positive behavior among designers. It provides a structured framework that emphasizes safety, sustainability, and the lifecycle impacts of design decisions. Through its standardized approach, Jacobs is embedding a safety-first culture into design, thus promoting consistency and responsibility across a global portfolio of projects.

Coleman emphasized the critical impact of design on construction outcomes, noting how design errors are often correlated with delays, cost overruns, and safety incidents. Citing studies, he highlighted that many construction fatalities in the U.S. are design-related. Design decisions also significantly affect the environment and society, ranging from CO₂ emissions to human well-being. Jacobs developed de5ign as a proactive solution to address prevalent issues and promote a responsible design culture.

He identified the global lack of a unified approach to design standards as a prevalent challenge. Variations in legislation and codes of practice across regions lead to inconsistent safety and sustainability outcomes, making it difficult for companies with global operations to maintain standard processes. Jacobs partially introduced de5ign to address this gap, offering a consistent and behavior-based framework that designers can apply regardless of a project location. De5ign promotes key behaviors that encourage positive design actions and efficient management, and considers the long-term impact of design decisions.

Jacobs developed several tools to support behaviors. The de5ign Manual is an online repository with templates, guides, and expert contacts to help designers in applying PtD principles. The de5ign Checklist is a tool in spreadsheet format with about 270 questions addressing lifecycle impacts, safety, mental health, environment, and sustainability. The de5ign Hazard Wheel is an

interactive tool for identifying health, safety, and environmental risks, while the de5ign Management Flowchart provides quick-reference guidance to integrate health, safety, and environmental considerations since early project stages. Figure 16 illustrates the de5ign Hazard Wheel.

Coleman presented case studies illustrating the impact of Jacobs' de5ign approach and shared tangible benefits such as reduced excavated spoil, concrete volume, construction costs, and improved timelines. Their commitment to PtD earned Jacobs the NIOSH's PtD Award in 2024. In closing, he highlighted key lessons learned. He emphasized that PtD offers measurable benefits beyond safety, enhancing design efficiency and sustainability. While legislation helps, he observed that fostering a positive safety culture among designers is crucial for lasting success.

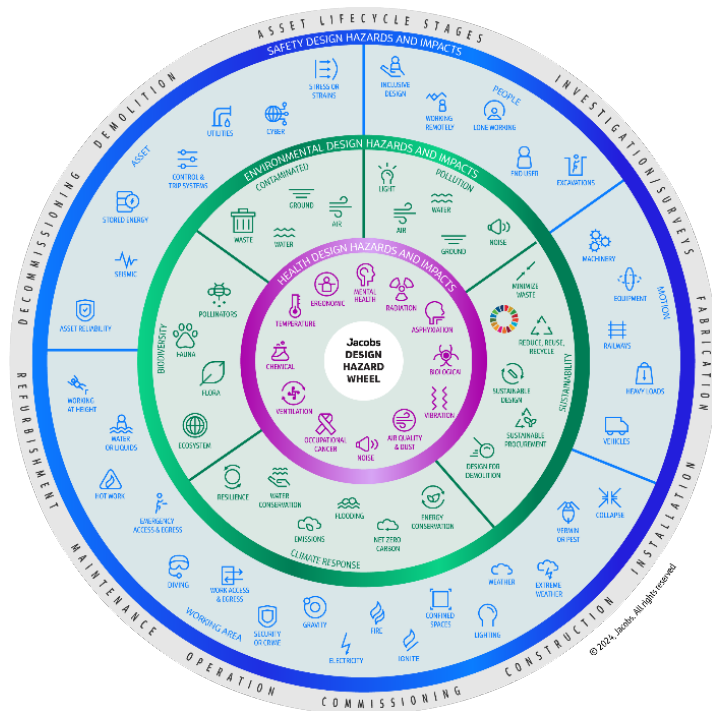


Figure 16: Hazard Wheel (extracted from Ray Coleman's presentation)

Dr. Babak Memarian, Director of Safety Research at CPWR, moderated the Q&A session following Ray Coleman's presentation (see Figure 17). The following key issues were discussed.

- Attendees discussed the need to tailor technical language to suit designers and engineers, and region-specific codes and regulations to ensure clarity in deliverables.
- Questions arose about how to enforce PtD requirements in contracts, noting that measurable criteria are necessary for enforceability. It was noted that PtD's process-driven nature makes quantifying the associated impacts challenging.
- The session acknowledged PtD's wide applicability, from manufacturing to construction, and the need for a structured approach to make it more actionable.

- Participants inquired if any conflicts had arisen between safety and sustainability. Coleman noted that while sustainability in PtD is evolving, no conflicts have been observed.
- When asked about the most impactful resource, Coleman highlighted the Hazard Wheel as a valuable tool for identifying risks in design.



Figure17: Dr. Babak Memarian moderating the Q&A session

9. Panel Discussion – Legislation or Self-Regulation

The discussion included expert panelists TJ Lyons, Principal at Lyonetics Consulting, Dr. Billy Hare from Glasgow Caledonian University, Dr. Babak Memarian from CPWR, and Dr. Zia Ud Din from the University of Houston. Dr. David Grau moderated the discussion (see Figure 18). The discussion delved into the benefits of legislation vs. self-regulation and compared it to safety regulations in other industries, such as transportation.



Figure 18: Panel discussion moderated by Dr. Grau with panelists, from left to right, Dr. Hare, Dr. Ud Din, Dr. Memarian, and TJ Lyons

The key takeaways from the discussion follow.

1. *Stagnation in Construction Productivity.* Unlike other industries, construction productivity has remained stagnant over the past 40 years, raising questions about why effective strategies like PtD are not more widely implemented.
2. *Legislation vs. Self-Regulation.* Panelists debated whether legislation similar to those in other industries, like helmet laws, can effectively improve construction safety or if PtD requires a more nuanced approach, given the complexity of the construction industry. Some argued for industry standards and legislation, while others felt that awareness and education combined with self-regulation could be more impactful than penalties.
3. *Return on Investment (ROI).* While some stakeholders would require proof of a positive ROI to adopt PtD, others believed that focusing on safety as a core value should drive

adoption regardless of ROI. However, panelists agreed on the need for trade-specific data and evidence on PtD's benefits and ROI.

4. *Role of Clients and Designers.* There was consensus that clients and owners play a pivotal role in enforcing PtD by setting clear requirements. Designers and architects may lack practical knowledge about field safety, so involving them in jobsite discussions could enhance their understanding of safety.
5. *Addressing Vulnerable Workers.* The panel discussed challenges in protecting vulnerable workers, such as foreign laborers, and debated whether legislation or conscientious employers can more effectively protect their safety.
6. *Education and Resources.* Emphasis was placed on the need for better educational materials and resources to integrate PtD into design and engineering education, enabling professionals to incorporate safety by design seamlessly into their work.
7. *Client Influence.* Major projects and industries are increasingly embedding PtD principles, often driven by client requirements. As clients see the value of PtD in reducing risks and costs, their demand for safer designs should become a driver for designers and contractors alike.
8. *Cross-disciplinary Insights.* From a public health perspective, the incorporation of normative ethical theory (deontology) introduces the idea that actions should be evaluated as right or wrong based on overarching principles rather than solely on their outcomes. This perspective suggests that a sense of moral responsibility could serve as a powerful motivator for adopting PtD, moving beyond the conventional reliance on cost-benefit analyses.

Overall, the discussion highlighted the complexity of implementing and driving PtD, suggesting that a combination of legislation, self-regulation, education, and a cultural shift in design toward safety should contribute to the advancement of PtD.

10. Facilitated Breakout – Legislation or Self-Regulation? What three things do we need to move forward? How should we address the PtD business case?

The workshop featured four breakout groups, each led by a facilitator: Mark Grushka, Dr. John Gambatese, Dr. Daniel Mehrabi, and Dr. Siyuan Song. Each group engaged in discussions focused on legislation vs. self-regulation, aiming to explore the advantages and challenges of both approaches to advancing PtD. After the breakout discussions, each group shared its insights and recommendations (see Figure 19). The plenary discussion and corresponding insights are summarized below.



Figure 19: Participants from each group reporting during the plenary discussion

A. Benefits and Drawbacks of Legislation vs. Self-Regulation

Benefits of Legislation:

- *Uniform Standards.* Consistent safety standards across the industry.
- *Increased Awareness and Compliance.* Mandatory PtD requirements improve compliance.
- *Life-Saving Potential.* Reduction of workplace injuries and fatalities.
- *Accountability.* Legal responsibility encouraging adherence.

Drawbacks of Legislation:

- *Slow to Update.* Standards may lag behind industry changes.
- *One-Size-Fits-All.* It may not suit all project types or organizations, e.g., small companies.
- *High Compliance Costs.* Financial strain for organizations, e.g., small organizations.
- *Complexity and Inconsistency.* Confusion from overlapping regulations may arise.

Benefits of Self-Regulation:

- *Flexibility and Innovation.* Tailored solutions for specific work environments and organizations.
- *Cost Efficiency.* Reduces compliance costs by focusing on effective, practical safety measures.
- *Enhanced Engagement.* Greater buy-in from employees and managers.
- *Reputational Benefits.* Companies can showcase their safety commitment.

Drawbacks of Self-Regulation:

- *Inconsistent Implementation.* Lack of uniform safety standards.
- *Initial Costs.* High setup costs.
- *Need for Education and Training.* Requires dedicated training resources.
- *Lack of Accountability.* Lack of legal consequences may lead to non-compliance.

B. Approaches to Promote PtD

- *Education and Engagement.* Incorporate PtD training at all levels, beginning with integration into higher educational curricula.
- *Clear Definitions and Standards.* Setting consistent definitions and trade-specific guidelines.
- *Data and Case Studies.* Collecting and sharing successful case studies and metrics on PtD benefits.

C. Building a Business Case for PtD

- *Insurance and Claim Savings.* Demonstrate reduction in medical claims and insurance premiums.
- *Long-Term ROI vs. Upfront Costs.* Demonstrate long-term financial savings.
- *Success Stories with Data.* Use data-backed examples of PtD benefits.
- *Ethical Responsibility and Corporate Image.* Sustained communication of PtD as a core company value.

- *Positive Reinforcement and Incentives.* Reward those adopting or excelling in implementing PtD.

In summary, the discussions highlighted the need for a balanced approach to PtD, with both legislative and self-regulated approaches playing an essential role. By finding a middle ground between flexibility and accountability, the construction industry can better protect its workforce, reduce costs, and promote a culture of safety through prevention-focused design practices.

11. Closing Remarks

Dr. David Grau delivered the closing remarks (see Figure 20), acknowledging the journey and accomplishments until the 2024 workshop, marking five years of collaborative efforts through the NIOSH-funded PtD Initiative. Dr. Grau expressed gratitude for the participants' engagement throughout the day. Reflecting on the Initiative's aims —advancing PtD



Figure 20: Dr. David Grau giving the closing remarks

knowledge, fostering implementation among leading organizations, and promoting PtD education— Dr. Grau emphasized the importance of the knowledge shared and networking opportunities during the workshop. He acknowledged progress in PtD knowledge and practice, though he noted the continued need for incorporating PtD into higher education curricula, particularly for disciplines like design and engineering.

Closing remarks also highlighted critical themes from the workshops, including legislative versus self-regulatory approaches, the value of positive reinforcement, and the importance of preserving not only safety but also long-term health. Dr. Grau pointed out the “elephant in the room” regarding health hazards, such as exposure to silica dust and welding fumes, which often have cumulative impacts that are not immediately evident. He urged PtD to evolve and include both safety and health, considering a holistic approach to the long-term wellbeing of workers.

Dr. Grau concluded by thanking the sponsors, steering committee members, and students who made the workshop event possible. He encouraged attendees to utilize the PtD resources and videos available online, thus sustaining the legacy of the 5-year Initiative beyond the series of workshops. The remarks ended with a unanimous applause, closing the workshop on a note of collective achievement and ongoing commitment to PtD. Figure 21 illustrates the workshop attendees.



Figure 21. Attendees

12.Efficacy of the Workshop

Workshop attendees were asked to fill out an evaluation survey at the end of the workshop. An answer to each question was requested using a 5-point Likert scale, with 1 being poor and 5 being excellent. The weighted average of each question is given in Table 1.

Table 1. Workshop Attendee Evaluation of Contents (n=34)

Question	Average Rating
Workshop content quality	4.62
Format and organization	4.62
Applicability to your present or future assignments	4.55
Networking opportunities	4.35
Overall Workshop rating	4.65

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

Table 2. Workshop Attendee Evaluation of workshop Value (n=34)

Question	Yes (%)	No (%)
Would you recommend a future similar Workshop to others?	97.06	2.94
Did the Workshop improve your understanding of how to implement PtD?	94.12	5.88
Was this Workshop worth the time that you spent attending?	97.06	2.94
Did the Workshop improve your overall understanding of PtD?	94.12	5.88

Appendix A. Workshop Agenda

August 27, 2024

7:00 – 8:00	Check in & breakfast
8:00 – 8:10	Welcome and Introduction Dr. Zia Ud Din (co-Chair), University of Houston
8:10 – 8:20	Keynote Speech “Opening Remarks” James Frederick, Occupational Safety and Health Administration
8:20 – 8:40	Q&A (Moderator: Dr. Scott Earnest)
8:40 – 9:10	Keynote Presentation “What did we Learn during the Last Five Years?” Dr. G. Edward Gibson, National Academy of Construction
9:10 – 9:30	Q&A (Moderator: Dr. David Grau)
9:30 – 10:00	Keynote Presentation “Review of UK Developments on PtD” Dr. Billy Hare, Glasgow Caledonian University Moderator: Dr. John Gambatese
10:00 – 10:15	<i>Networking break</i>
10:15 – 10:40	Keynote Presentation “PtD in the Australian construction industry: Legislation, Knowledge and opportunities” Dr. Helen Lingard, Dr. Payam Pirzadeh, RMIT University at Melbourne & Dr. Dennis Else, Global Multiplex
10:40 – 11:00	Q&A (Moderator: Dr. John Gambatese)
11:00 – 12:10	Facilitated Breakout Session “Strategies for Leveraging PtD Practices” Facilitators: Mark Grushka; Dr. John Gambatese; Dr. Siyuan Song; Dr. Daniel Mehrabi
12:10 – 1:00	Networking Lunch
1:00 – 1:25	Keynote Presentation “Structural Collapses during Construction: Lessons Learned in PtD” Dr. Alan Lu, Occupational Safety and Health Administration
1:25 – 1:45	Q&A (Moderator: Dr. Scott Earnest)
1:45 – 2:15	Keynote Presentation “PtD in Practice: Influencing Positive Design Behavior through ‘deSign’” Ray Coleman, Jacobs
2:15 – 2:35	Q&A (Moderator: Dr. Babak Memarian)
2:35 – 3:10	Expert Panel on “Legislation or Self-Regulation?” TJ Lyons, Lyonetics Consulting; Dr. Billy Hare, Glasgow Caledonian University; Dr. Babak Memarian, CPWR (moderator); Dr. Zia U Din, University of Houston
3:10 – 3:20	Q&A (Moderator: Jack Toellner)
3:20 – 3:30	<i>Networking break</i>
3:30 – 4:40	Facilitated Breakout Session “Legislation or Self-Regulation? What 3 things we do need to move forward. And how should we address the business case in PtD?” Facilitators: Jack Toellner; Dr. Siyuan Song; Dr. Daniel Mehrabi; Mark Grushka
4:40 – 5:00	Closing Remarks Dr. David Grau (Chair), Arizona State University

Appendix B. Acronyms

ANSI – American National Standard Institute

ASU – Arizona State University

BEAM – Built Environment Asset Management (Research Center)

BIM – Building Information Modeling

CDM – Construction Design and Management

CIB – Research and Innovation in Building and Construction

CPWR – The Center for Construction Research and Training

EU – Enforceable Undertaking

HSE – Health and Safety Executive

IBC – International Building Code

NAC – National Academy of Construction

NIOSH – National Institute for Occupational Safety and Health

OSHA – Occupational Safety and Health Administration

PPE – Personal Protective Equipment

PtD – Prevention through Design

RMIT – Royal Melbourne Institute of Technology

ROI – Return on Investment

TPI – Truss Plate Institute

UK – United Kingdom

VDC – Virtual Design and Construction

WHS – Work Health and Safety

Appendix C. List of Attendees

Name	Company/ Organization
Siyuan Song	Arizona State University
Pooja Priyadarshini Pothula	Arizona State University
Shiva Arabi	Arizona State University
Daniel Mehrabi Moezabadi	Arizona State University
David Grau	Arizona State University
Jessica Lawson	Catholic University of America
Michael Behm	East Carolina University
Billy Hare	Glasgow Caledonian University
John Gambatese	Oregon State University
Helen Lingard	Royal Melbourne Institute of Technology
Payam Pirzadeh	Royal Melbourne Institute of Technology
Richard Wright Jr.	Smithsonian Institution
Mary Winkler	Smithsonian Institution
Zia Ud Din	University of Houston
Taha Demirbag	University of Maryland
Evan McMullen	University of Maryland
Kevin Cannon	AGC of America
Nazia Shah	AGC of America
Don Allen	Association of the Wall and Ceiling Industry
Tre'Vaughn Howard	Bloomberg
Elizabeth Revelt	BSI Consulting Group
Douglas Trout	CDC/NIOSH
Scott Earnest	CDC/NIOSH
Allen Martin	Choate Construction Company
Carmen Hernández	Consultora León y Asociados
Guillermo León	Consultora León y Asociados
Bill Wright	CPWR - The Center for Construction Research and Training
Rick Rinehart	CPWR - The Center for Construction Research and Training
Babak Memarian	CPWR - The Center for Construction Research and Training
Sara Brooks	CPWR - The Center for Construction Research and Training
Hannah Loftes	Dimeo construction company
Ian Umstead	DPR Construction
Raghuvaran Chakkravarthy	Gilbane Building Company
Paul Gorham	Henry M Jackson Foundation
Mark Revesz	Hensel Phelps
Andrew Griffith	Independent Project Analysis, Inc.
Robert Moser	Jacobs Engineering
Ray Coleman	Jacobs Engineering
Rob Matuga	Job-Site Safety Institute
Ryan Papariello	Laborers Health and Safety Fund of North America
Nathan Schreiber	Laborers Health and Safety Fund of North America
TJ Lyons	Lyonetics
Helene Cilione	Merck & Co. Inc.
Mark Grushka	MJGrushka Consulting
George Gibson, Jr.	National Academy of Construction
Jared Culligan	National Association of Home Builders
Thomas Trauger	Nationwide Insurance
Cheryl Ambrose	NRCA

Gopal Menon	OSHA
Sanginiben Patel	OSHA
Tierra Gaines	OSHA
James Frederick	OSHA
Alan Lu	OSHA
Steve Gauthier	OSHA
Bryant Seymour	OSHA
Blake Skogland	OSHA
Carlos Alvarez	Skanska USA
Roger Zemba	U.S. Army Corps of Engineers
Darryl White-SR	Uniformed Services University of the Health Sciences
Kyle Shireman	USACE
Jean Beard	Windjammer Environmental

Appendix D. Keynote Speakers, Panelists, and Moderators' Bios

Keynote Speakers

James Frederick, Deputy Assistant Secretary at OSHA was sworn in on January 20, 2021, beginning his role with OSHA that same day. Though new to government work, he brought 30 years of experience in worker safety and health, including 25 years as a union safety representative with the United Steelworkers Union, and had collaborated closely with OSHA throughout his career. At OSHA, Jim emphasizes genuine worker involvement without retaliation, aiming to better control hazards and reduce traumatic injuries and chronic illnesses. He engages daily with stakeholders, focuses on regulatory priorities, whistleblower protections, and enhances OSHA's cooperative programs. Believing clear communication is essential, he has expanded OSHA's resources, including appointing a national family liaison to support families of fallen workers. Jim values his role at OSHA as a unique privilege and a deeply rewarding experience.

Dr. Zia Ud Din, *co-chair of the 2024 Workshop*, is an Assistant Professor in the Department of Construction Management at the University of Houston, specializing in construction safety, innovative teaching methods, and construction information technology. His current research focuses on using augmented and virtual reality to enhance risk identification in construction for job hazard analysis (JHA). He earned his Bachelor of Science in Civil Engineering from the University of Engineering and Technology, Taxila, Pakistan, a Master of Science in Construction Engineering and Management from Hanyang University in Seoul, South Korea, and a Ph.D. in Civil, Environmental, and Sustainable Engineering from ASU. He also completed two years of postdoctoral training at ASU. Dr. Ud Din is committed to education, teaching courses like "Project Controls," "Building Information Modeling Applications for Construction Management," and "LEED and Green Construction Principles."

Dr. Edward Gibson, Jr. serves as the President and CEO of the National Academy of Construction (NAC) as of 2024. He is Professor Emeritus in Construction Management at ASU's Del E. Webb School, where he retired in 2022 after leading the School of Sustainable Engineering and the Built Environment from 2010 to 2018. Edd holds a bachelor's in civil engineering and a PhD from Auburn University, along with an MBA in engineering management from the University of Dallas. Known for his work in PtD, earned value management, and risk management, he has supervised over 100 graduate students. Among his

honors, he was a Fulbright Fellow, Visiting Fellow at Cambridge, and ASCE Distinguished Member, receiving awards like the ASCE Peurifoy Award and NAC's Richard L. Tucker Service Award. Edd is a licensed engineer in Texas.

Dr. Billy Hare is a Professor of Construction Management within the School of Computing Engineering & Built Environment at Glasgow Caledonian University. He is Research Theme Lead for Built Environments, Deputy Director of the School's Research Centre for 'Built Environment & Asset Management' (BEAM). Dr. Hare has a PhD in Construction Management (H&S Thesis); BSc (Hons) in Construction Management & Engineering and a BA in Occupational Health and Safety. He has delivered research on several HSE, IOSH, EPSRC, CITB and industry funded projects totalling over £900k, 50+ peer-reviewed publications and Impact Case Studies for the UK Research Excellence Framework. His research portfolio is mainly focused on improving safety health and wellbeing within the construction industry, including studies that have improved worker engagement, migrant worker H&S, and safety in design. He has developed several CPD courses on the subject of construction health and safety, and is currently International Coordinator of the 'International Council for Research and Innovation in Building and Construction' Safety Health and Wellbeing Working Group.

Dr. Helen Lingard is Distinguished Professor at RMIT University in Melbourne, Australia. Dr. Lingard started her career working for a contracting organisation in the civil engineering/construction sector in Hong Kong. Since moving to Australia, she has worked as a consultant to organisations in the mining, construction and telecommunications industries. Dr. Lingard has undertaken extensive applied in the areas of workplace safety, workers' health and wellbeing and work-family interaction in the construction industry. Her work has been funded by private and public sector construction organisations. Recent projects include an examination of client initiatives in driving work health and safety improvements in the planning, design and construction of major transport infrastructure construction projects, and an analysis of the cultural, organisational and job design factors that impact construction workers' physical and mental health. Dr. Lingard is currently working with government and industry leaders in a Construction Industry Culture Taskforce focused on improving work hours, gender diversity and health in the Australian construction industry.

Payam Pirzadeh is a civil engineer and a researcher at RMIT University in Melbourne, Australia. As an engineer, Payam has worked on projects involving construction of major

infrastructures and large processing facilities in the energy and mining sectors. He is a member of the Institute of Engineers Australia. Payam also holds a Master Degree in Project Management and a PhD in Construction Management. His doctoral research on design decision-making and its impact on construction workers' health and safety has led to him receiving two prestigious research awards in 2019, the RMIT Prize for Research Excellence (HDR-Design) and the Chartered Institute of Building (CIOB) Research Award.

Dr. Dennis Else leads safety and sustainability strategies at Multiplex with the aim of building a sustainable and long-term business. Prior to joining Multiplex Dr. Else was Chair of the Australian National Occupational Health and Safety Commission and Dean of Engineering and Science the University of Ballarat. Dr. Else was a member of the Board for the Cooperative Research Centre (CRC) for Low-Carbon Living and a part-time Professor of Occupational Health and Safety at the University of Ballarat.

Dr. Alan Lu earned his Ph.D. in Civil Engineering, focusing on Geo-technical and Materials Engineering, from Iowa State University. His expertise spans geo-technical and structural engineering, encompassing building design, structural dynamics, and earthquake engineering. Early in his career, he was involved in designing diverse building structures, conducting complex structural analyses, and overseeing projects from conception to completion. Presently, he leads OSHA's Office of Engineering Services, where he provides engineering support to various Agency components and manages a program dedicated to investigating and inspecting construction incidents involving fatalities and catastrophes.

Ray Coleman is a Chartered Civil Engineer with over 20 years' experience in the design, procurement and construction of infrastructure projects. He is currently the global HSE in Design Lead for Jacobs and is responsible for both the development and deployment of our global sustainable design management process de5ign (pronounced 'five in design').

Dr. David Grau, *Chair of the 2024 Workshop*, is the Sundt Construction Professor at the School of Sustainable Engineering and the Built Environment within ASU. He graduated with doctorate and master's degrees in civil, architectural, and environmental engineering from the University of Texas at Austin, and with an industrial engineering degree from the Universitat Politècnica de Catalunya in Barcelona. During his academic career, he has received numerous teaching and research awards, including the Distinguished Professor and Research Awards by the Construction Industry Institute and the Celebration of Engineering & Technology Innovation (CETI) award by FIATECH. Complementing his academic career, he has worked

in the private industry for more than 10 years inclusive of positions such as program manager for heavy industrial projects and director of a large engineering design department. He has led large interdisciplinary and multicultural teams to deliver capital projects in South America, Africa and Europe. David is a member of ASCE and AACE professional societies and holds a professional license in Industrial Engineering.

Panelists

TJ Lyons, Principal at Lyonetics Consulting LLC, supports field teams and operations in the United States from Malta, New York. Board-certified as an Occupational Health and Safety Technologist and Certified Safety Professional, he is proud to have taken some of these skills to his local community. A past assistant chief, New York adjutant fire instructor (hazardous materials), emergency medical technician, and still a volunteer firefighter, he sees the need to bring safety from the field to the home as often as possible. His safety passion is focused on working with people and the idea of preventing incidents through the smarter design of the structure being built and the way the building is built. Rather than install roof anchors on a flat roof and hope everyone will remember to attach their fall protection, build common parapets around the roof to eliminate the fall itself, implementing simple steps that he calls “design intervention.

Dr. Babak Memarian is the Director of Safety Research at CPWR and the co-chair of the NIOSH/CPWR Engineering Controls Workgroup. He currently leads a NIOSH-funded project titled “Prevention through Augmented Pre-Task Planning.” He holds a Ph.D. in Construction Management from ASU and a M.S. in Civil Engineering with a concentration in Construction Engineering & Project Management from Oklahoma State University. His research interest involves development of high reliability production systems with a focus on safety & health, production improvement, and error management. He is an active member of the American Society of Safety Professionals. Dr. Memarian is also a Certified Safety Professional (CSP) and Construction Health and Safety Technician (CHST).

Dr. Zia Ud Din is an Assistant Professor in the Department of Construction Management at the University of Houston, specializing in construction safety, innovative teaching methods, and construction information technology. His current research focuses on using augmented and virtual reality to enhance risk identification in construction for job hazard analysis (JHA). He earned his Bachelor of Science in Civil Engineering from the University of Engineering and

Technology, Taxila, Pakistan, a Master of Science in Construction Engineering and Management from Hanyang University in Seoul, South Korea, and a Ph.D. in Civil, Environmental, and Sustainable Engineering from ASU. He also completed two years of postdoctoral training at ASU. Dr. Ud Din is committed to education, teaching courses like “Project Controls,” “Building Information Modeling Applications for Construction Management,” and “LEED and Green Construction Principles.

Moderators

Dr. Scott Earnest is the Associate Director for Construction Safety and Health at NIOSH. Prior to joining the Office of Construction Safety and Health, Scott was Engineering Branch Chief in the NIOSH, Division of Applied Research and Technology from 2005-2015. Scott has over 70 peer reviewed publications and technical reports. He began his career as an active duty, commissioned officer in the U.S. Army, Corps of Engineers. He is a registered Professional Engineer (PE) and Certified Safety Professional (CSP) with M.S. and Ph.D. degrees in industrial and mechanical engineering.

Dr. 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, PtD, 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.

Appendix E. 5-Year Prevention through Design Initiative

Construction hazard PtD holds the promise to eventually reduce construction workers' exposure to safety and health hazards, and hence minimize accidents, morbidity, and fatalities. PtD aims to proactively identify and mitigate 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 advance PtD knowledge and disseminate and engage influencing stakeholders who are in the position to lead and advocate for implementing a holistic PtD approach. In order to address these gaps, highly influential stakeholders in client//owner, designer, and contractor organizations will be engaged with this PtD Workshop Initiative. With a kickoff workshop in March 2020 and a fifth and final workshop in August 2024 (this report), the aims of the 5-year PtD Initiative follows:

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

Aim 2: To advance knowledge in PtD. We aim at collecting implementation guidelines and tools, as well as identify case studies and business case models to effectively demonstrate concepts and strategies. We also aim at querying stakeholder participants, for example, on PtD drivers, benefits, and barriers, identifying and analyzing information gaps, and propose a high-payoff research agenda, and evaluating the number, quality, and broader impacts of knowledge contributions.

Aim 3: To promote PtD instruction in construction management and construction engineering programs at US colleges and universities. We aim at designing and proactively disseminating graduate instruction materials around PtD Workshop themes, and cumulatively tracking academics and programs that are including the PtD approach in their curriculum.

Appendix F. Steering Committee

Name	Organization
Dr. Scott Earnest	NIOSH
Dr. Edward Gibson	National Academy of Construction
Mike Flowers	American Bridge Company (retired)
Dr. John Gambatese	Oregon State University
Mark Grushka	MJGrushka Consulting
Charlie Hoes	Hoes Engineering, Inc
TJ Lyons	Lyonetics Consulting LLC
Dr. Babak Memarian	CPWR
Jack Toellner	Toellner Consulting LLC
Kenneth Daigle	GE Vernova Inc.
Dr. Daniel Mehrabi Moezabadi	Arizona State University
Dr. Zia Ud Din	University of Houston
Dr. David Grau	Arizona State University

Appendix G. PtD Initiative Resources

Reports:

- 2020: [Click here](#)
- 2021: [Click here](#)
- 2022: [Click here](#)
- 2023: [Click here](#)

YouTube Channel: [Visit here](#)

Information and resources about the PtD initiative are available on the [dedicated website](#).

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