Prevention through Design (PtD) 5-year Initiative – What did we learn?

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Sundt Construction Professor
Arizona State University

NORA Construction Sector Council Meeting
November 20, 2024

NIOSH Award #1 R13OH011707-01-00

We built that.
Del E. Webb School of Construction
ASU Ira A. Fulton Schools of Engineering
Arizona State University

National Institute for Occupational Safety and Health
NIOSH®

ASU Ira A. Fulton Schools of Engineering
Arizona State University

5-year PtD 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. In order to address these gaps, this PtD Initiative engages highly influencing stakeholders at client / owner, designer, contractor organizations, and agencies.

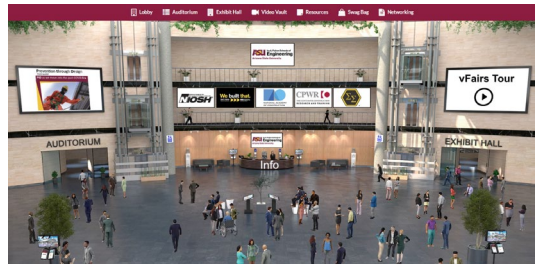
Aim 1: To drive the implementation of PtD at large industry organizations.

Aim 2: To advance knowledge about PtD. We will collect implementation guidelines, tools, and identify case studies and business case models for the effective demonstration of concepts and strategies.

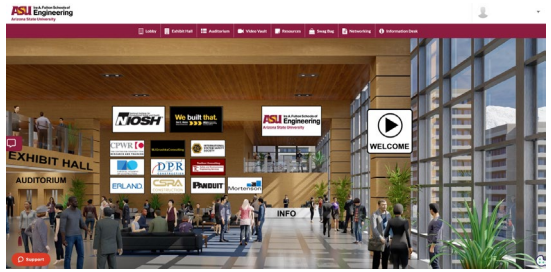
Aim 3: To promote the instruction of PtD in construction management and construction engineering programs at US colleges and universities.

Five-year PtD Initiative

2020 - Tempe, Arizona



2021 - Online, VFairs



2022 - Online, VFairs

2023 - Boston, Massachusetts

2024 - Washington, DC

We built that. Del E. Webb School of Construction ASU Ira A. Fulton Schools of Engineering Arizona State University

CDC Workplace Safety and Health NIOSH

ASU Ira A. Fulton Schools of Engineering Arizona State University

Five-year PtD Initiative

- 401 participants to date
- 159 academics representing 50 universities
- 242 practitioners representing 121 organizations
- 59 speakers and panelists
- 31 moderators
- 2,580 YouTube views

Sponsors Over the Years

Prevention Through Design

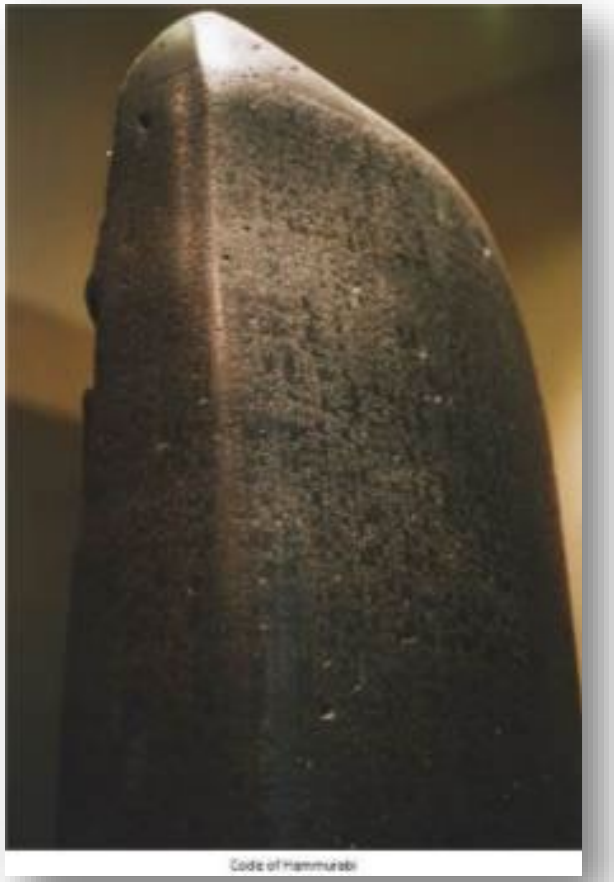
To proactively design out potential hazards to eliminate or minimize the risk and improve worker safety and health.

PtD also known as safety in design, safety through design, design for safety, safety through engineering, design for construction safety, etc.

PtD is definitely NOT new …

1750 B.C., Code of Hammurabi, Law 229:
"If a builder builds a house for someone, and does not construct it properly, and the house which he built falls in and kills its owner, then that builder shall be put to death."

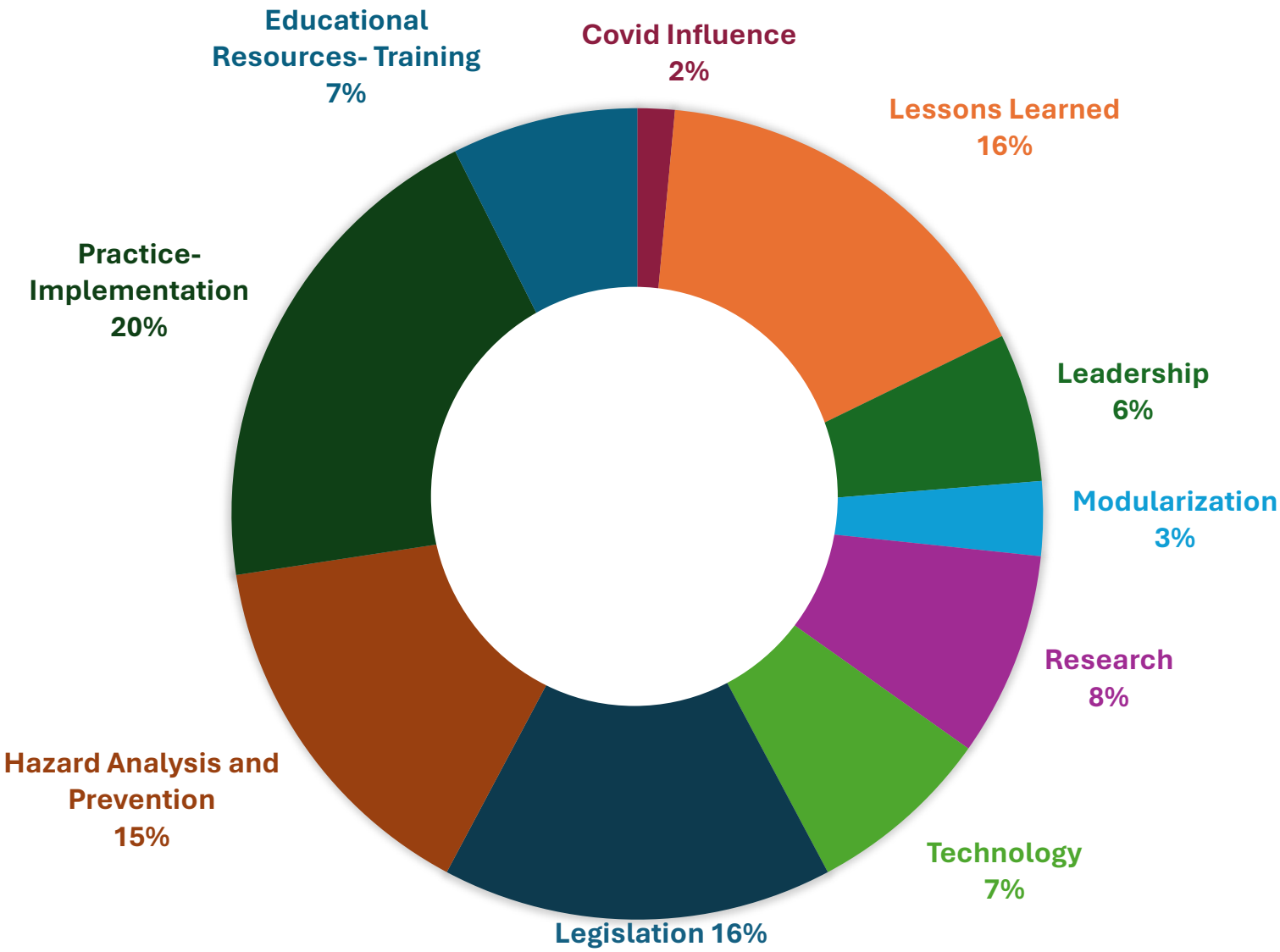
(Punitive code. *PtD implied!*)



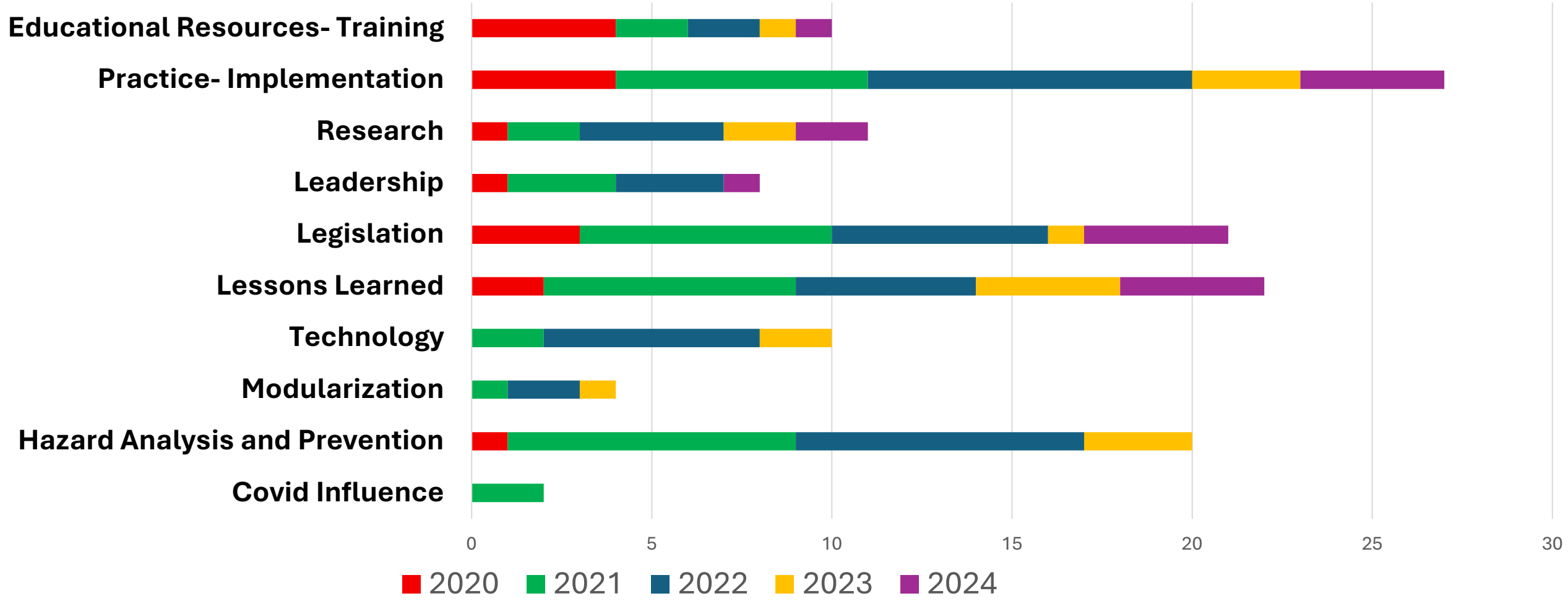
Year	Theme	Focus Areas	
2020	Current and Future State-of-the-Art on Research, Practice and Education	• Lessons Learned • Leadership • Research • Legislation	• Hazard Analysis and Prevention • Practice- Implementation • Educational Resources- Training
2021	Prevention through Design as we move into the post-COVID Era	• Covid Influence • Lessons Learned • Leadership • Modularization • Research	• Technology • Legislation • Hazard Analysis and Prevention • Practice- Implementation • Educational Resources- Training
2022	PtD Journey from What to How	• Lessons Learned • Leadership • Modularization • Research	• Technology • Legislation • Hazard Analysis and Prevention • Practice- Implementation • Educational Resources- Training
2023	Continuing the Journey Proven Strategies for Design & Execution	• Lessons Learned • Modularization • Research • Technology	• Legislation • Hazard Analysis and Prevention • Practice- Implementation • Educational Resources- Training
2024	Education, Training, & Legislation Where do we go from here?	• Lessons Learned • Research • Legislation	• Practice- Implementation • Educational Resources- Training

MAJOR AREAS OF CONCENTRATION (2020-2024)

34 PRESENTATIONS

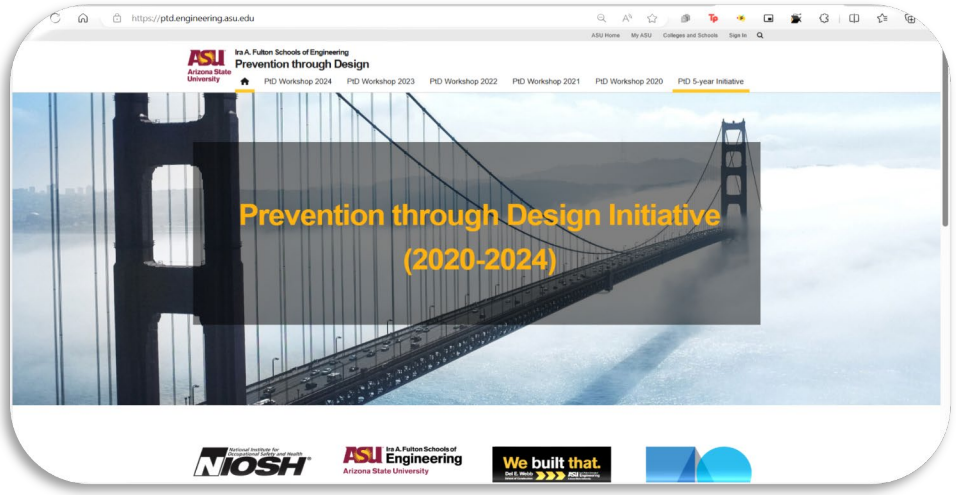


MAJOR AREAS OF CONCENTRATION (2020-2024)



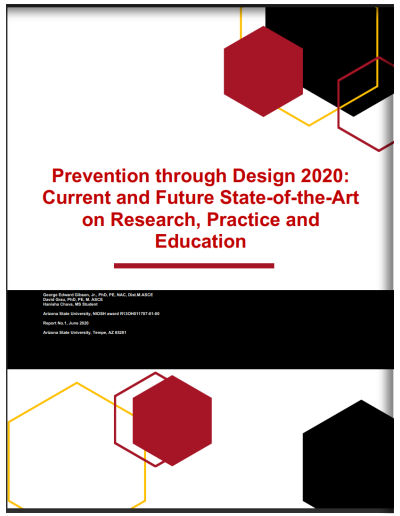
Workshop Materials

Website

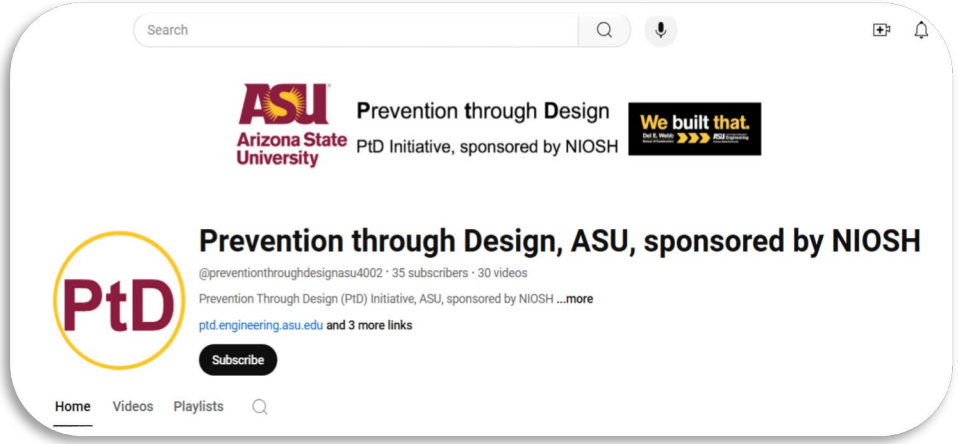


https://ptd.engineering.asu.edu/

Reports



YouTube



https://www.youtube.com/@preventionthroughdesignasu4002/featured

What did we learn?

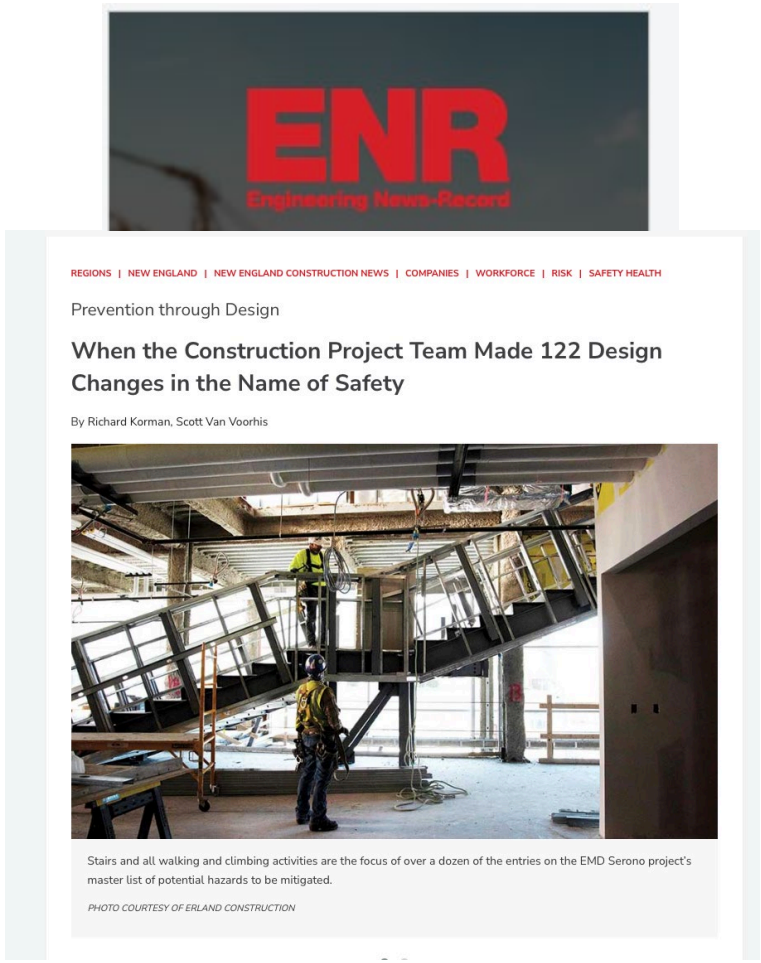
What did we learn…….

Prevention Through Design is Widely Practiced….

Though not consistently practiced…

Case studies presented

- 2021 Allegheny County Airport Authority, Pittsburgh International Airport
- 2021 Skanska, LaGuardia Terminal 1, New York
- 2021 Gulf Coast Growth Ventures (Exxon-Sabic) Yosemite Project
- 2021 Erland/EMD Serono, Horizon Building, Billerica, MA
- 2022 Mortensen-Meta hyperscale data management facilities
- 2022 NSF/DOE Vera C. Rubin Observatory Project, Chile
- 2023 Safety and Health in Design
- 2023 Central Repository to Monitor the Status of BIM Implementation for OSH
- 2024 PtD in Practice: Influencing Positive Design Behavior through ‘de5ign
- 2024 Structural Collapses During Construction



What did we learn….

It is more widely Practiced outside the U.S…..

Required by regulation in the UK, Australia and other places

PtD and Legislation

Jonathan Bach (NIOSH)
“NIOSH Prevention through Design (PtD) Program” (2020, 2023)


Helen Lingard and Payem Pirzadeh,
“Prevention Through Design—the Australian Construction Industry Experience” (2021)
“PtD in the Australian construction industry: Legislation, Knowledge and opportunities” (2024)

Alistair Gibb, Loughborough University
“Highlighting Current Learning from UK’s PtD Construction” (2022)

Billy Hare, Glasgow Caledonian University
"Lessons learnt from UK PtD Legislation” (2022);
“Review of UK Development on PtD” (2024)

James Frederick
“Occupational Safety and Health Administration” (2024)




Expert Panel: TJ Lyons, Billy Hare, Babak Memarian, and Zia U Din
“Legislation or Self- Regulation?” (2024)

Legislation

- UK CDM (construction design and management) laws passed in late 1990s requiring PtD; UK's fatality rate per capita is about 1/5 of US.
- Australia's Work Health and Safety Strategy passed in 2012 requiring PtD; fatality rate about 1/4 of US.

US 9.6/100,000 workers; AUS 2.4/100,000 workers; UK 2.1/100,000 workers

See https://ptd.engineering.asu.edu; 2021, 2022, and 2024 presentations

What did we learn....

Done correctly, PtD practice can save lives and prevent injuries in construction

Accidents Linked to Design

- 22% of the 226 injuries that occurred from 2000 to 2002 in Oregon, Washington, and California were linked partly to design [Behm 2005]
- 42% of 224 sample construction fatalities evaluated in the U.S. between 1990 and 2003 were linked to design [Behm 2005]
- In Europe, a 1991 study concluded that 60% of fatal accidents resulted, in part, from decisions made before site work began [European Foundation for the Improvement of Living and Working Conditions 1991]
- 63% of all fatalities and injuries could be attributed to design decisions or lack of planning [CHAIR safety in design tool 2001]
- 33% of incidents in Iran are attributed to the design process. [Ghaderi and Kasirossafar, 2011]
- 37% of the 210 workplace fatalities investigated in Australia were definitely or probably related to design issues [Driscoll et al. 2008]

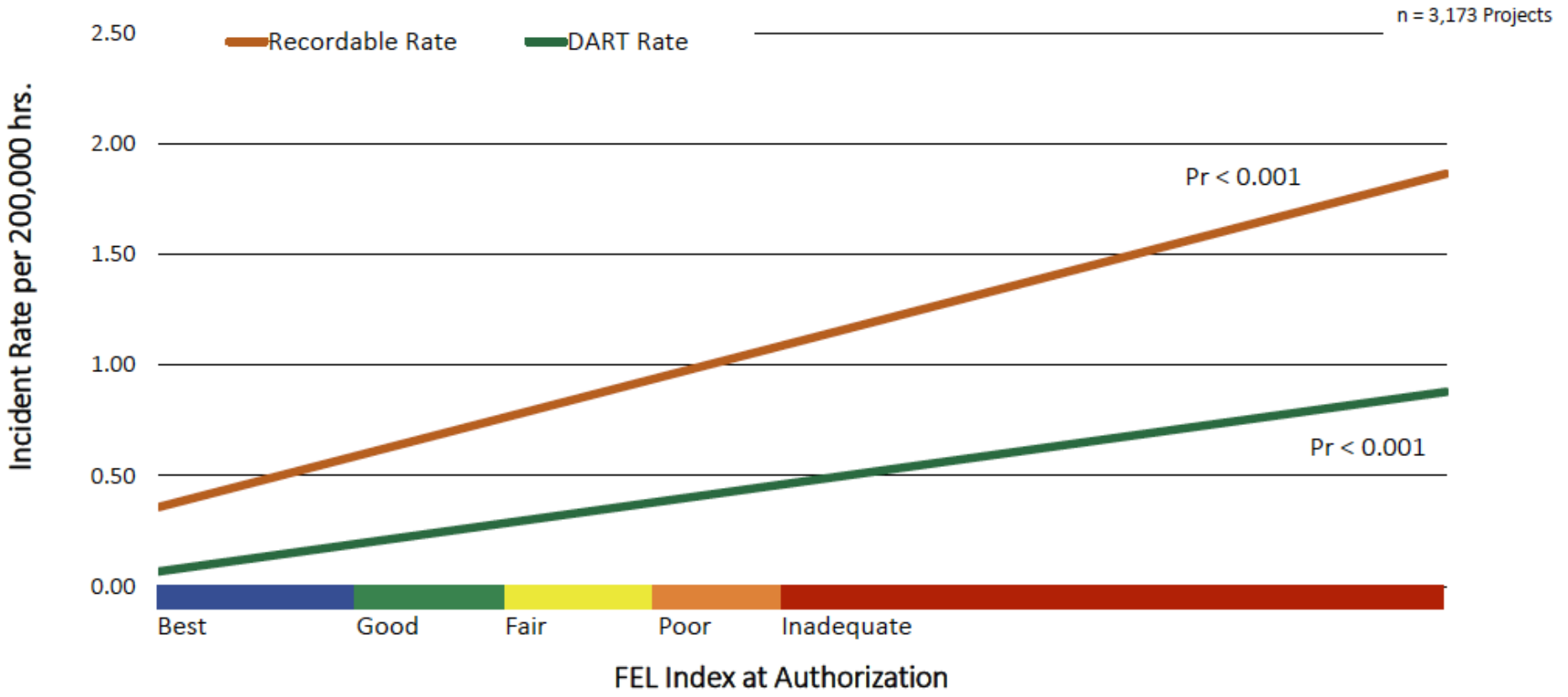
What did we learn....

Done correctly, PtD practice can save lives and prevent injuries in construction

Should begin as early as possible on the Project

Dr. Andrew Griffith, IPA, 2022

FEL at Authorization Drives Construction Safety Results



Projects with Estimated Total Costs >$10MM (2022) Authorized Since 2000
Controlled for Year of Authorization and Project Size

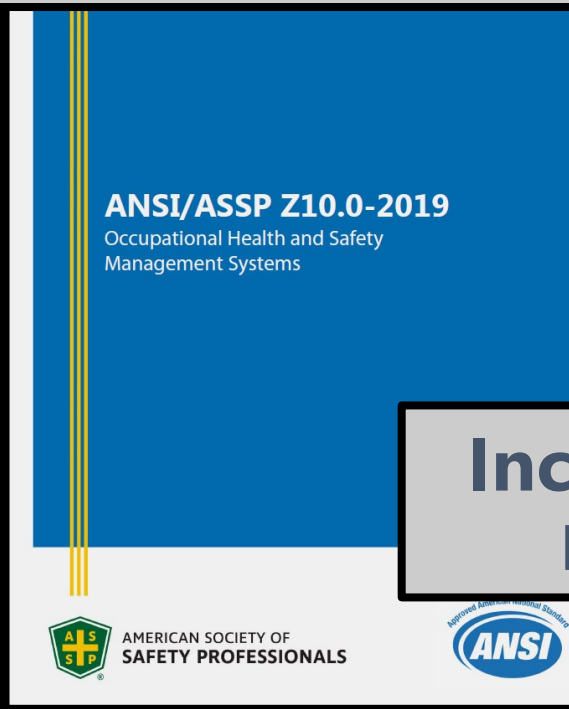
What did we learn….

Prevention through design practices are well documented

Policy: Consensus Standard Revisions

Z10

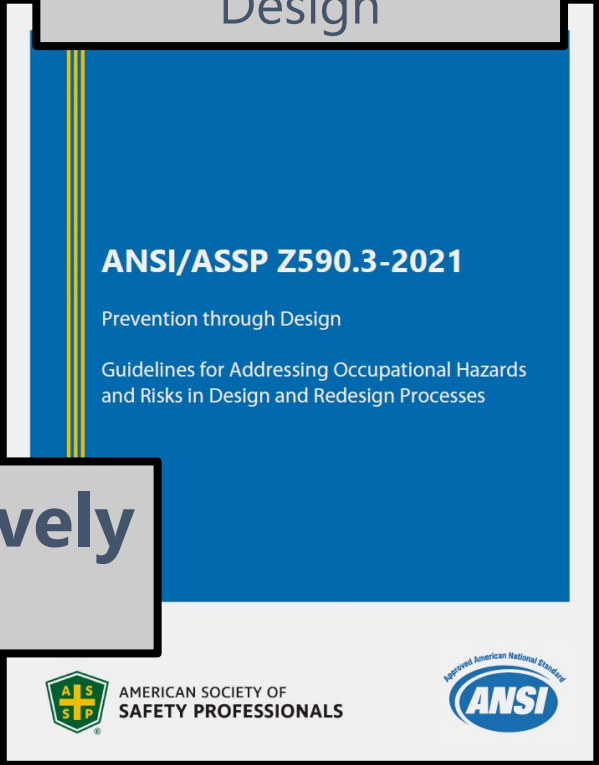
Occupational Health and Safety Management Systems



Includes PtD

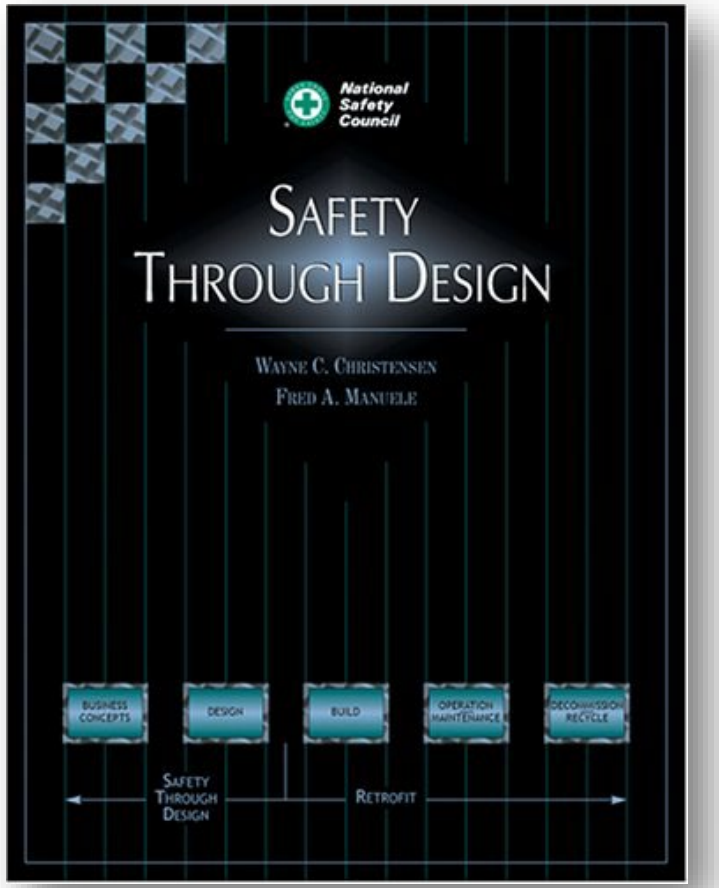
z590.3

Prevention through Design



Exclusively PtD

Lots of books and how to's



PREVENTION THROUGH DESIGN (PTD) IN THE PROJECT DELIVERY PROCESS

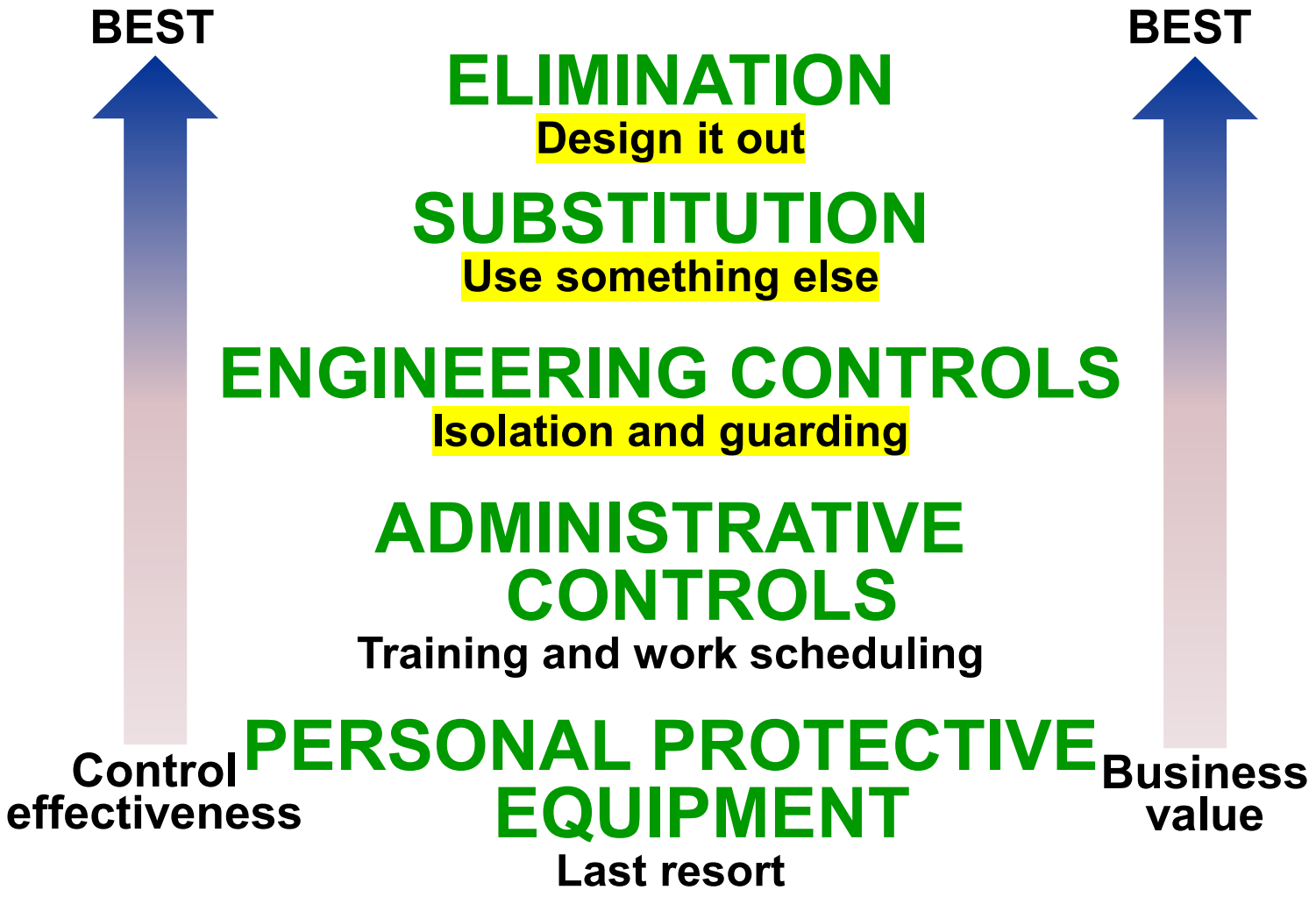
A PtD Sourcebook for Construction Site Safety

By:
John Gambatese, PhD, PE(CA)
School of Civil and Construction Engineering
Oregon State University

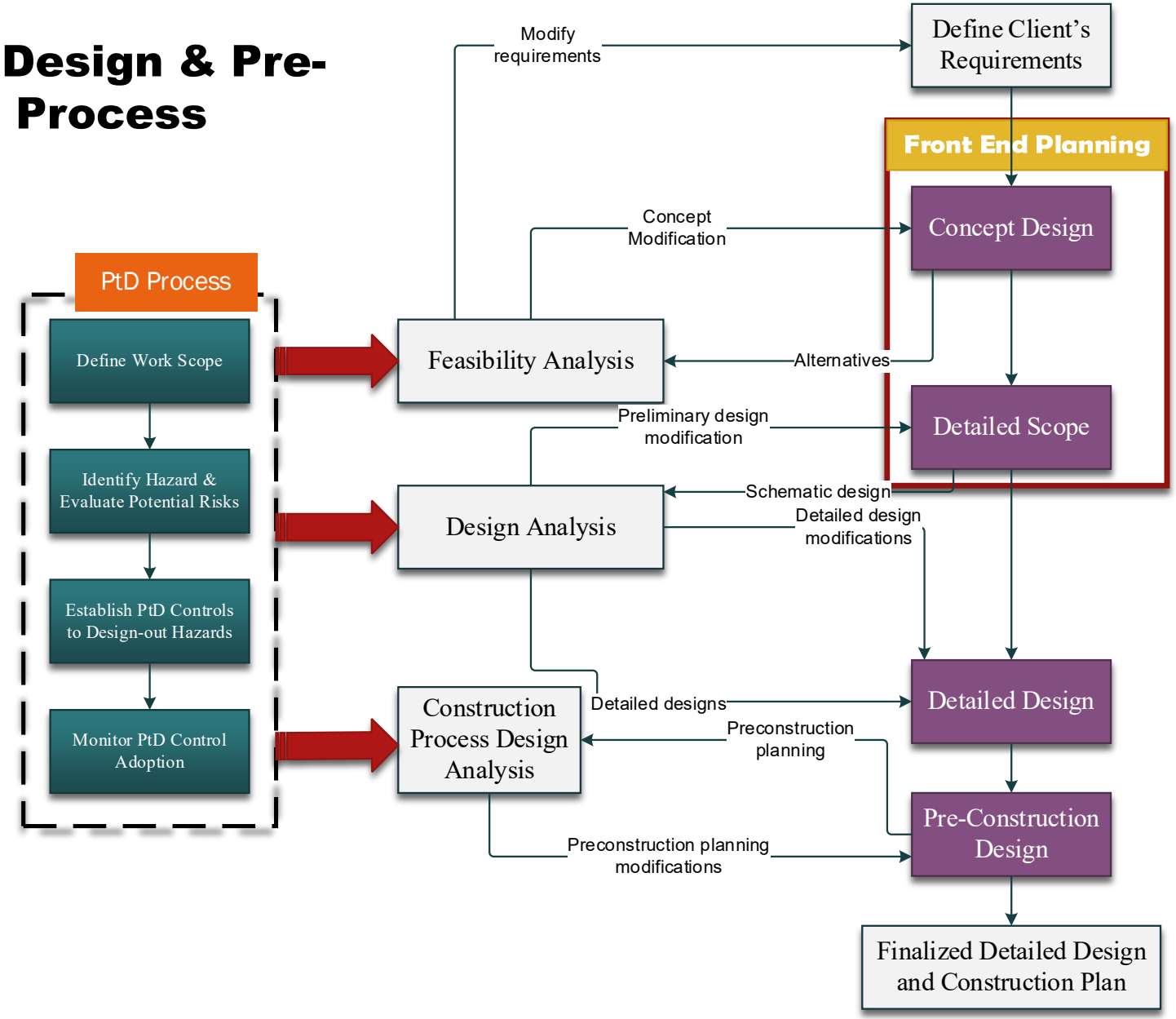
August 2019

Oregon State University

Hierarchy of Controls per ANSI/AIHA Z10-2005

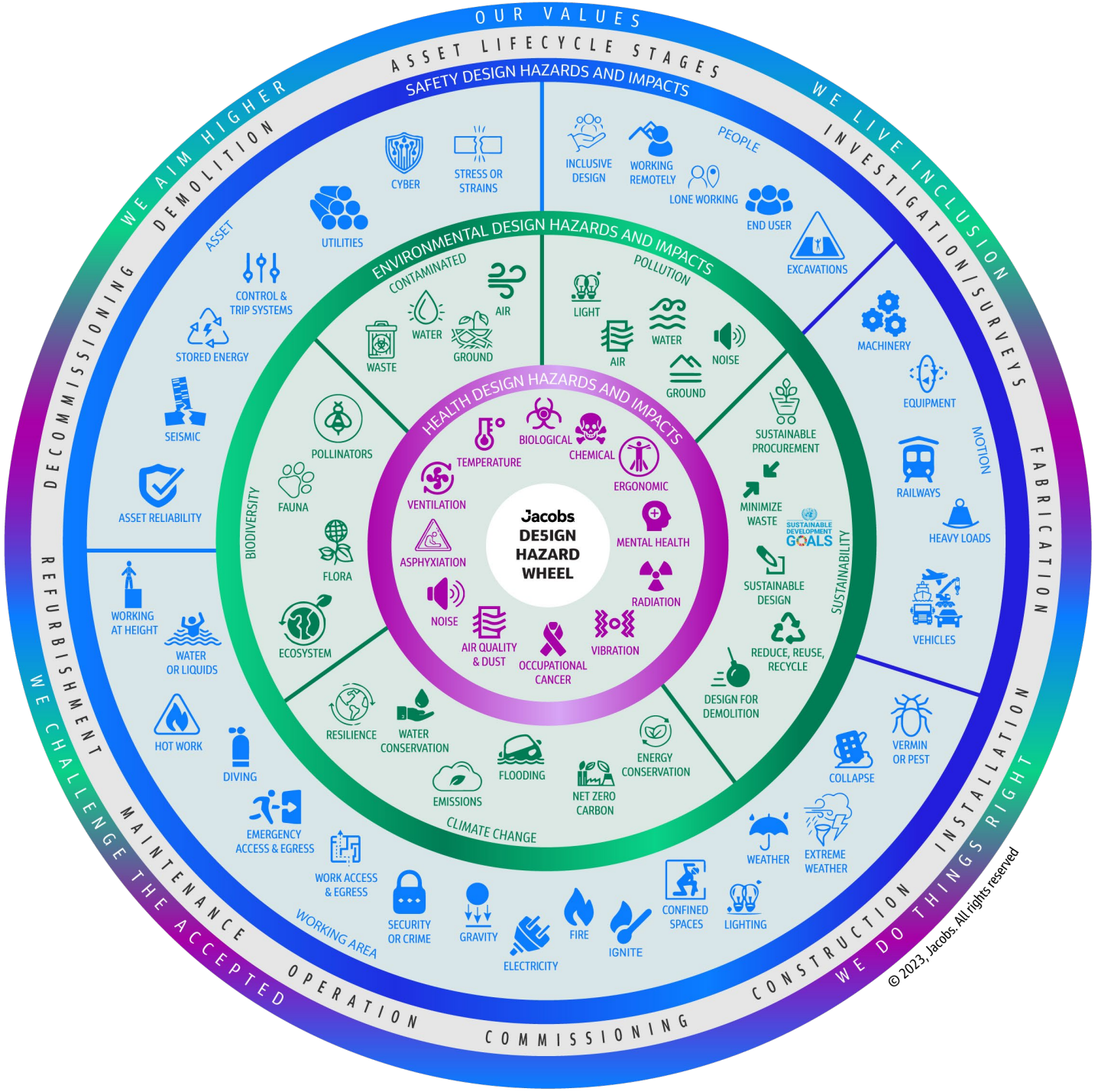


PtD Considerations in Design & Pre-Construction Planning Process



Ud Din 2017, Adapted from Kamerdeen, 2013

Jacob's design hazard wheel, Moser (2023)



Example Checklist as a Tool

Item	Description
1.0	**Structural Framing**
1.1	Space slab and mat foundation top reinforcing steel at no more than 6 inches on center each way to provide a safe walking surface.
1.2	Design floor perimeter beams and beams above floor openings to support lanyards.
1.3	Design steel columns with holes at 21 and 42 inches above the floor level to support guardrail cables.
2.0	**Accessibility**
2.1	Provide adequate access to all valves and controls.
2.2	Orient equipment and controls so that they do not obstruct walkways and work areas.
2.3	Locate shutoff valves and switches in sight of the equipment which they control.
2.4	Provide adequate head room for access to equipment, electrical panels, and storage areas.
2.5	Design welded connections such that the weld locations can be safely accessed.

[Checklist courtesy of John Gambatese]

What did we learn….

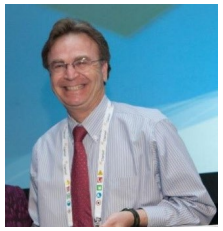
Prevention through design practices are well documented

Training as well as experience in design and safety practices helps

A number of “how to do this” presentations

1. Mike Flowers (American Bridge, ret.) “PtD Integration into Engineering Education and Project Execution” (2020)
2. John Gambatese (Oregon State) “PtD Research: Why Implement Prevention through Design?” (2020)
3. Mike Toole (Toledo) “Opportunities and Challenges for PtD Education” (2020)
4. TJ Lyons (Lyonetics) “Moving from Risk Management to Risk Elimination” (2020)
5. Jonathan Bach (NIOSH) “NIOSH Prevention through Design (PtD) Program” (2020, 2023)
6. Kate McGee (Pennoni) “Potential Applications of Safety by Design in Civil Engineering” (2021)
7. Chris Trahan Cain (CPWR) “CPWR COVID-19 Resources and Reducing Risk Through Ventilation” (2021)
8. Deborah Dickerson (Virginia Tech) “Prevention through Design Solutions for Occupational Health Risks” (2021)
9. Matt Hallowell (CU Boulder, CSRA), “Energy-Based Hazard Recognition in Design” (2022)
10. Andrew Griffith (Independent Project Analysis) “Driving Superior Construction Safety Performance begins Early” (2022)
11. Carisa Harris-Adamson (University of California, San Francisco and Berkeley) “Using survey data to inform prevention through design translational research (2022)
12. Donna S. Heidel (Amazon) “Applying PtD principles to control risk to industrial hygiene hazards” (2023)
13. Bob Moser (Jacobs), “Safety in Design” (2023)
14. Andrew Griffith (Independent Project Analysis) “Driving Superior Construction Safety Performance begins Early” (2022)
15. Carisa Harris-Adamson (University of California, San Francisco and Berkeley) “Using survey data to inform prevention through design translational research (2022)
16. Donna S. Heidel (Amazon) “Applying PtD principles to control risk to industrial hygiene hazards” (2023)
17. Bob Moser (Jacobs), “Safety in Design” (2023)
18. Ray Coleman (Jacobs), “PtD in Practice: Influencing Positive Design Behavior through ‘de5ign’ (2024)
19. Dr. Alan Lu (OSHA), “Structural Collapses during Construction: Lessons Learned in PtD” (2024)

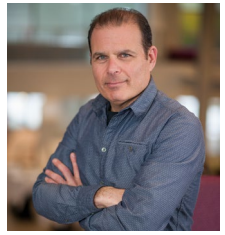
Plus many others on Panels

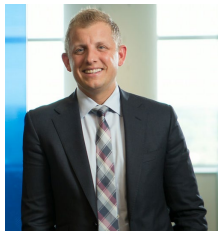

Mark J. Grushka


Anette Balestrand


Peter Hanson


Duanne Shanks


Jeff Hyman


Keith Switzer


Carmine Cimetti


Jim Steele


Jack Toellner


Chuck Gessner


Austin Roberts


Dr. Babak Memarian


Jason Hopper


Justin Riley


Mike Flowers

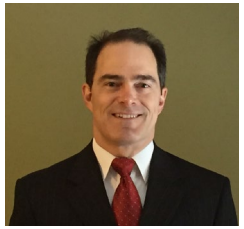

TJ Lyons


Victor Krabbendam


Dr. Scott Earnest


Dr. Zia Ud Din


Corey Wallace

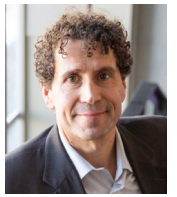

Daniel P. Lavoie


Mr. Rob Berryman


Mr. Charles Hoes

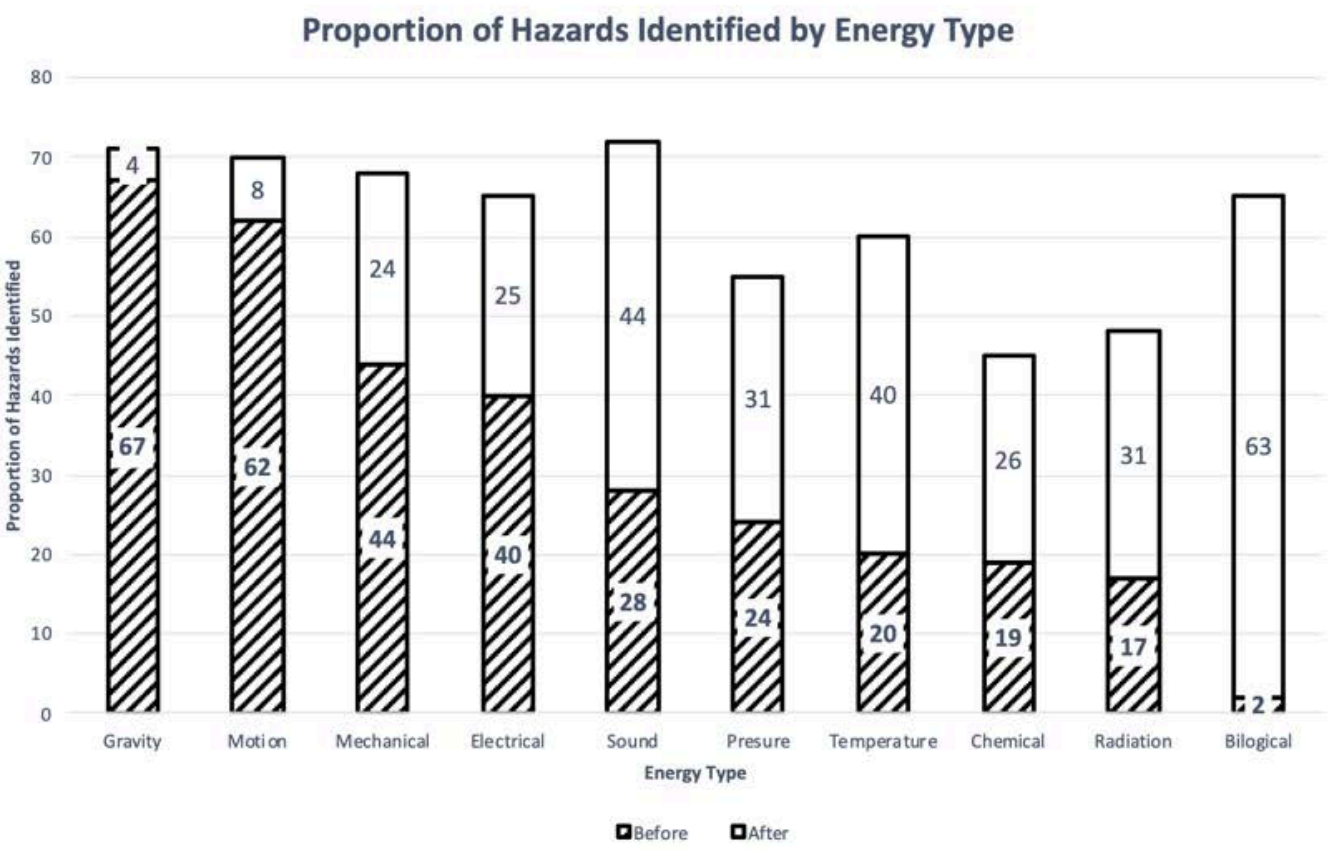

Brian Bennett


Dr. John Gambatese


Dr. David Grau


Dr. G. Edward Gibson

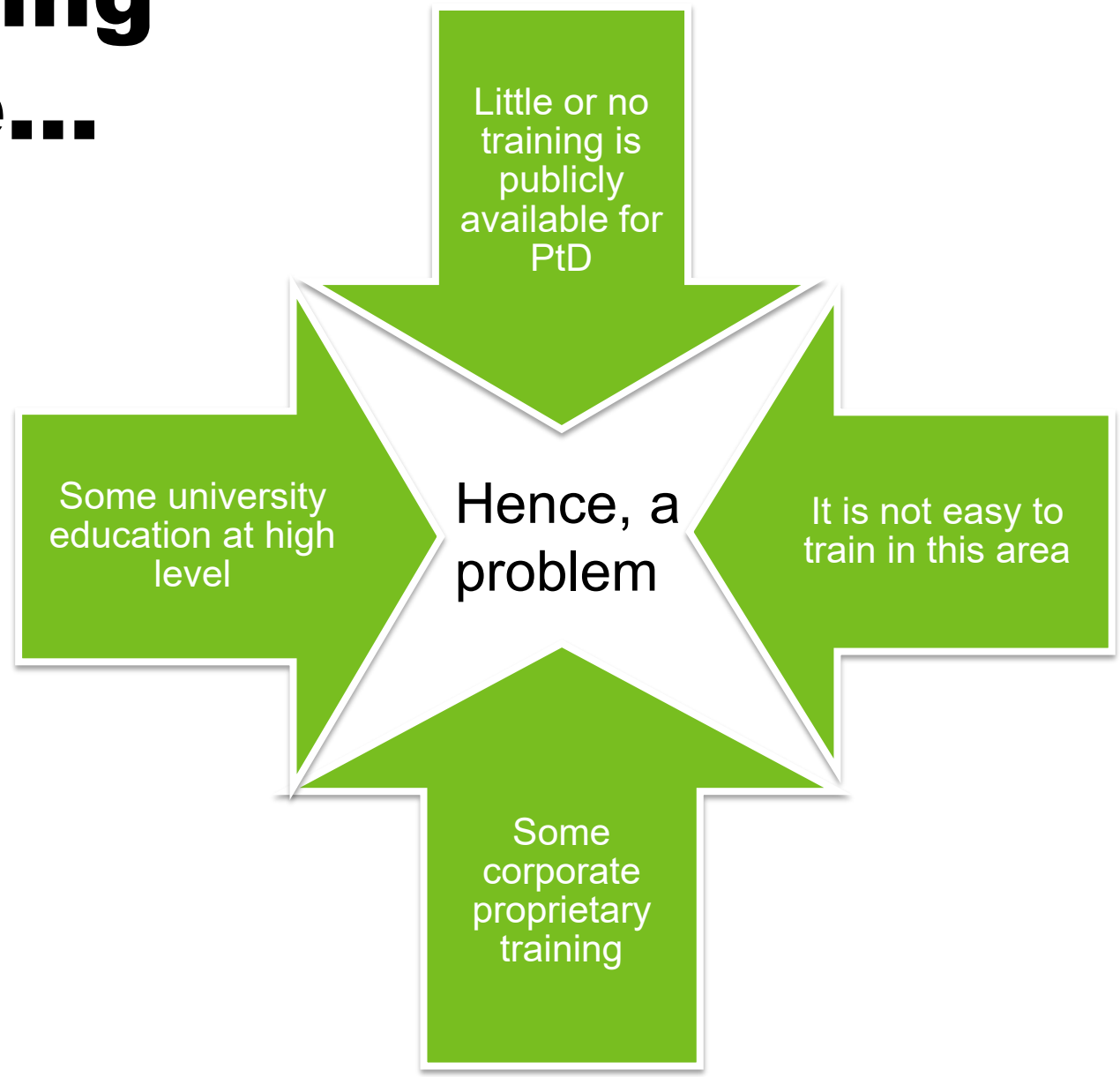
Dr. Matt Hallowell described hazard recognition in design (2022)



Hallowell, M.R., Albert, A., Skaggs, M., and Kleiner, B. (2017). "Empirical measurement and improvement of hazard recognition skill" *Safety Science*, 93, 1-8.

CSRA

PtD training available…

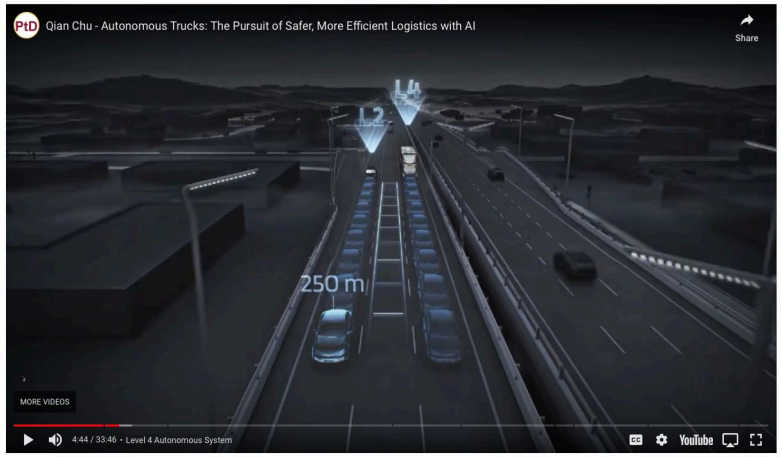


What did we learn….

Technology can assist in PtD

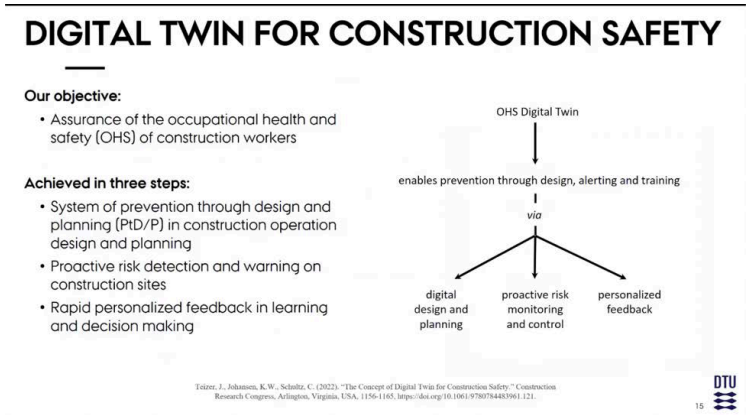
Technology

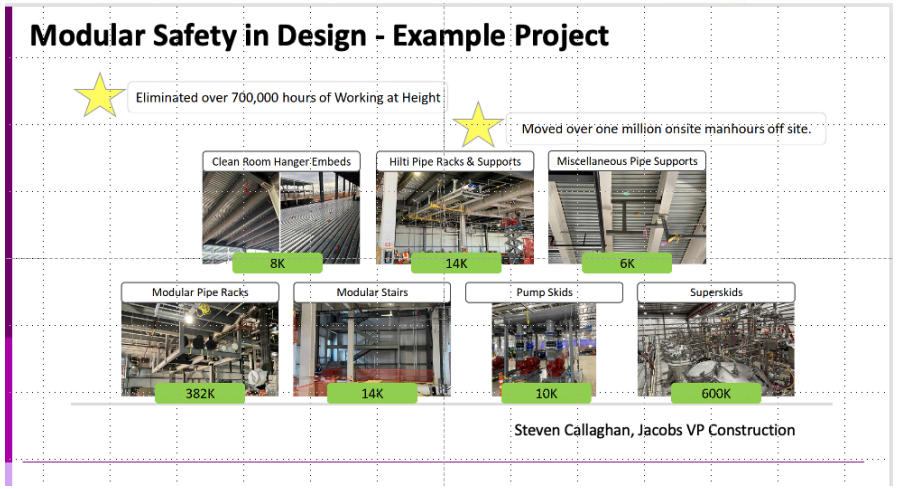
- Wearables and Data, GoX Labs (Hitt), 2022
- Exoskeletons, ASU (Sugar), 2022
- Machine Learning and AI, TuSimple (Chu), 2021
- Modularization and Off-site work, Exxon (Bennett) 2021



Technology

- Digital OSH, Tender, 2023
- Modularization, Jacobs (Mozer), 2023
- Modularization, Mortensen (Hopper and Riley), 2022
- BIM and VDC, Teizer, 2022





What did we learn….

Technology can assist in PtD

Implementation Barriers Exist

Barriers or Perceived Barriers

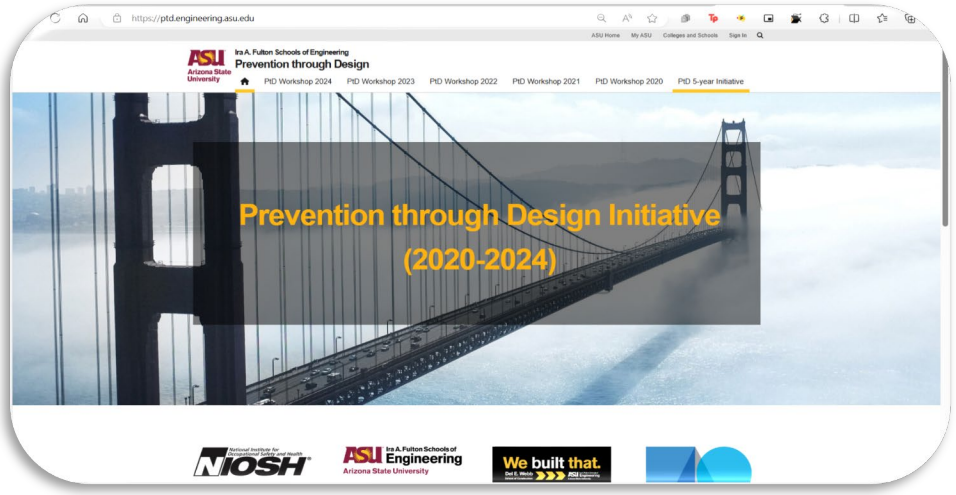
- No or minimal designer education and training in safety and especially PtD
  - Site safety and designing for safety; identification of hazards
- Difficult to assess risks during design
- Contractual separation of design and construction
- Cost/time required to implement PtD
- Fear of increased liability
- Competing priorities (e.g., safety vs. cost/schedule)
- Industry fragmentation

Our Steering Committee

Name	Organization
Dr. Edd Gibson	National Academy of Construction
Dr. Scott Earnest	NIOSH
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 - The Center for Construction Research and Training
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

Workshop Materials

Website



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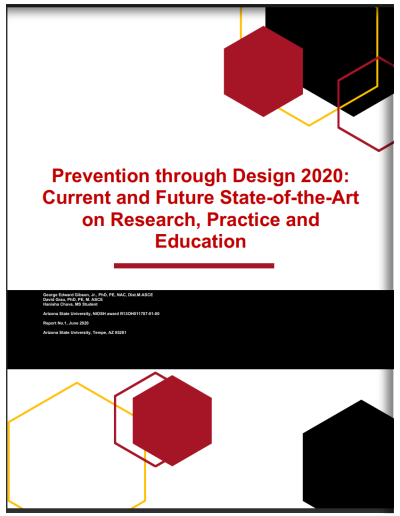
Reports



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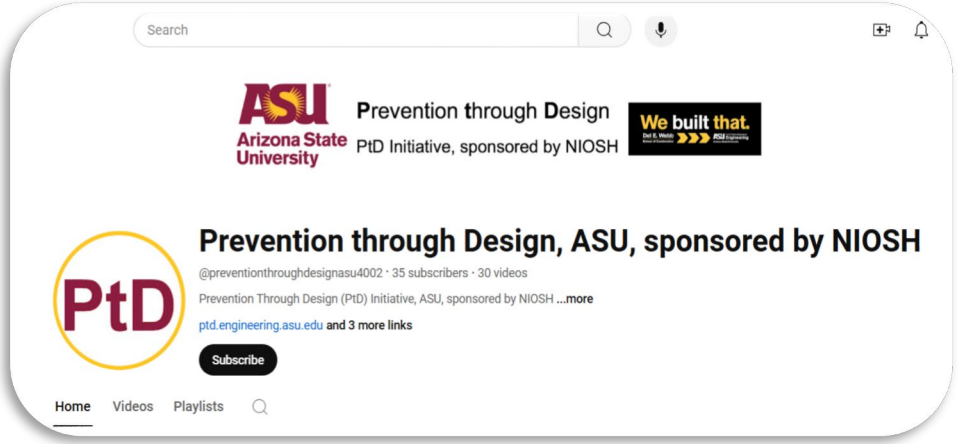

https://www.youtube.com/@preventionthroughdesignasu4002/featured

Recap

- **Prevention through Design (PtD)** is a process that saves lives, time, and money while protecting workers' health.
- There are tools and examples to facilitate PtD.
- PtD is the smart thing to do and the right thing to do.
- Although site safety is the contractor's responsibility, the designer has the ethical duty to create drawings with good constructability with safety in mind.

Q&A

Thank You!

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