

DESIGNER-CONSTRUCTOR COLLABORATION TO ACHIEVE PREVENTION THROUGH DESIGN

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Based in part on past presentations with
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WWW.DESIGNFORCONSTRUCTIONSAFETY.ORG

Prevention through Design

Spreading the word about Design for Construction and Maintenance Safety

[THE PTD CONCEPT](#)

[PROCESS AND WORK PRODUCT](#)

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Welcome to Prevention through Design!

OVERVIEW

- ❑ Design feedback is critical
- ❑ PtD Concept
- ❑ Examples
- ❑ Processes and Tools
- ❑ Barriers and Solutions to implementing PtD

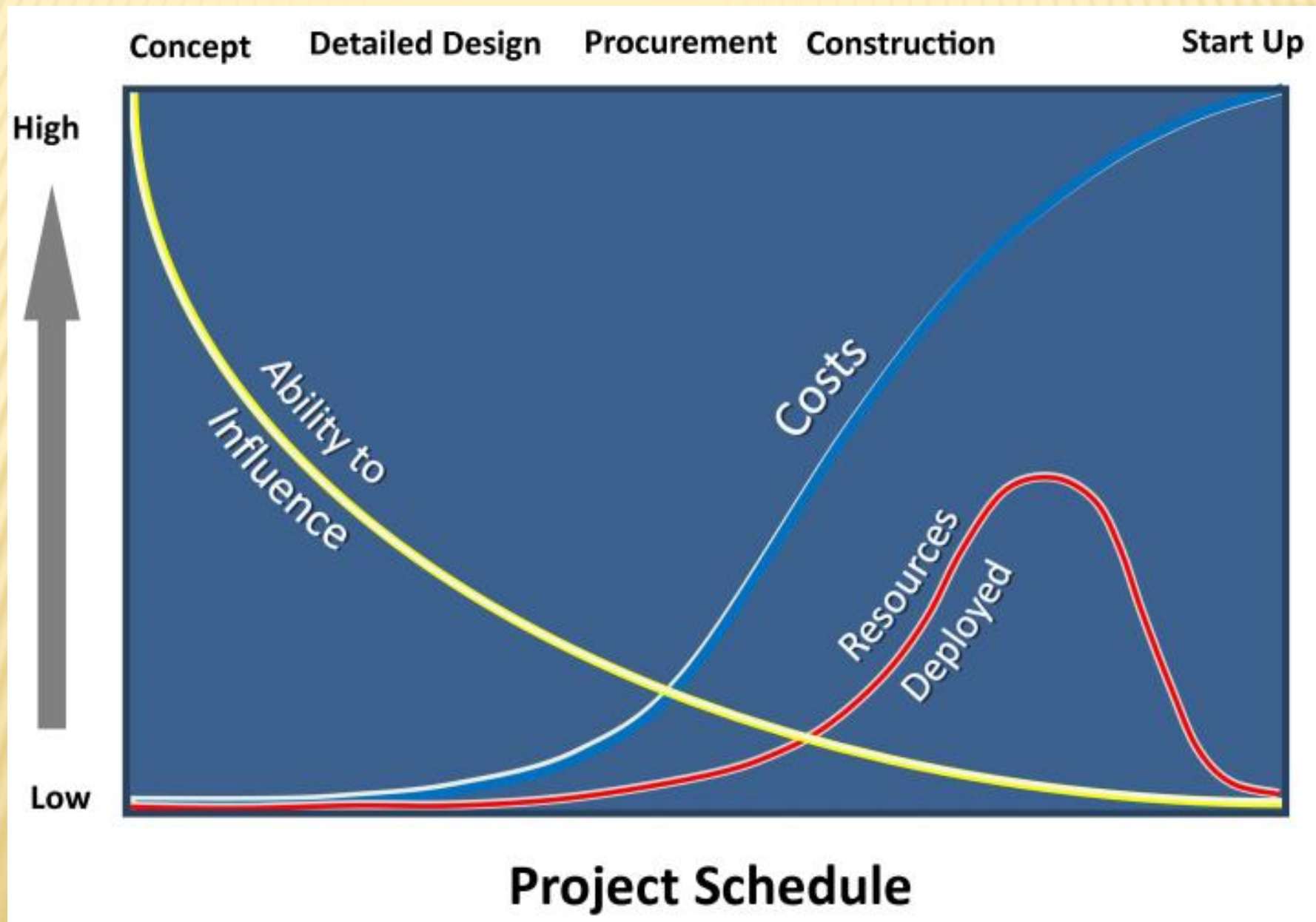
**Prevention through Design
= Design for Safety
= Engineering for Safety**



TO ACHIEVE PROJECT GOALS, DESIGN FEEDBACK IS NEEDED FROM STAKEHOLDERS WITH EXPERTISE

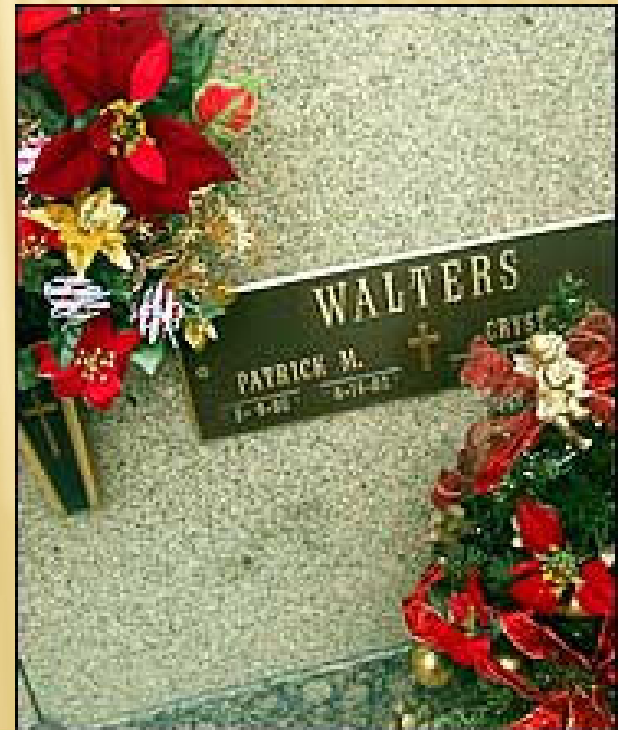
- ❑ Construction cost
- ❑ Construction duration (prefabrication)
- ❑ Quality (service life, performance)
- ❑ Operational efficiency
- ❑ Sustainability (energy, water, waste)
- ❑ Safety (construction, operations, maintenance)

ACHIEVEMENT OF PROJECT GOALS IS DEPENDENT ON DESIGN



WHY PtD? ANNUAL CONSTRUCTION ACCIDENTS IN U.S.

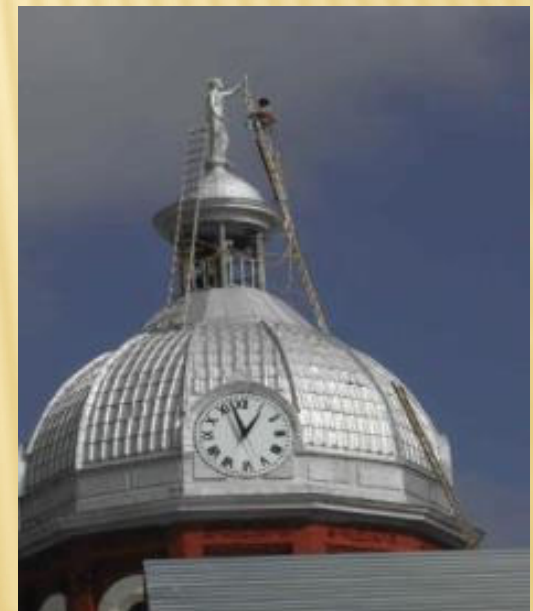
- ❑ Nearly 200,000 serious injuries
- ❑ 1,000+ deaths



PREVENTION THROUGH DESIGN (PtD)

“Addressing occupational safety and health needs in the design process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of facilities, materials, and equipment.”

(<http://www.cdc.gov/niosh/topics/ptd/>)



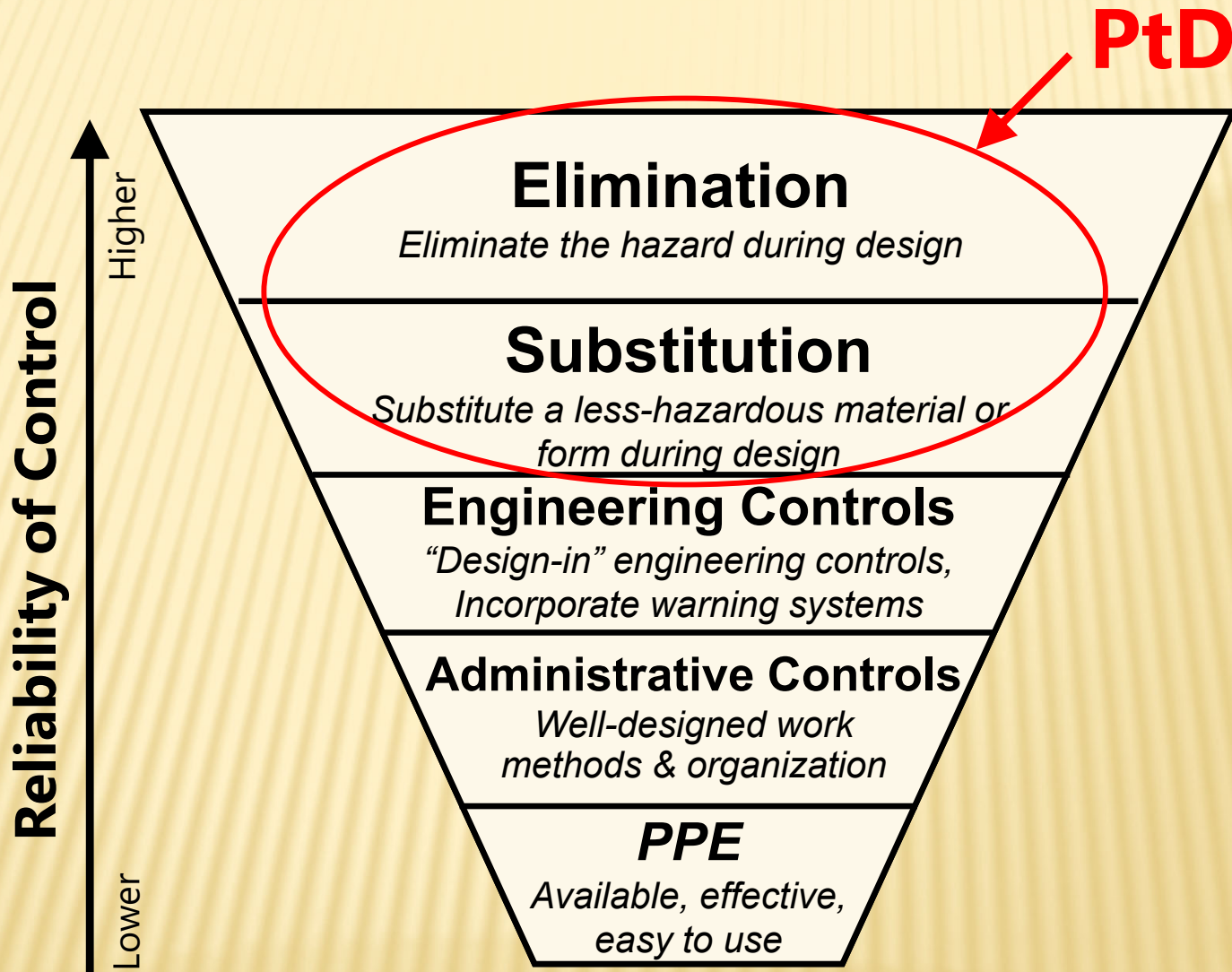
PtD IN CONSTRUCTION IS...

- ❑ Explicitly considering construction and maintenance safety in the design of a project.
- ❑ Being conscious of, **and valuing**, the safety of construction and maintenance workers when performing design tasks.
- ❑ Making design decisions based in part on a design element's inherent safety risk to construction and maintenance workers.

“Safety Constructability and Maintainability”



HIERARCHY OF CONTROLS



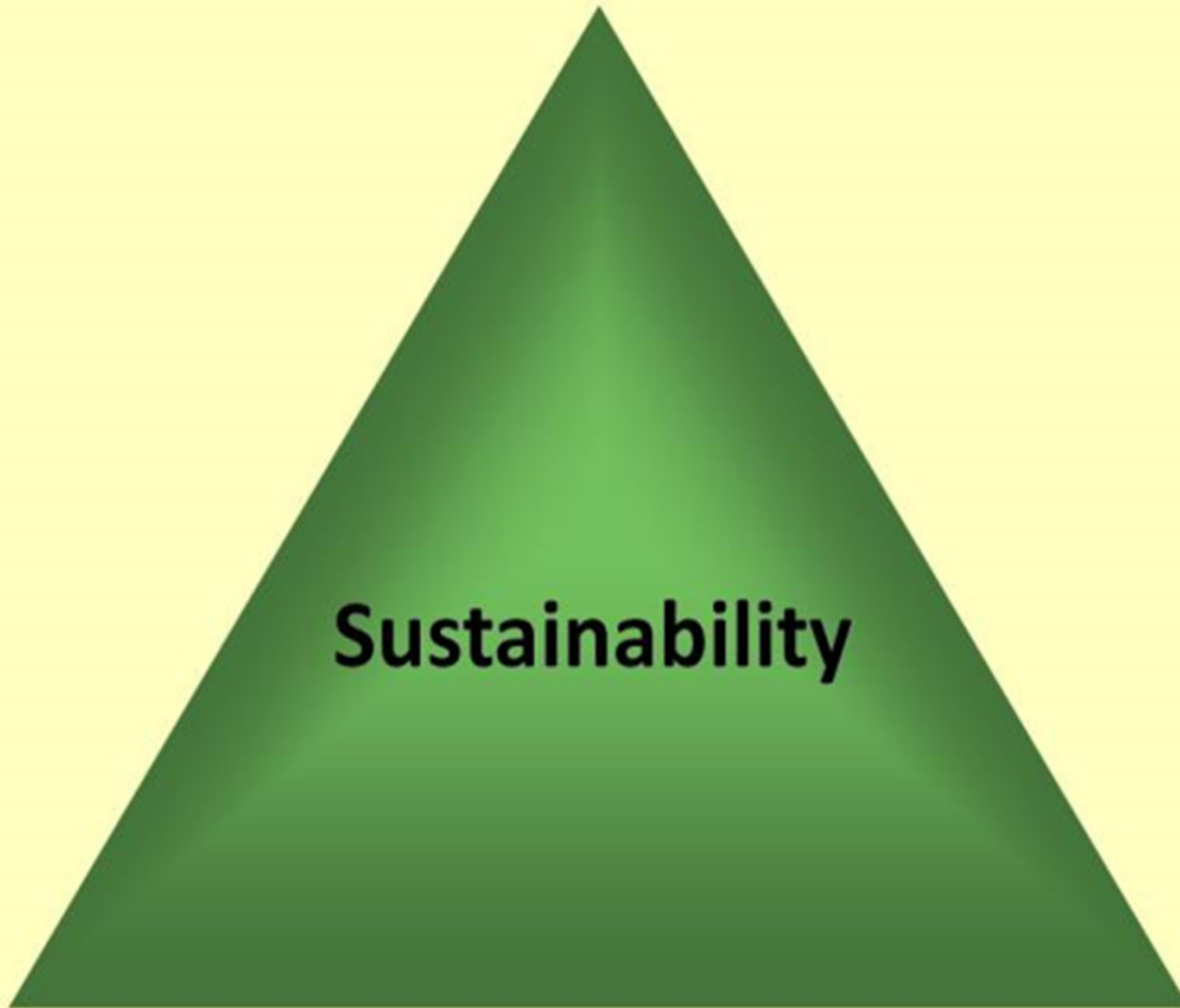
WHY PtD? SUSTAINABILITY

Environmental

Sustainability

**Economic
Viability**

**Social
Equity**



Sustainable Development



Capital projects that do not unfairly affect people who are not at the table

Further reading:

Toole, T. M. and G. Carpenter (2013). "Prevention through Design as a Path Towards Social Sustainability." *ASCE Journal of Architectural Engineering* 19(3):169-173.

THE ETHICS OF PTD

- ❑ AIA Code of Ethics (2020)
 - *E.S. 1.5 Design for Human Dignity and the Health, Safety, and Welfare of the Public: Members should employ their professional knowledge and skill to design buildings and spaces that will enhance and facilitate human dignity and the health, safety, and welfare of the individual and the public.*
- ❑ Don't our duties include minimizing all risks over which we have control? Is it ethical to create designs that are not as safe as they could (practically) be?
- ❑ Don't we have the same duties for construction, maintenance, and line workers as we do for the "public"?

TRUE STORY FROM NIOSH F.A.C.E REPORT

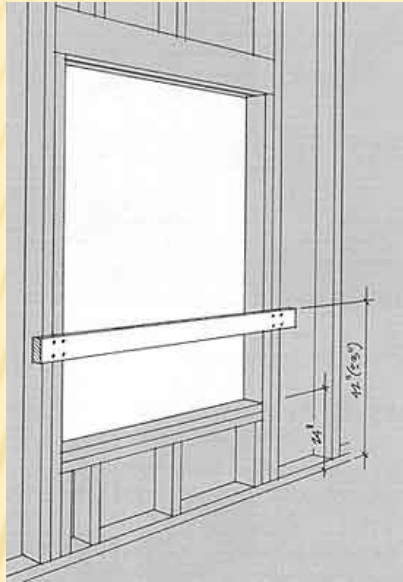


- ❑ Groundwater monitoring well plan called for a well to be installed under overhead power lines.
- ❑ Drill rig operator was electrocuted by arc flash from power line to rig
- ❑ Had design engineer known about proximity of power line and possibility of arc flash, the well location could have been shifted out of hazard zone

EXAMPLE: ANCHORAGE POINTS



EXAMPLES: ROOFS AND PERIMETERS



Skylights



Upper story windows

Parapet walls



EXAMPLE: PREFABRICATION



Pipe Spools

www.wermac.org/documents/fabrication_shop.html



Concrete Wall Panels



MEP Corridor Racks



Concrete Segmented Bridge

PREFABRICATION: THE LINK BETWEEN ENVIRONMENTAL SUSTAINABILITY AND SAFETY

- ❑ Prefabricated construction is inherently safer than “stick-built.”
- ❑ Work is shifted to engineered work environments and processes away from dangerous work environments:
 - at height
 - in trenches
 - in confined spaces
 - exposed to weather (wind, water, ice, mud, lightning)
- ❑ Prefabricated construction has
 - lower construction waste
 - lower embodied energy
 - lower embodied greenhouse gases

DESIGN FOR MAINTENANCE SAFETY

- ❑ Provide safe access for recurring maintenance/preventive maintenance
 - Light Bulbs, Air Filters, Belts, Valves
 - Avoid at height, confined space, awkward ergonomics

- ❑ Provide safe clearance for replacing units
 - Blower Units, Boilers, Compressors, Pumps
 - Consider issues with Isolation, Material handling, Path out and in

WHY PtD? TANGIBLE BENEFITS

- ❑ Reduced site hazards
 - **Fewer worker injuries and fatalities**
- ❑ Reduced workers' compensation premiums
- ❑ Increased productivity and quality
- ❑ Fewer delays due to accidents
- ❑ Encourages designer-constructor collaboration
- ❑ Improved operations and maintenance safety



PtD IS GAINING MOMENTUM

- ❑ Required in UK, Europe for since 1995
- ❑ Required in Australia, S. Africa, Singapore
- ❑ OSHA DfCS Workgroup since 2005
- ❑ NIOSH PtD Workshops and Funding
- ❑ ANSI Standard and Technical Report
- ❑ Adoption primarily in the process/industrial construction sector
- ❑ LEED Pilot Credit

PtD DESIGN REVIEW

□ Hazard identification

- What construction safety hazards does the design create?

□ Risk assessment

- What is the level of safety and health risk associated with each hazard?

□ Design option identification and selection

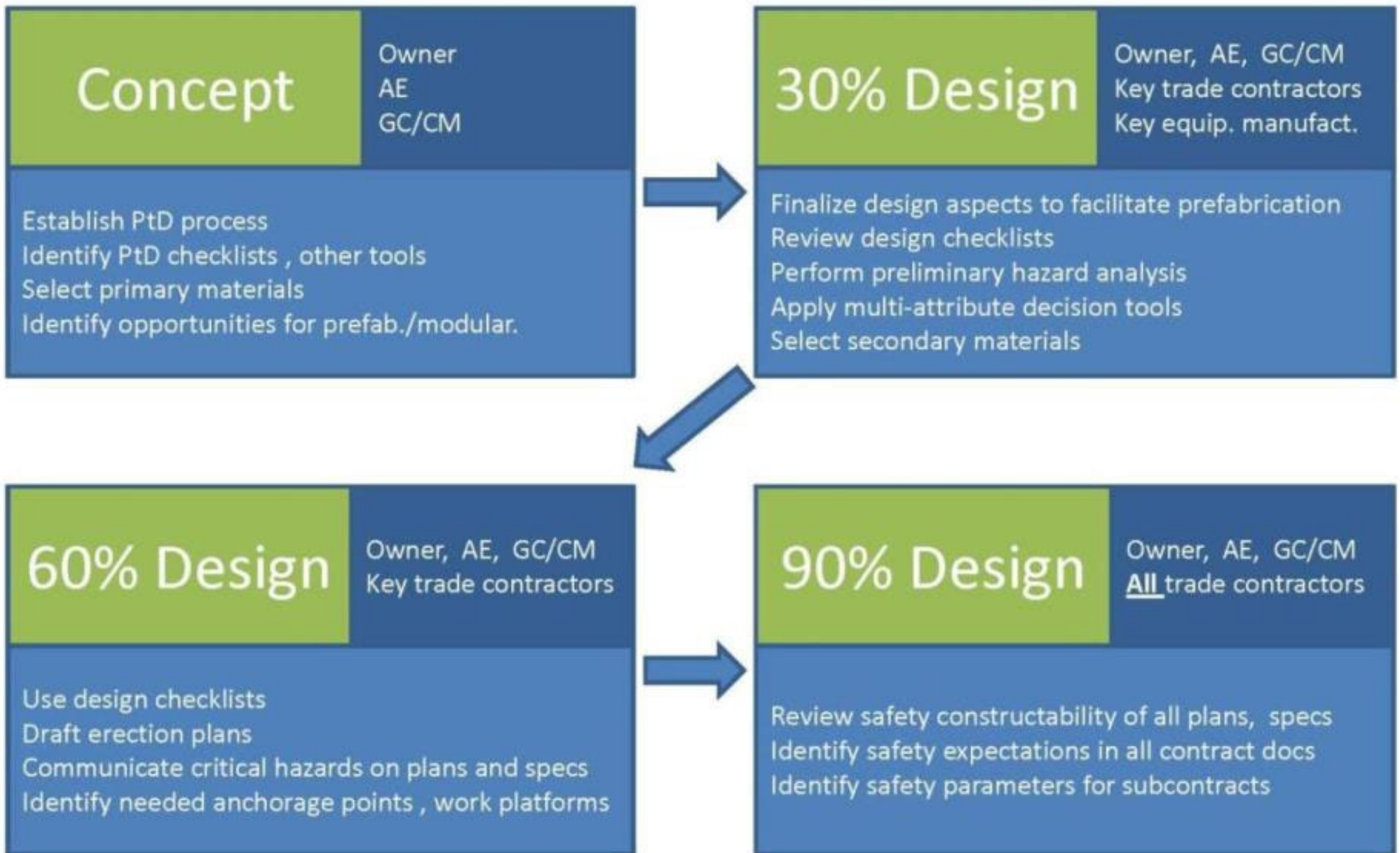
- What can be done to eliminate or reduce the risk?
- Remember the hierarchy of controls...

PTD REQUIRES EFFECTIVE DESIGN REVIEWS

- ❑ **Get the right people in the room**
 - Specialty designers
 - Contractors: field ops, safety
 - Specialized equipment engineers
 - Operators
 - Maintenance: plant ops, safety

- ❑ **Talking about the right things at the right time**
 - Starting very early in the design process
 - Periodic, 2-4 days
 - Use visualization tools
 - Use checklists and documentation tools
 - Establish norms to ensure all voices heard

PtD PROCESS



POTENTIAL BARRIERS TO PTD

- ❑ Designer's lack of safety expertise
- ❑ Increased design fees
- ❑ Designer's fear of liability

BARRIER: DESIGNERS' FEAR OF LIABILITY

- ❑ Barrier: Fear of undeserved liability for worker safety.
- ❑ Potential solutions:
 - Communicate designers should not be held responsible for construction accidents.
 - Develop revised model contract language.
 - Work with insurance carriers and attorneys.
 - Start with lowest level of PtD activity.

THREE STEPS TOWARDS PtD

1. Establish a lifecycle safety culture
2. Establish enabling processes
3. Team with organizations who value lifecycle safety

Culture

Processes

Partners

PTD ENABLED BY CHANGES IN PROCUREMENT PROCESSES AND CONTRACTS

- ❑ Traditional Design-Bid-Build does not allow PtD unless Design-Assist used
- ❑ Design-Build *may* integrate construction knowledge into design
- ❑ Integrated Project Delivery's use of Target-Value Design and Co-location facilitates integration
- ❑ Designer training and tools needed
- ❑ **INCLUDE** operators and maintenance professionals!
- ❑ Don't prioritize initial costs over lifecycle costs!

LEVELS OF PTD IMPLEMENTATION

□ Level 1: Invisible PtD Process

- PtD not mentioned during AE selection.
- AE considers safety constructability input during design progress reviews.

LEVELS OF PTD IMPLEMENTATION, CONT.

□ Level 2: Added PtD Process

- PtD not addressed in RFP proposal documents but AE verbally agrees to participate in a PtD process if appropriate disclaimer included in contract.
- AE sends designers to PtD training given by owner or CM.
- AE is given PtD design tools by owner or CM and uses them.
- AE considers safety constructability input during design reviews.

LEVELS OF PTD IMPLEMENTATION, CONT.

- Level 3: Most Embedded PtD Process
 - AE PtD capability explicitly included in AE section.
 - AE has internal PtD training program.
 - AE chooses and uses PtD tools.
 - AE has internal safety design reviews.
 - Safety constructability input from Owner and Contractor incorporated into design.
 - AE actively solicits feedback on safety of final design and uses lessons learned system.

SUMMARY

- ❑ Achieving project goals on construction projects increasingly requires Integrated Design and Construction.
- ❑ Prevention through Design is a promising way to achieve economic, social and environmental sustainability.
- ❑ Successful implementation of PtD will require changed attitudes, processes and contracts.

FOR (FREE) FURTHER READING, GO TO TMICHAELTOOLE.COM

Toole, T. M. and Erger, K. (2018). “**Prevention through Design: Promising or Perilous?**” *ASCE Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*. DOI: 10.1061/(ASCE)LA.1943-4170.0000284.

Gambatese, J. A., T. M. Toole and D. Abowitz (2017). “**Barriers to Prevention through Design.**” *J. of Construction Engineering and Management*. DOI 10.1061/(ASCE)CO.1943-7862.0001296.

Toole, T. M., J. A. Gambatese and D. Abowitz (2016). “**Owners’ Role in Facilitating Prevention through Design.**” *J. of Professional Issues in Engineering Education and Practice*. DOI 10.1061/(ASCE)EI.1943-5541.0000295.

Toole, T. M. and G. Carpenter (2013). “**Prevention through Design as a Path Towards Social Sustainability.**” *J. of Architectural Engineering* 19(3):169-173.

THANK YOU FOR LISTENING!

- ❑ Questions, comments?
- ❑ michael.toole@utoledo.edu
- ❑ www.designforconstructionsafety.org

PtD INFORMATION SOURCES

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WHY PtD?

Ground-breaking studies reveal design and/or planning decisions threatened safety:

- ❑ **22%** of 226 injuries that occurred from 2000-2002 in Oregon, WA, and CA¹
- ❑ **42%** of 224 fatalities in US between 1990-2003¹
- ❑ **60%** of fatal accidents resulted in part from decisions made before site work began²
- ❑ **63%** of all fatalities and injuries could be attributed to design decisions or lack of planning³



¹ Behm, M., "Linking Construction Fatalities to the Design for Construction Safety Concept" (2005)

² European Foundation for the Improvement of Living and Working Conditions

³ NSW WorkCover, *CHAIR Safety in Design Tool*, 2001

ESTABLISH A LIFECYCLE SAFETY CULTURE

- ❑ Instill the right safety values
- ❑ Secure management commitment
- ❑ Training
- ❑ Confirm Life Cycle Costing criteria
- ❑ Ensure recognition that designing for safety is the smart thing to do and the right thing to do
 1. Professional Codes of Ethics
 2. Payoff data

CHOOSE YOUR PARTNERS WISELY

- ❑ PtD capability in designer RFP
- ❑ Designer interaction experience in GC RFP
- ❑ Consider Design-Builders with industrial and international project experience
- ❑ Collaborative culture and experiences
- ❑ Open to change

BARRIER: DESIGNERS' LACK OF SAFETY EXPERTISE

- ❑ Barrier: Few design professionals possess sufficient expertise in construction safety.

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- ❑ Potential solutions:
 - Involve construction professionals in design review.
 - Develop and distribute PtD tools.
 - Add safety to design professionals' curricula.
 - Develop training modules for design professionals.

BARRIER: INCREASED DESIGN COSTS

- ❑ Barrier: PtD processes will increase both direct and overhead costs for designers.
- ❑ Potential solution:
 - Educate owners that total project costs and total project life cycle costs will decrease.