

## Prevention through Design

2018 GOVERNOR'S OCCUPATIONAL SAFETY & HEALTH  
CONFERENCE  
October 29, 2018



Mike Toole, PhD, PE, FASCE

Dean, College of Engineering  
University of Toledo

Based in part on past presentations  
with Dr. John Gambatese  
Professor, Civil and Const.  
Engineering, Oregon State Univ.

## OVERVIEW

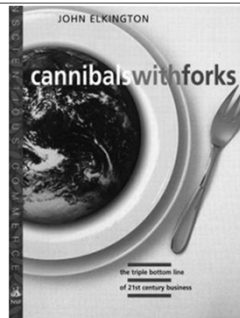
- ❑ Triple Bottom Line and Social Sustainability
- ❑ We all have a Role to Play in Site Safety
- ❑ PtD Concept and Benefits
- ❑ Integrated Design and Construction
- ❑ PtD Examples
- ❑ PtD has Momentum
- ❑ PtD Processes and Tools
- ❑ Implementing PtD

Prevention through Design  
= Design for Safety  
= Safety by Design

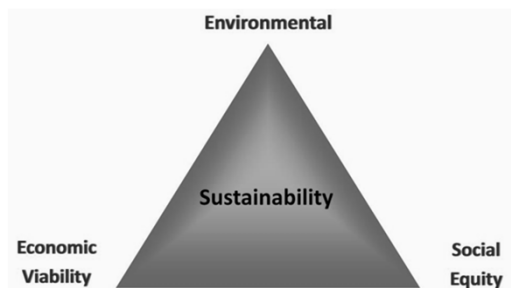


## TRIPLE BOTTOM LINE

"All businesses can and must help society achieve three goals that are linked – **economic** prosperity, **environmental** protection and **social** equity."



## SUSTAINABILITY AND THE TRIPLE BOTTOM LINE



## SOCIAL SUSTAINABILITY

- ❑ Definition of Sustainable Development in Brundtland Commission Report (1987)
- ❑ Focus on people as much as on the environment
  - Meet the needs of people who can't speak for themselves



5

## Sustainable Development



Design and construction that doesn't 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.

6

### SOCIAL SUSTAINABILITY ISSUES

- How will we convince all stakeholders that our project will not unfairly affect people who are not at the table during the concept development, design and construction planning?
  - Building occupants
  - Nearby residents
  - Local politicians and regulators
  - Our employees
  - Construction workers
  - Maintenance workers

7

### ANNUAL CONSTRUCTION ACCIDENTS IN U.S.

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



### ASCE CODE OF ETHICS

#### Canon 1: Hold Safety Paramount

- Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties.
- a. Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering judgments, decisions and practices incorporated into structures, machines, products, processes and devices.

### ASCE SITE SAFETY POLICY (350)

- The American Society of Civil Engineers (ASCE) believes improving construction site safety requires attention and commitment from all parties involved.
- Design engineers have responsibility for: Recognizing that safety and constructability are important considerations when preparing construction plans and specifications;
- Educators are encouraged to: ... Emphasize engineer's role in providing a safe and healthy environment to personnel engaged in project activities through proper planning and design; and

10

### SOCIAL SUSTAINABILITY ISSUES

- Do not our duties include minimizing all risks (especially to people) that we have control over?
- Do not we have the same duties for construction and maintenance workers as for the "public"?

### OVERVIEW

- Triple Bottom Line and Social Sustainability
- We all have a Role to Play in Site Safety
- PtD Concept and Benefits
- Integrated Design and Construction
- PtD Examples
- PtD has Momentum
- PtD Processes and Tools
- Implementing PtD



## 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/>)



## DESIGN-SAFETY LINKS

- **22%** of 226 injuries that occurred from 2000-2002 in Oregon, WA, and CA<sup>1</sup>
- **42%** of 224 fatalities in US between 1990-2003<sup>1</sup>
- **60%** of fatal accidents resulted in part from decisions made before site work began<sup>2</sup>
- **63%** of all fatalities and injuries could be attributed to design decisions or lack of planning<sup>3</sup>

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

<sup>2</sup> European Foundation for the Improvement of Living and Working Conditions

<sup>3</sup> NSW WorkCover, CHAIR Safety in Design Tool, 2001

## 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”**

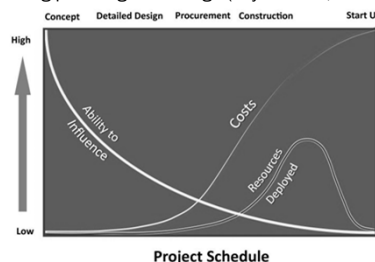
## WHAT PTD IN CONSTRUCTION IS NOT

- Having designers take an active role in construction safety **DURING** construction.
- An endorsement of future legislation mandating that designers design for construction safety.
- An endorsement of the principle that designers can or should be held partially responsible for construction accidents.

15

## DESIGN HAS MAJOR LEVERAGE

- Ability to influence key project goals is greatest early in the project schedule during planning and design (Szymburski, 1997)



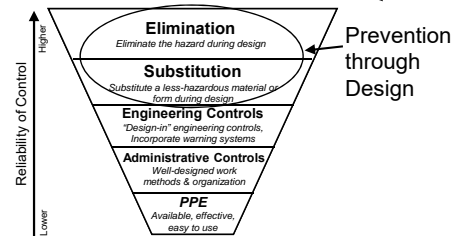
## INTEGRATED DESIGN AND CONSTRUCTION

- Project success requires that design reflects input from all stakeholders, including:
  - Users/occupants
  - Owner facility management personnel
  - Contractors
- Constructability feedback must start early in the design process

### BENEFITS OF INTEGRATED DESIGN AND CONSTRUCTION

- Obvious: Cost, Schedule, Quality
- Accepted: Sustainability
- Emerging: Prefabrication
- Emerging: Safety

### HIERARCHY OF CONTROLS



### ECONOMIC BENEFITS OF PTD

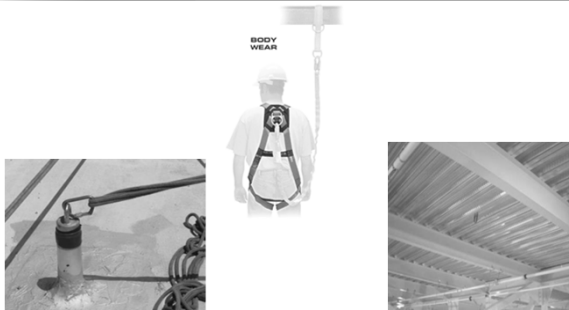
- Reduced site hazards
  - **Fewer worker injuries and fatalities**
- Reduced workers' compensation premiums
- Increased productivity and quality
- Fewer delays due to accidents
- Improved operations/maintenance safety

### EXAMPLE OF THE NEED FOR PTD



- Design spec:
  - Dig groundwater monitoring wells at various locations.
  - Wells located directly under overhead power lines.
- Accident:
  - Worker electrocuted when his drill rig got too close to overhead power lines.
- Engineer could have:
  - specified wells be dug away from power lines; and/or
  - better informed the contractor of hazard posed by wells' proximity to powerlines through the plans, specifications, and bid documents.

### PTD EXAMPLE: ANCHORAGE POINTS



### PTD EXAMPLE: ROOFS AND PERIMETERS

Upper story windows



Skylights



Parapet walls



<https://www.safesystems.com/roofing/perimeter-guard-rails>

### PTD EXAMPLE: STRUCTURAL STEEL DESIGN

*Detailing Guide for the Enhancement of Erection Safety*  
Published by the National Institute for Steel Detailing and  
the Steel Erectors Association of America



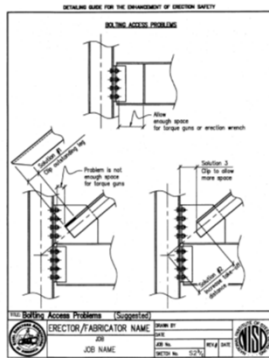
#### The Erector Friendly Column

- + Include holes in columns at 21" and 42" for guardrail cables and at higher locations for fall protection tie-offs
- + Locate column splices and connections at reasonable heights above floor

Photo: AISC educator ppt



- Provide enough space for making connections



- Know approximate dimensions of necessary tools to make connections

Photo: AISC educator ppt



### PTD EXAMPLE – STEEL DESIGN

- Bechtel's steel design process
- PTD elements:
  - Temporary access platforms
  - Lifting lugs
  - Shop installed vertical brace ladders
  - Bolt-on column ladders and work platforms



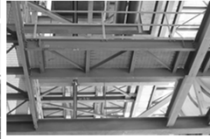
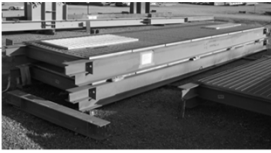
#### Temporary Ladder, Platform, and Safety Line



Photos courtesy of Bechtel Corp.

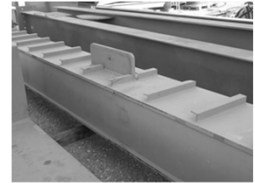


### Modular Platforms



Photos courtesy of Bechtel Corp.

### Brace Lifting Clips and Rungs



Photos courtesy of Bechtel Corp.

### PTD AND PREFABRICATION



Pipe Spools [www.wernmac.org/documents/fabrication\\_shop.html](http://www.wernmac.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 from dangerous work environments to engineered work environments and processes.
  - 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
  - At height, confined space, awkward ergonomics
- ❑ Provide safe clearance for replacing units
  - Blower Units, Boilers, Compressors, Pumps
  - Isolation, Material handling, Path out and in

35

### WHAT DO YOU THINK?

- ❑ What do you think about the Triple Bottom Line concept?
- ❑ Do codes of ethics apply to construction and maintenance workers?
- ❑ What do you think about the Prevention through Design concept?
- ❑ What are your experiences in design for safe construction and design for safe maintenance?

36

## 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
- ❑ Adoption primarily in the process/industrial construction sector

37

## ANSI DOCUMENTS

**ASSP TR-A10.100-2018**  
Technical Report: Prevention through Design – A Life Cycle Approach to Safety and Health in the Construction Industry

A Technical Report prepared by ASSP and registered with ANSI



AMERICAN SOCIETY OF  
SAFETY PROFESSIONALS



ANSI/ASSP Z590.3-2011(R2016)

Prevention through Design Guidelines for  
Addressing Occupational Hazards and  
Risks in Design and Redesign Processes

This standard pertains primarily to the avoidance, elimination, reduction or control of occupational safety and health hazards and risks in the design and redesign process.

38

39

## ARTBA SAFETY CERTIFICATION FAQ

<https://puttingsafetyfirst.org/>

Why should a state or local transportation department support their managers, inspectors and designers earning the Safety Certification for Transportation Project Professionals™?

- Because as custodians of the public's tax dollars and trust, project safety is the top priority for transportation agencies and your personnel. Having SCTPP recipients on your team demonstrates that commitment.
- It shows your employees that project safety is the agency's top priority.
- Having professionally certified personnel involved at all stages of a project—from inception through completion—should help reduce safety incidents, thus saving lives and preventing disabling injuries.
- Because safety incident mitigation can be worked into transportation project plans and designs, if designers know what causes safety incidents on project sites.

40

## LEED PTD PILOT CREDIT

- ❑ Identify and document the items found for the following two stages:
  - Operations and Maintenance
  - Construction
- ❑ For each stage, complete three stages of analysis:
  - Baseline
  - Discovery
  - Implementation

41

## PTD IN PRACTICE: OWNERS

- ❑ Southern Co. (power)
- ❑ Intel (computer chips)
- ❑ San Fran. Public Utilities Commission (water infrastructure)
- ❑ Marine Well Containment System (Gulf Oil Drilling)
- ❑ US Army Corps of Engineers (Water Infrastructure)
- ❑ BHP Billiton (Mining)

### BHP BILLITON'S PTD INITIATIVES

- PTD staff embedded in procurement and design
- PTD in technical specifications
- Required designer PTD training
- Design reviews includes 3D models

43

### OVERVIEW

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### 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 PROCESS

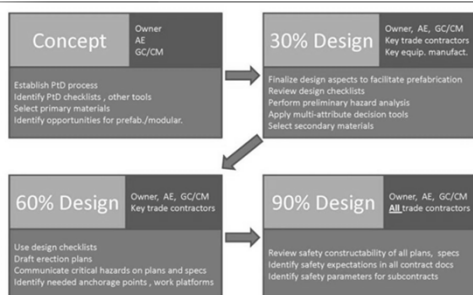
**Get the right people  
talking about the right things  
at the right time!**



www.sagegate.com/

45

### PTD PROCESS



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### SUTTER HEALTH'S IPD PROCESS

- Integrated Project Delivery (IPD) facilitates collaboration of design and construction professionals during design
  - Co-located
  - Processes and norms for candid feedback
  - Trust
  - Sufficient time
  - Life cycle costing criteria
  - Common success criteria



## PTD TOOLS – DESIGN RISK ASSESSMENT

www.constructionindustry.org

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### SLIDE RULE for Building

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#### Safety in Design...

Enhancing construction worker safety through a building's design

The design of a building influences the safety hazards that are present during construction. Architects and engineers can help to improve construction worker safety by addressing safety in their designs.

**SLIDE RULE** Safety in Design Risk Evaluation helps building designers assess the construction safety risk associated with their designs. Use SLIDE RULE for buildings to:

- Determine the level of safety risk associated with an entire building, a specific building system, or each of the many design features within a building
- Complete prescriptive design based on construction safety risk
- Learn about design features that increase and decrease the risk of injury
- Create building designs that minimize the risk of construction worker injury

By using SLIDE RULE, hazards can be eliminated, safety risk reduced, and construction worker injuries and fatalities prevented.

Read more about SLIDE RULE

ASSESS A PROJECT  
Use the online calculator

- Overview
- Case Studies
- Tutorial

## DESIGN FOR CONSTRUCTION SAFETY TOOLBOX

- Created by Construction Industry Institute (CII)
- Interactive computer program
- Used in the design phase to decrease the risk of incidents
- Over 400 design suggestions



All Sector Skills Councils are in the process of being relicensed by UKCES

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FEEDBACK Form

Home > Design Guides

CDM Guidance for Designers

Compliance with these guidance notes does not necessarily confer immunity from prosecution under health and safety legislation.

Flexible opportunities for feedback and contributions are allowed for in A 003 Review Sheets. Such contributions would be welcomed.

NOTE: Always check you have the latest revision.

Home > Design Guides

### Safety in Design - Design Guides

- 1 A000 - Preface
- 2 A001 - Index
- 3 A002 - Review Sheets
- 4 A004 - How To Use Guidance
- 5 G 10 001 - Practice Policies
- 6 G 10 002 - Health and Safety File
- 7 G 10 003 - CDM - What Designers Should Know
- 8 H 10 001 - Hazardous Materials
- 9 H 10 002 - Lined Panel Design Guide
- 10 H 20 001 - Muroto-Skeletal
- 11 H 20 002 - Noise
- 12 T 10 002 - Excavations
- 13 T 20 001 - Erection of Structures
- 14 T 20 002 - Scaffolding Erection
- 15 T 20 003 - Scaffolding

Design Guides

- File Administration
- Preface
- Index
- Review Sheets
- How To Use Guidance
- General Guidance
- Practice Policies
- Health and Safety File
- Designers Should Know
- Health Guidance
- Hazardous Materials
- Lined Panel
- Muroto-Skeletal
- Noise
- Technical Guidance
- Excavations
- Erection of Structures
- Scaffolding Erection
- Refurbishment
- Temp Works Equip
- Work At Height
- Roads
- Spacial Design
- Strip Access Equip
- Concrete Blockwork

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## Designing to make management of hazards associated with working on roofs easier

### INTRODUCTION

1. Designers can play a major part in making it easier to manage the hazards associated with roof working.
2. Roofs are hazardous places to work, because they are at height and have coverings, which are lightweight and often fragile and deteriorate over time through being exposed to the elements.
3. While work on roofs is an infrequent activity, the opportunity for a fatal or serious accident is very high. And, designers who see roofs only as a means making the building watertight, exacerbate the situation. They forget that people have to construct roofs and maintain them. Consequently, little provision is made for this.
4. People are often killed or injured when falling from roofs. Therefore, designers need to consider alternative designs to ensure roof work can be eliminated or significantly reduced where reasonably practicable.
5. This guidance note makes designers aware of the issues and gives information on how they can help to make roof work safer through their designs.

### HAZARDS ASSOCIATED WITH WORK ON ROOFS

6. Workers on roofs are exposed to the hazard of falling from height. This can either be off an unguarded edge or through a fragile surface.
7. Manual handling and premature collapse hazards also exist.

### WHAT DESIGNERS SHOULD DO

8. Designers should consider two phases: the construction phase and the maintenance phase.

#### The construction phase

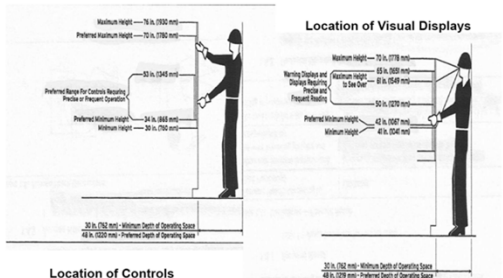
9. During this phase, it is inevitable that people will need to be on the roof and designers should consider providing for systems that will help a contractor to manage the hazard of falling from height.

#### Falls off unguarded edges

- General Guidance
- Practice Policies
- Health and Safety File
- Designers Should Know
- Health Guidance
- Hazardous Materials
- Lined Panel
- Muroto-Skeletal
- Noise
- Technical Guidance
- Excavations
- Erection of Structures
- Scaffolding Erection
- Refurbishment
- Temp Works Equip
- Work At Height
- Strip Access Equip
- Concrete Blockwork
- Demolition
- General Information
- Manual Handling
- Lifting - Cranes
- HSR01 - Alterations
- HSR02 - Common regulation



## Requirements for Workspace Design & Layout



## SOUTHERN CO.'S DESIGN CHECKLISTS

### DESIGN SAFETY CHECKLIST CIVIL

THIS HAZARD OR CONCERN NEEDS TO BE ADDRESSED ON THIS PROJECT? Y=Yes, N=NO

THIS HAZARD OR CONCERN: \_\_\_\_\_

HAS BEEN ADDRESSED IN OUR DESIGN \_\_\_\_\_

WILL BE ADDRESSED IN OUR DESIGN \_\_\_\_\_

OTHER \_\_\_\_\_

Design Lead: \_\_\_\_\_

Project No.: \_\_\_\_\_

Plant: \_\_\_\_\_

Date: \_\_\_\_\_

Decision click to add "Y" to boxes	Item No.	Description
<input type="checkbox"/>	1	Project Engineer has communicated "HAZCOM" project information required for design engineering personnel making a site visit. (Each person that is sent to the job site must be informed of any potential hazards.)
<input type="checkbox"/>	2	Discipline Lead Engineer and civil team understand our safety goal: All engineering drawing and specifications will be prepared with a consideration for safety and constructability.
<input type="checkbox"/>	3	Construction people working near fiberglass manufacturing need to understand the toxic air pollutants.
<input type="checkbox"/>	4	Locations are identified where guard posts, walls, or barriers should be provided to prevent access to potentially unsafe areas.
<input type="checkbox"/>	5	Underground hazards and reference drawings locating any potential hazards are identified. (Examples: buried pipes, electrical cables, etc.)
<input type="checkbox"/>	6	Process engineer, construction project manager, customer, and vendor representatives have identified special loads that should be considered in our design.
<input type="checkbox"/>	7	Required quality records will be identified, collected, filed, and stored with proper disposition for structural specified materials. (Examples: high strength bolts, U-drawn plates, concrete cylinder breaks.)

## PTD INFORMATION SOURCES



Welcome to Prevention through Design!

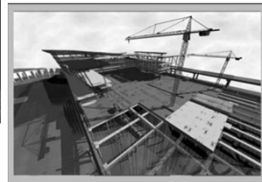
News:

[www.designforconstructionsafety.org](http://www.designforconstructionsafety.org)

## 1700+ ITEM PTD CHECKLIST

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.

## PTD TOOLS – BIM AND VISUALIZATION



## 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

## ESTABLISH A LIFECYCLE SAFETY CULTURE

- ❑ Secure management commitment to safety and to a life cycle approach
- ❑ Instill the right safety values
- ❑ Training
- ❑ 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

## ESTABLISH ENABLING PROCESSES

- ❑ Qualifications-based contracting
- ❑ Negotiated or Cost-Plus contracting
- ❑ IPD or enabled safety constructability input
- ❑ Collaborative decision processes
- ❑ Designer training and tools



### 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

### WHAT EACH ENTITY NEEDS TO DO TO ENABLE PTD 1

- Owner
  - Require PtD on projects
  - Allow project delivery methods other than DBB
  - Involve construction and maintenance safety staff in constructability reviews
- AE
  - Acquire PtD capability
  - Work on PtD projects
  - Participate in safety constructability discussions and revise project documents as appropriate

62

### WHAT EACH ENTITY NEEDS TO DO TO ENABLE PTD 2

- GC/CM and Subcontractors
  - Encourage clients to require PtD on projects
  - Collaborate with owner and staff on constructability reviews
  - Persist if safety is not prioritized

63

### INITIATING PTD IN YOUR ORGANIZATION

- Leadership
- Sustainability
- Ethics
- Innovation
- Change management

64

### SUMMARY

- Our clients and taxpayers may increasingly be demanding that we deliver integrated design and construction and proactively consider the triple bottom line on our projects.
- Prevention through Design is a promising way to achieve economic, social and environmental sustainability and increase safety and health.
- Management commitment, training and client engagement are necessary first steps.
- PtD can be an important part of achieving the Pennsylvania Governor's safety and health vision.

### THANK YOU FOR YOUR TIME!

Mike Toole  
 michael.toole@utoledo.edu  
[www.designforconstructionsafety.org](http://www.designforconstructionsafety.org)

