



PREVENTION THROUGH DESIGN: A Leadership Opportunity for YOU

2014 Spring Owners Leadership Conference

Houston, TX

May 16, 2014

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Based on past presentations with

John Gambatese, PhD, PE



DOWNLOAD THIS PRESENTATION NOW FROM WWW.DESIGNFORCONSTRUCTIONSAFETY.ORG

Prevention through Design Design for Construction Safety



[Home](#) | [Concept](#) | [Process](#) | [History & Future](#) | [Challenges](#) | [Resources](#) | [Links](#) | [Contacts](#)

News and Updates:

[Presentation](#) by Mike Toole at the COAA Spring Leadership Conference on May 16, 2014.

"Means and methods" continue to be misunderstood. [Read why PtD does not conflict with typical contractual references to means and methods.](#)

[Read actions that owner organizations should take to effectively implement PtD on their projects](#) (revised Jan. 2014).

Researchers at Oregon State University have created a [tool](#) 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."

PtD-related Linked In groups include the [Safety in Design](#) group (which contains many helpful links and files) and the ANSI/ASSE SH&E Standards Information Center.

Researchers and practitioners have created [The Sustainable Construction Safety and Health \(SCSH\) rating system](#) to evaluate construction worker safety and health on construction projects.

A free American Institute of Architects (AIA) approved [course](#), "Overview of Construction Prevention through Design" is being offered by East Carolina University through a grant from the Virginia Tech Occupational Safety and Health Research Center. Email Mike Behm, behm@ecu.edu, for information.



This website is maintained by Mike Toole at Bucknell University in conjunction with the OSHA Alliance Program Construction Roundtable workgroup on designing for construction safety and the NIOSH NORA Construction Sector Council Construction Hazards Prevention through Design workgroup. This website is not associated with the American Society of Civil Engineers or its Construction Institute. [Privacy Statement](#).

OVERVIEW

- ❑ PtD Concept
- ❑ Motivation
- ❑ Examples
- ❑ Leaders
- ❑ Tools and Processes
- ❑ Moving forward in your organization

Prevention through Design

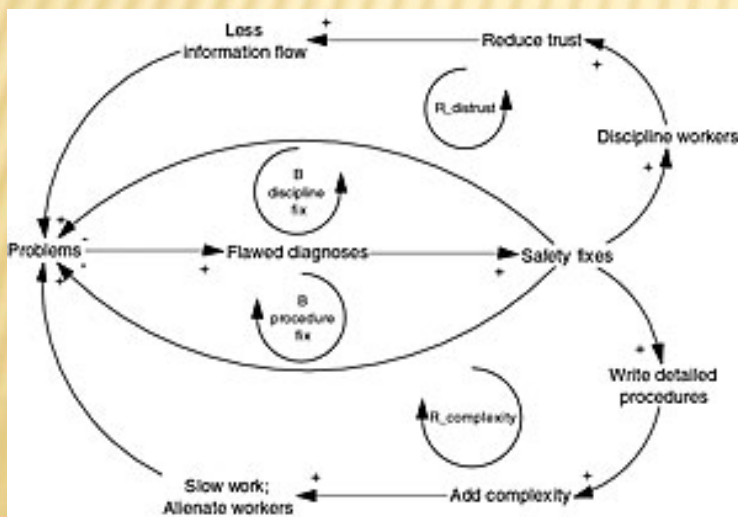
= Design for Safety

= Engineering for Safety



IMPORTANT MANAGEMENT CONCEPTS UNDERLYING SBD

- ❑ Sustainability
- ❑ Collaboration
- ❑ Managing Change
- ❑ Systems Thinking



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

“Safety Constructability”



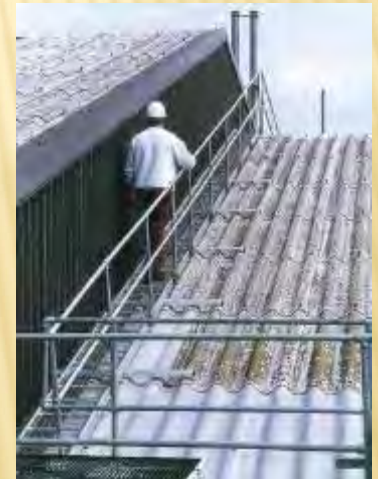
WHY PTD? ANNUAL CONSTRUCTION ACCIDENTS IN U.S.

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



WHY PTD? DESIGN-SAFETY LINKS

- ❑ **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

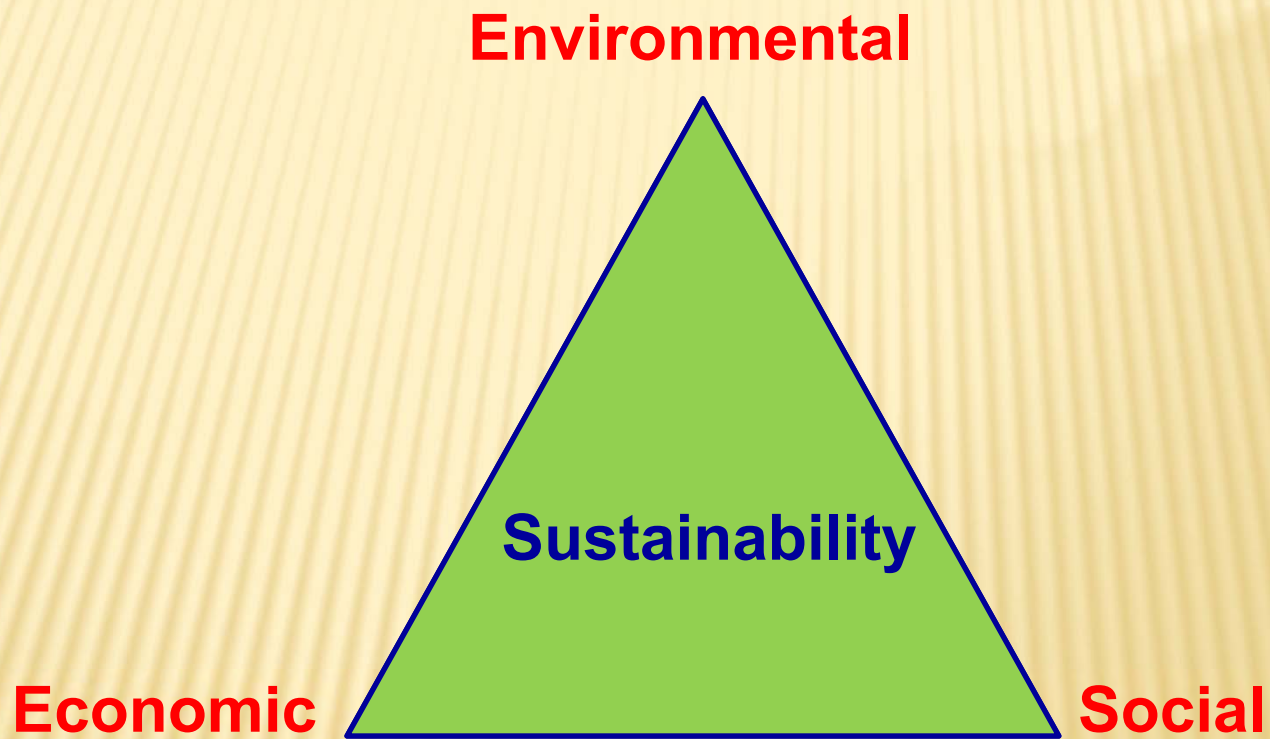
³ NSW WorkCover, *CHAIR Safety in Design Tool*, 2001

WHY PTD? PROFESSIONAL ETHICS

- National Society of Professional Engineers (NSPE)
Code of Ethics:
 - Engineers shall hold paramount the safety, health, and welfare of the public.

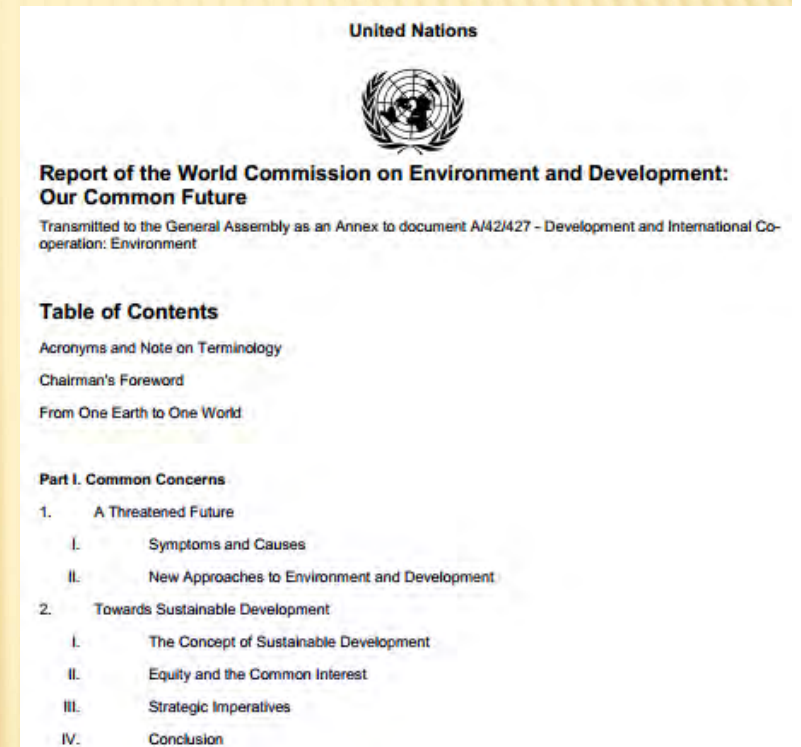
- American Society of Civil Engineers (ASCE) Code of Ethics:
 - Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering decisions

WHY PTD? SUSTAINABILITY



SBD'S TIE TO 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



CORPORATE SOCIAL RESPONSIBILITIES

- ❑ “Commitment by business to behave ethically and contribute to economic development;
- ❑ “Improve quality of life of the local community and society at large.”
- ❑ “Improve quality of life of the workforce and their families;

Source: World Business Council for Sustainable Development

CSR: SUPPLY CHAIN MANAGEMENT

- Supplier social equity
 - Anti-Sweatshop movement
 - Fair Trade
 - Bangladesh factory collapse

SUSTAINABILITY IS NOT JUST BEING GREEN



PTD AND SOCIAL SUSTAINABILITY/EQUITY

- ❑ Do not our duties include minimizing all risks that we have control over?
- ❑ Do not we have the same duties for construction, maintenance, line workers as for the “public”?
- ❑ Is it ethical to create designs that are not as safe as they could (practically) be?

DESIGN HAS MAJOR LEVERAGE

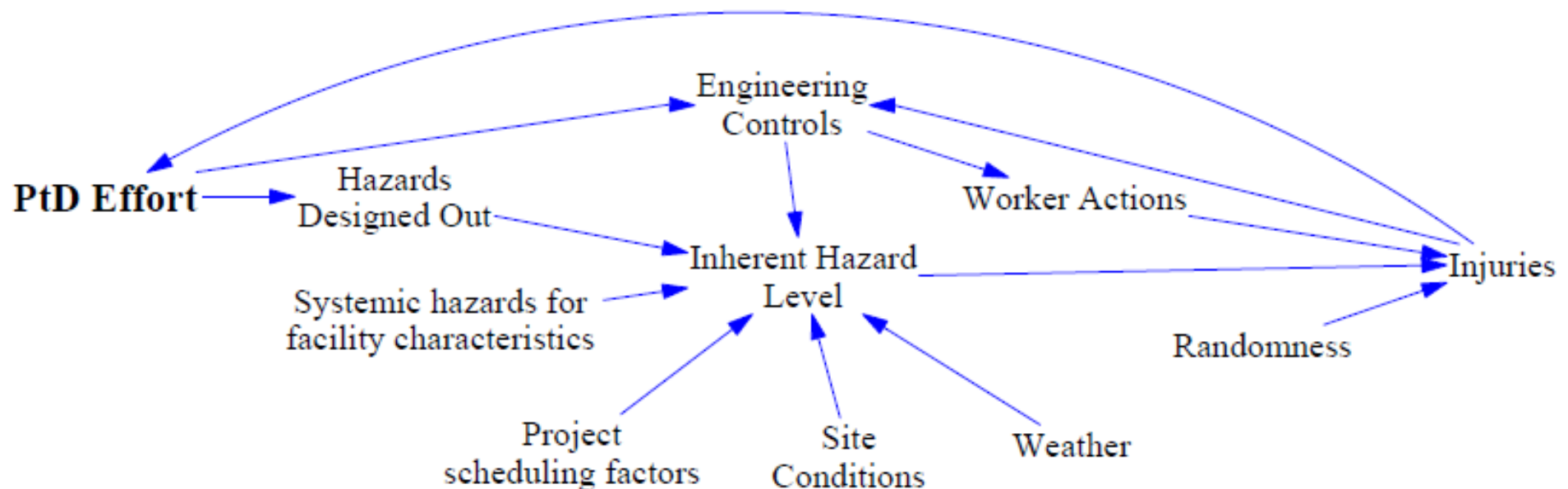
- ❑ The Right thing to do and...
- ❑ The Smart thing to do

SUSTAINABLE PRINCIPLE: LIFE CYCLE THINKING

- ❑ Need to make decisions not just based on initial criteria, but criteria over the entire life cycle of the product or facility
 - Example: Buy printer based on total costs per printed page, not on initial printer cost.
 - Application: Design product or facility for the service life, not on only initial cost or safety of only users.

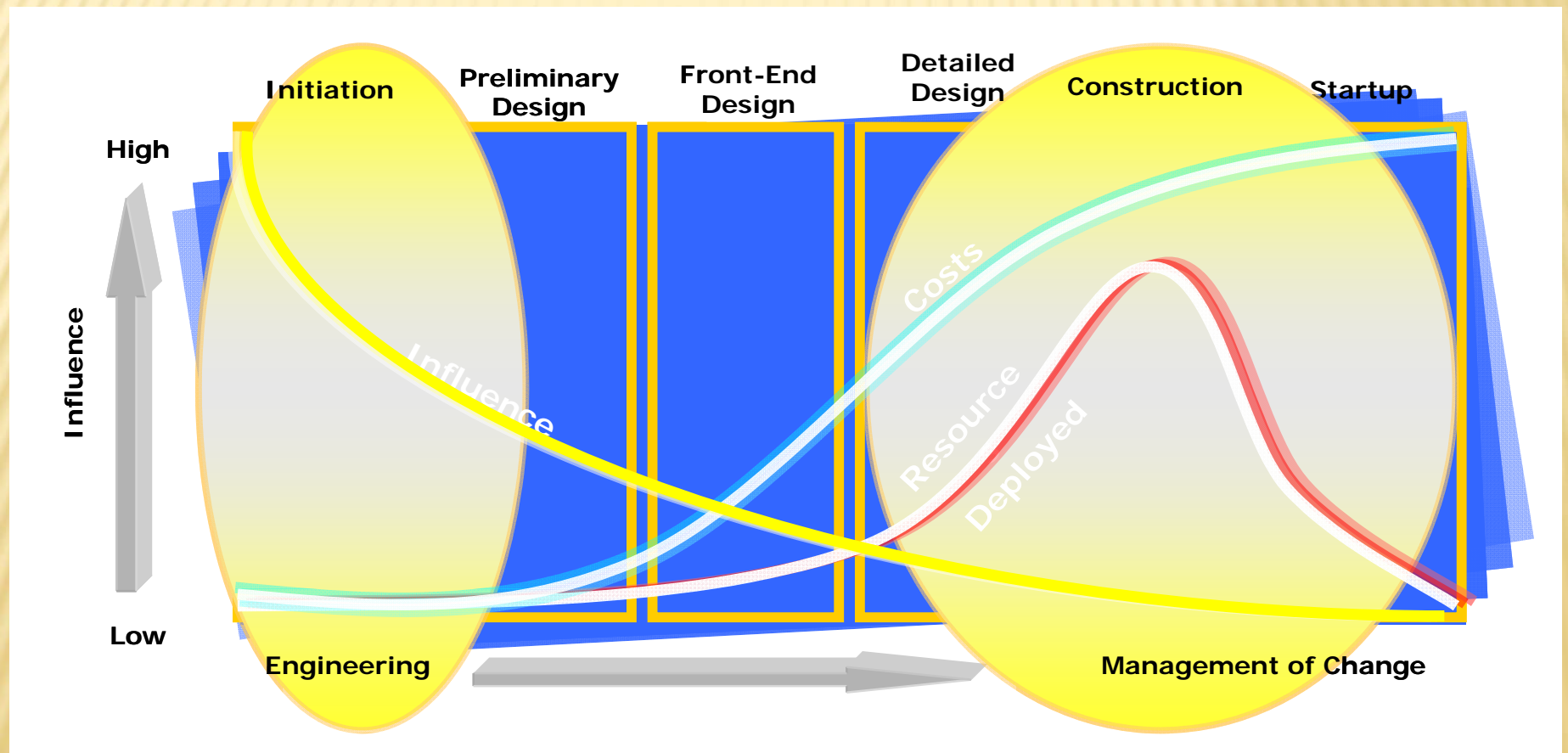
SUSTAINABLE PRINCIPLE: SYSTEMS THINKING

- ❑ One thing affects other things within the system
 - Example: PC use increases ergonomic injuries
 - Example: Designer decisions affect the inherent risk of the construction / manufacturing, use and maintenance of the facility/product.



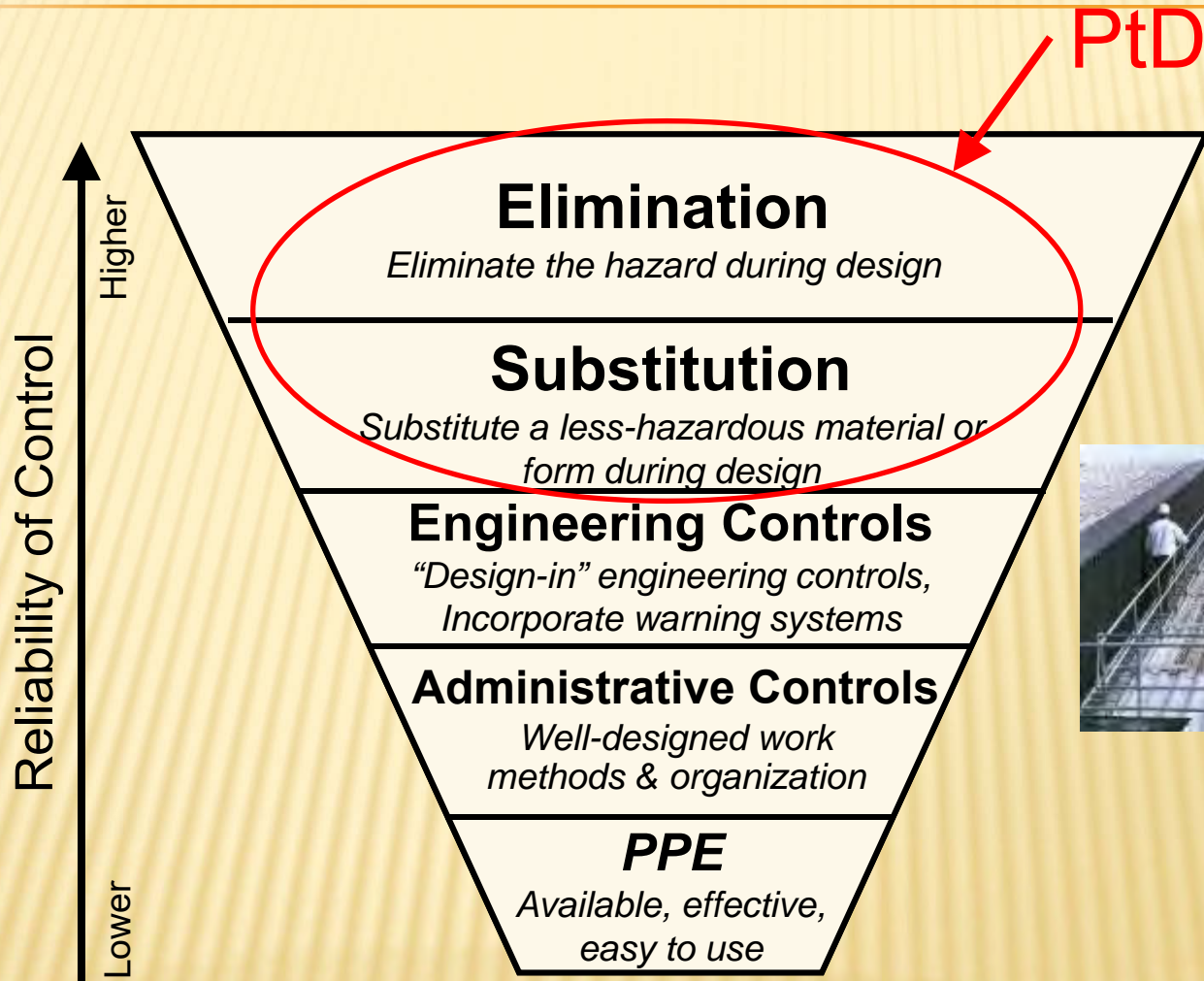
WHY PTD? BANG FOR THE BUCK

- Ability to influence safety is greatest early in the project schedule during planning and design (Szymberski, 1997)



(Graphic courtesy of the Bechtel Corp.)

HIERARCHY OF CONTROLS



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/maint. safety



OVERVIEW

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- ❑ **Examples**
- ❑ Leaders
- ❑ Tools and Processes
- ❑ Moving forward in your organization



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

Skylights



Upper story windows

Parapet walls



PTD EXAMPLE: PREFABRICATION



**Steel
Stairs**

**Concrete
Wall
Panels**



**Concrete
Segmented
Bridge**

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



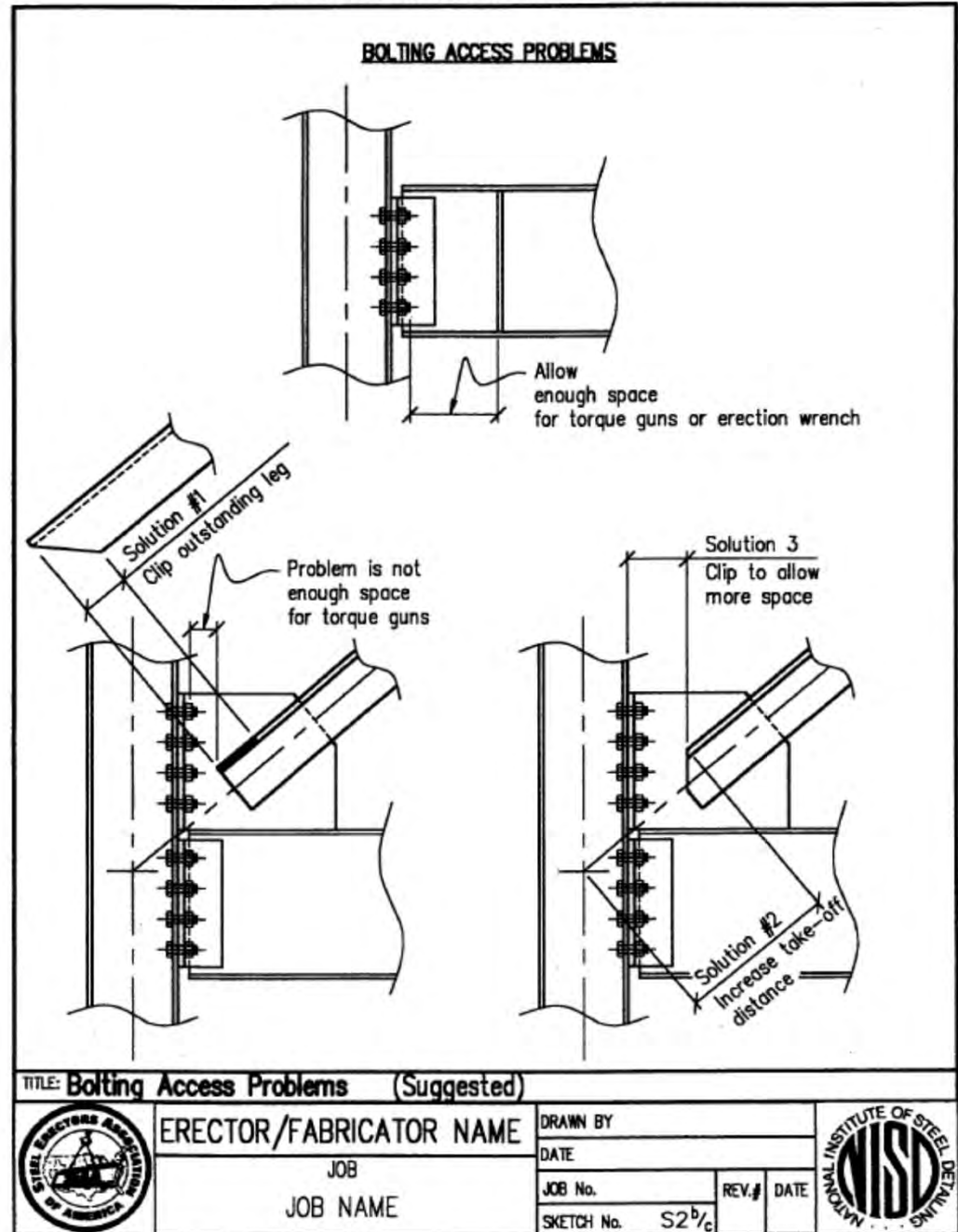
The Erector Friendly Column

- + 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

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URS CORP. PTD PROCESS



PEPS

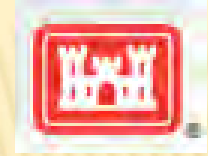
202	207	208	212	314	315	363	364	365	368
Project Execution Plan	Licenses, Permitting, Codes and Hazard Requirements	Environmental, Safety and Health	Preparation of Project Risk Management Plans	Change Control	Project Quality Control	Project Hazard Review	Regulatory Compliance Plan and Compliance Review	Constructability Review	Design for Safety

DFCS IN PRACTICE: OWNERS

- ❑ USACE
- ❑ ExxonMobil
 - MWCS
- ❑ Intel
- ❑ BHP Billiton
- ❑ Southern Co.
- ❑ Sutter Health

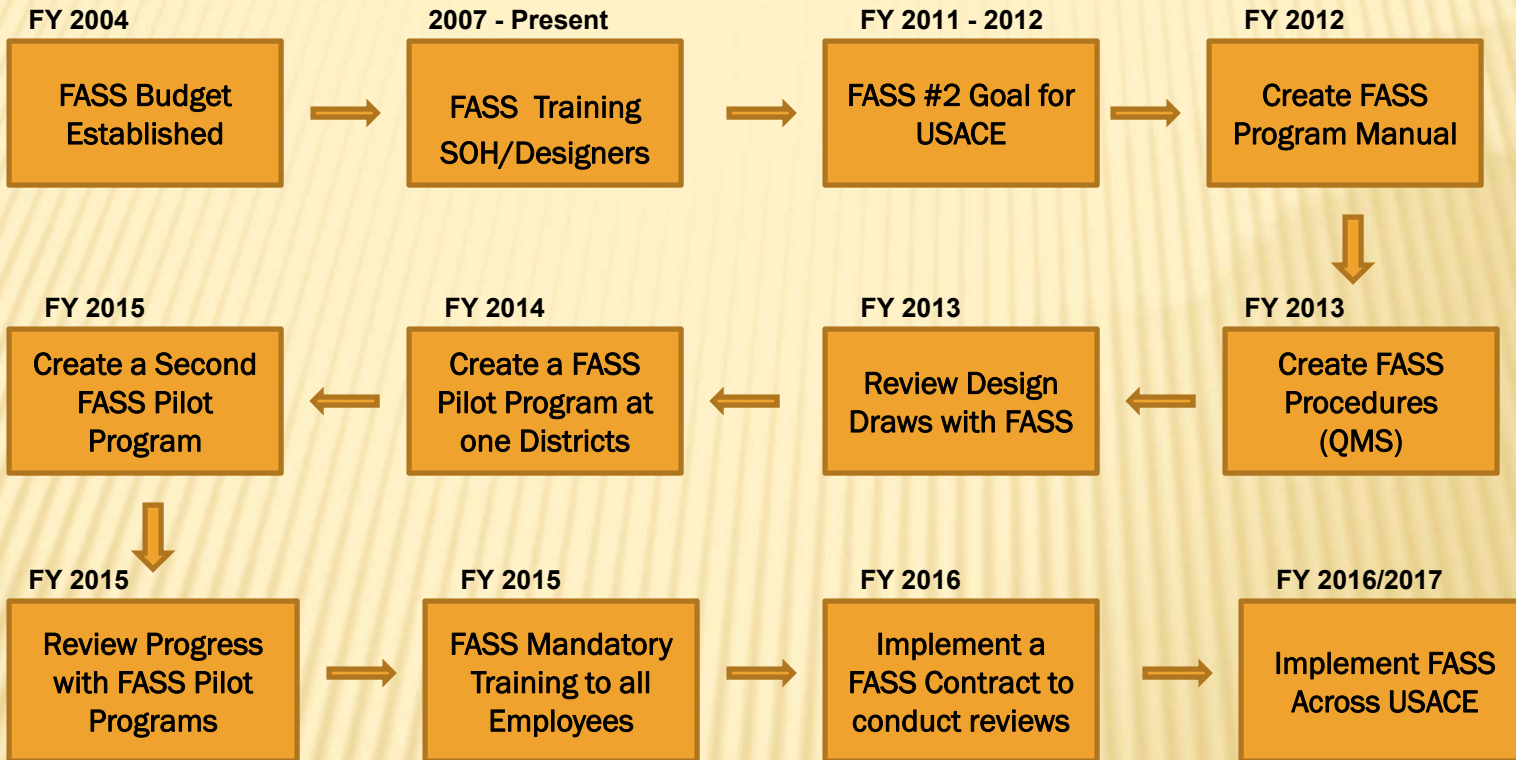
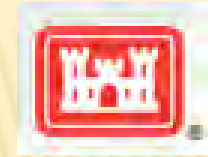


USACE FACILITY SYSTEMS SAFETY

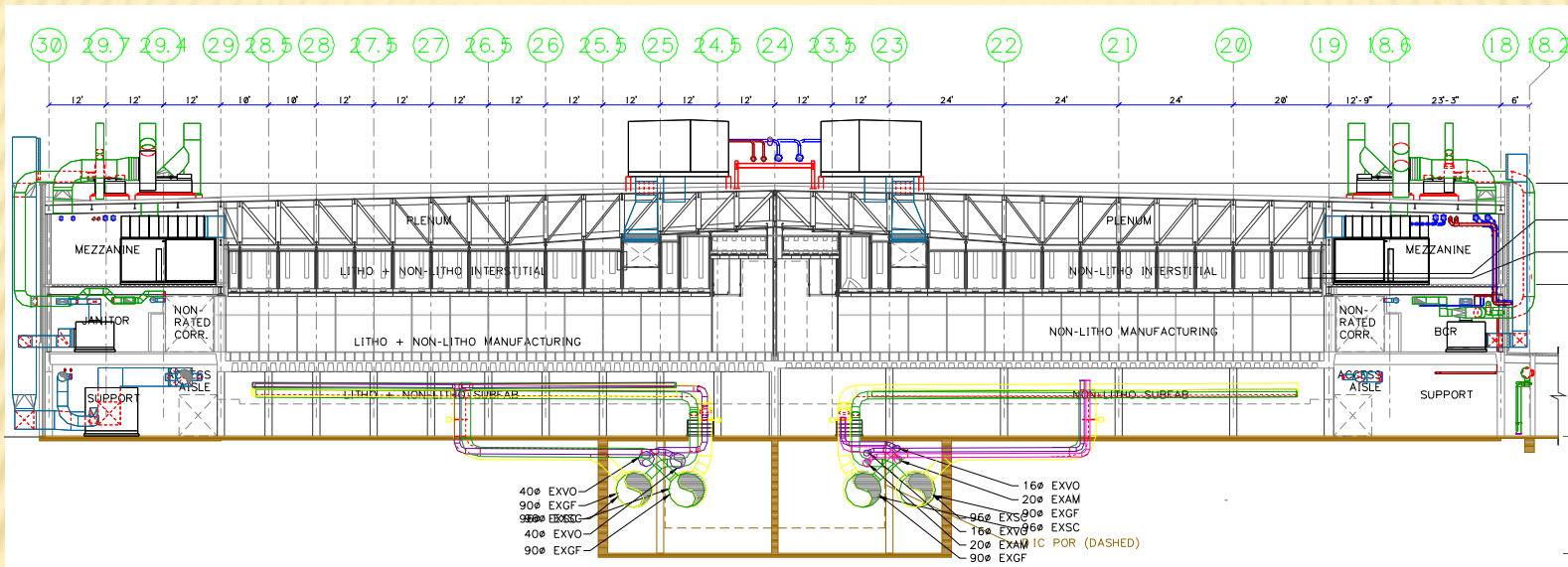


To incorporate systems safety engineering and management practices into a facility life cycle process used in the conceptual phase, planning stages, construction of facilities, and facility reduction (demolition).

FACILITY SYSTEMS SAFETY PATH FORWARD



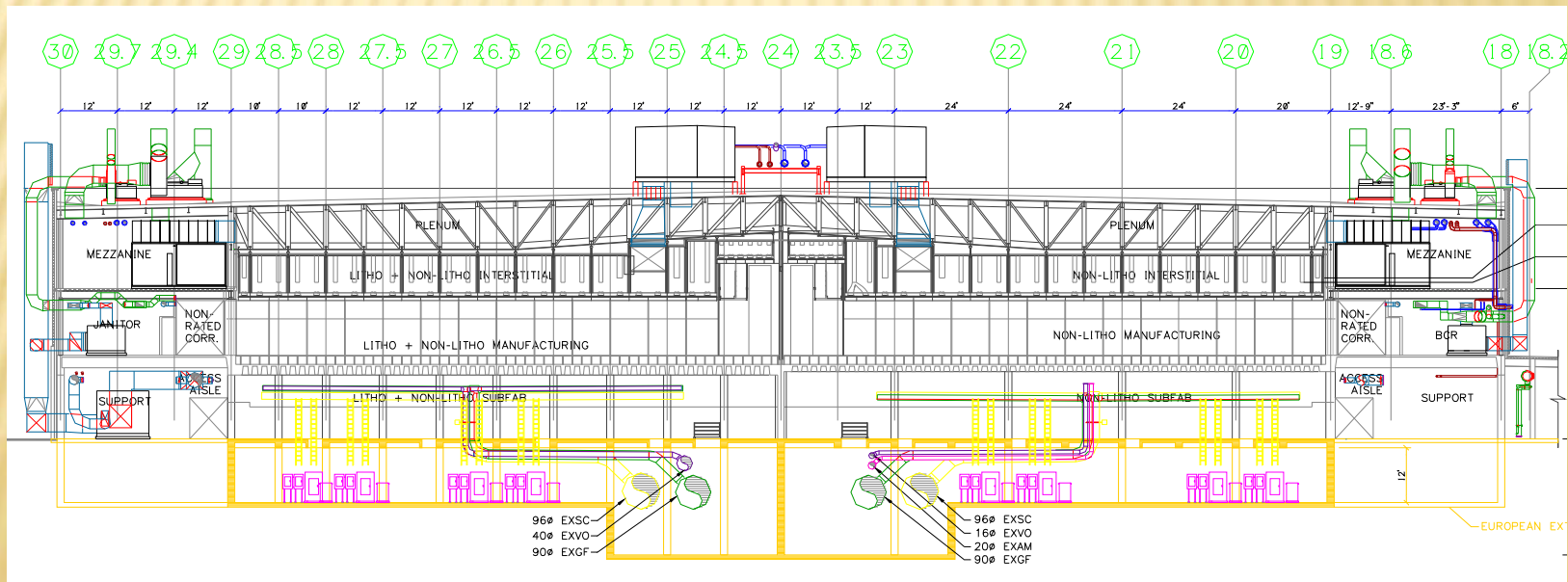
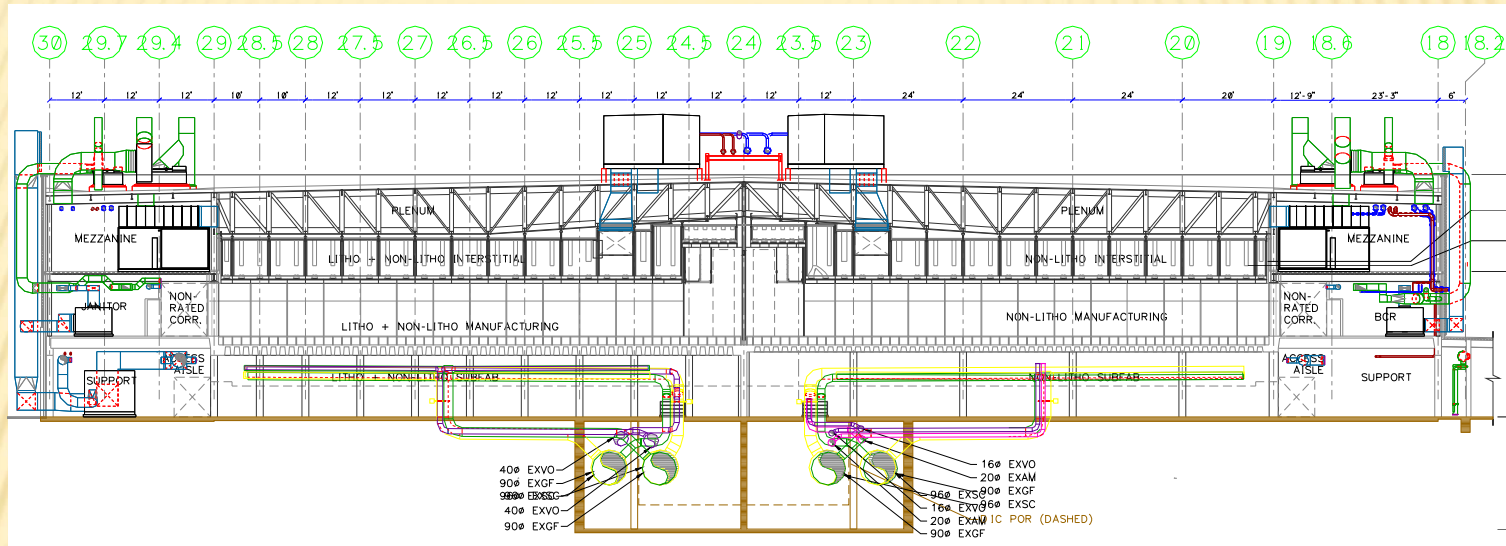
INTEL'S PROBLEM: ACCESS TO UTILITIES



Original design: Trench below equipment



INTEL'S SOLUTION: NEW FULL BASEMENT



EUROPEAN EX

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

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: _____

Double-click to add "x" to boxes. ↓				Item No.	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<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"/>	<input type="checkbox"/>	<input type="checkbox"/>	<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"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3.	Construction people working near fiberglass manufacturing need to understand the toxic air pollutants .
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<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"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5.	Underground hazards and reference drawings locating any potential hazards are identified. (Examples: buried pipes, electrical cables, etc.)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<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"/>	<input type="checkbox"/>	<input type="checkbox"/>	<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-drain grates, concrete cylinder breaks.)

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

NATIONAL INITIATIVES AND ACTIVITIES

□ NIOSH

- PtD National Initiative
- PtD Workshops: July 2007 and August 2011
- NORA Construction Sector Council CHPtD Workgroup

□ OSHA Construction Alliance Roundtable

□ ANSI/ASSE PtD Standard (Z590.3-2011)

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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.....

DfS Tools – Design Risk Assessment



The screenshot shows the website for SliDeRule for Buildings. The header features the logo 'SliDeRule for Buildings' in a stylized font over a background image of a modern glass building. Below the header is a navigation menu with links for 'About', 'News', 'Links', 'Support Research', and 'Contact us'. The main content area is titled 'Safety in Design...' and includes the following text:

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.

SliDeRule (Safety in Design Risk Evaluator) helps building designers assess the construction safety risk associated with their designs. Use SliDeRule 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
- Compare projective designs 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 SliDeRule, hazards can be eliminated, safety risk reduced, and construction worker injuries and fatalities prevented.

[Read more about SliDeRule...](#)

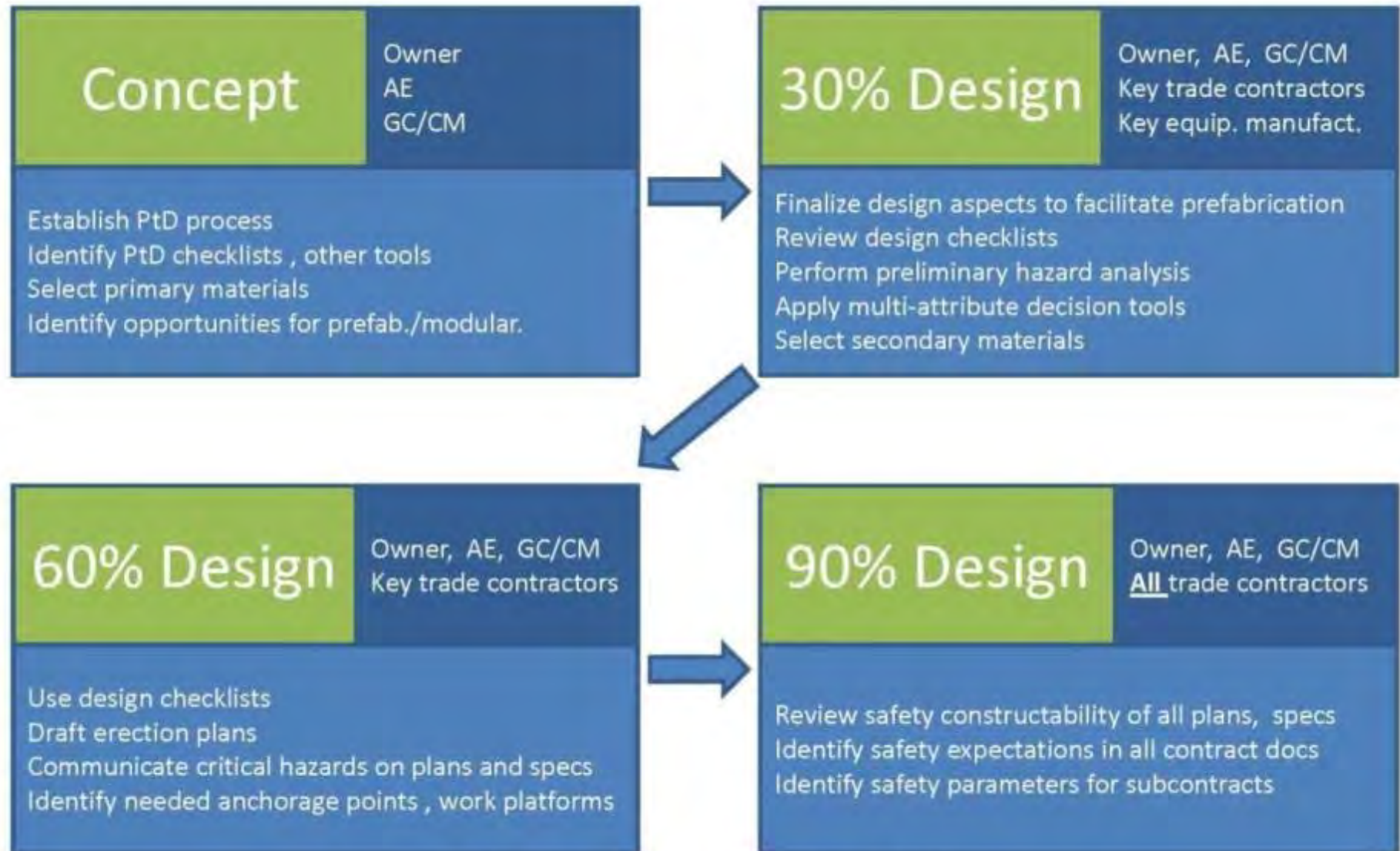
On the right side of the page, there is a sidebar with the following links:

- ASSESS A PROJECT
Like the online calculator
- Overview
- Case Studies
- Tutorial

At the bottom of the page, there is a footer with the text: '© 2013 SliDeRule. All rights reserved.'

www.constructionsliderule.org

PTD PROCESS

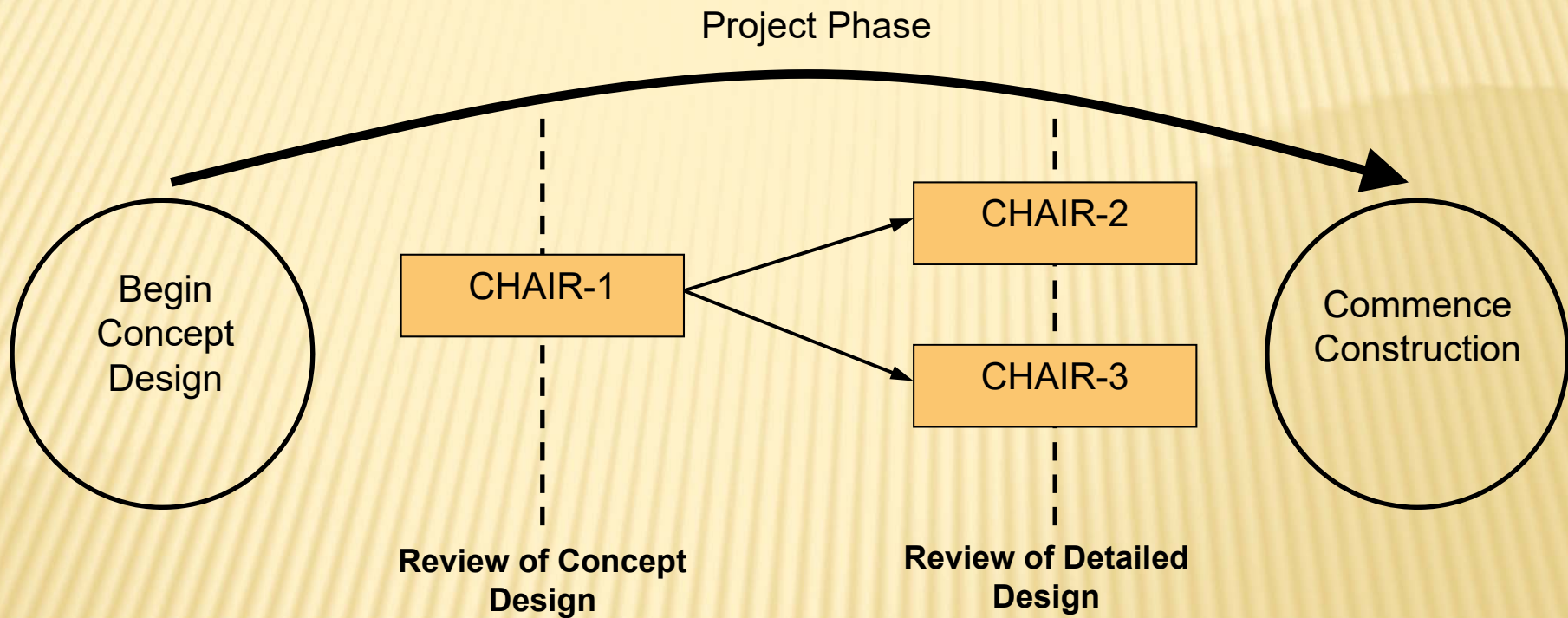


PTD PROCESS

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



CHAIR SAFETY IN DESIGN TOOL

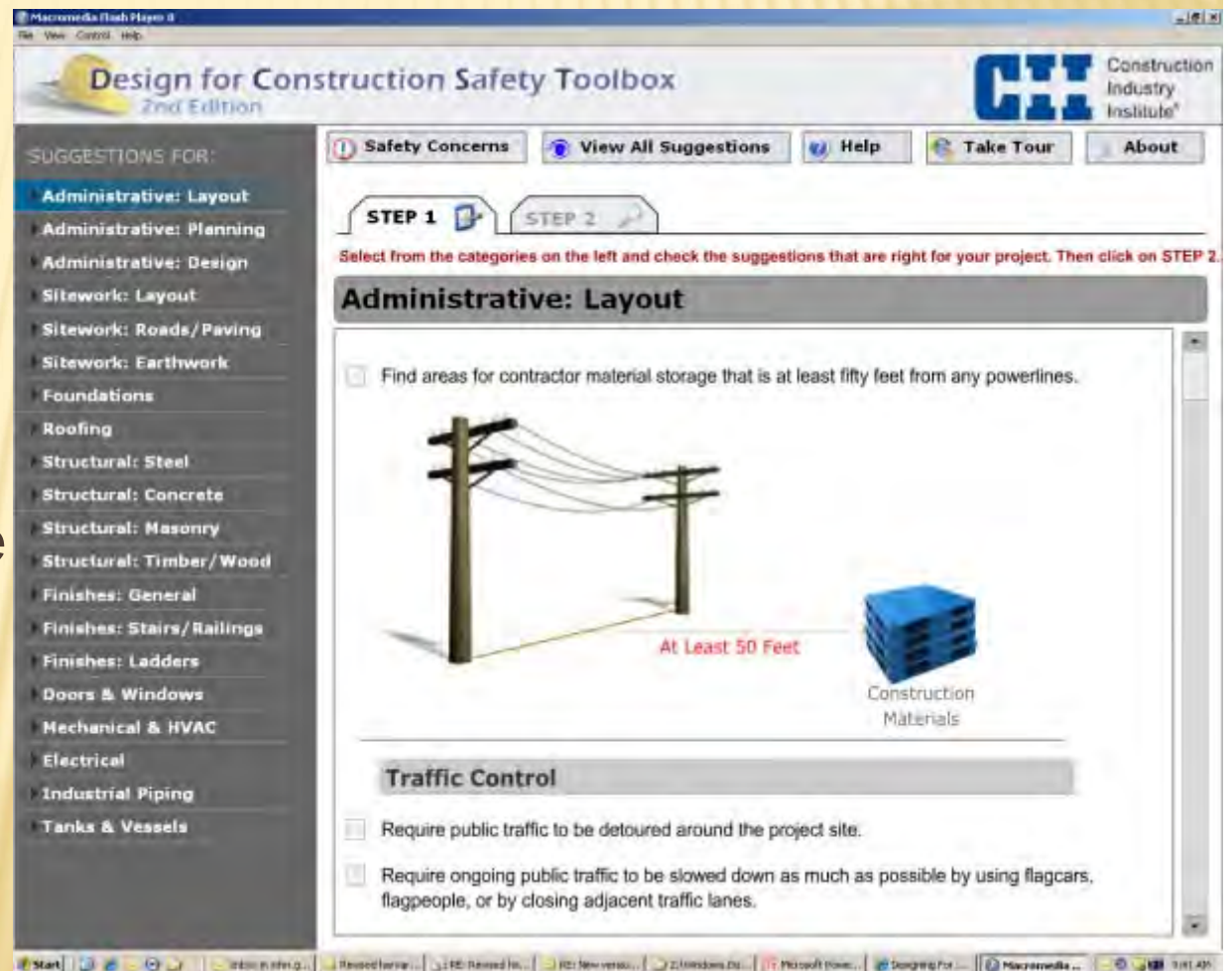


Construction Hazard Assessment and Implication Review
(CHAIR)

(Source: NSW WorkCover, *CHAIR Safety in Design Tool*, 2001)

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



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 A003 - Review Sheets
- 4 A004 - How To Use Guidance
- 5 G 10.001 - Practice Policies
- 6 G 10.003 - Health and Safety File
- 7 G 30.001 - CDM - What Designers Should Know
- 8 H 10.001 - Hazardous Materials
- 9 H 10.003 - Lead Paint Design Guide
- 10 H 20.001 - Musculo-Skeletal
- 11 H 20.002 - Noise
- 12 T 10.002 - Excavations
- 13 T 20.001 - Erection of Structures
- 14 T 20.002 - Steelwork Erection
- 15 T 20.005 - Refurbishment

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](#)
- [Lead Paint](#)
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- [Steelwork Erection](#)
- [Refurbishment](#)
- [Temp Works Equip](#)
- [Work At Height](#)
- [Roofs](#)
- [Spatial Designs](#)
- [Susp Access Equip](#)
- [Concrete Blockwork](#)
- [-- Building Services --](#)

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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

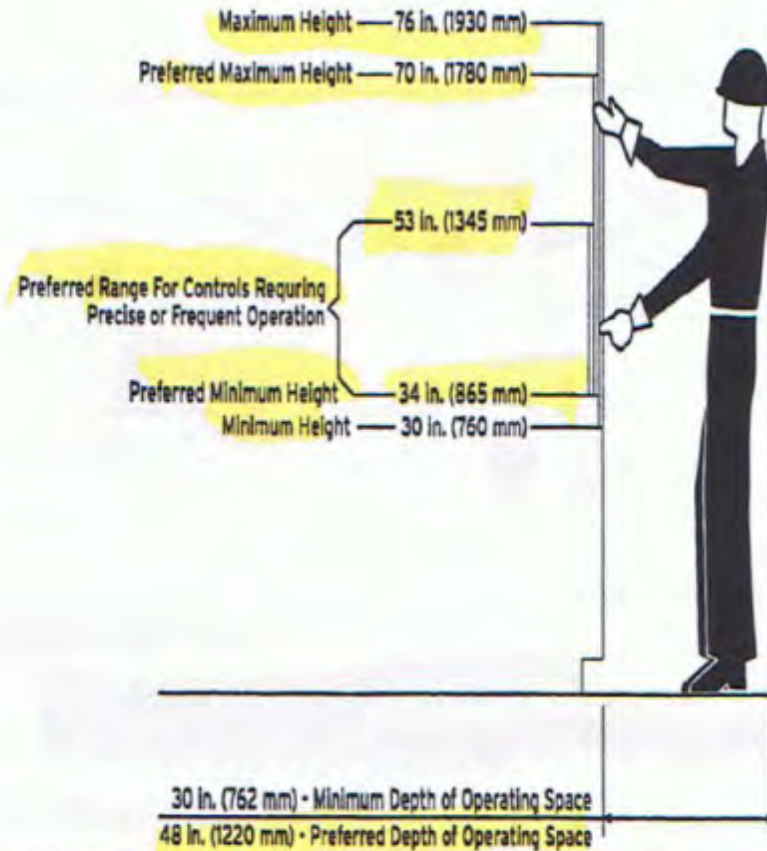
8. Designers should consider two phases: the construction phase and the maintenance phase

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.

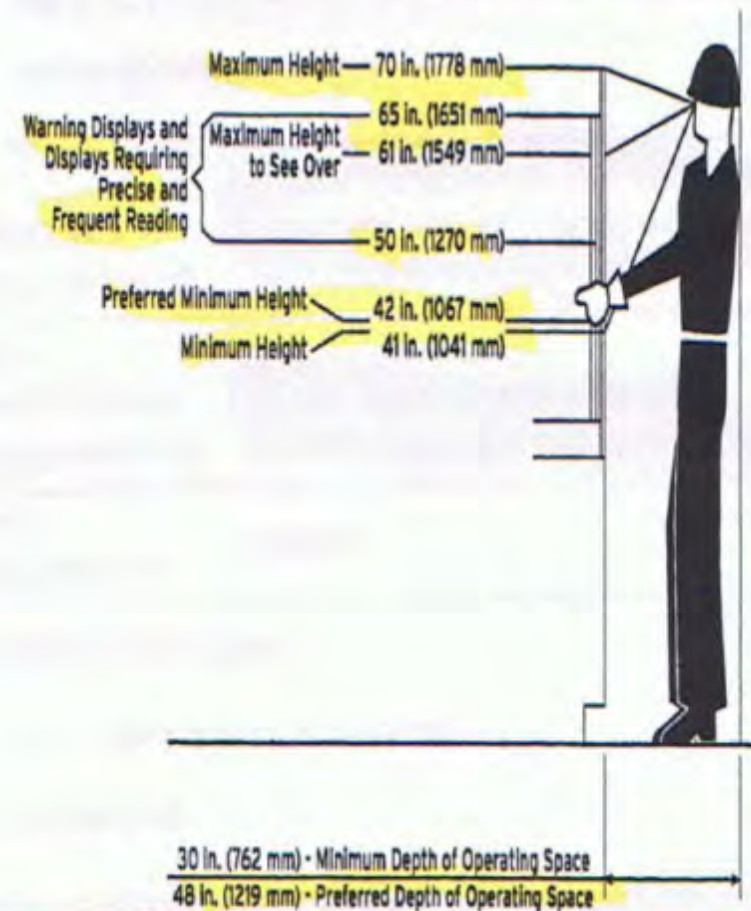
Falls off unguarded edges

- How to Use Guidance
- -- General Guidance --
- Practice Policies
- Health and Safety File
- Designers Should Know
- -- Health Guidance --
- Hazardous Materials
- Lead Paint
- Musculo-Skeletal
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- Steelwork Erection
- Refurbishment
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- Work At Height
- Roofs
- Spatial Designs
- Susp Access Equip
- Concrete Blockwork
- -- Building Services --
- Demolition
- -- General Information --
- Manual Handling
- Lifting - Cranes
- INF001 Abbreviations
- INF002 Common legislation

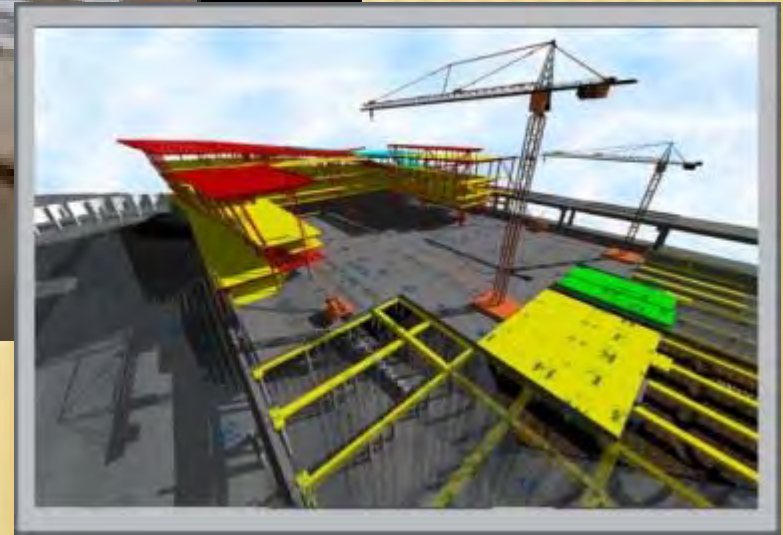


Location of Controls

Location of Visual Displays



PTD TOOLS – BIM AND VISUALIZATION



PTD INFORMATION SOURCES



The image shows a screenshot of the website for Prevention through Design (PTD). The header features the title "Prevention through Design" and "Design for Construction Safety" in white text on a green background. To the right is a yellow hard hat with "PTD" and a green cross. Below the header is a navigation menu with links: Home, Concept, Process, History & Future, Challenges, Resources, Links, and Contacts. The main content area is titled "News and Updates:" and contains several paragraphs of text with hyperlinks. On the right side of the main content area is a photograph of two construction workers in hard hats and safety vests standing near a large window frame. At the bottom of the page is the "alliance" logo, which includes a star and the text "An OSHA Cooperative Program". To the right of the logo is a small block of text providing information about the website's maintenance and its association with OSHA and NIOSH programs.

Prevention through Design

Design for Construction Safety

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alliance
An OSHA Cooperative Program

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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.

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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

- ❑ 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

ESTABLISH ENABLING PROCESSES

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

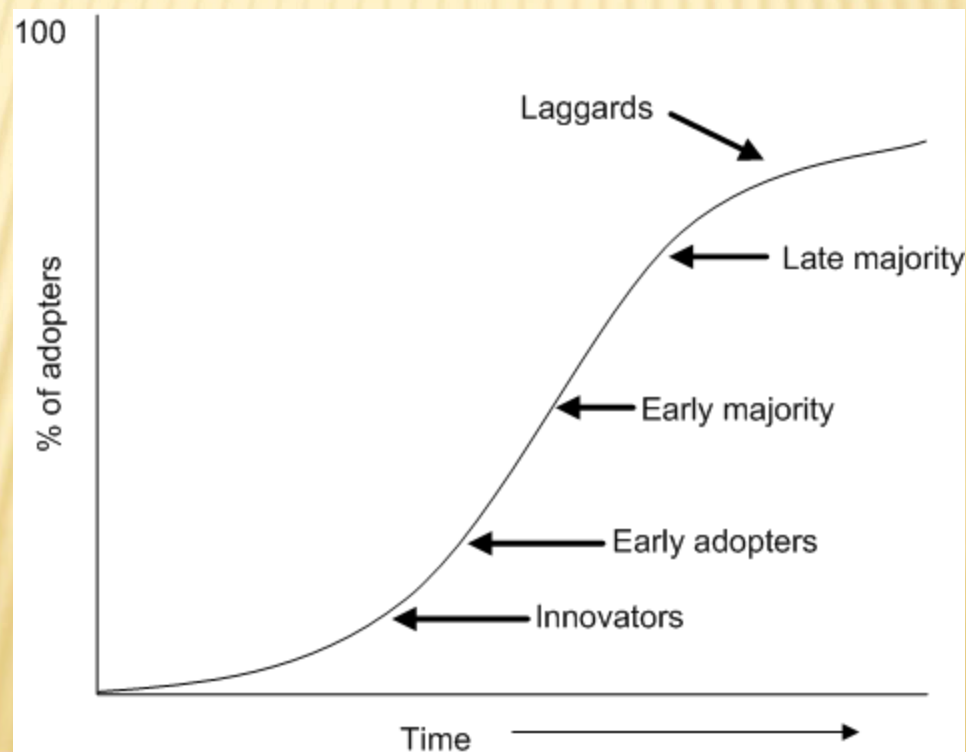


CHOOSE YOUR PARTNERS WISELY

- ❑ 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

PTD: AN OPPORTUNITY FOR YOU

- ❑ All organizational change starts with individual initiative
- ❑ Will you and your firm be leaders or laggards?



INITIATING PTD IN YOUR ORGANIZATION

- ❑ Leadership
- ❑ Sustainability
- ❑ Ethics
- ❑ Innovation
- ❑ Change management

SUMMARY

- ❑ PtD is tied with sustainability, CSR, ethics
- ❑ Successful organizations have implemented PtD
- ❑ Keys to implementing PtD
 - Life cycle cost perspective and budgeting
 - Systems thinking
 - Contracts facilitate collaboration
- ❑ Three first steps to implementing PtD
 - Culture, Processes, Partners
- ❑ You can be a leader in implementing PtD in your organization

THANK YOU FOR LISTENING!

- ❑ Questions, comments?

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