Using Prevention through Design to Achieve Project Safety Goals

COLLEGE OF ENGINEERING
THE UNIVERSITY OF TOLEDO

Project Management Institute
Western Lake Erie Chapter

PMI WLEC
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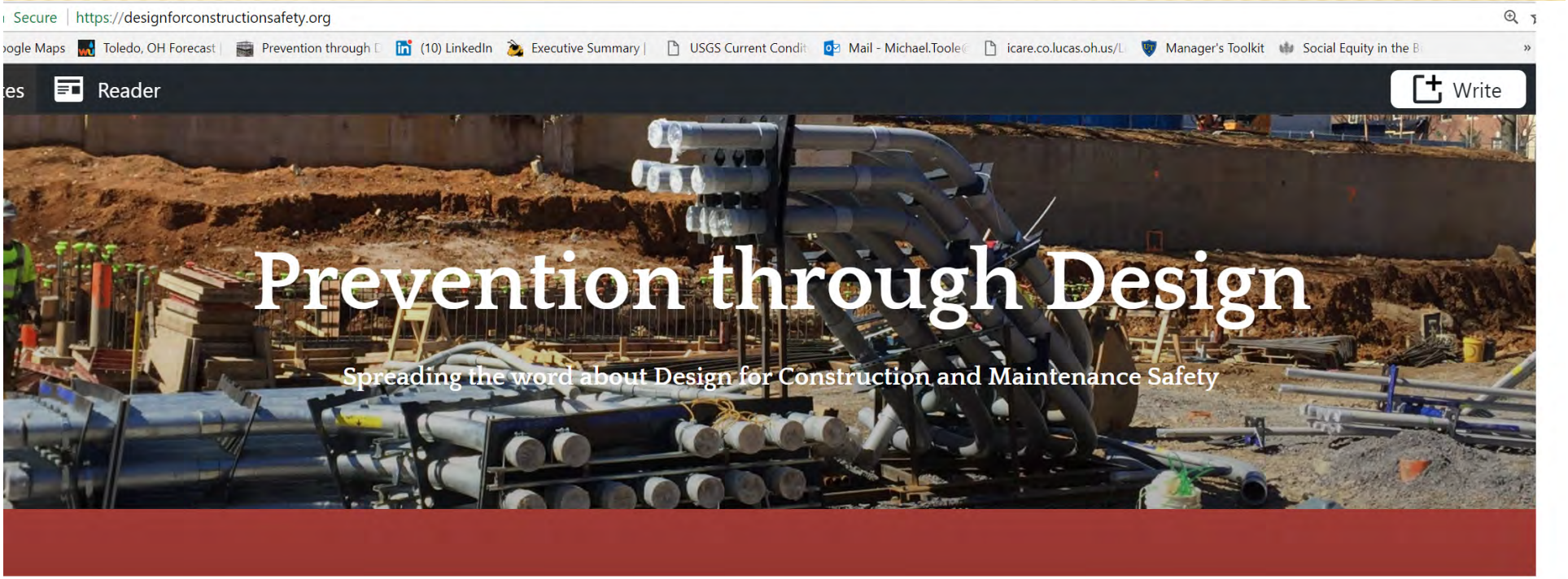
TO DOWNLOAD THIS SLIDE DECK, GO TO WWW.DESIGNFORCONSTRUCTIONSAFETY.ORG



PROJECT GOALS ARE EVOLVING

- Traditional, Universal:
  - *Whatever the Client wants*
  - Cost
  - Schedule
  - Quality/functionality
- Context-Specific and/or Emerging
  - Safety
  - Sustainable
  - Life-cycle savvy
  - Corporate socially responsible

OVERVIEW

- Triple Bottom Line and Social Sustainability
- Improving Site Safety requires Integrated Design and Construction
- PtD Concept and Benefits
- Examples
- Processes and Tools
- Moving forward

Prevention through Design

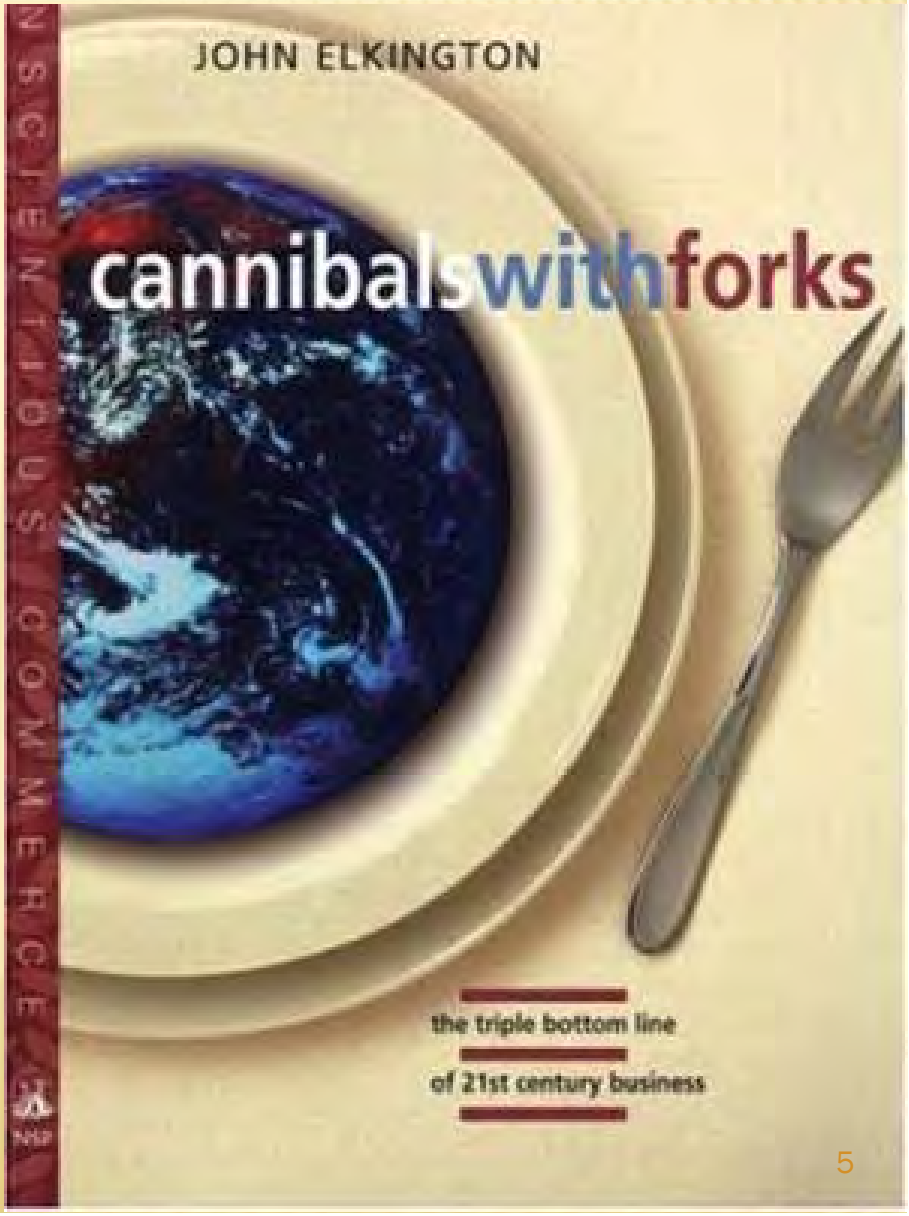
= Design for Safety

= Safety by Design

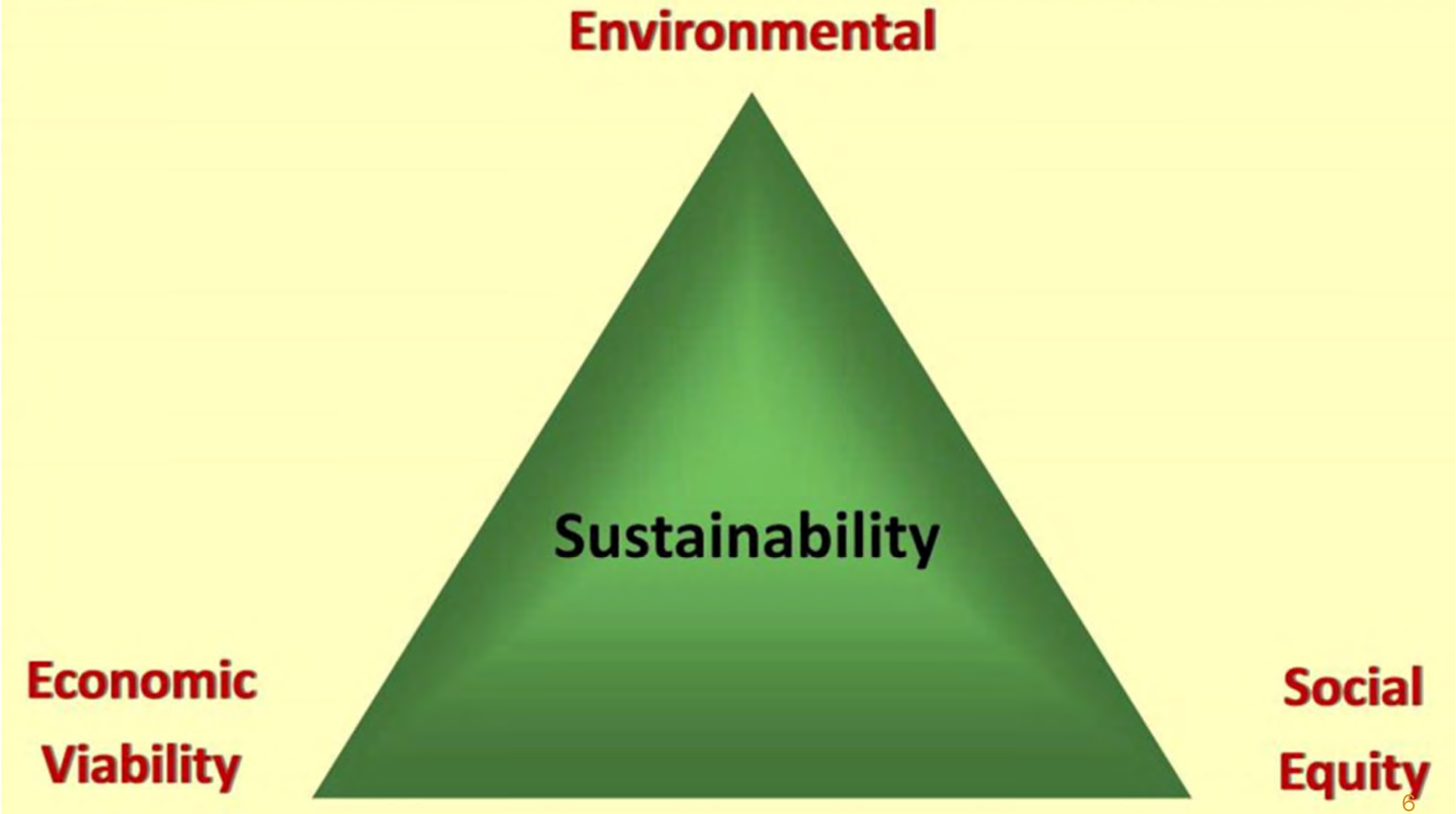
TRIPLE BOTTOM LINE

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

http://blueandgreentomorrow.com/features/book-review-cannibals-with-forks-john-elkington-1999/

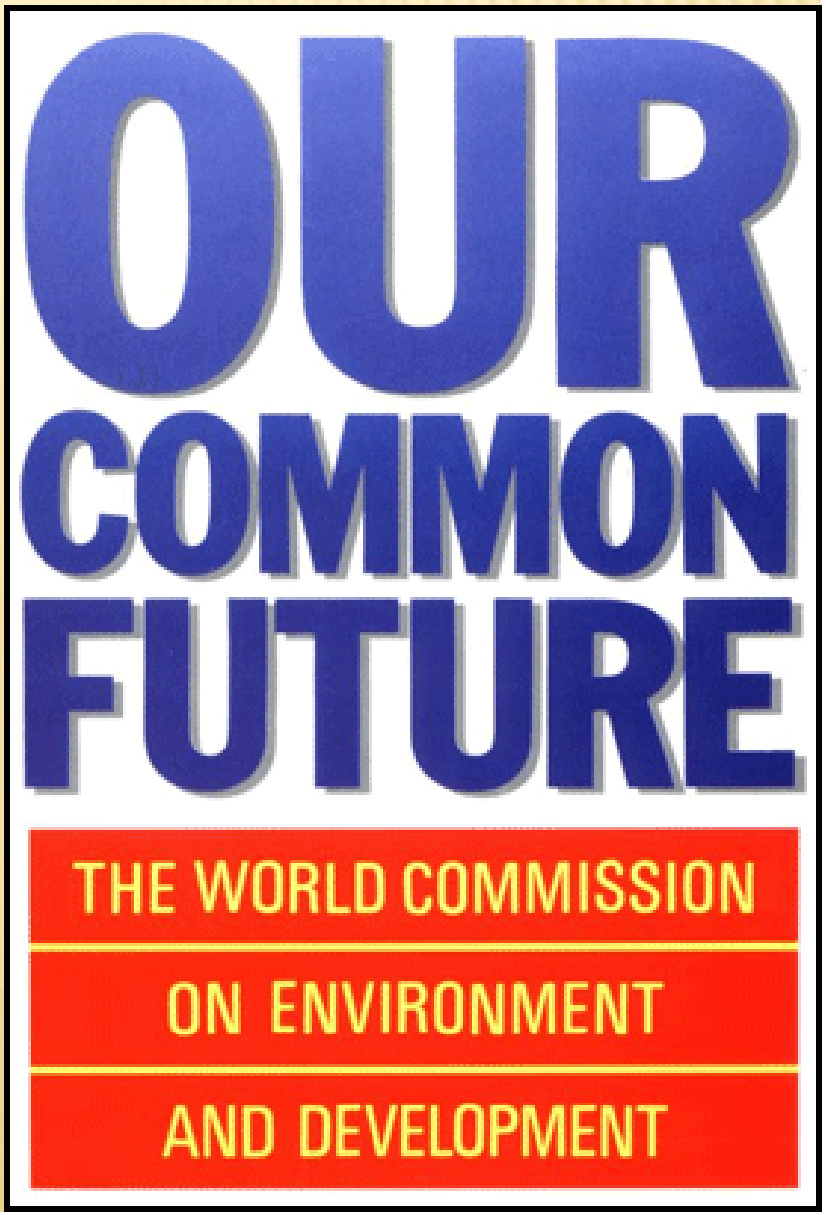


SUSTAINABILITY AND THE TRIPLE BOTTOM LINE



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



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.

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

ANNUAL CONSTRUCTION ACCIDENTS IN U.S.

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

DESIGN-SAFETY LINKS

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

[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

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
Prevention through Design

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”

INTEGRATED DESIGN AND CONSTRUCTION

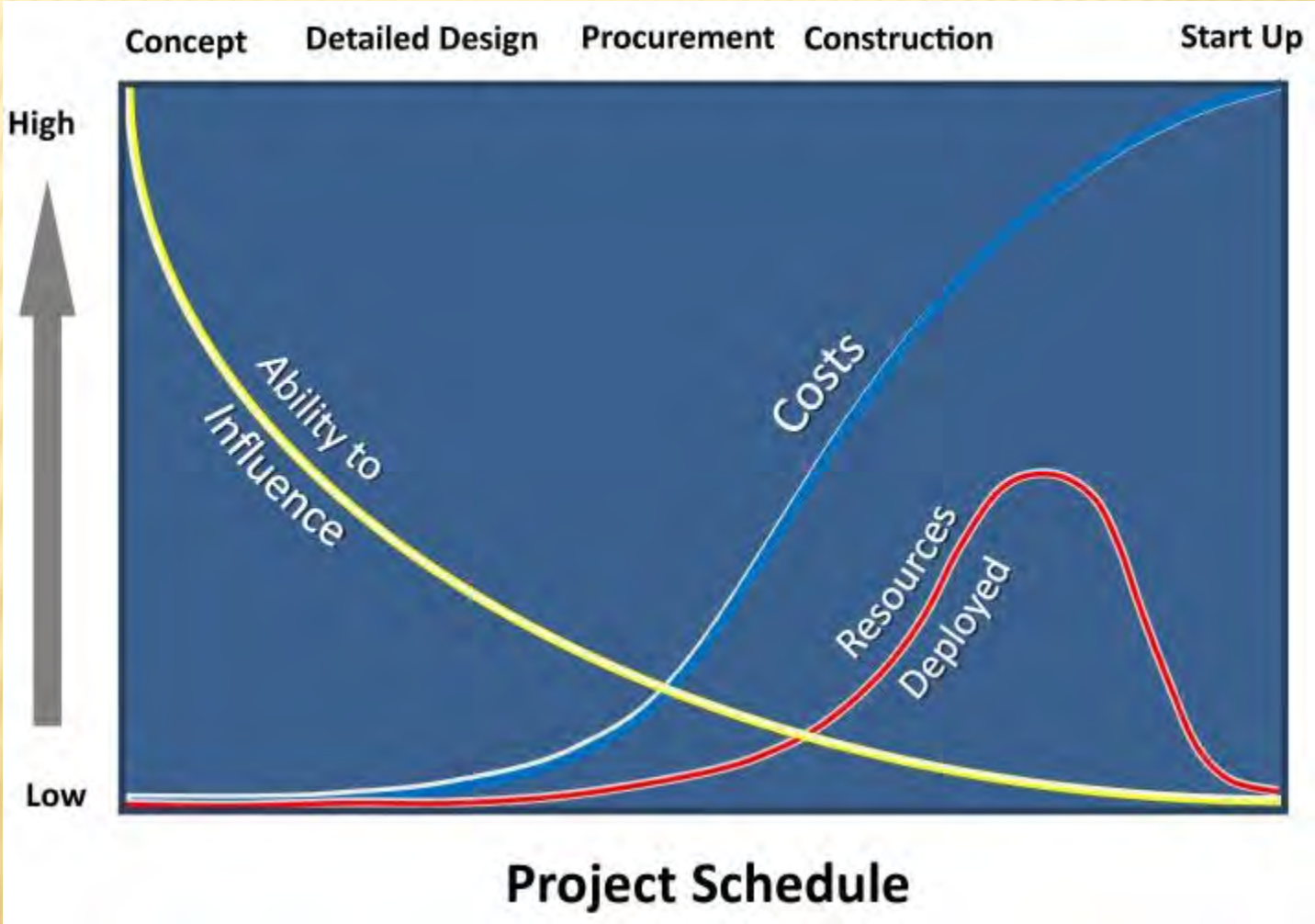
- Project success requires that design reflects input from all stakeholders, including:
  - Users/occupants
  - Owner facility management personnel
  - Contractors
- Constructability and maintainability feedback must start early in the design process

BENEFITS OF INTEGRATED DESIGN AND CONSTRUCTION

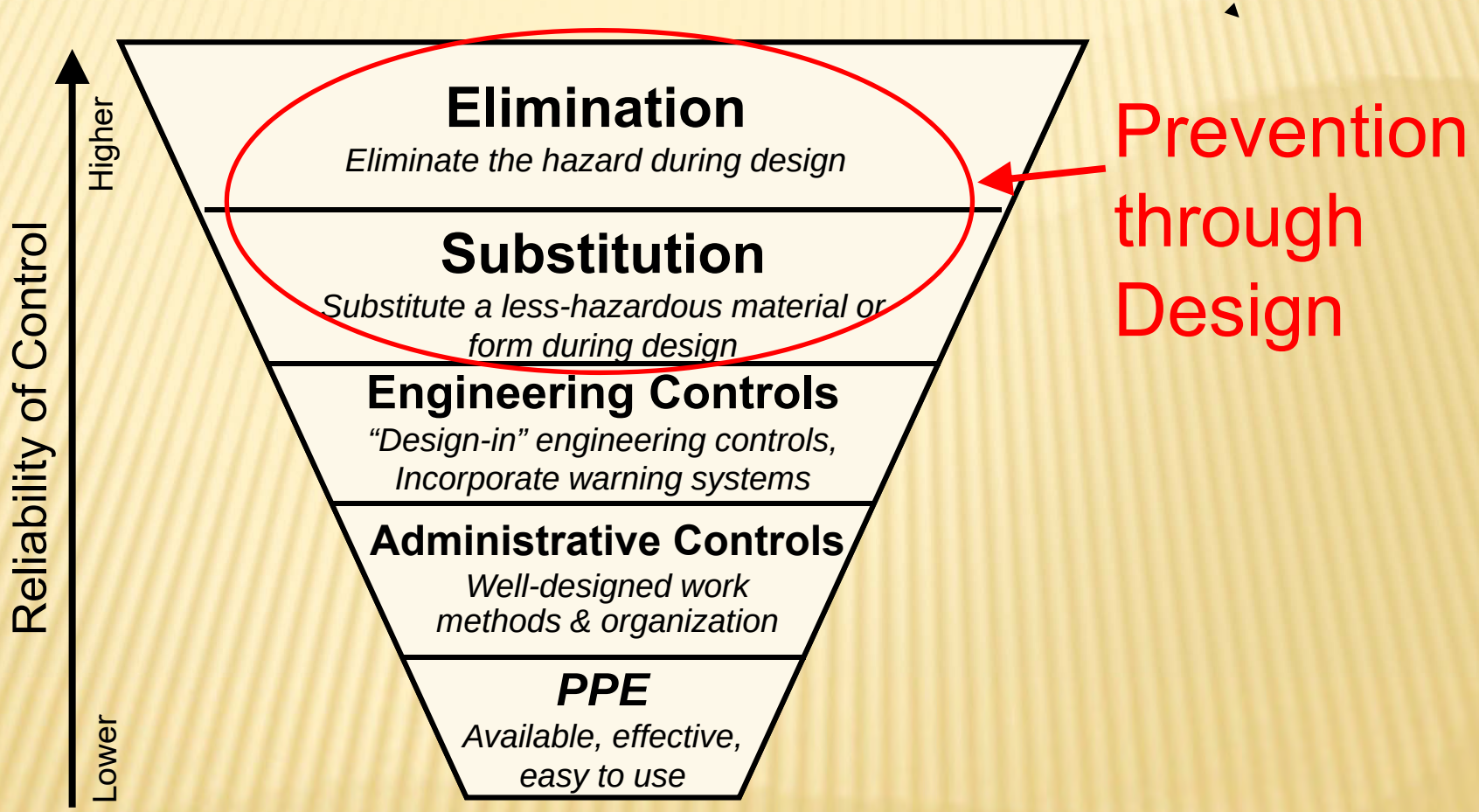
- Obvious: Cost, Schedule, Quality
- Accepted: Sustainability
- Emerging: Prefabrication
- Emerging: Safety

DESIGN HAS MAJOR LEVERAGE

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



HIERARCHY OF CONTROLS



ECONOMIC BENEFITS OF PTD

- Reduced site hazards
  - Fewer worker injuries and fatalities
- Reduced workers' compensation premiums
- Increased quality
- Increased productivity and fewer delays due to accidents so project deadlines are met

CODES OF ETHICS

- Engineering (ASCE):
  - 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.

- PMI:
  - 2.2.1 We make decisions and take actions based on the best interests of society, public safety, and the environment.

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”?

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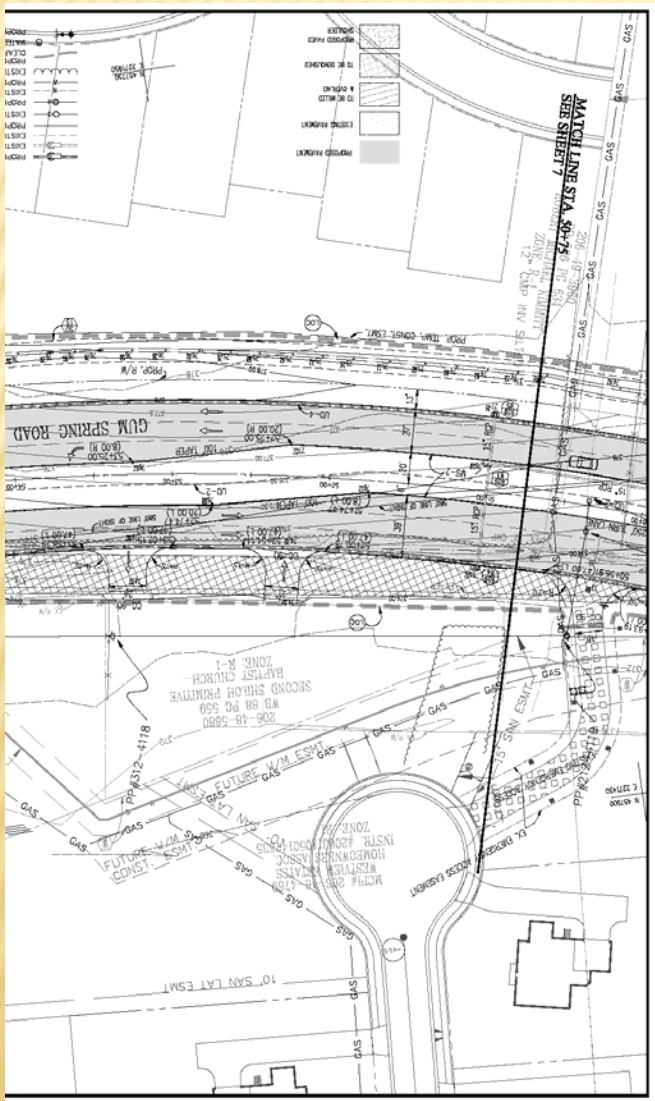
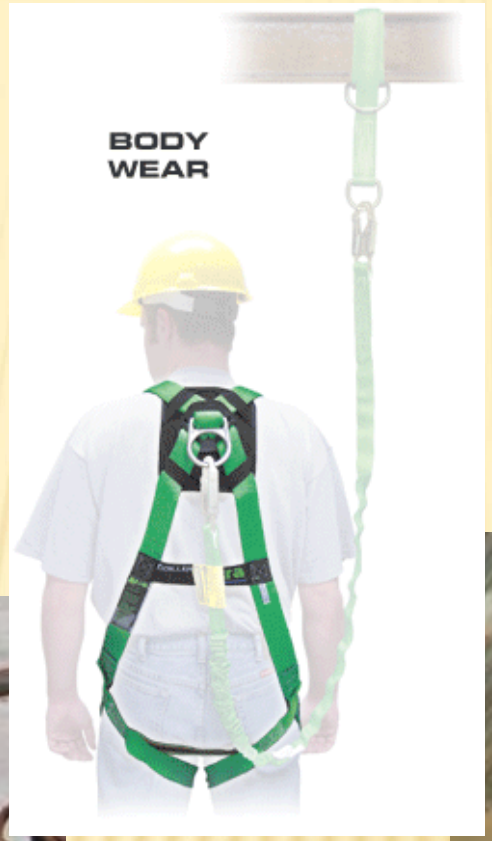
EXAMPLE OF THE NEED FOR PTD



- 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: STRUCTURAL STEEL DESIGN

Detailing Guide for the Enhancement of Erection Safety

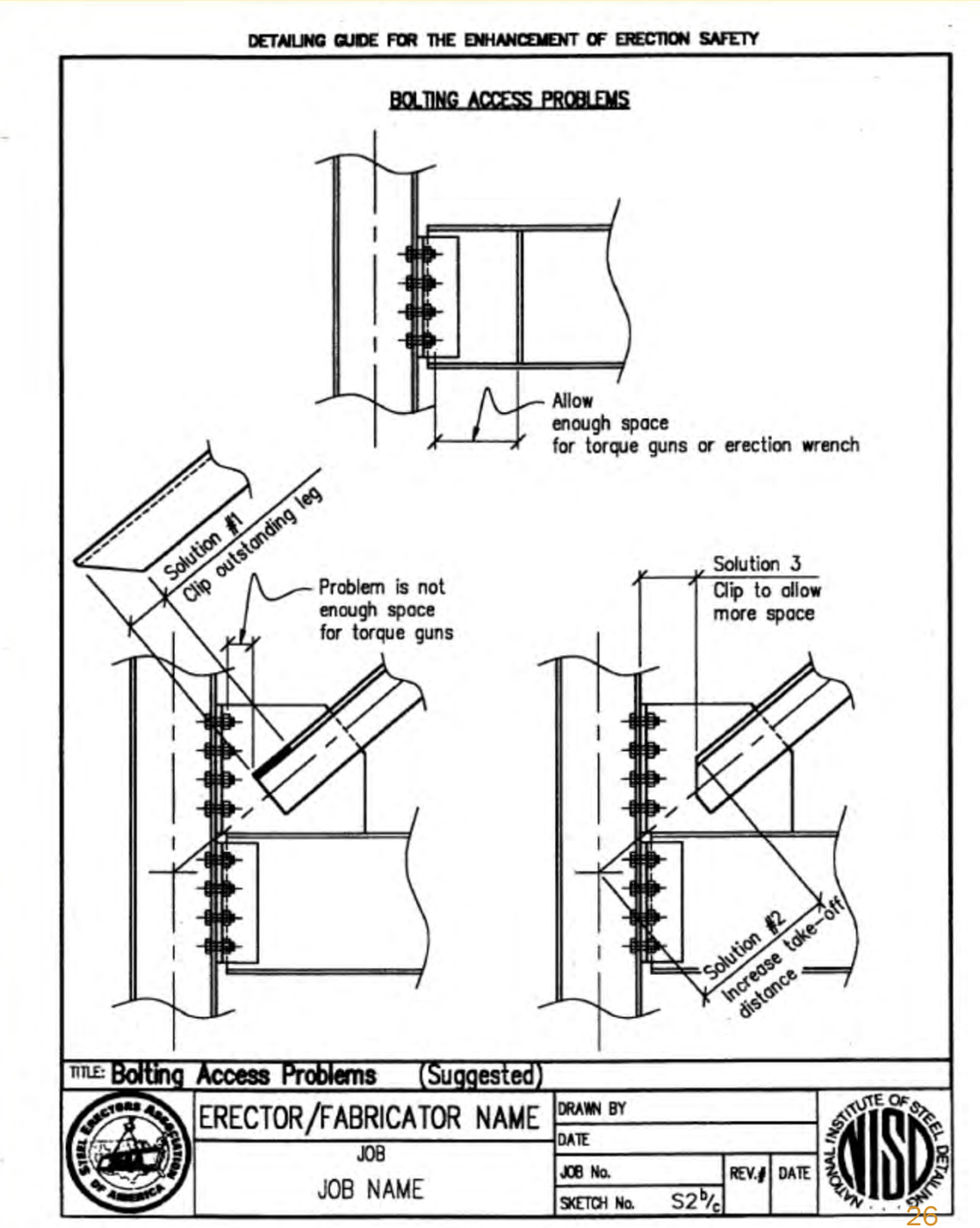
Published by the National Institute for Steel Detailing and the Steel Erectors Association of America

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

EXAMPLES: PREFABRICATION

Bridge Trusses

Concrete Wall Panels

www.ultimateengineering.com

Pre-engineered buildings

Concrete Segmented Bridge

test.jedinstvo.com

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

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
- LEED Pilot Credit

PTD IN PRACTICE: OWNERS

- Southern Co.
- Intel
- San Fran. Public Utilities Commission
- BHP Billiton
- MWCS
- USACE

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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

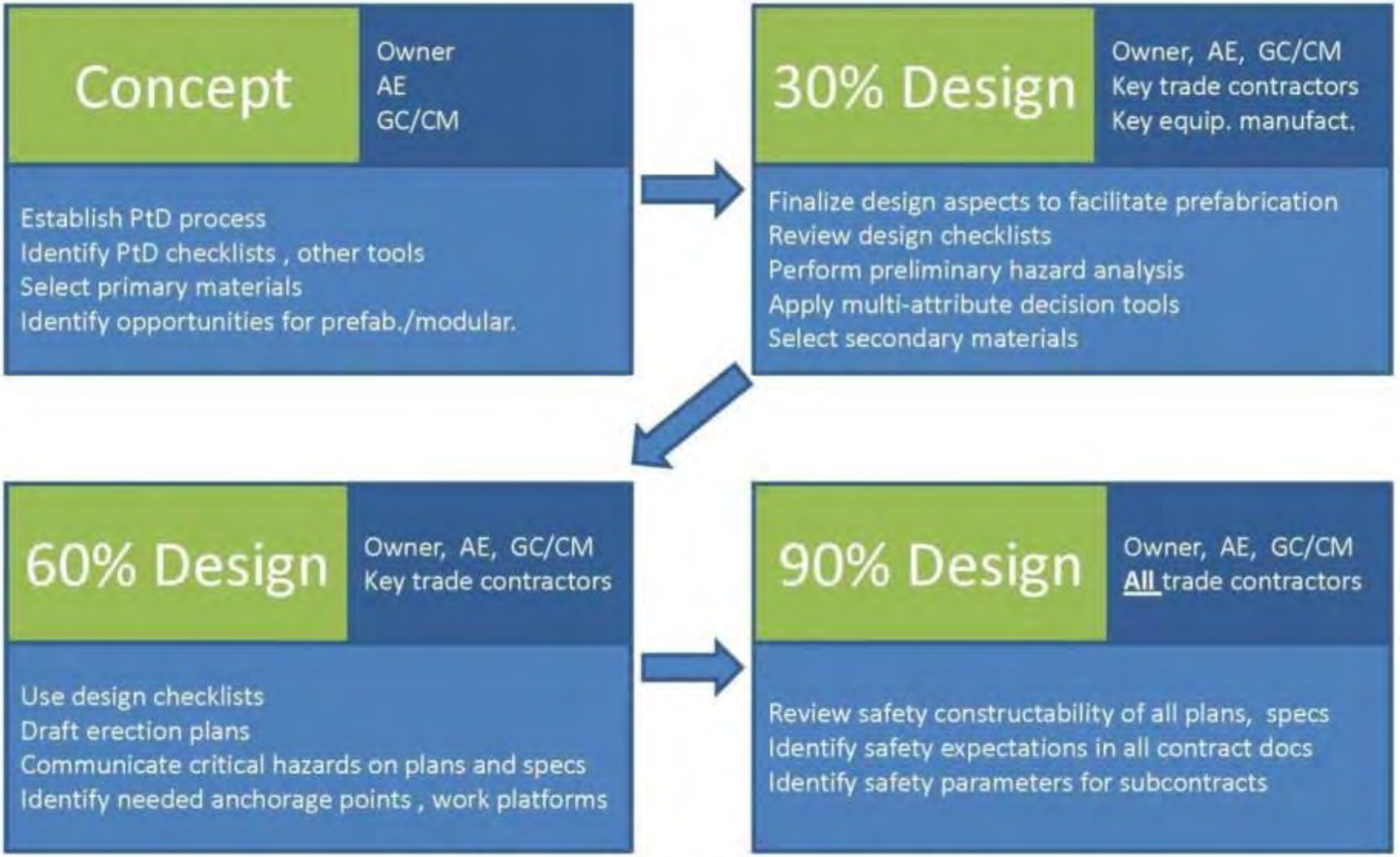
Get the right people

talking about the right things

at the right time!

www.seagrave.com/

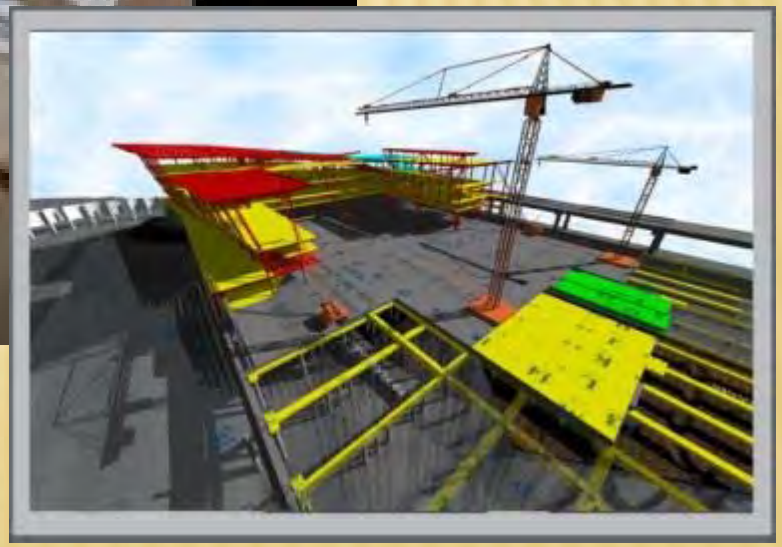
PTD PROCESS



PTD DESIGN CHECKLISTS

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



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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

- 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

- Designer training and tools
- Collaborative decision processes
- IPD or enabled safety constructability input

CHOOSE YOUR PARTNERS WISELY

- Commitment to safety and to a life cycle approach
- Collaborative culture and experiences
- Open to change
- Negotiated or Cost-Plus contracting

SUMMARY

- Our clients 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.
- Management commitment, training and client engagement are necessary first steps.
- PMI members can help spread the word that project goals should be socially sustainable.

THANK YOU FOR YOUR TIME!

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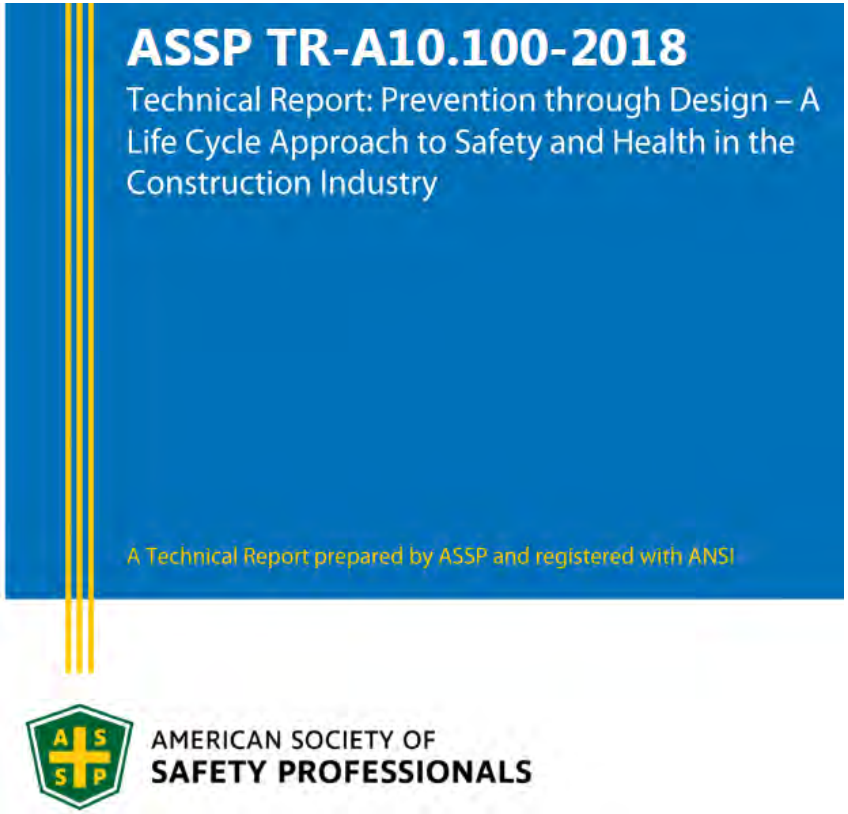
EDUCATING DESIGNERS

ANSI documents



ANSI/ASSP Z590.3-2011(R2016)

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

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