

Prevention through Design

The Live Webinar will begin shortly . . .

Upcoming PE Institute Live Webinar

Wednesday, May, 9 at 2pm

Architects & Engineers Claims Risk: Impact of Changing
Technology and Inexperience

Wednesday, May 16 at 2pm

Engineering Ethics: Conflicts of Interest and the Protection
of the Public

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Prevention through Design

The Triple Bottom Line in Capital Projects

NSPE Webinar
April 25, 2018



COLLEGE OF ENGINEERING
THE UNIVERSITY OF TOLEDO

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Based in part on past presentations with Dr. John Gambatese, PE, Professor, Civil and Construction Engineering, Oregon State University

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 with PtD

Prevention through Design

= Design for Safety

= Safety by Design



See May 2015 *PE* magazine article entitled “Safety by Design”



20



24



28



20 Designing the Future

As technology advances, do we have an ethical responsibility to ask questions about the long-term implications? Some say this is imperative and believe engineers should be the ones to lead the effort. PEs may be especially qualified to do so.

BY EVA KAPLAN-LEIBERSON

24 Safety by Design

In 2013, about one in five worker deaths in the private sector occurred in the construction industry. Engineers and architects can reduce risk for construction workers by considering construction safety in their designs, however, it's a slowly growing idea, but comes with some caveats.

BY MATTHEW McLAUGHLIN

28 New Ways of Seeing

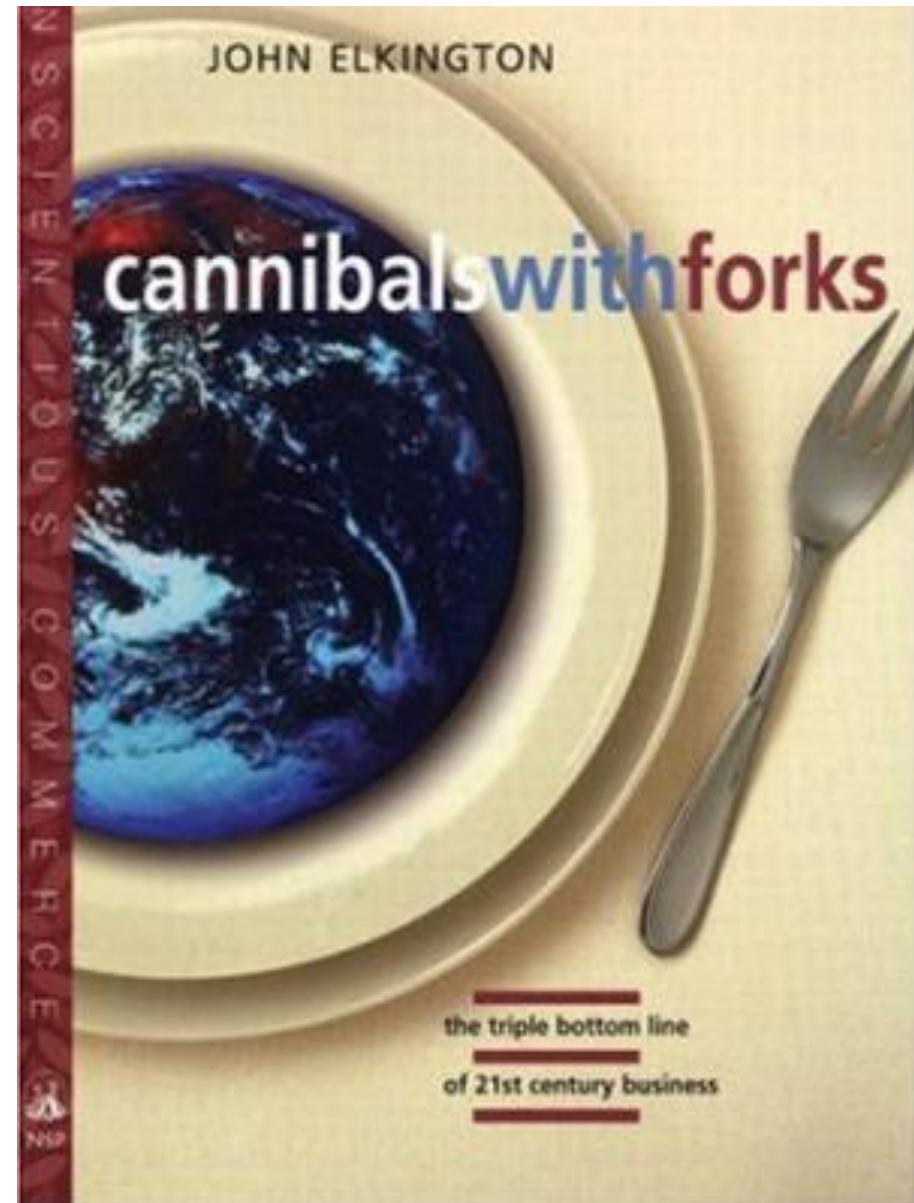
The more than 610,000 highway bridges in the US require safety inspections to ensure proper maintenance, repair, and rehabilitation. Increasingly, transportation departments are taking advantage of new technology to help assess bridge conditions.

BY DANIELLE BOYEN

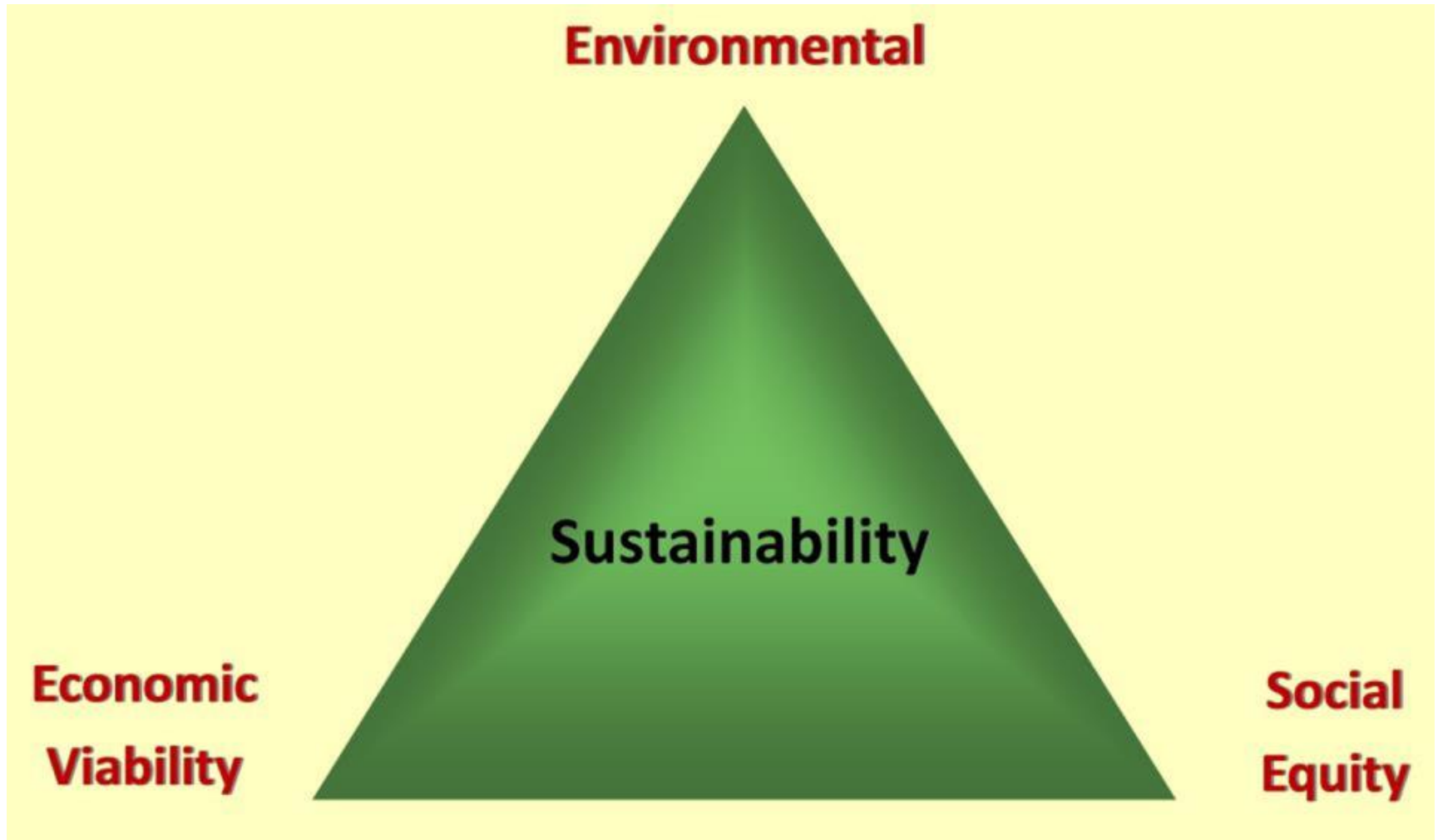
Triple Bottom Line

“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



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.

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 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

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”



Integrated Design and Construction

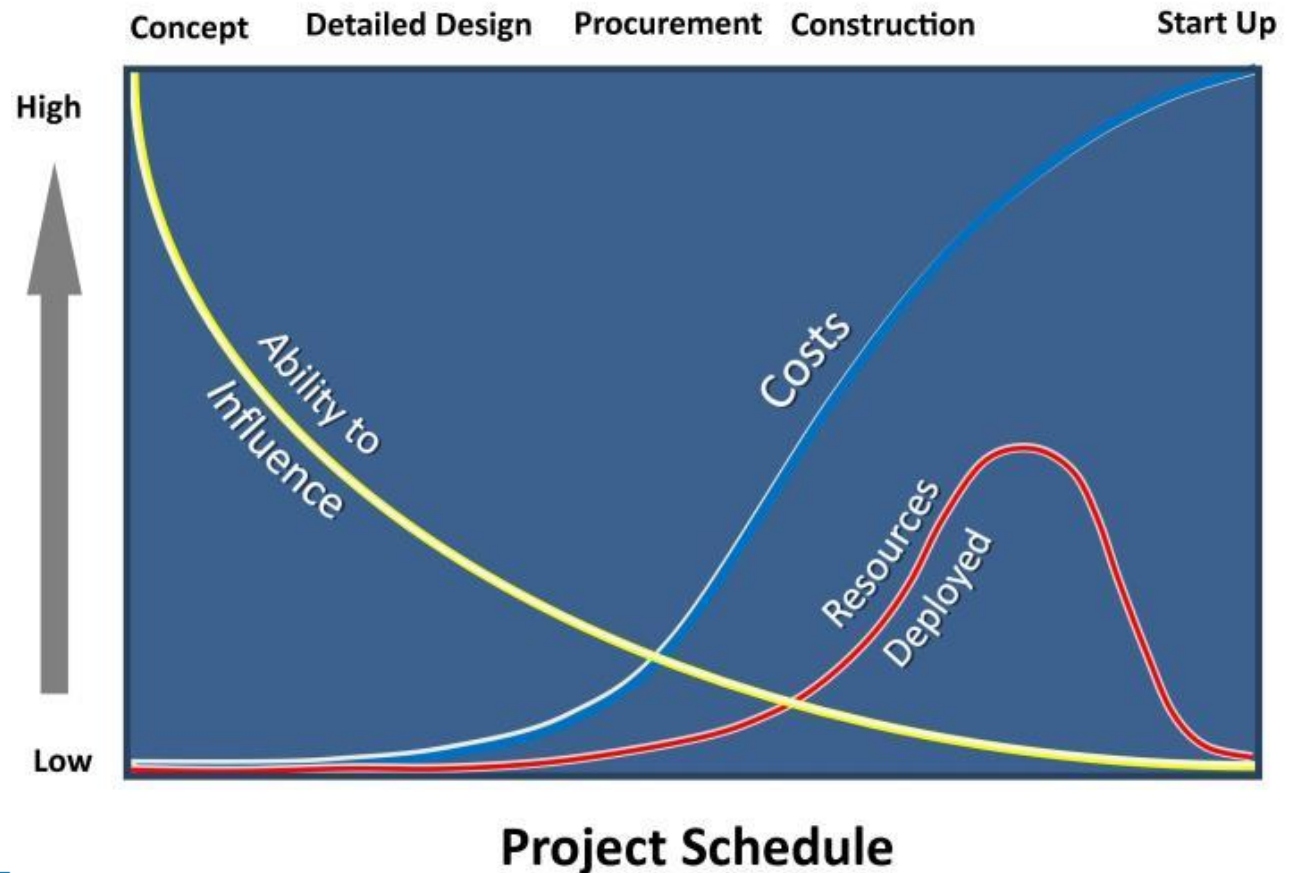
- Project success requires that design reflects input from all stakeholders, including:
 - Users/occupants
 - Owner facility management personnel
 - Contractors
- Constructability feedback must start early in the design process

Benefits of Integrated Design and Construction

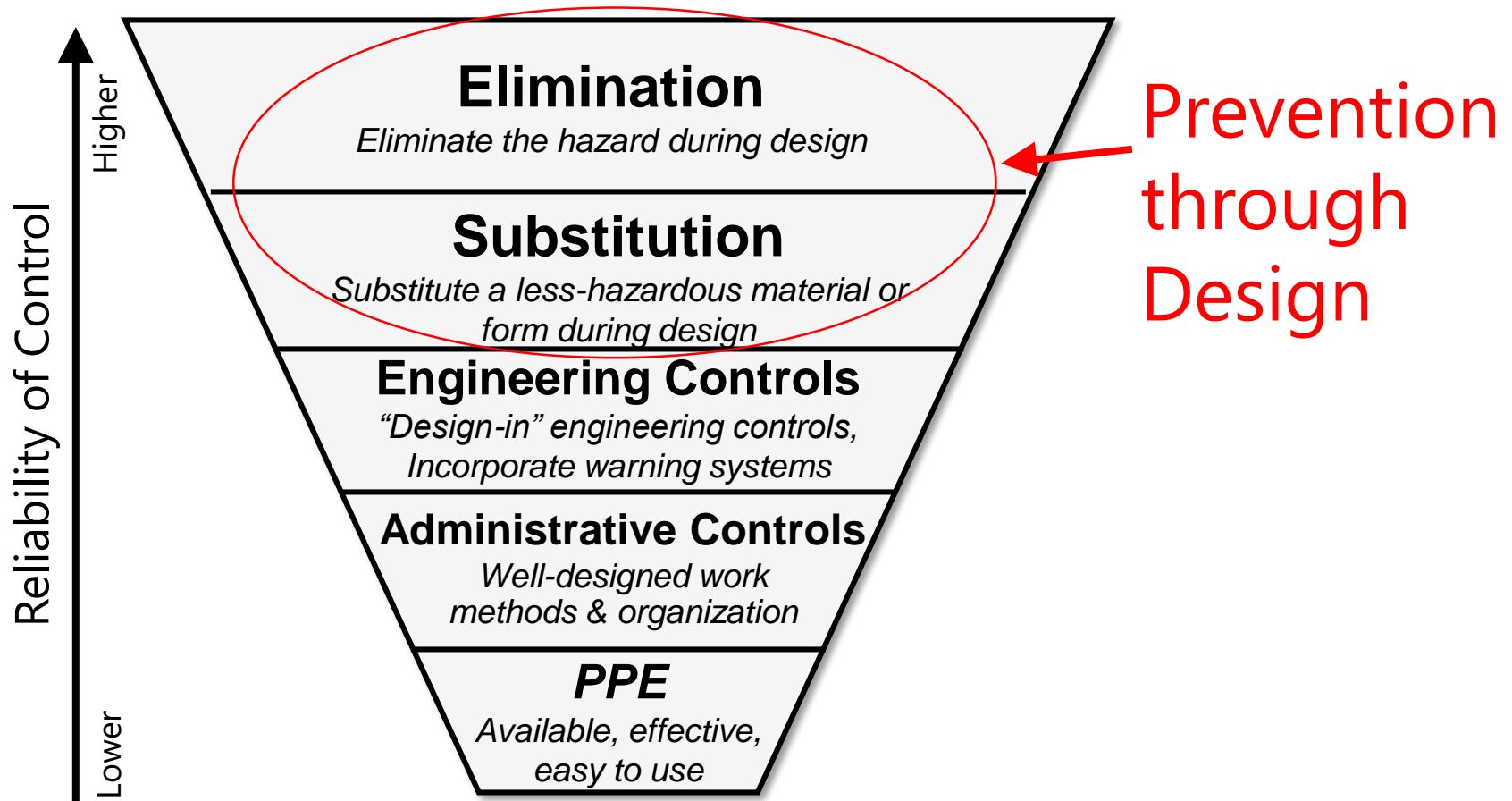
- Obvious: Cost, Schedule, Quality
- Accepted: Sustainability
- Emerging: Prefabrication
- Emerging: Safety

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



When Safety is Not Discussed during Design

1. Users/Occupants can be hurt.

Example: Kansas City Hyatt

2. Designs are unconstructable.

Example: high school masonry wall collapse

3. Designs are more hazardous to construct than they need to be.

Examples: excavation, superstructure, MEP, finishes...

4. Designs are more hazardous to maintain than they need to be.

Examples: skylights, access to light bulbs, valves....

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

PtD and Professional Ethics

- NSPE Code of Ethics:
 - **Engineers shall hold paramount the safety, health, and welfare of the public.**
- ASCE Code of Ethics:
 - **Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering decisions**

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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[illegible]

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PtD Example: Anchorage Points



PtD Example: Structural Steel Design

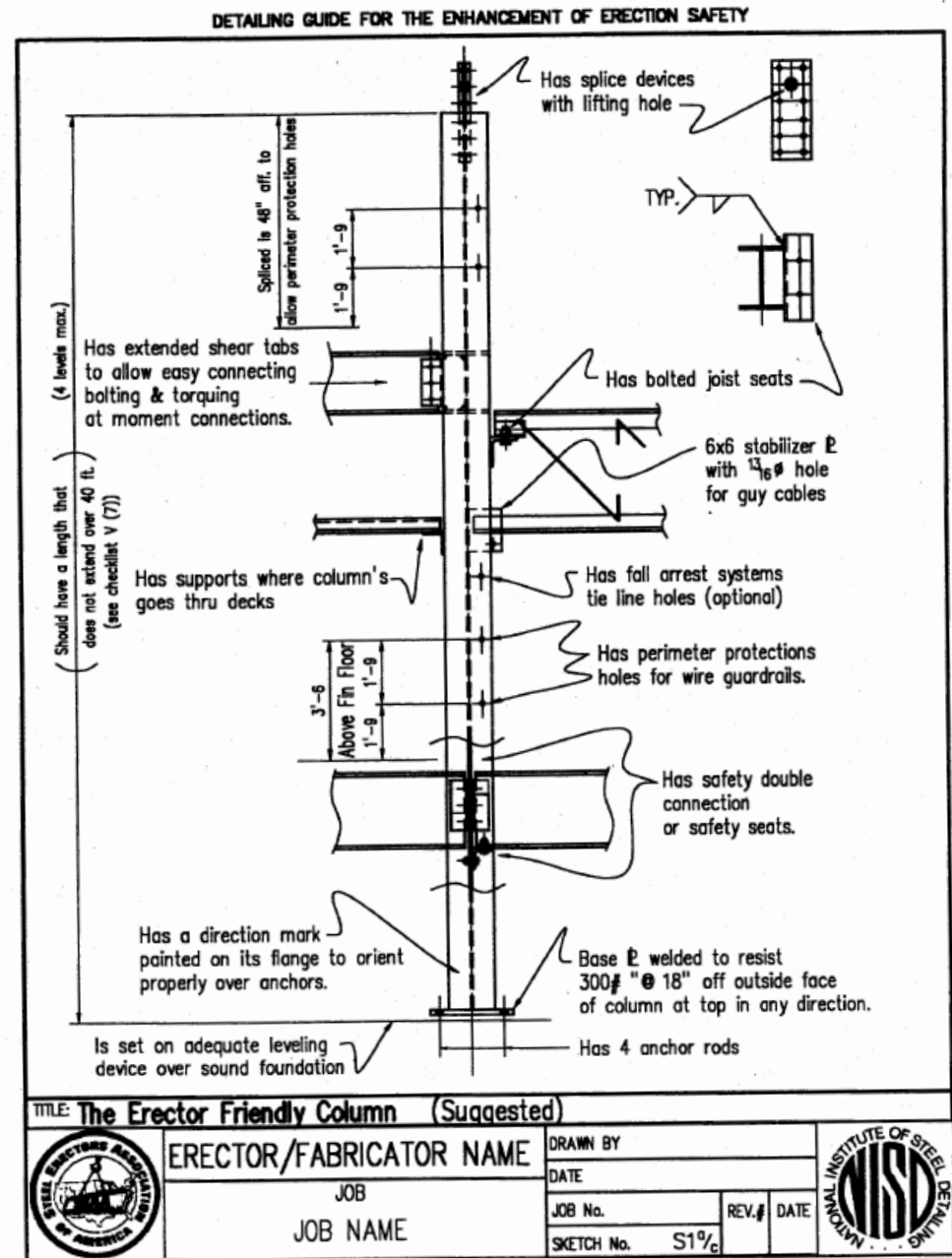
Detailing Guide for the Enhancement of Erection Safety

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



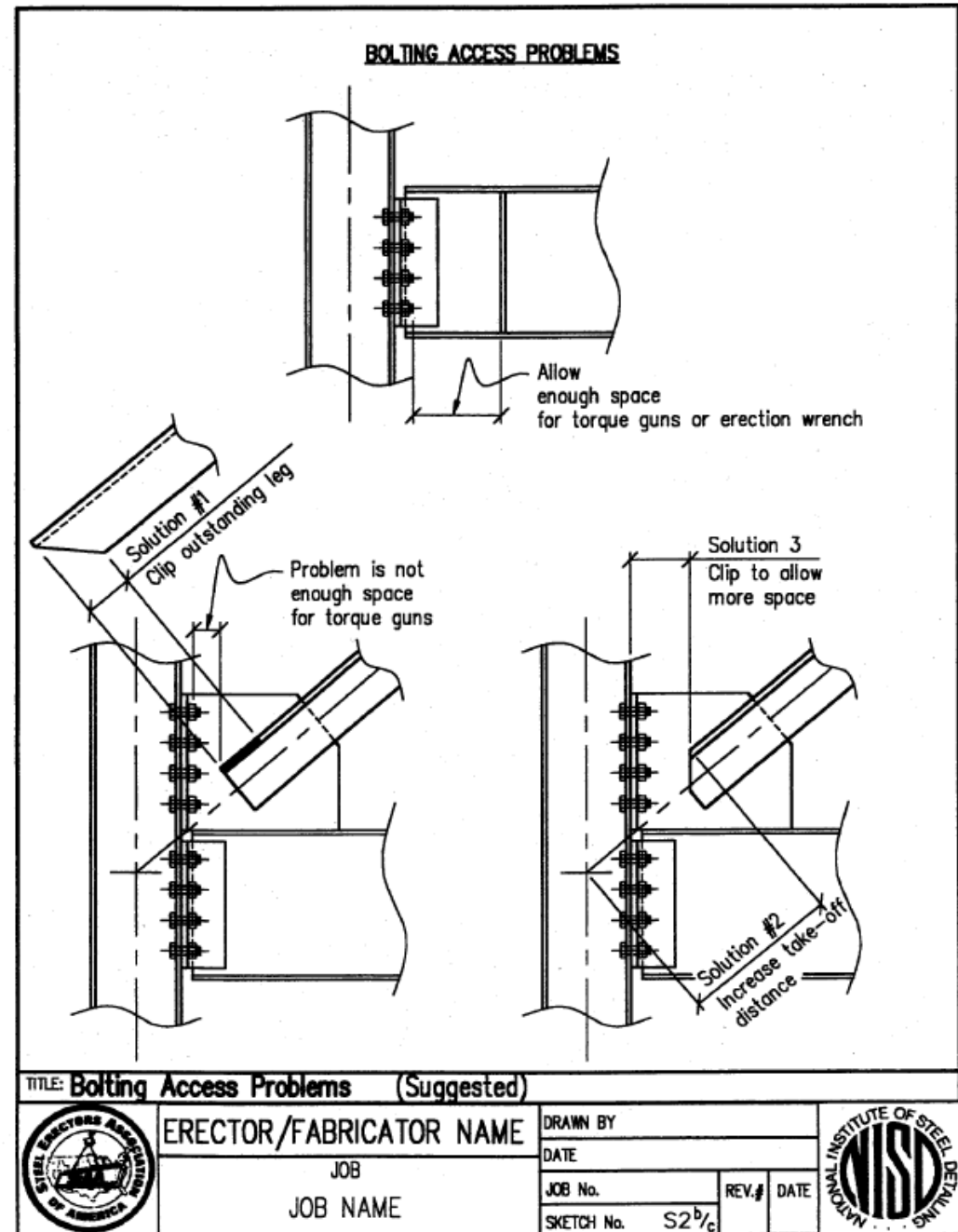
The Erector Friendly Column

- 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



PtD Example: Roofs and Perimeters

Skylights



**Upper story
windows**

Parapet walls



PtD Example: Prefabrication

Steel Stairs



Concrete Wall Panels



Concrete Segmented Bridge



MEP Corridor Racks



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

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



ARTBA Transportation Development Foundation

The Vision:

“To ensure the safety and well-being of construction workers, motorists, truck drivers, pedestrians and their families by making transportation project sites worldwide zero-incident zones.”

“The Safety Certification for Transportation Project Professionals” (SCTPP) program – identification of the target audience, core competencies to test, and the exam itself – was developed by leading executives and safety professionals in the transportation infrastructure industry. Thus, the SCTPP credential shows your employer and peers that you can identify common hazards found on transportation project sites and correct them to prevent safety incidents that could result in deaths or injuries. Earning the professional certification also provides you with a competitive edge in the work place because it demonstrates your command of internationally-recognized core competencies for safety awareness and risk management on transportation projects.

ARTBA Safety Certification FAQ

<https://puttingsafetyfirst.org/>

Why should a transportation planning and design firm support their designers earning the Safety Certification for Transportation Project Professionals™?

- Because safety incident mitigation can be worked into transportation project plans and designs, if designers know what causes safety incidents on project sites.
- It shows owners and contractor partners that your firm understands safety can be designed into transportation projects and that it shares their commitment to ensuring the safety of on-site workers and those travelling through the projects you design.
- 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.
- It makes your firm a more desirable partner to contractors with a world-class safety culture.

LEED PtD Pilot Credit

- Identify and document the items found for the following two stages:
 - Construction
 - Operations and Maintenance
- For each stage, complete three stages of analysis:
 - Baseline (design prior to safety constructability review)
 - Discovery (hazards posed by design)
 - Implementation (hazards reduced by design changes)

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- **Processes and Tools**
- Moving forward in SSOE

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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

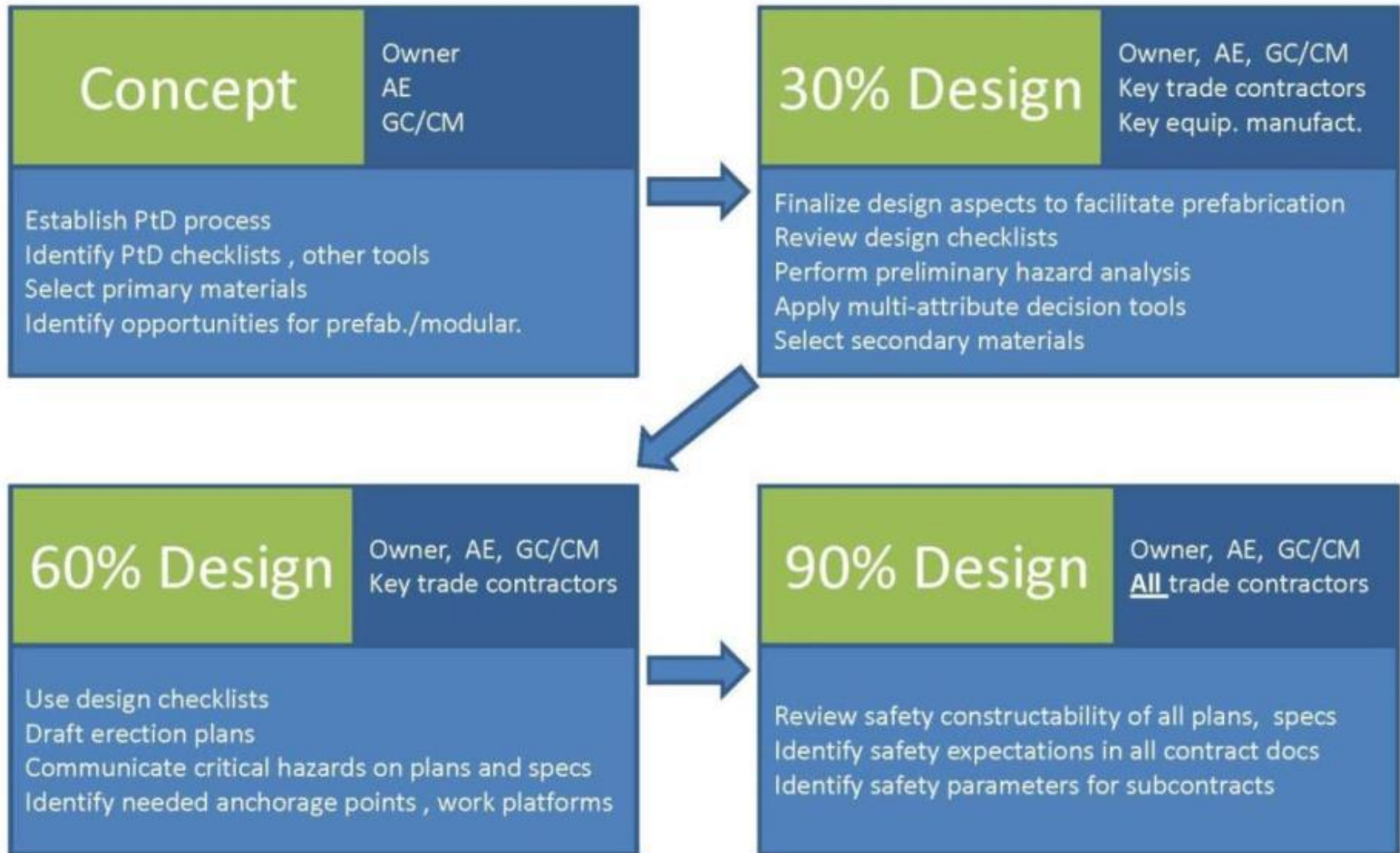
**Get the right people
talking about the right things
at the right time!**



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PtD Process



© T. Michael Toole and John Gambatese 2011

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.

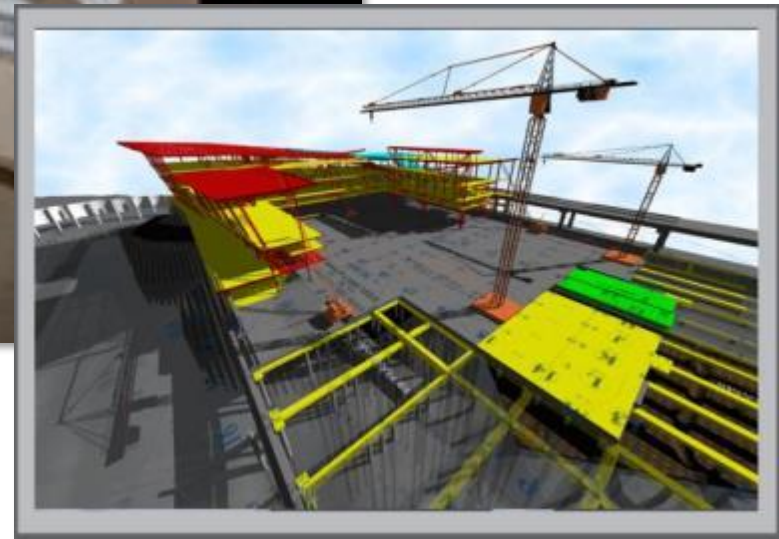
2.0 Accessibility

- 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.



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PtD Tools – BIM and Visualization



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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.

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
 1. Professional Codes of Ethics (right thing to do)
 2. Payoff data (smart thing to do)
- Training

Establish Enabling Processes

- Designer training and tools
- Enabled safety constructability input
 - Design-Build
 - Integrated Project Delivery
 - Design-Bid-Build with Design-Assist
- Collaborative decision processes

Choose Your Partners Wisely

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

Summary

- Our clients and others are increasingly 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.
- NSPE can become a leader in moving PtD forward in appropriate ways.
- Management commitment, training and client engagement are necessary first steps.

THANK YOU FOR YOUR TIME!

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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

HISTORY AND FUTURE OF PTD

CHALLENGES

PTD INFORMATION AND PUBLICATIONS

DESIGN TOOLS

INTERNATIONAL GUIDELINES

PRESENTATION FILES

Prevention through Design

To receive credit for this course, each registrant will need to take the quiz below and pass with a score of 70 or above. Click link

<http://quiz.nspe.org/quiz/prevention-design.aspx>

to take the quiz.

Prevention through Design

NSPE would like your feedback regarding this live webinar.

Click link

<https://www.surveymonkey.com/r/QYCQVYV>

to take a short survey.