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Occupational Health and Safety in the Design and Construction of Projects

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AIHA Yuma Pacific Southwest Section
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San Diego, CA
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Oregon State University

AIHA Protecting Worker Health

Yuma Pacific Southwest Section

The Importance of Design

"Things alter for the wrong spontaneously, if they be not altered for the better designedly."

Francis Bacon *(1561-1626), British author, statesman, philosopher, and scientist*

A Focus on Ethics

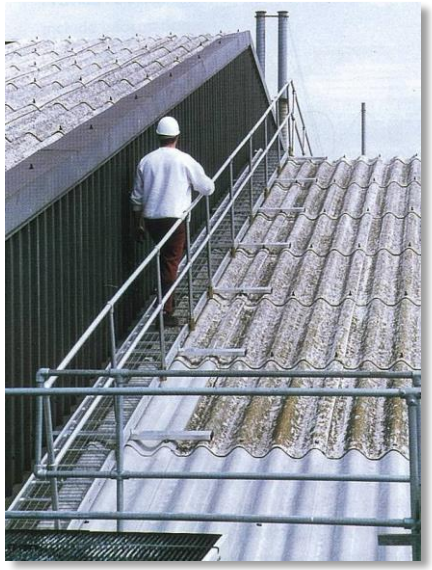
- National Society of Professional Engineers (NSPE) Code of Ethics:
  - "Engineers shall hold paramount the safety, health, and welfare of the public."
- American Board of Industrial Hygiene (ABIH) Code of Ethics:
  - "First and foremost, ABIH certificants and candidates give priority to health and safety interests related to the protection of people……"

ABIH
american board of industrial hygiene

NSPE

Supporting Research

- 22% of 226 injuries that occurred from 2000-2002 in Oregon, WA, and CA related to design[1]
- 42% of 224 fatalities in US between 1990-2003 related to design[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 Constr. Safety Concept" (2005)

[2] European Foundation for the Improvement of Living and Working Conditions

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

Hierarchy of Controls

High

Reliability of the Control

Low

Elimination

Eliminate the hazard during design

Substitution

Substitute a less-hazardous material or form during design

Engineering Controls

"Design-in" engineering controls, Incorporate warning systems

Administrative Controls

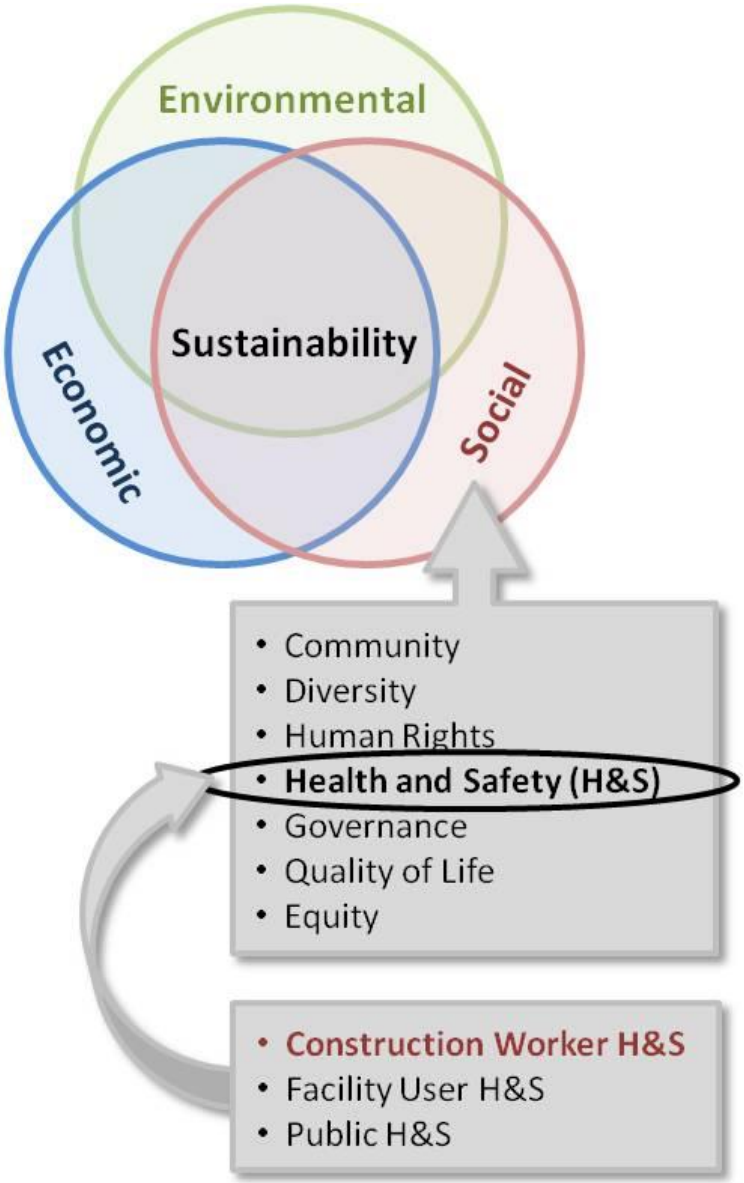
Well-designed work methods & organization

PPE

Available, effective easy to use

Sustainable Development

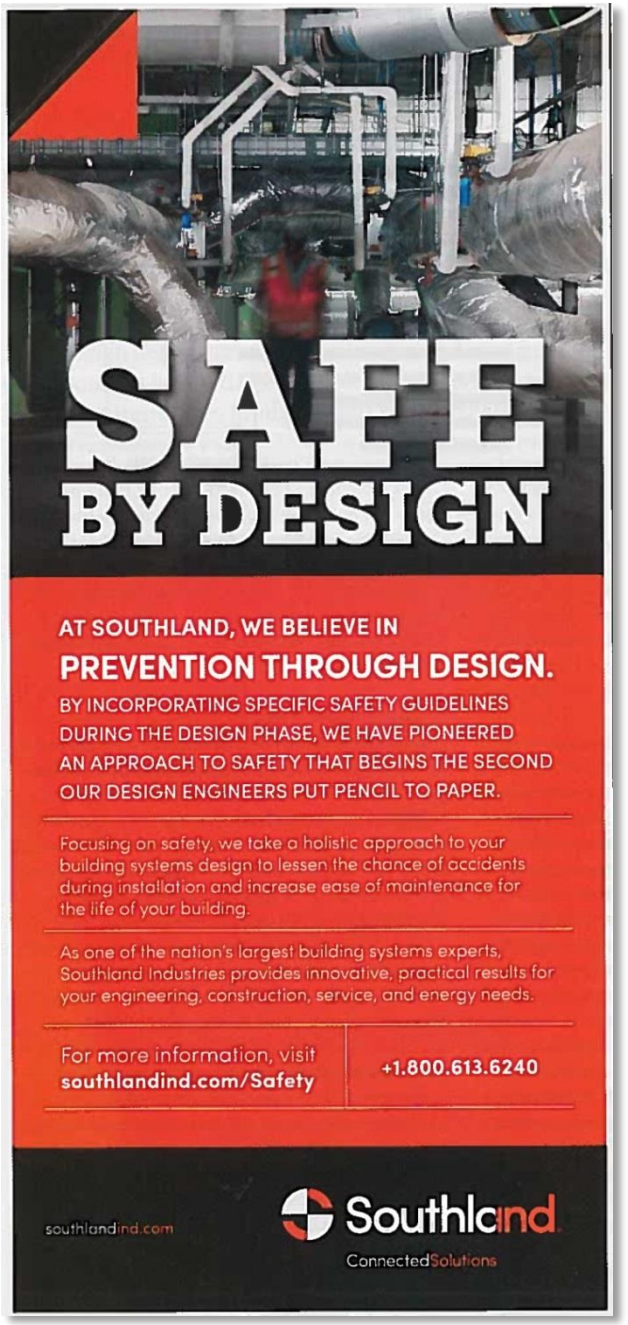
- USGBC – Prevention through Design (PtD) LEED Pilot Credit, IPpc93
  - Safety Design Review
  - Safety Constructability Review



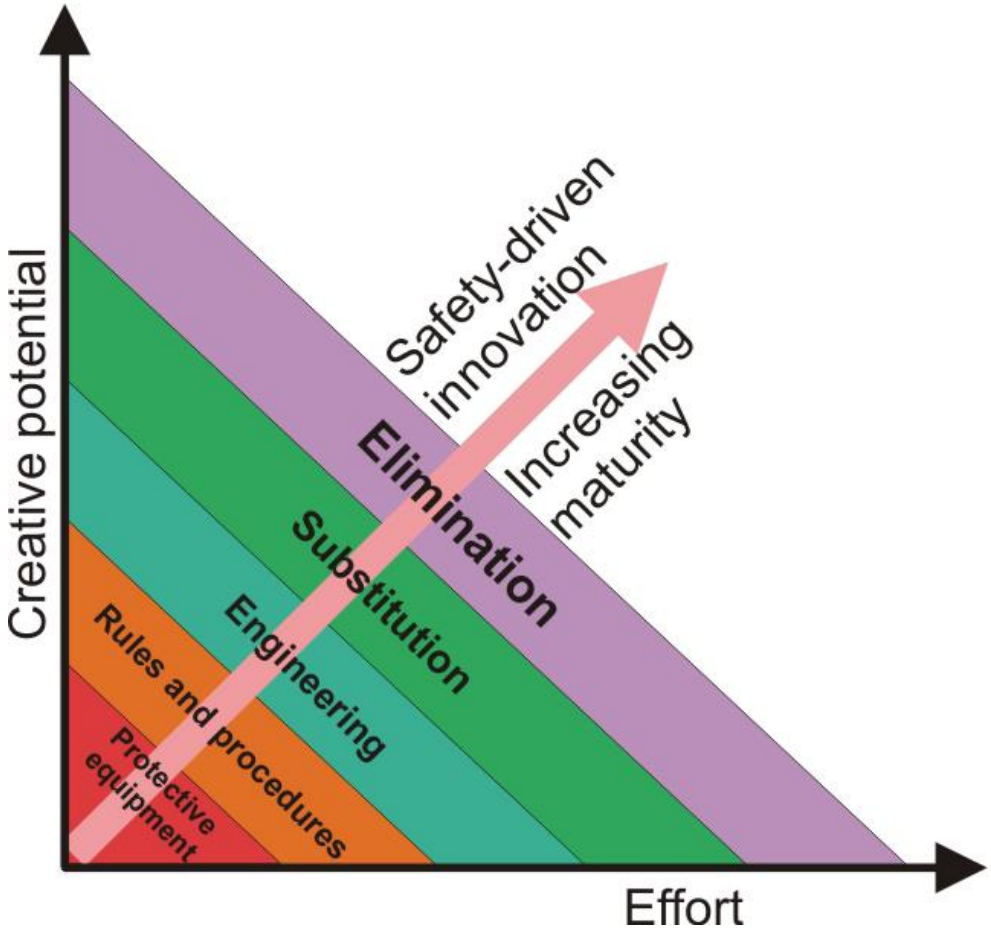
Source: http://sustainablesafetyandhealth.org/scsh-overview/

Benefits of Prevention through Design (PtD) Implementation

- Reduced site hazards
  - Fewer worker injuries and fatalities
- Increased productivity
- Increased quality
- Fewer delays due to accidents
- Designer-constructor collaboration
- Improved operations/maint. H&S
- Reduced workers' comp. premiums
- Marketing, recognition



A Driver of Innovation



Source: Culvenor, J. (2006). "Creating Transformational Change through Innovation in Risk Management Keynote Address: 'Creating transformational change through innovation in risk management'." *Risk Management Research and Practice: An Educational Perspective*, Welsh Risk Pool and University of Wales, Bangor, Trearddur Bay Hotel and Conference Centre, Holyhead, Anglesey, UK, March 30-31, 2006.

Expected Impacts

Survey of design and construction professionals in the UK:

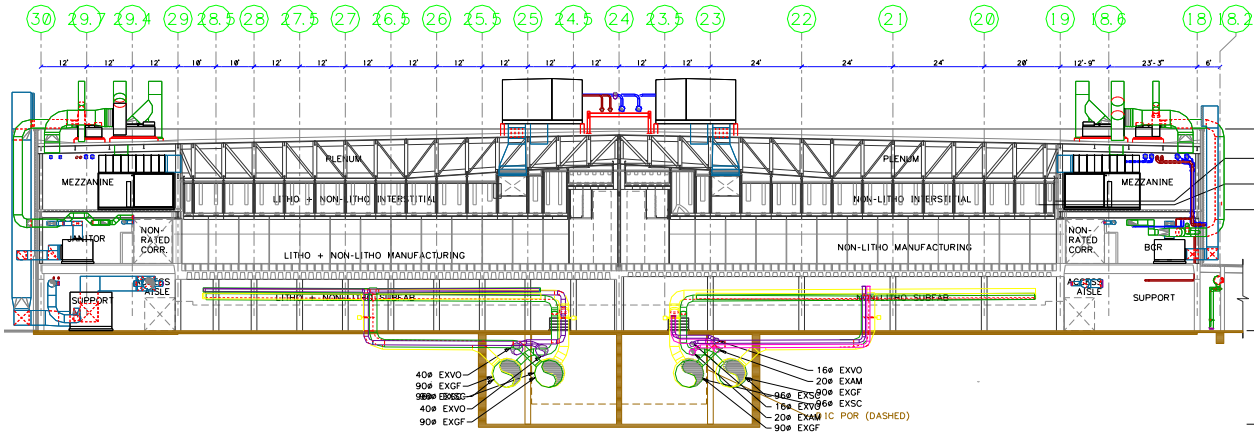
- Change as a result of implementing PtD (% of respondents)

Item	Decrease	No Change	Increase
Design cost (n=35)	6%	46%	49%
Construction cost (n=38)	34%	24%	42%
Design duration (n=37)	8%	57%	35%
Construction duration (n=39)	38%	44%	18%
Construction quality (n=39)	8%	28%	64%
Construction worker productivity (n=30)	13%	33%	53%
Construction worker health & safety (n=45)	4%	9%	87%
End-user health and safety (n=42)	5%	10%	86%

Source: Final Report, NIOSH PtD in the UK study, May 2013.

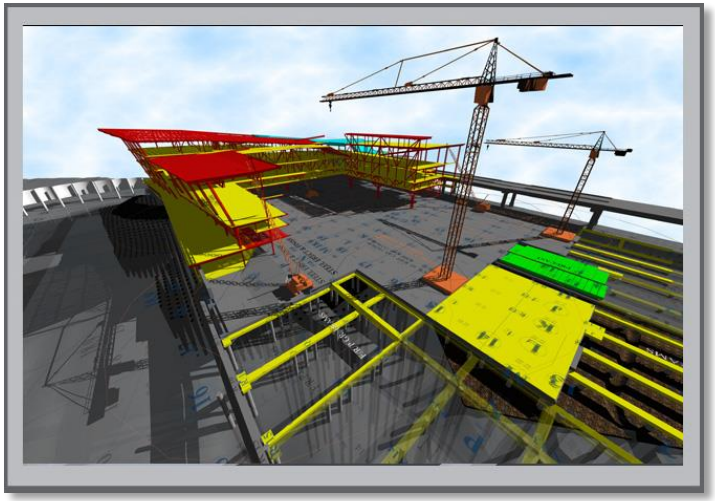
Inhibitors of PtD Implementation

- No or minimal designer education and training in safety
  - Site safety and designing for safety
- Difficult to assess risks during design
- Contractual separation of design and construction
- Cost/time required to implement PtD
- Fear of increased liability
- Competing priorities (e.g., safety vs. cost/schedule)



Enablers of PtD Implementation

- A committed owner/client
- Positive safety culture
- Design engineer experience and training
  - Construction, maintenance, and safety
- Integrated project delivery methods
- Design/construction visualization tools



PtD Initiatives

- NIOSH PtD National Initiative
- OSHA Construction Alliance Roundtable
- ANSI/ASSE PtD Standard Z590.3-2011

- U.K.: Construction (Design and Management) Regulations
- Spain: Royal Decree 1627/1997, “Minimum provisions for health and safety at construction sites”
- Singapore: Design for Safety Pledge, 2012

- Other EU countries, Australia, South Africa, and more

Steps to Implementing PtD in Practice

Source:

Gambatese, J.A., "Designing for Construction Safety and Health: From Research to Practice," keynote presentation. *Working Together: Planning, Designing, and Building a Healthy and Safe Construction Industry*, International Council for Research and Innovation in Building and Construction (CIB) W99 Conference, Melbourne, Australia, Oct. 21-23, 2009.

Steps to Implementing PtD in Practice

- Education, training, and tools
  - OHS in architecture/engineering education
  - Professional continuing education classes
  - OHS in professional licensure requirements
  - Visualization and work flow tools

Steps to Implementing PtD in Practice

- Right place, right time, right resources
  - OHS review in project development process
  - Integrated project delivery methods
  - Co-locating design and construction staff
  - Supported by owner/client (resources)

Steps to Implementing PtD in Practice

- OHS is a design criterion
  - Part of standard design practice
  - Incorporated into design codes
  - Contractually prescribed by owner/client
  - Required by legislation

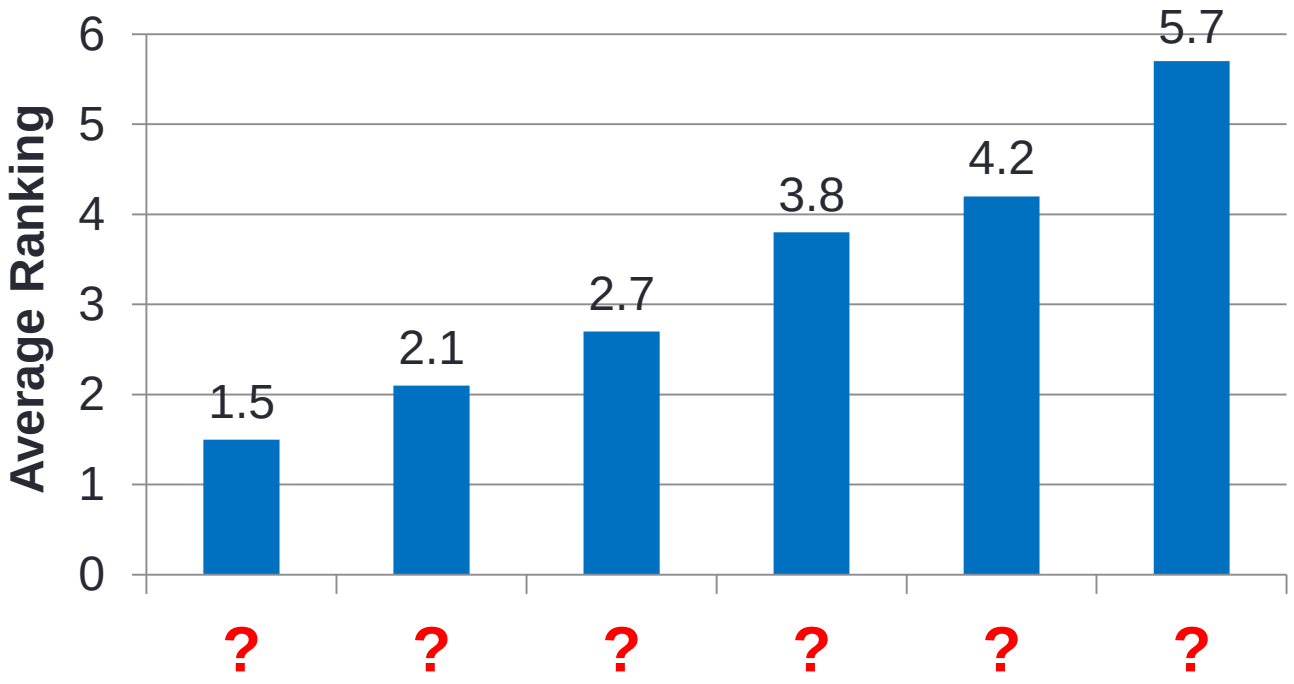
Steps to Implementing PtD in Practice

- OHS is a high priority
  - Authorization to modify the design for OHS
  - Designing out the hazard is first choice
  - OHS given high priority relative to other project criteria

Test your knowledge…

What is the average rank of priority given to each of the following criteria by architects and design engineers (1 = highest ranking; 6 = lowest ranking)?

A. Quality
B. End-user safety
C. Cost
D. Schedule
E. Aesthetics
F. Construction Safety



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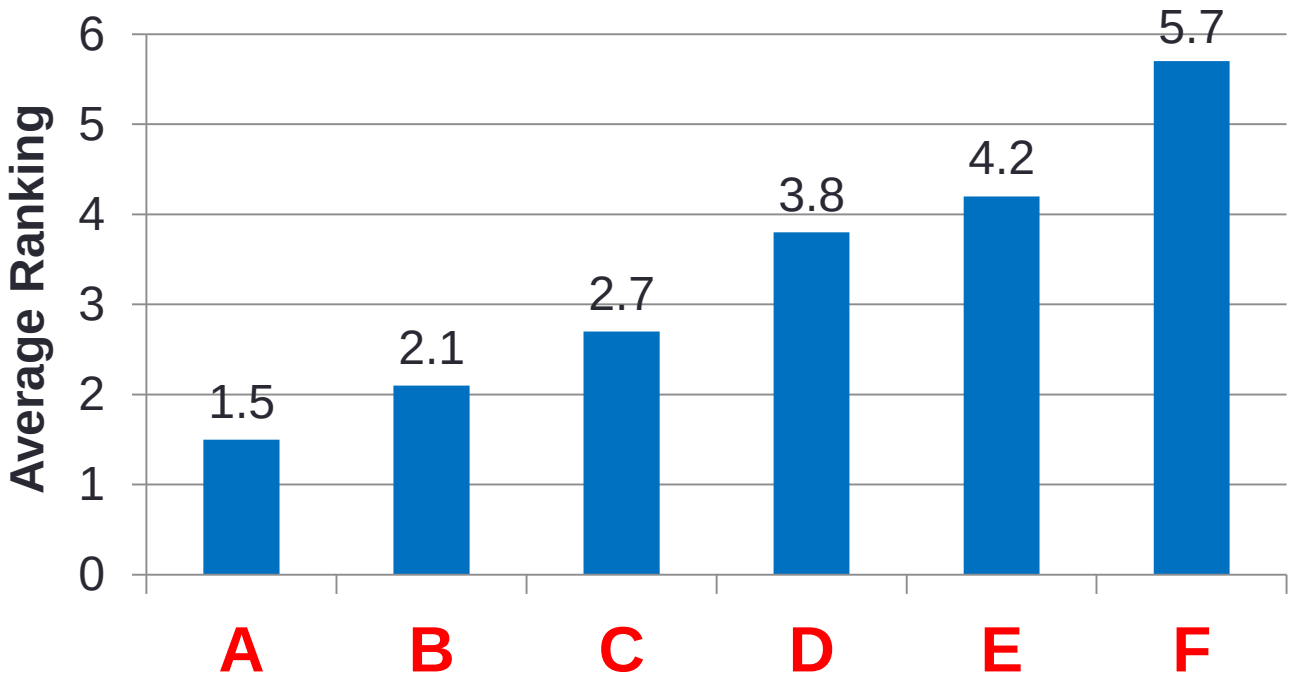

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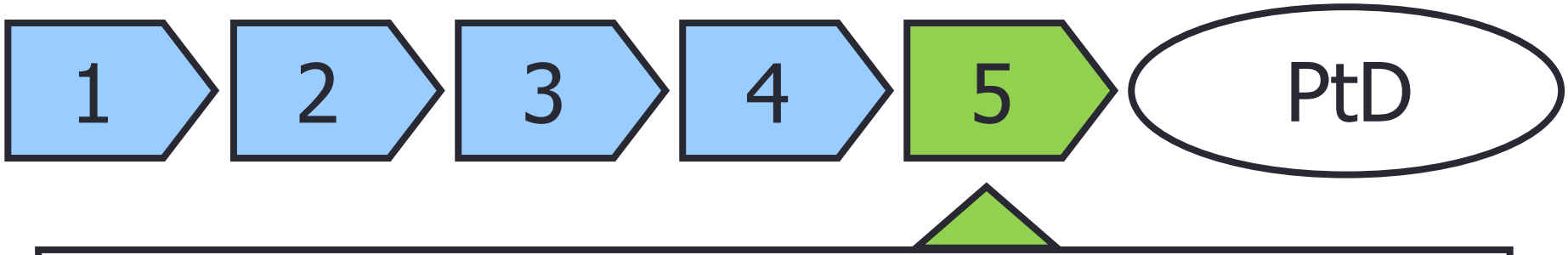
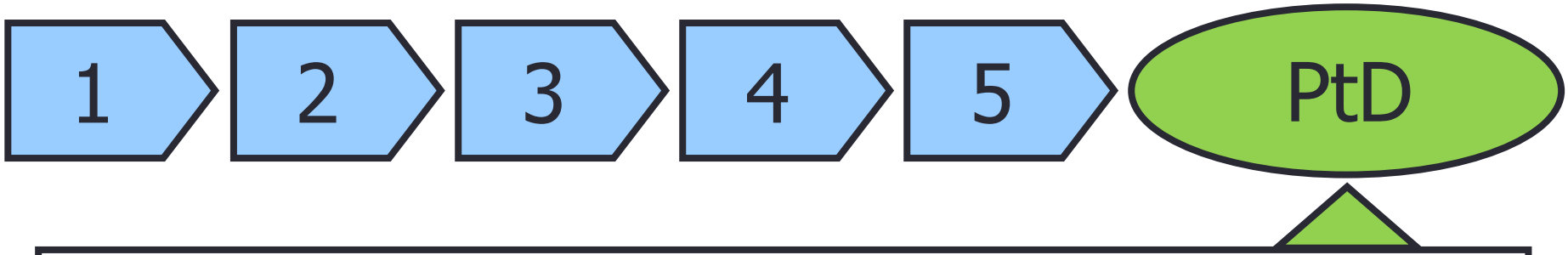


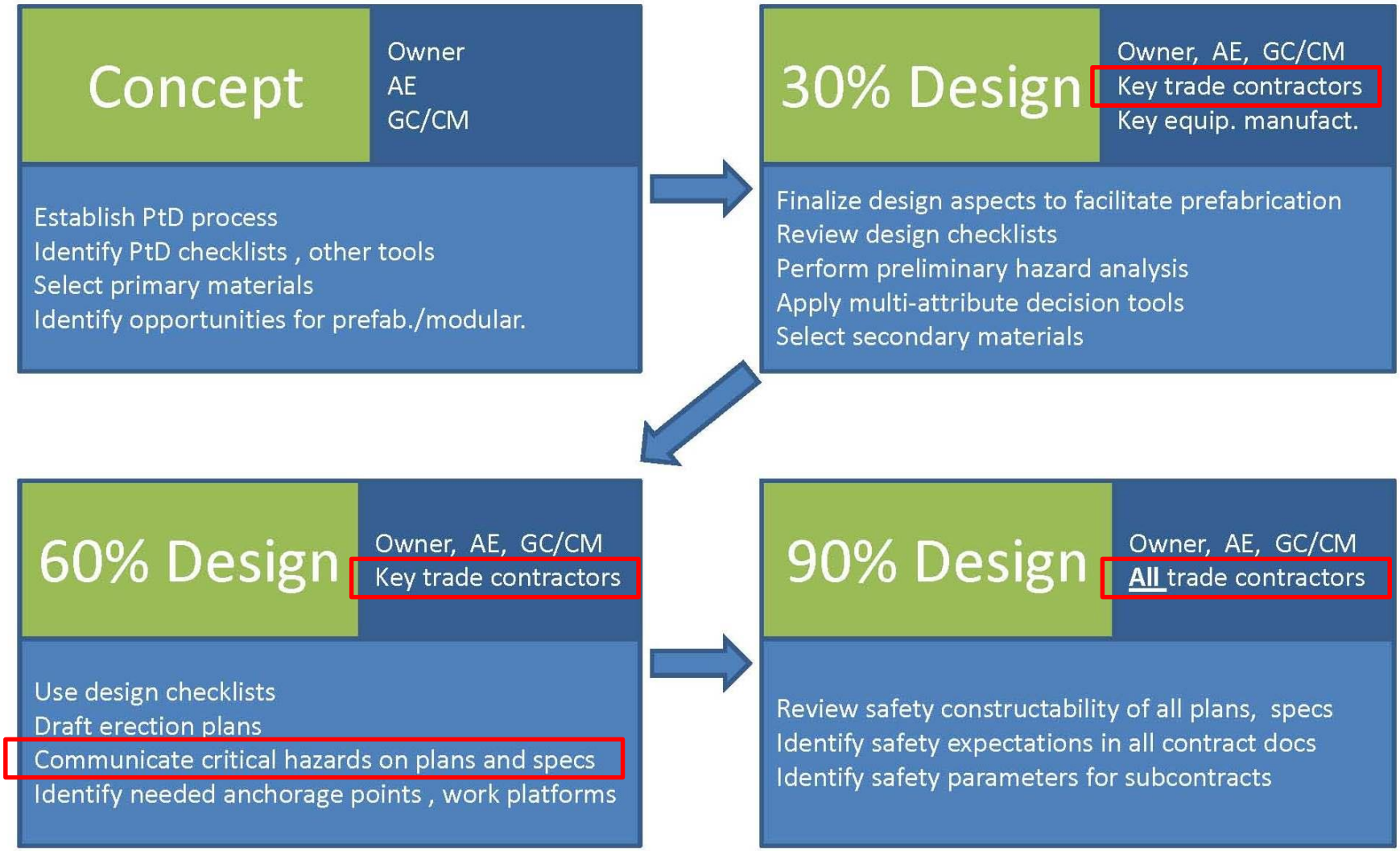
- Designing for OHS has value
  - Lifecycle savings outweigh costs, and economically feasible for designers
  - Improvements in OHS, quality, productivity
  - Morally and ethically responsible
  - Desired by owners/clients (priority)

Steps to Implementing PtD in Practice



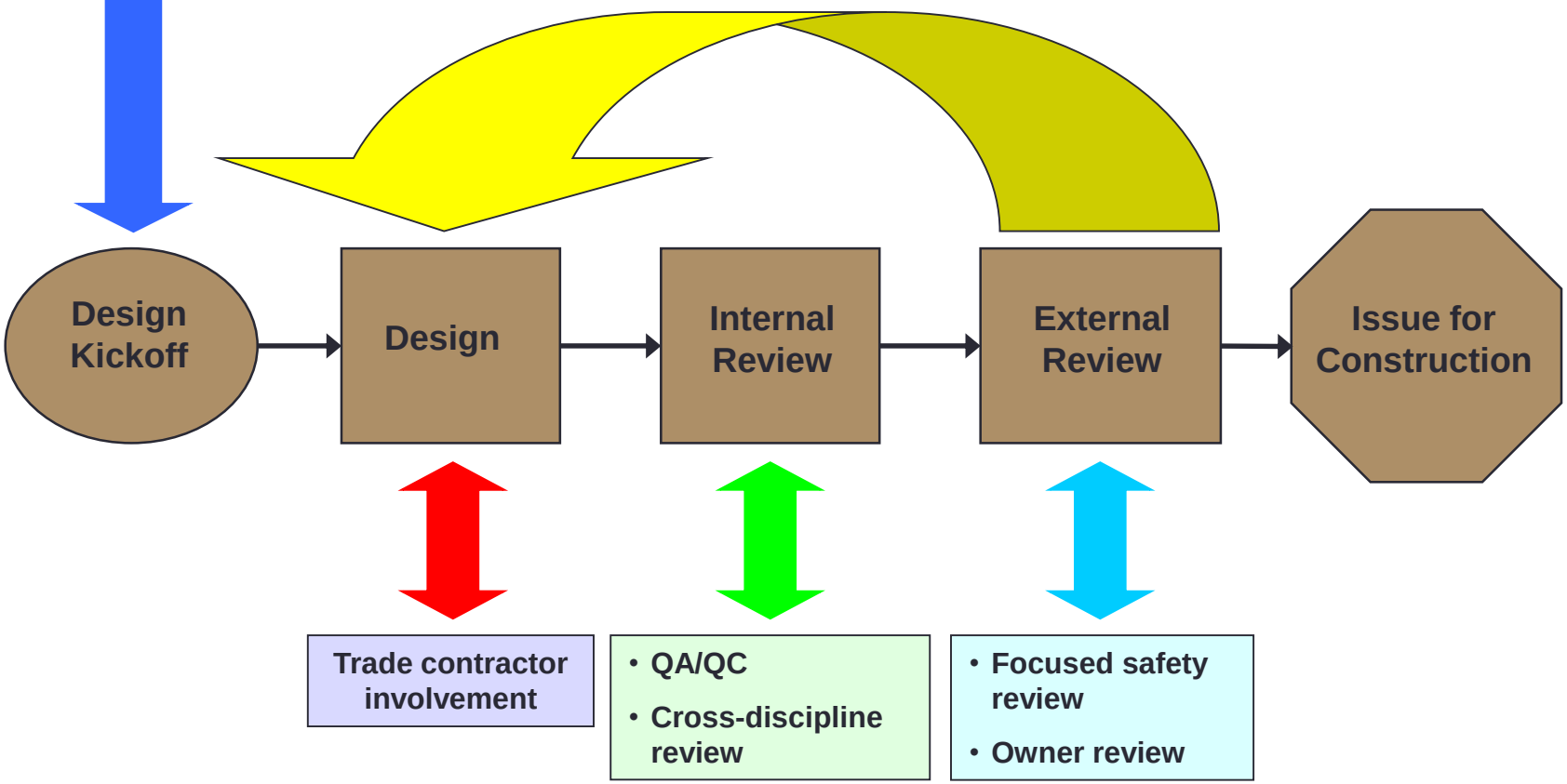
- Designed for construction safety and health
  - Construction site hazards eliminated/reduced
  - Improvements in OHS, quality, productivity
  - Improvements in maintenance H&S
  - Design and construction integration and collaboration

Planning and Design Process



Design Development

- Establish design for safety expectations
- Include construction and operation perspective
- Identify design for safety process and tools



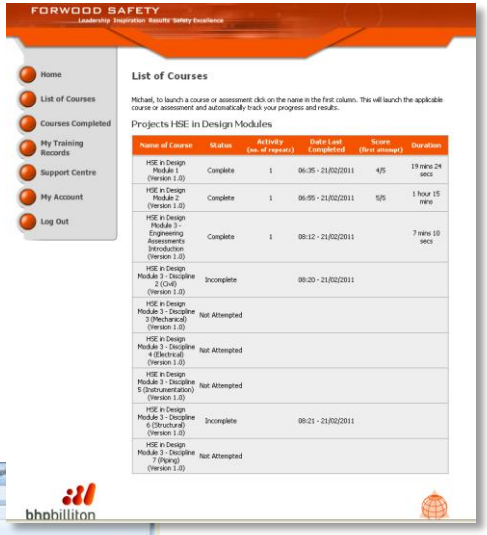
Source: Hecker et al., 2005

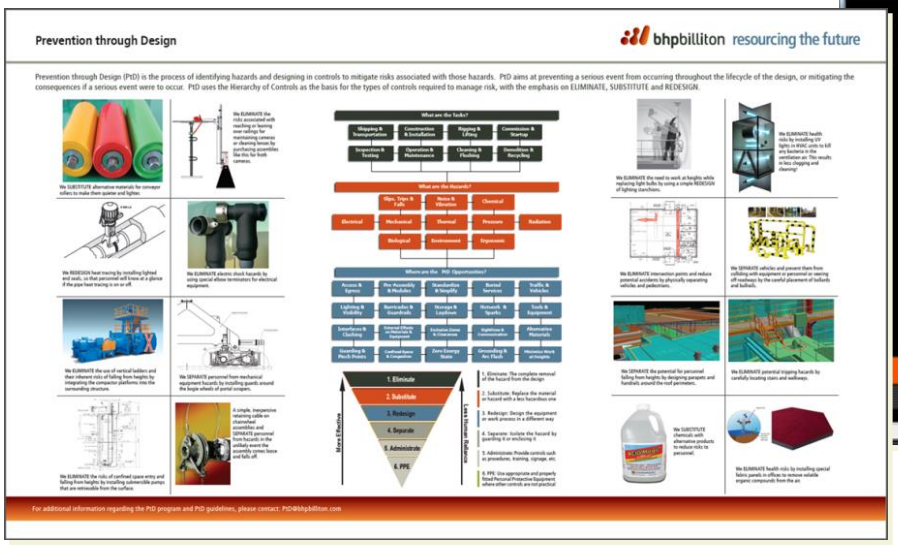
Example PtD Program

- The Haskell Co.: “Safety Alert System” (SAS)
- Designer safety education, training, awareness
- Safety reviews during design
  - All disciplines
  - Identify hazards
  - Incorporate safety suggestions into design
- Safety symbols on design drawings
  - Alert constructors to safety hazards
  - Include reference to related OSHA standards

Example: BHP Billiton PtD Initiative

- PtD staff embedded in procurement and design
- Communication and training
- PtD in technical specifications





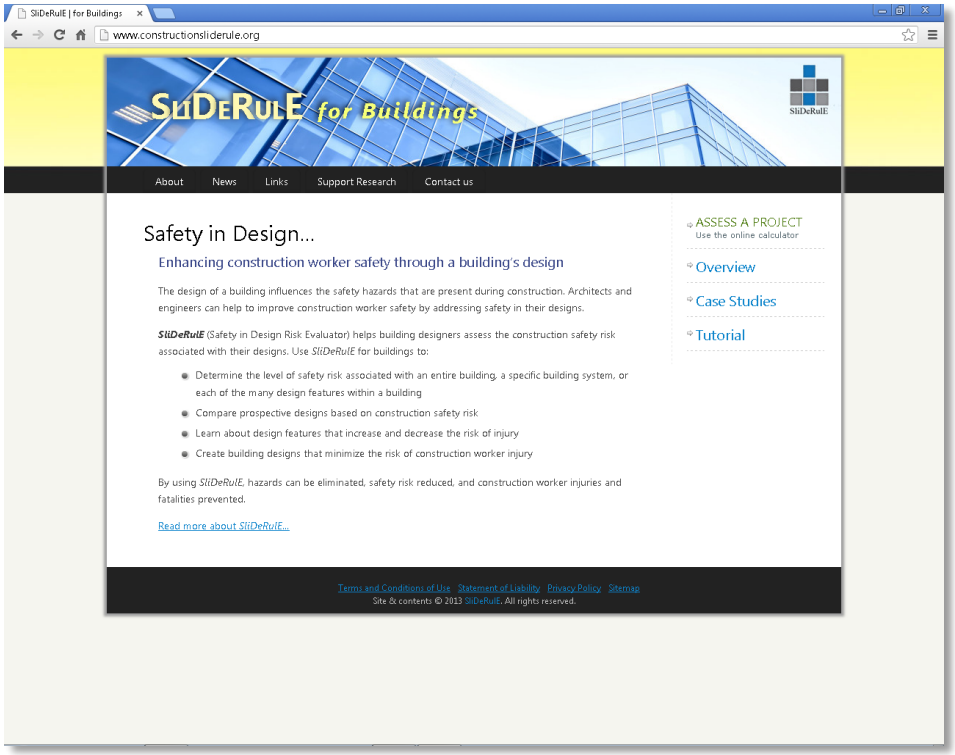
Courtesy of BHP Billiton

Design Risk Assessment

Which is safer to build? How much safer?

Steel-framed building

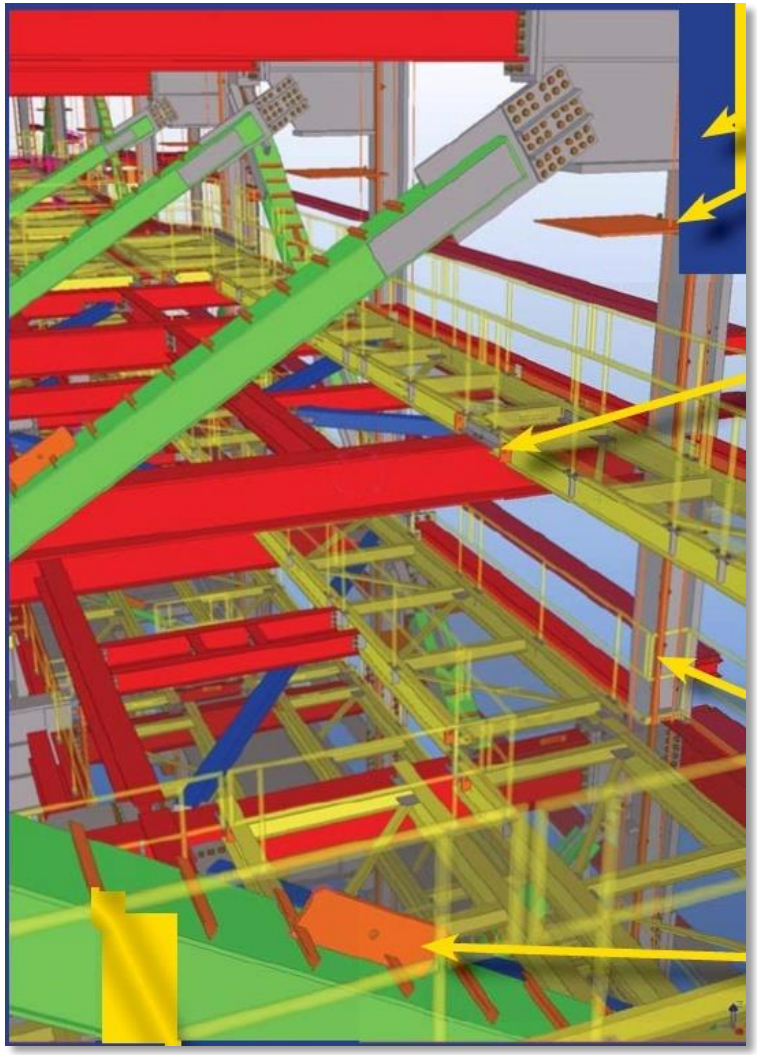
Concrete-framed building



www.constructionsliderule.org

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



Graphic courtesy of Bechtel Corp.

Example: Steel Design

Temporary ladder, platform, and safety line

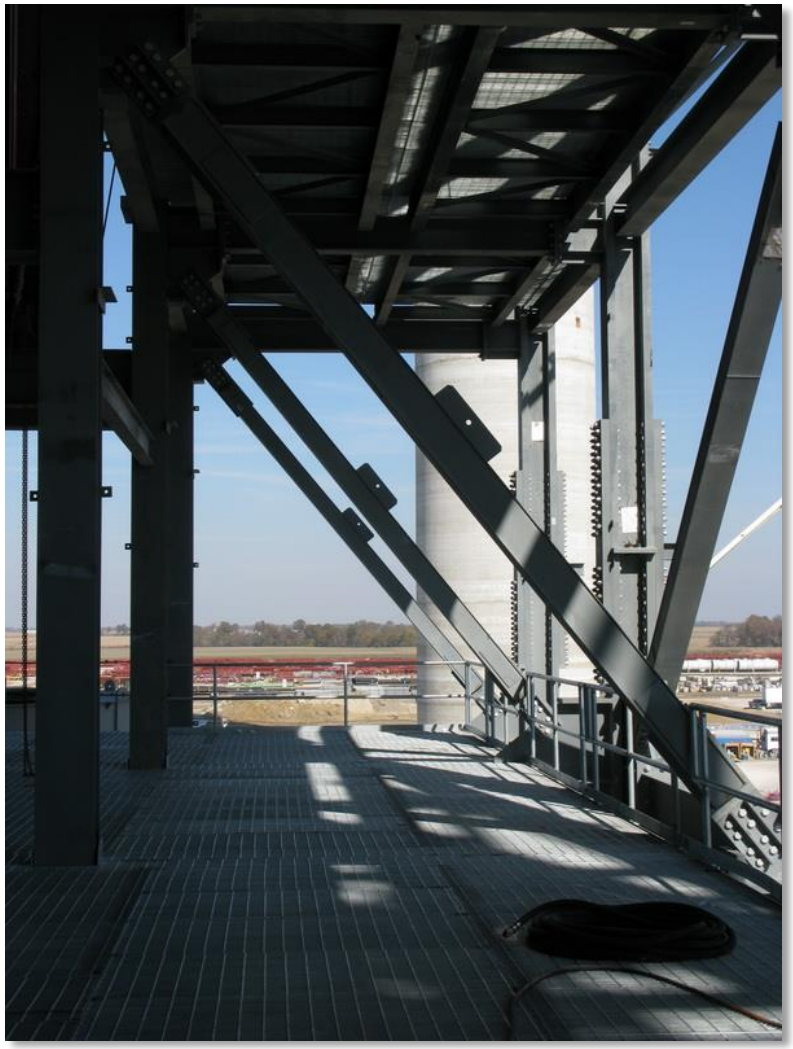
Photos courtesy of Bechtel Corp.

Example: Steel Design

Modular platforms

Photos courtesy of Bechtel Corp.

Example: Steel Design



Brace lifting clips and rungs

Photos courtesy of Bechtel Corp.

Example: Anchorage Points

Roof anchors

Panel and guardrail anchor points

Example: Roofs and Perimeters

Skylights

Upper story windows

Parapet walls

Example: Walking Surfaces

- Walkable ceiling space for worker access above clean room

Example: Prefabrication

Steel stairs

Concrete wall panels

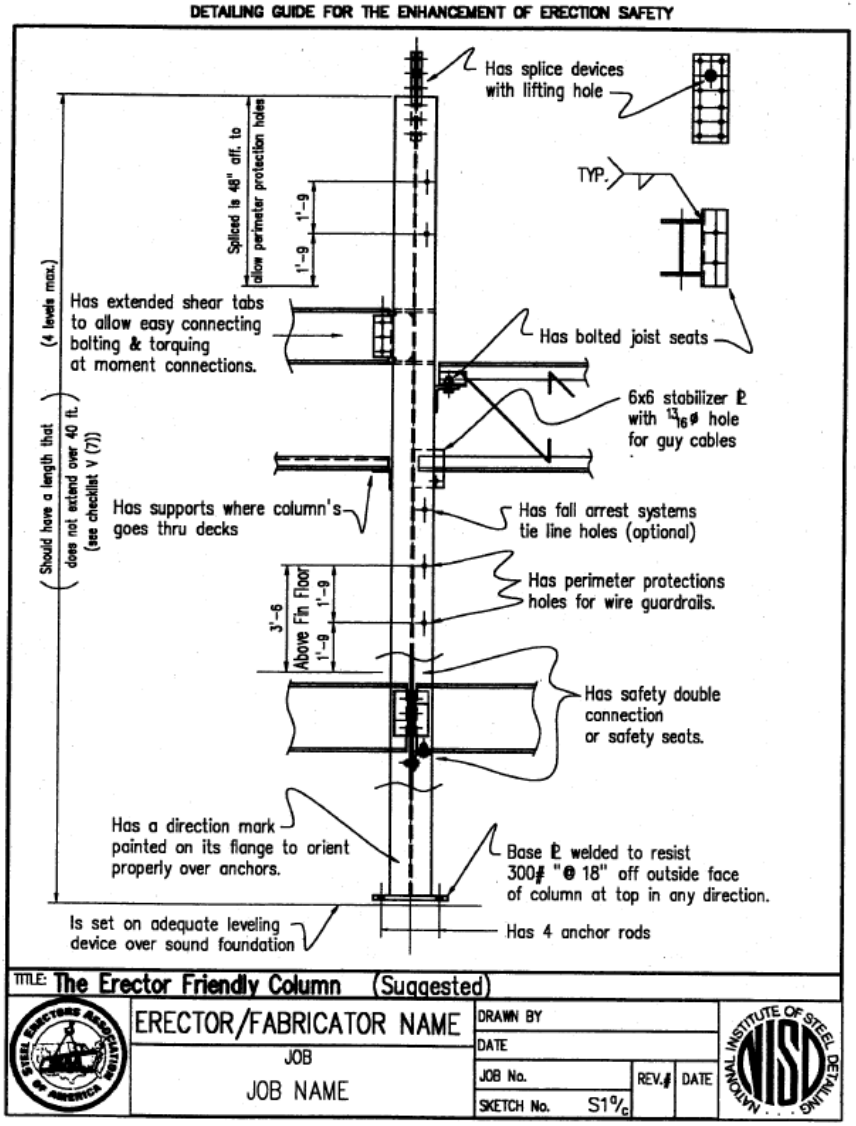
Concrete segmented bridge

Example: Modularization

- Modular service risers

Example: The Erector Friendly Column

- National Institute of Steel Detailers (NISD) and Steel Erectors Association of America



Example: The Erector Friendly Column

- Holes in columns at 21” and 42” for guardrail cables
- Column splices and connections at reasonable heights above floor
- Seats for beam connections

Example: Equipment Design

Grinding without engineering controls

Grinding using a vacuum dust collector

OSHA®

Example: Equipment Design

Jackhammer use without engineering controls

Jackhammer use with water spray to control dust

OSHA

Example: Equipment Design

Cutting concrete block without engineering controls

Cutting concrete block with water applied to the saw blade

OSHA®

Example: Coatings

- Non-isocyanate
- Low volatile organic compounds (VOC)

Example: Poka-yoke (mistake-proofing)

Example: Buffers

Example: Reliability

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- Questions? Comments?
- For more information:
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