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Occupational Health and Safety in the Design and Construction of Projects

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**AIHA Yuma Pacific Southwest
Section**

43rd Annual Meeting

San Diego, CA

January 17-19, 2018



**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



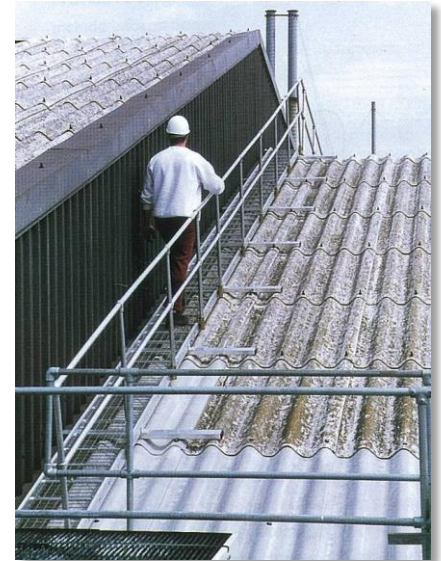
A Focus on Ethics

- 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.....**”



Supporting Research

- **22%** of 226 injuries that occurred from 2000-2002 in Oregon, WA, and CA related to design¹
- **42%** of 224 fatalities in US between 1990-2003 related to design¹
- **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

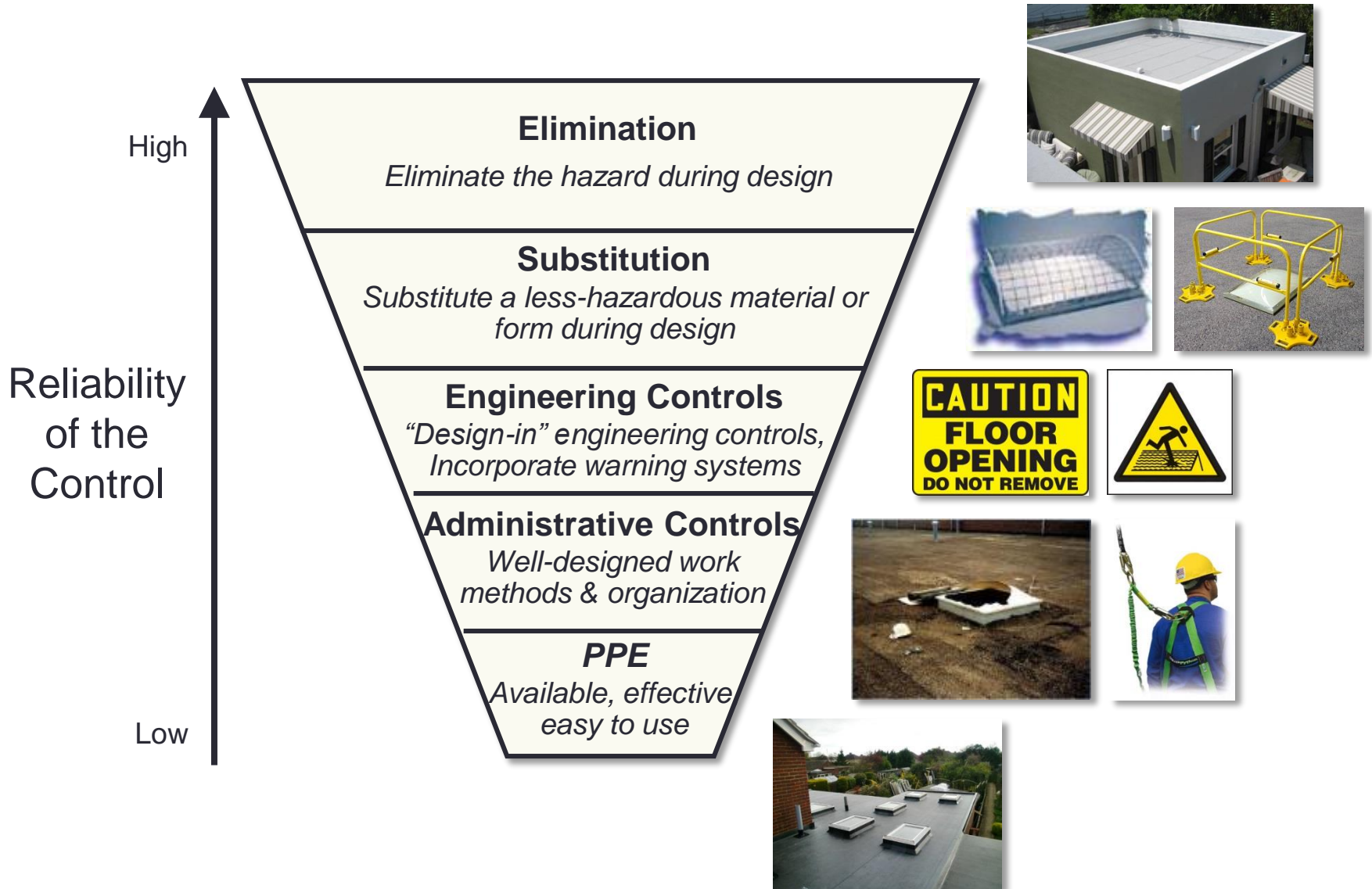


¹ Behm, M., "Linking Construction Fatalities to the Design for Constr. Safety Concept" (2005)


² European Foundation for the Improvement of Living and Working Conditions

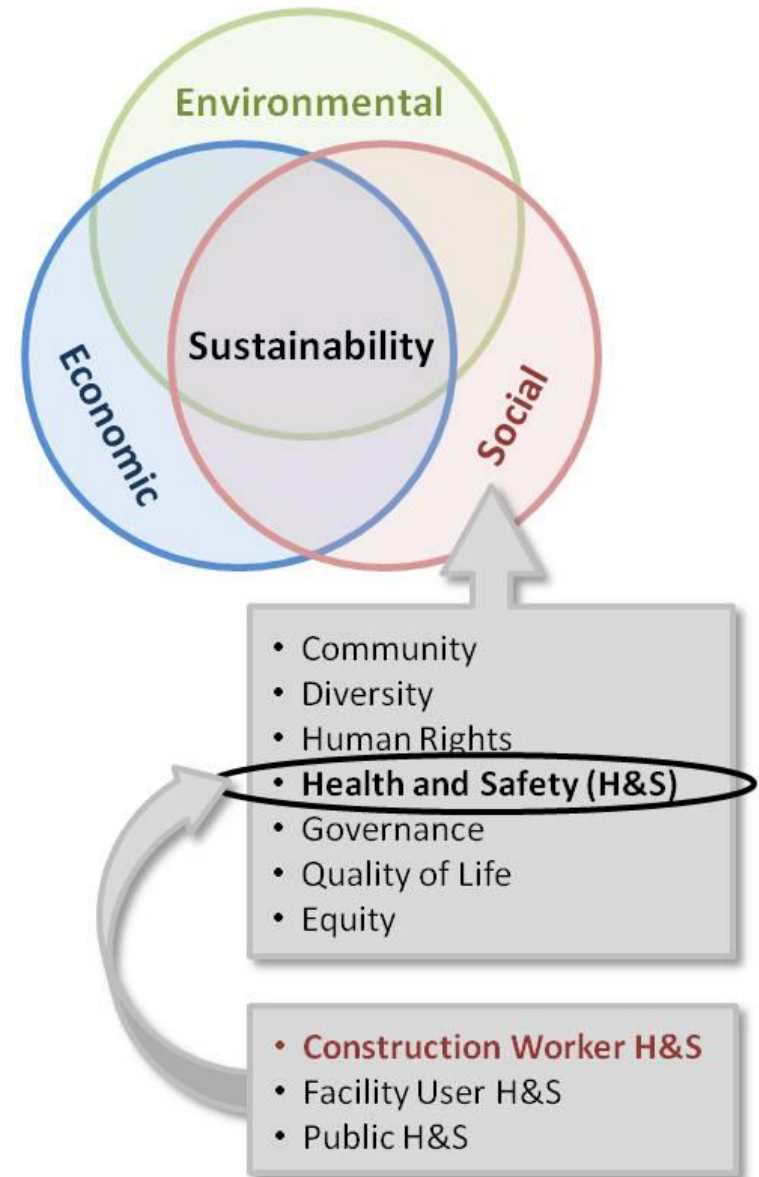
³ NSW WorkCover, *CHAIR Safety in Design Tool*, 2001

Hierarchy of Controls



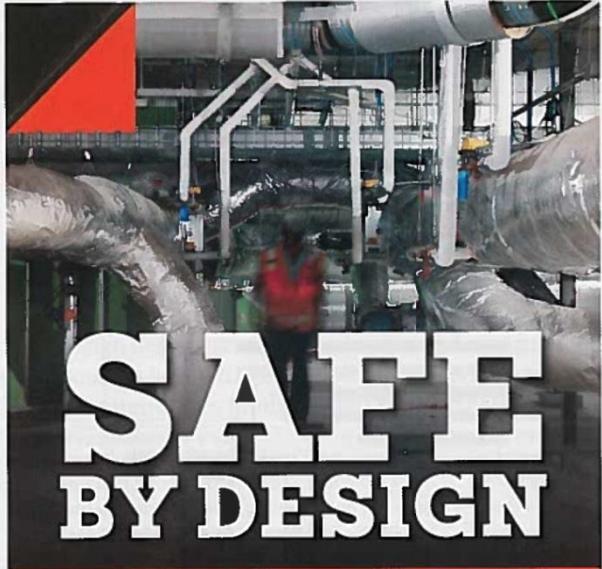
Sustainable Development

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



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



SAFE BY DESIGN

AT SOUTHLAND, WE BELIEVE IN
PREVENTION THROUGH DESIGN.
BY INCORPORATING SPECIFIC SAFETY GUIDELINES DURING THE DESIGN PHASE, WE HAVE PIONEERED AN APPROACH TO SAFETY THAT BEGINS THE SECOND OUR DESIGN ENGINEERS PUT PENCIL TO PAPER.


Focusing on safety, we take a holistic approach to your building systems design to lessen the chance of accidents during installation and increase ease of maintenance for the life of your building.

As one of the nation's largest building systems experts, Southland Industries provides innovative, practical results for your engineering, construction, service, and energy needs.

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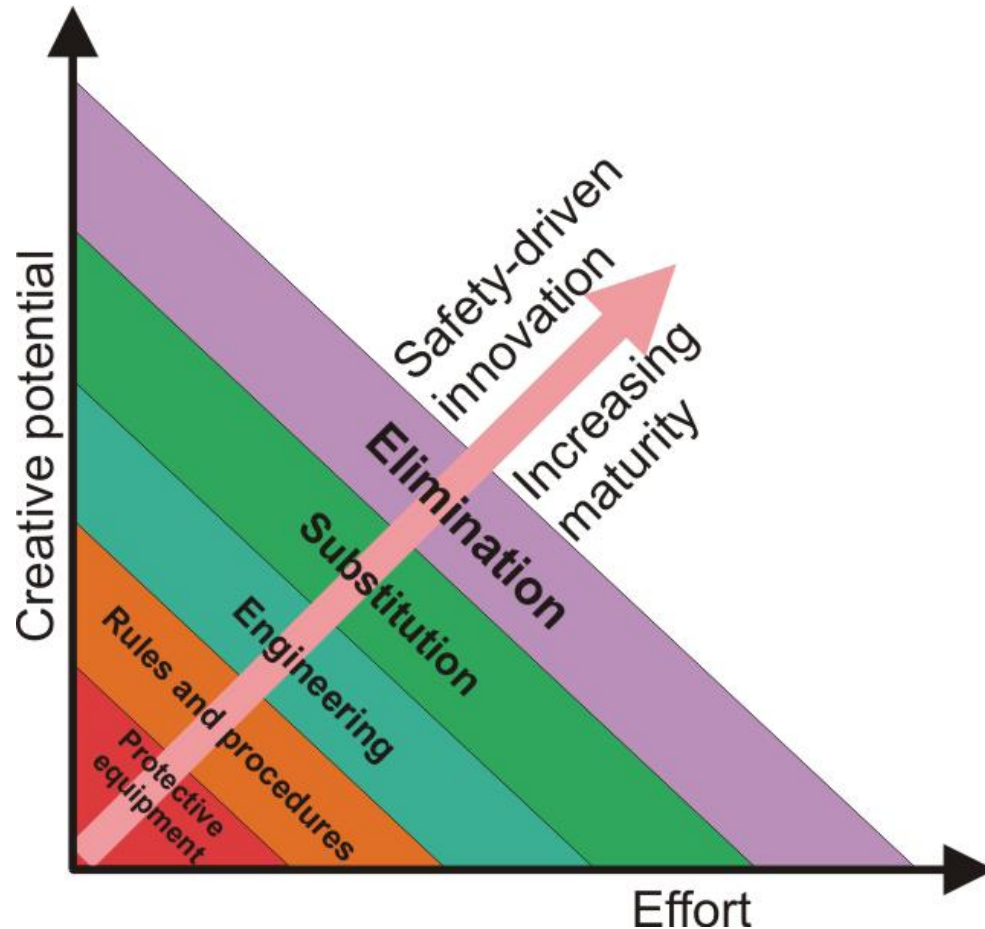
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A Driver of Innovation



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

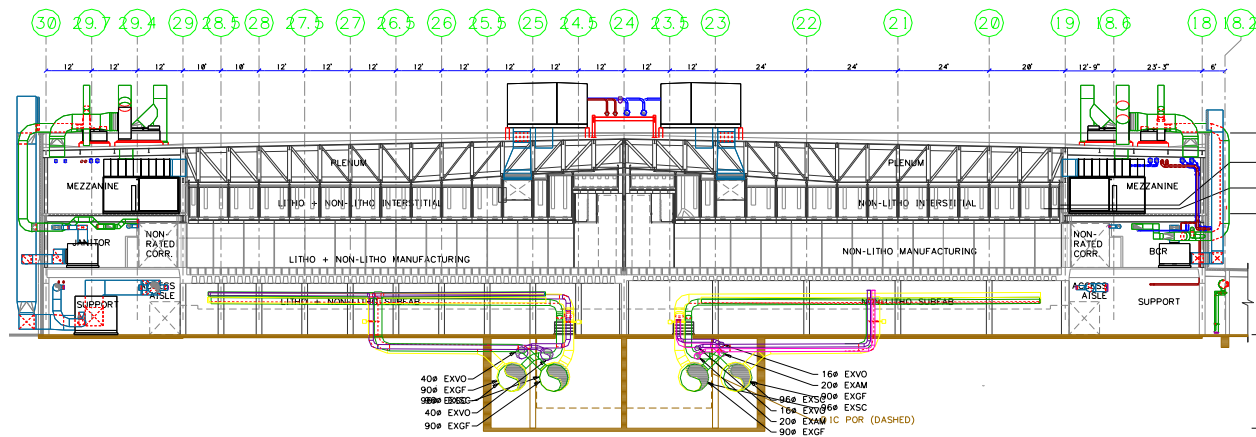
Survey of design and construction professionals in the UK:

- 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%

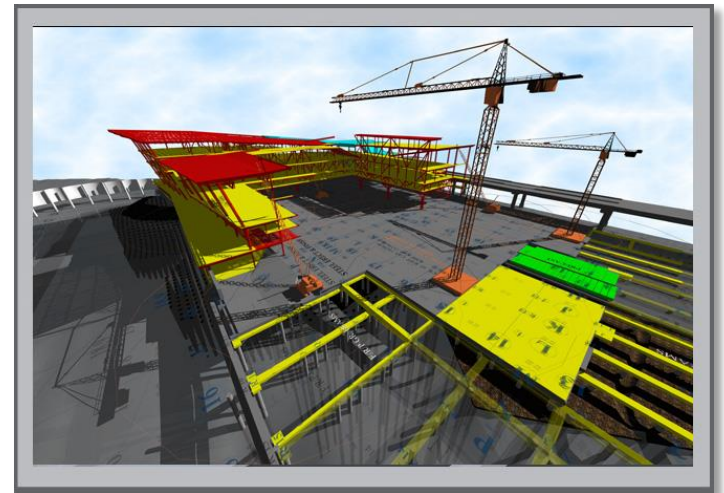
Inhibitors of PtD Implementation

- 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



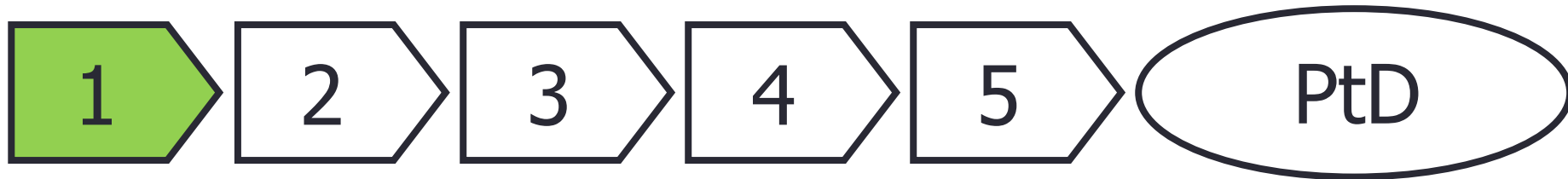
Steps to Implementing PtD in Practice



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**

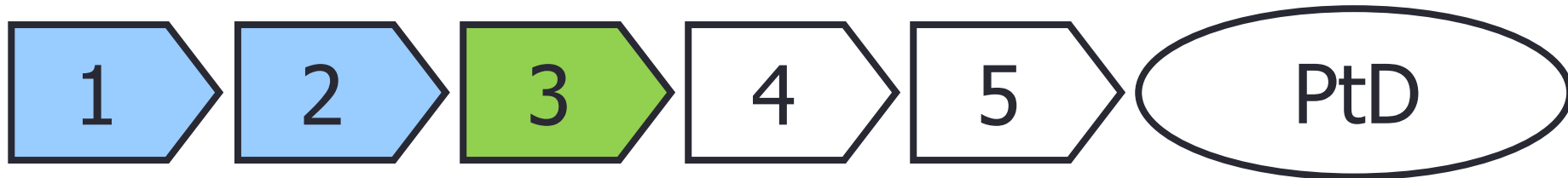
- OHS in architecture/engineering education
- Professional continuing education classes
- OHS in professional licensure requirements
- Visualization and work flow tools

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

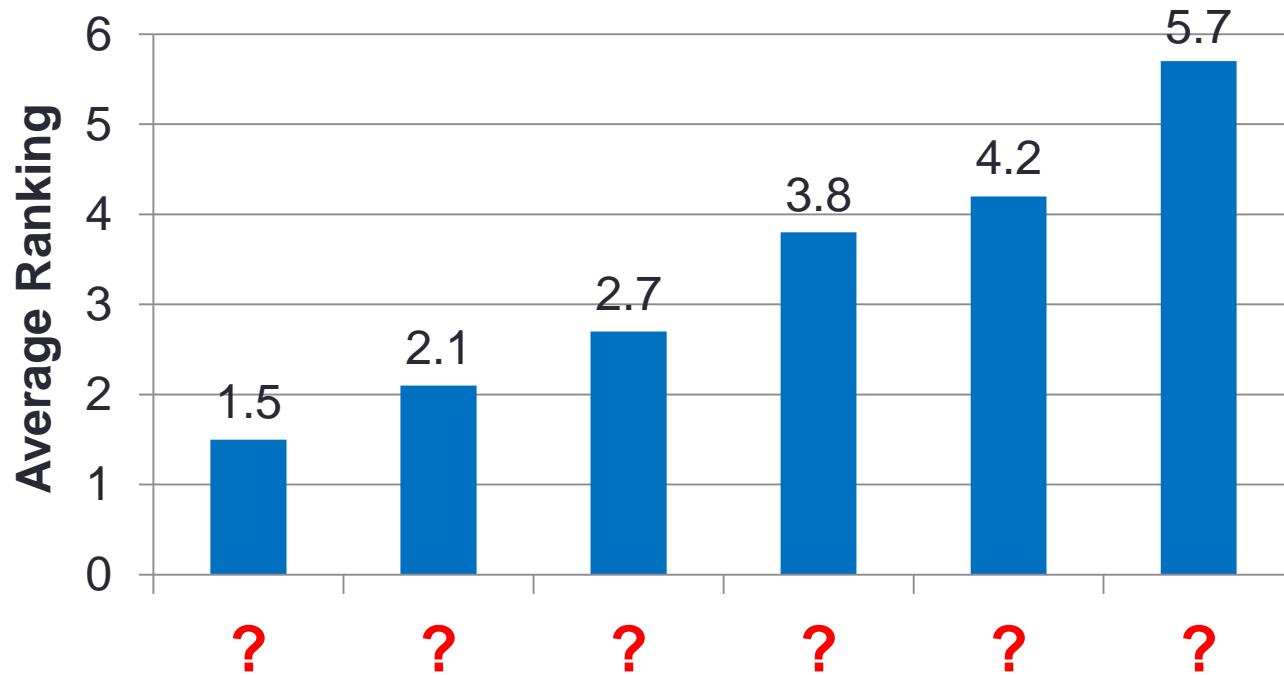
C. Cost

E. Aesthetics

B. End-user safety

D. Schedule

F. Construction Safety



Source: Gambatese, J., Behm, M., and Hinze, J. (2005). "Viability of Designing for Construction Worker Safety." *Journal of Construction Engineering and Management*, ASCE, 131(9), 1029-1036.

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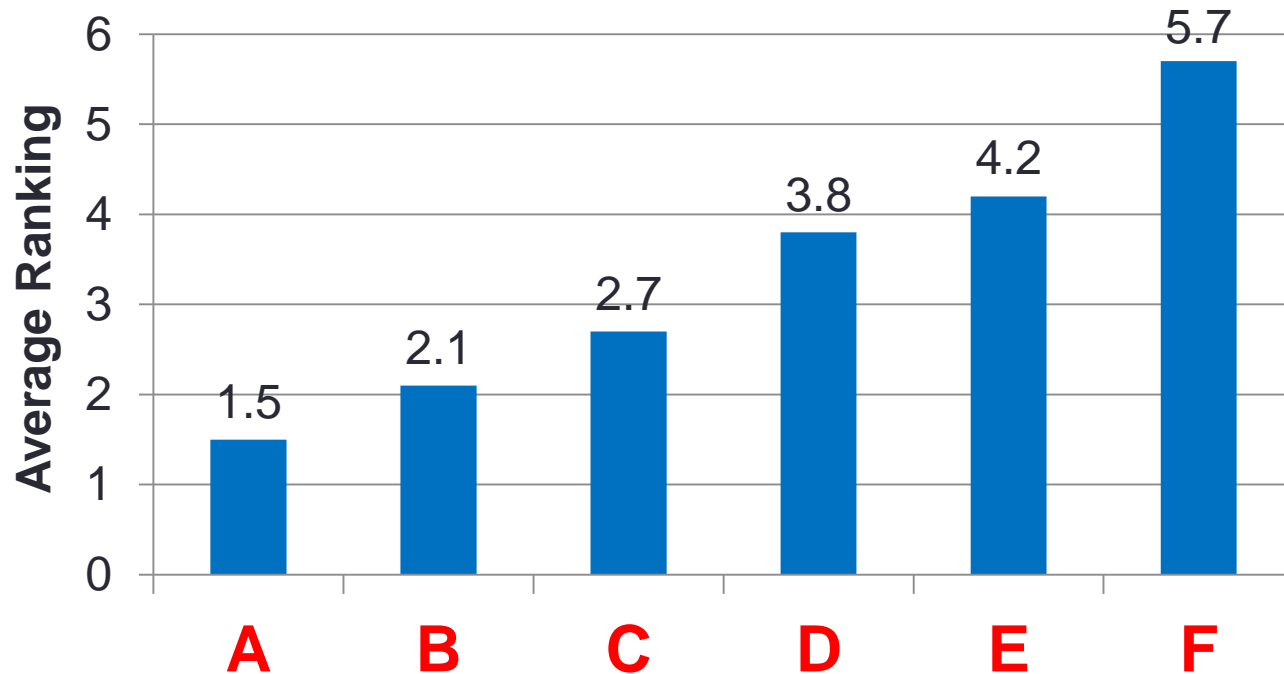
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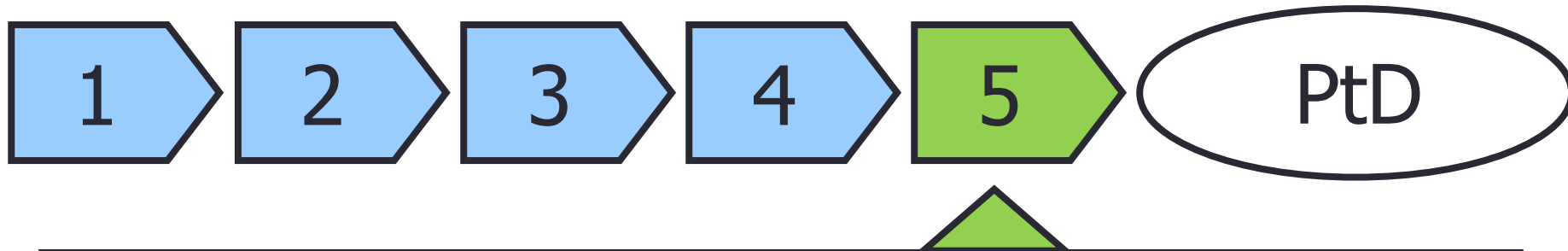
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F. Construction Safety



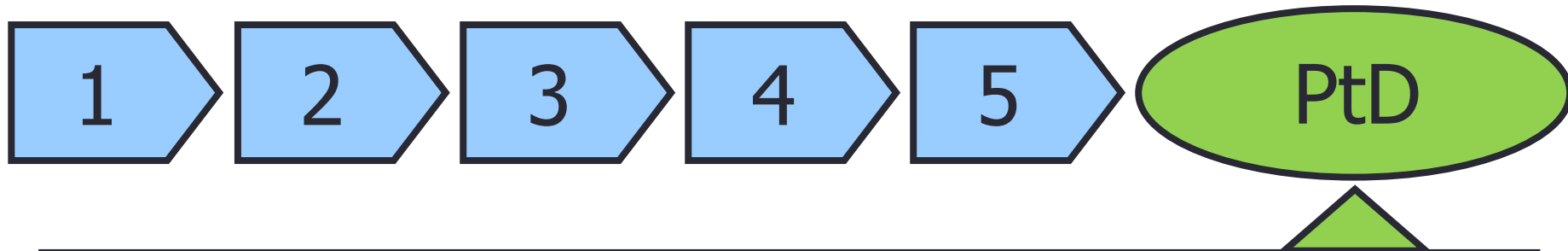
Source: Gambatese, J., Behm, M., and Hinze, J. (2005). "Viability of Designing for Construction Worker Safety." *Journal of Construction Engineering and Management*, ASCE, 131(9), 1029-1036.

Steps to Implementing PtD in Practice



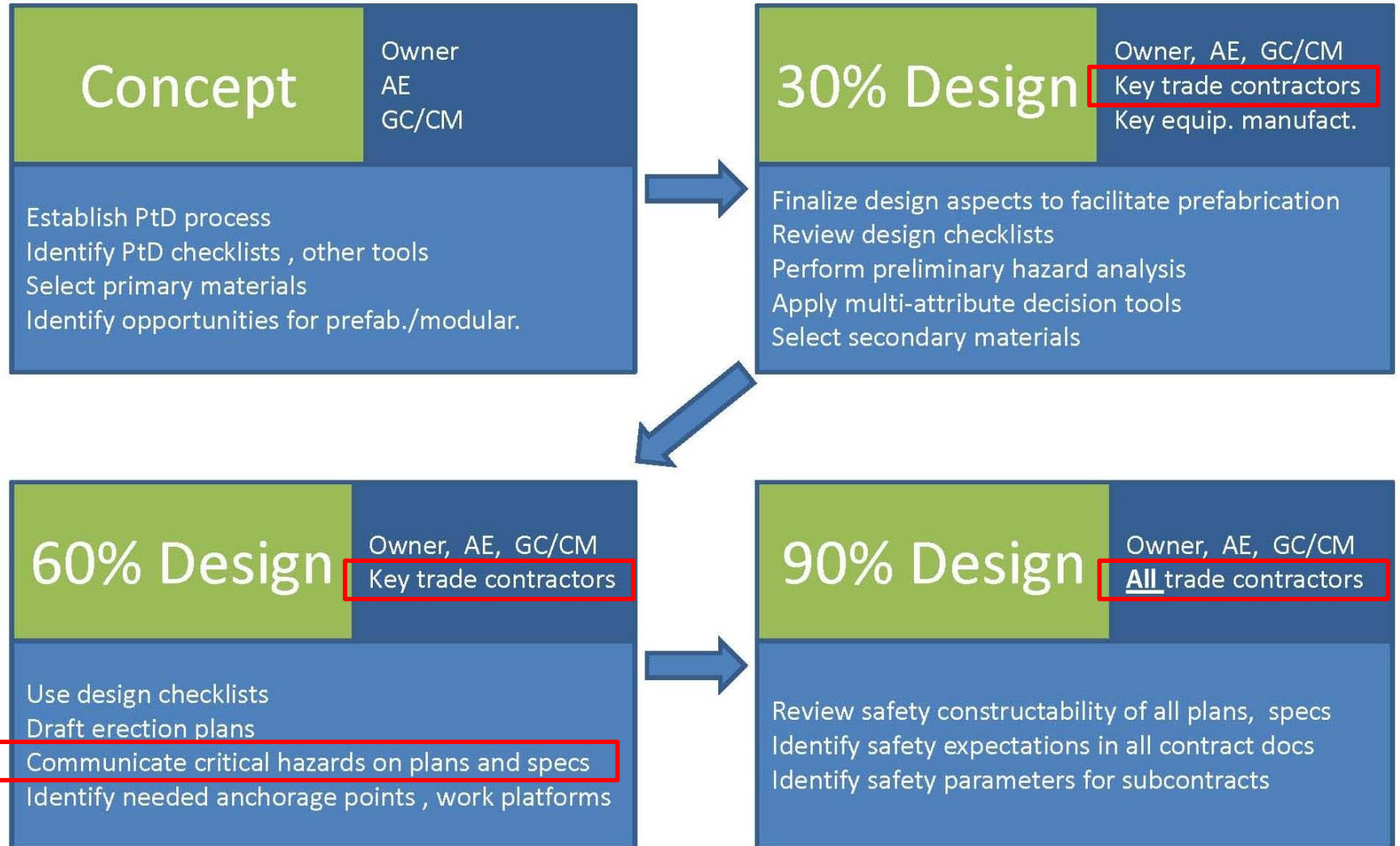
- **Designing for OHS has value**
 - Lifecycle savings outweigh costs, and economically feasible for designers
 - Improvements in OHS, quality, productivity
 - Morally and ethically responsible
 - Desired by owners/clients (priority)

Steps to Implementing PtD in Practice



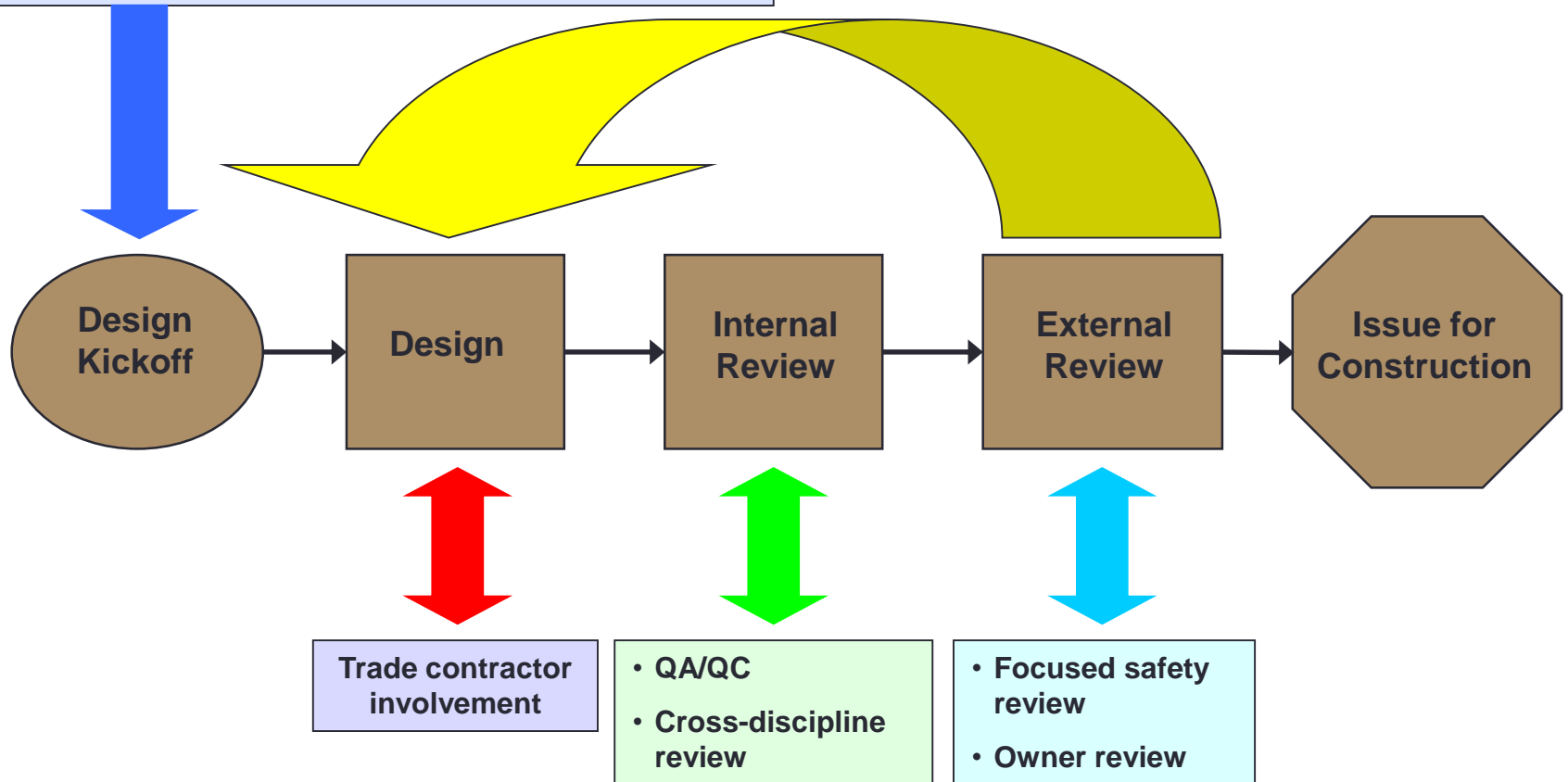
- **Designed for construction safety and health**
 - Construction site hazards eliminated/reduced
 - Improvements in OHS, quality, productivity
 - Improvements in maintenance H&S
 - Design and construction integration and collaboration

Planning and Design Process



Design Development

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



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

FORWOOD SAFETY
Leadership Inspiration Knowledge Safety Excellence

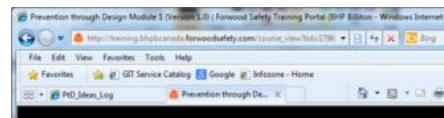
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List of Courses

Michael, to launch a course or assessment click on the name in the first column. The will launch the applicable course or assessment and automatically track your progress and results.

Projects | HSE in Design Modules

Name of Course	Status	Activity (no. of repeats)	Date Last Completed	Score (Out of 100)	Duration
HSE in Design Module 1 (Revision 1.0)	Complete	1	06-25-21/02/2011	4/5	19 mins 24 secs
HSE in Design Module 2 (Revision 1.0)	Complete	1	06-25-21/02/2011	0/5	1 hour 15 mins
HSE in Design Module 3: Engineering Assessment Introduction (Revision 1.0)	Complete	1	08-12-21/02/2011		7 mins 10 secs
HSE in Design Module 3 - Discipline 2 (Civil) (Revision 1.0)	Incomplete		08-20-21/02/2011		
HSE in Design Module 3 - Discipline 2 (Mechanical) (Revision 1.0)	Not Attempted				
HSE in Design Module 3 - Discipline 4 (Electrical) (Revision 1.0)	Not Attempted				
HSE in Design Module 3 - Discipline 5 (Structural/Architectural) (Revision 1.0)	Not Attempted				
HSE in Design Module 3 - Discipline 6 (Structural) (Revision 1.0)	Incomplete		08-21-21/02/2011		
HSE in Design Module 3 - Discipline 7 (Piping) (Revision 1.0)	Not Attempted				



Prevention through Design

Prevention through Design (PtD) is the process of identifying hazards and designing in controls to mitigate risks associated with these hazards. PtD aims at preventing a serious event from occurring throughout the lifecycle of the design, or mitigating the consequences if a serious event were to occur. PtD uses the Hierarchy of Controls as the basis for the types of controls required to manage risk, with the emphasis on ELIMINATE, SUBSTITUTE and REDESIGN.

What are the tools?

- Design & Simulation
- Checklists & Templates
- Checklists & Templates
- Checklists & Templates
- Checklists & Templates

What are the benefits?

- Eliminate
- Substitute
- Reduce
- Relocate
- Personal Protective Equipment
- Administrative
- Warning

Hierarchy of Controls

1. Eliminate: The most effective control measure is to eliminate the hazard or the activity that creates the hazard.
2. Substitute: Replace the material or the process with a less hazardous alternative.
3. Reduce: Design the equipment in such a way as to reduce the risk of injury or illness.
4. Relocate: Relocate the equipment to a safer location.
5. Administrative: Provide controls such as procedures, training, signage, etc.
6. PPE: Use respiratory and safety harnesses, fall protection, etc. when other controls are insufficient.

For additional information regarding the PtD program and PtD guidelines, please contact: PtD@bhpbilliton.com

POTASH CANADA'S PREVENTION THROUGH DESIGN LEARNING PROGRAMME

Module 1: Understanding HSE in Design

Course Introduction | Module 1 Overview | Learning Objectives

Powered by Forwood Safety



Courtesy of BHP Billiton

Design Risk Assessment

Which is safer to build? How much safer?



Steel-framed building



Concrete-framed building

SiDeRule | for Buildings

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SiDeRule for Buildings

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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.

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

[Read more about SiDeRule.](#)

ASSESS A PROJECT
Use the online calculator

- Overview
- Case Studies
- Tutorial

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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

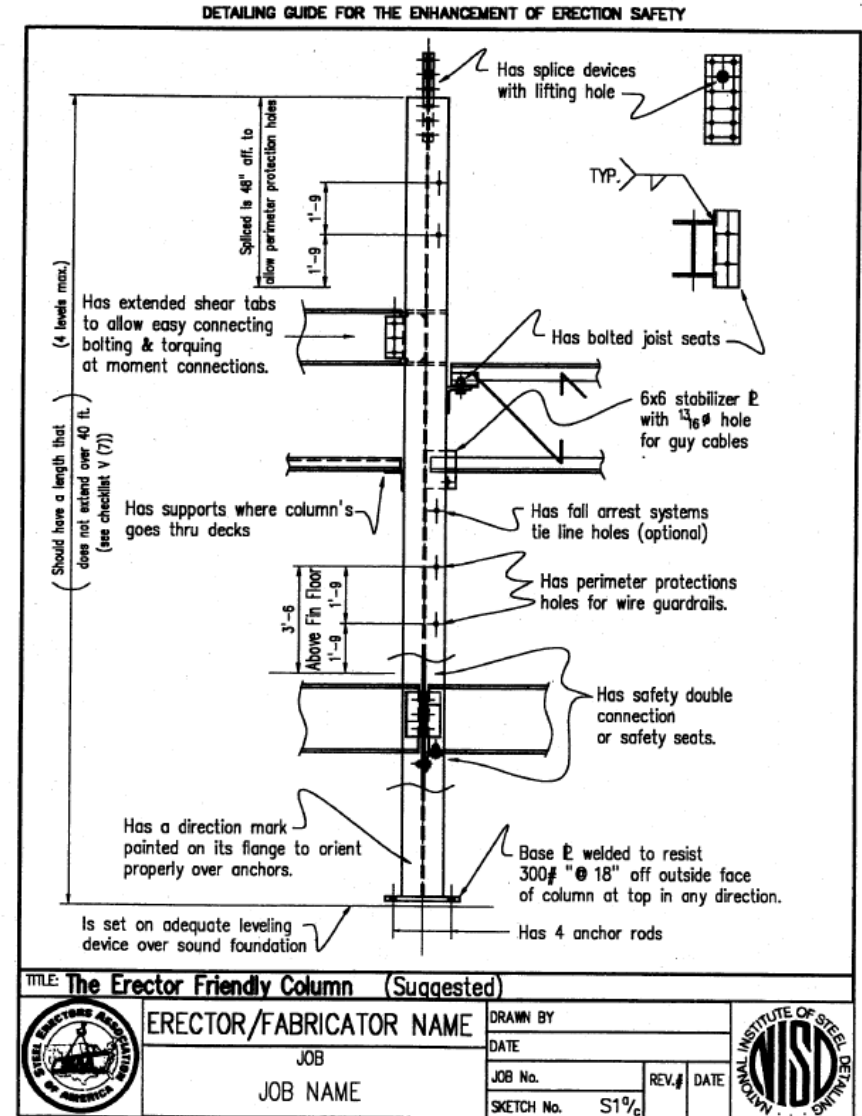
Example: Modularization

- 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

Example: Equipment Design

Jackhammer use without engineering controls



Jackhammer use with water spray to control dust

Example: Equipment Design

Cutting concrete block without engineering controls



Cutting concrete block with water applied to the saw blade

Example: Coatings

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



Example: Poka-yoke (mistake-proofing)



Example: Buffers



Example: Reliability



Occupational Health and Safety in the Design and Construction of Projects

- Questions? Comments?
- For more information:
john.gambatese@oregonstate.edu

