SAFETY BY DESIGN:

A Path to Sustainable Leadership

WorkSafeBC Symposium

The Human Factors: Safety by Design

May 22, 2014

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Professor, Civil and Env. Engineering, Bucknell University

Some slides based on past presentations with

John Gambatese, PhD, PE

Professor, Civil and Construction Engineering, Oregon State University

DOWNLOAD 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 WorkSafeBC Safety by Design Symposium on May 22, 2014. (9 megabytes so be patient)

Presentation by Mike Toole at the COAA Spring Leadership Conference on May 16, 2014. (9 megabytes so be patient)

"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 DfCS on their projects (revised Jan. 2014).

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

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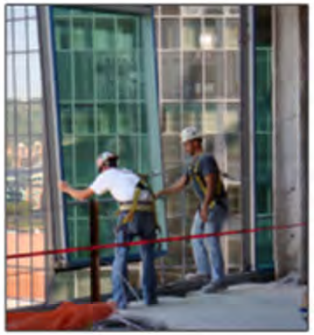


alliance
An OSHA Cooperative Program

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

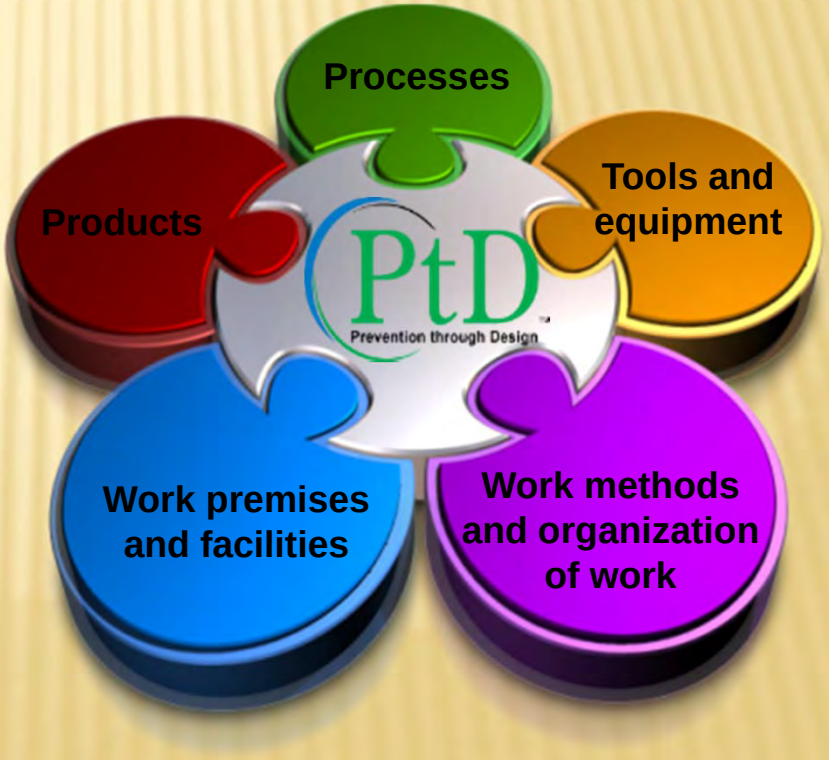
- Concept
- Motivation
- Examples
- Leaders
- Tools and Processes
- Moving forward in your organization

Safety by Design

= Prevention through Design

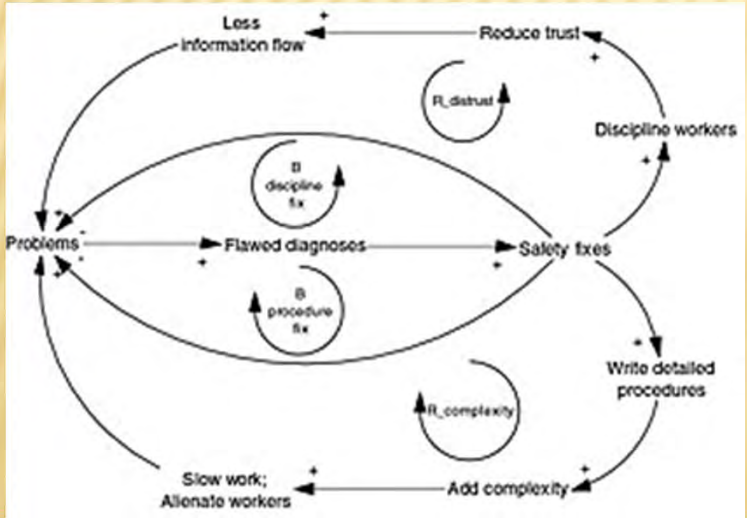
= Design for Safety

= Engineering for Safety



IMPORTANT MANAGEMENT CONCEPTS UNDERLYING SBD

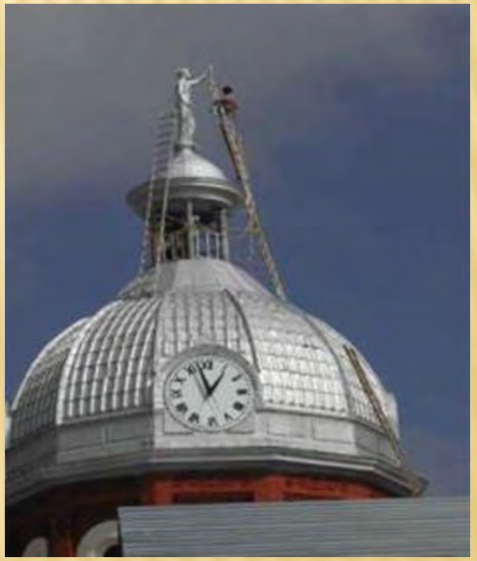
- Sustainability
- Collaboration
- Managing Change
- Systems Thinking



PREVENTION THROUGH DESIGN (PTD)

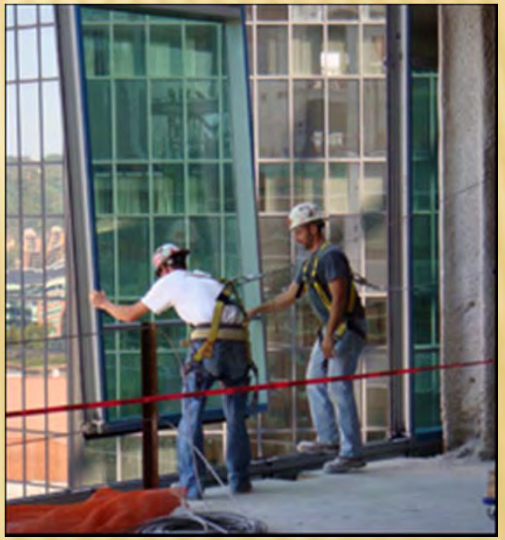
"Addressing occupational safety and health needs in the design process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of facilities, materials, and equipment."

(http://www.cdc.gov/niosh/topics/ptd/)



SBD 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.



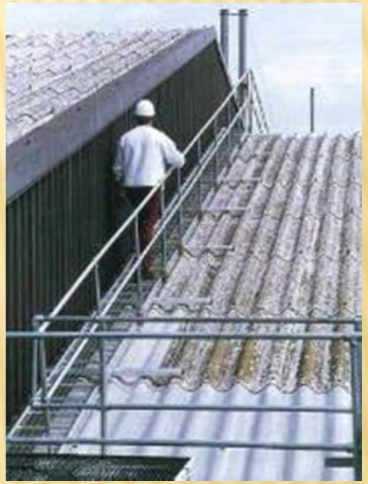
"Safety Constructability"

WHY SBD? ANNUAL CONSTRUCTION ACCIDENTS

- In USA, nearly 200,000 serious injuries and 1,000 deaths
- In BC, nearly 2,800 serious injuries and 31 deaths

WHY SBD? 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]

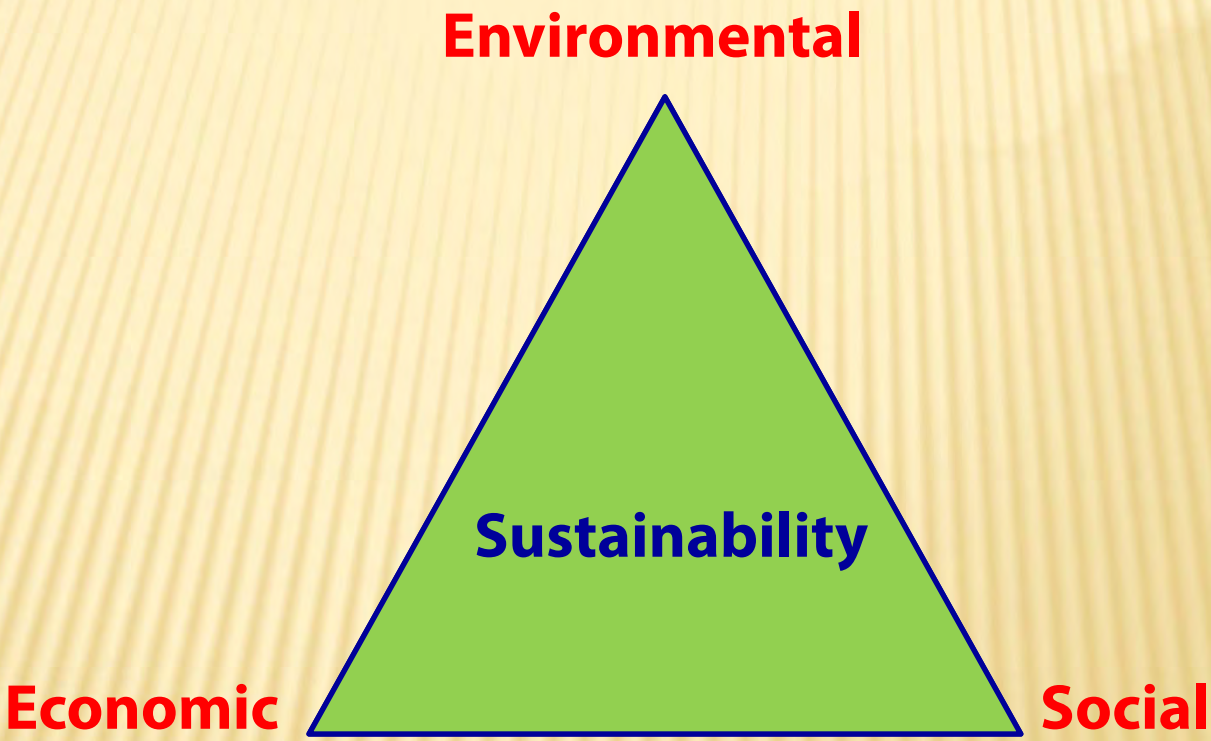


[1] Behm, M., "Linking Construction Fatalities to the Design for Construction Safety Concept" (2005)
[2] European Foundation for the Improvement of Living and Working Conditions
[3] NSW WorkCover, *CHAIR Safety in Design Tool*, 2001

WHY SBD? PROFESSIONAL ETHICS

- Code of Ethics for the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC):
  - "hold paramount the safety, health and welfare of the public, the protection of the environment and promote health and safety within the workplace"
- Engineers Canada Guideline on the Code of Ethics:
  - "engineers must ensure that works they are involved with conform with accepted engineering practice, standards, and applicable codes, and would be considered "safe" based on peer adjudication."

WHY SBD? 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

United Nations

Report of the World Commission on Environment and Development: Our Common Future

Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment

Table of Contents

Acronyms and Note on Terminology

Chairman's Foreword

From One Earth to One World

Part I. Common Concerns

1. A Threatened Future
   - I. Symptoms and Causes
   - II. New Approaches to Environment and Development
2. Towards Sustainable Development
   - I. The Concept of Sustainable Development
   - II. Equity and the Common Interest
   - III. Strategic Imperatives
   - IV. Conclusion

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

SBD 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

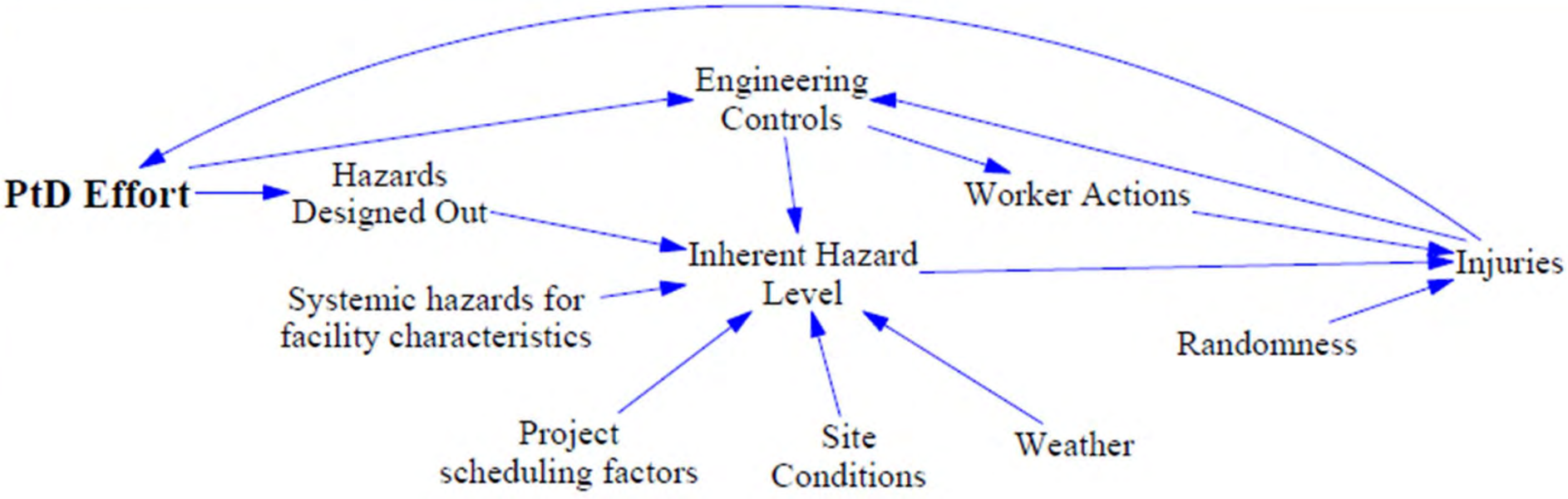
- The Right thing to do and…
- The Smart thing to do

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.

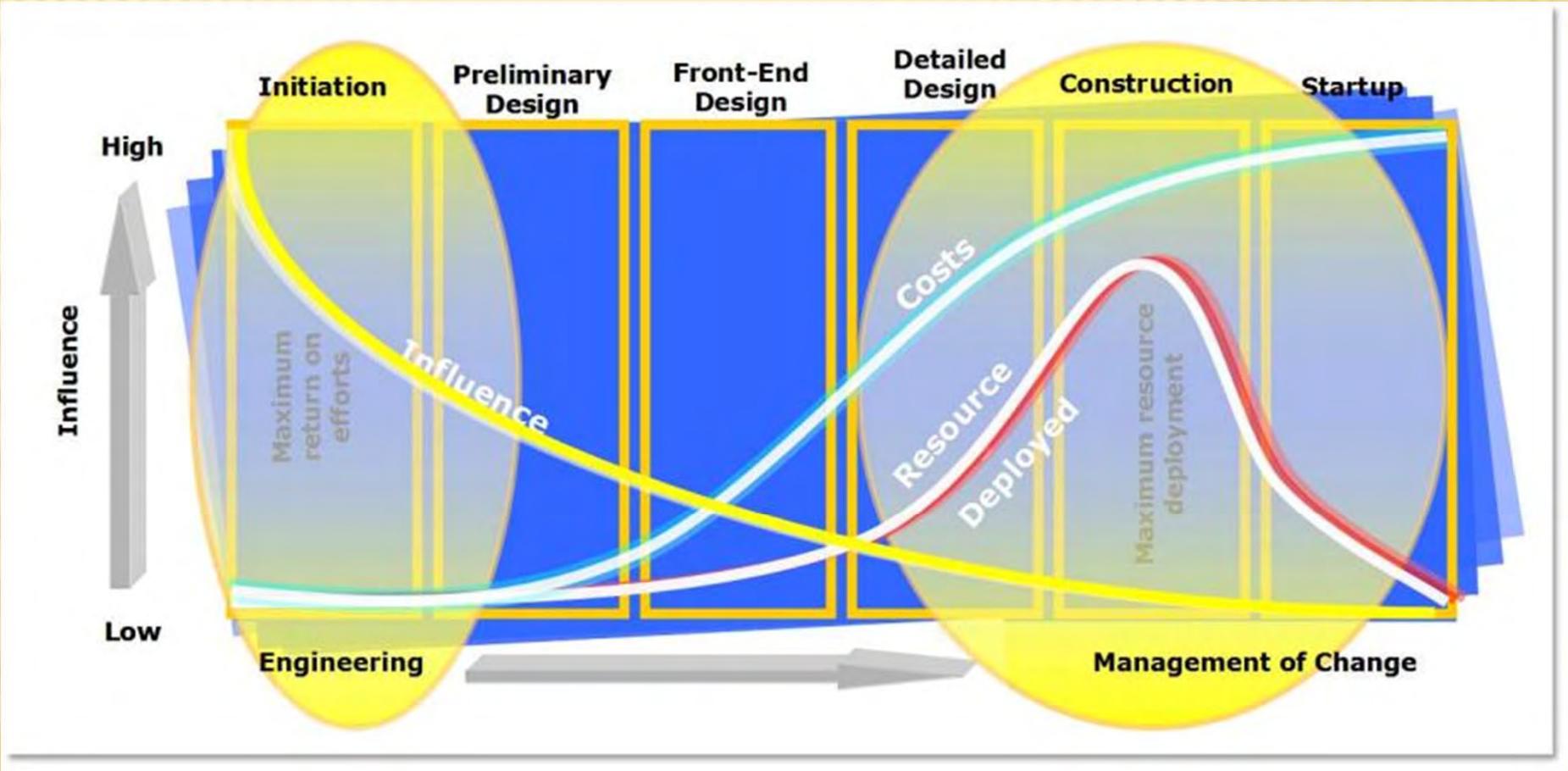
SUSTAINABLE PRINCIPLE: SYSTEMS THINKING

- 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.



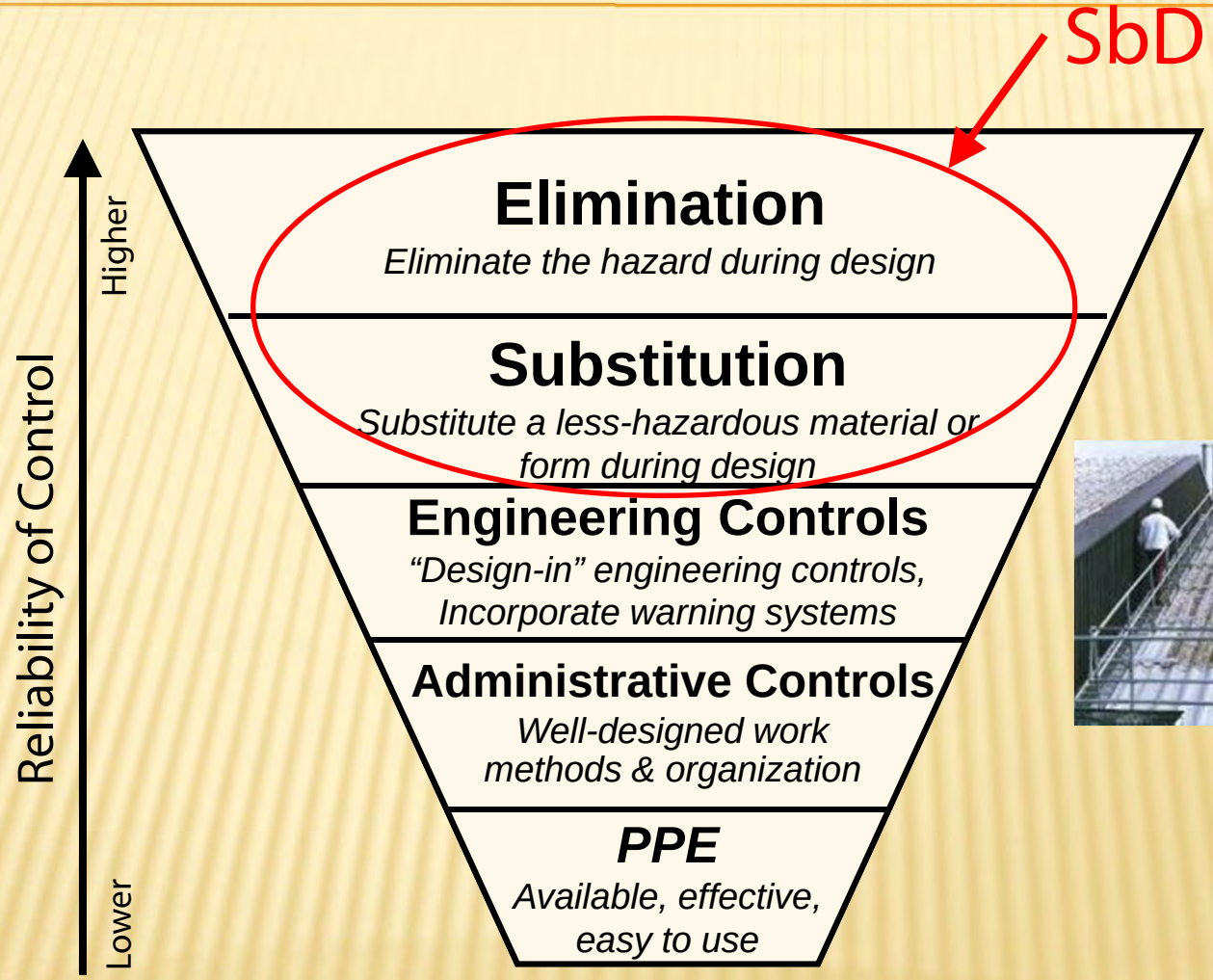
WHY SBD? BANG FOR THE BUCK

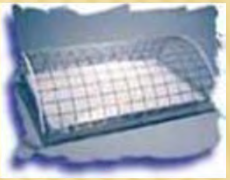
- Ability to influence safety is greatest early in the project schedule during planning and design (Szymberski, 1997)



(Graphic courtesy of the Bechtel Corp.)

HIERARCHY OF CONTROLS





WHY SBD? TANGIBLE BENEFITS

- Reduced workplace hazards
  - Fewer construction worker injuries
  - Fewer operator injuries
  - Fewer maintenance worker injuries
- Reduced workers' compensation premiums
- Increased productivity and quality
- Fewer delays and shutdowns due to accidents and near-misses
- Encourages **collaboration between** designers, manufactures/constructors, operators, and maintainers

OVERVIEW

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

PRESENTATIONS AT 2011 NIOSH CONF.

- *Quiet-by-Design*
- *Facility Designs to Reduce Risks from Hazardous Gases*
- *Prevention of Slips, Trips and Falls Through Facility Design*
- *Incorporating Safety and Ergonomics in the Toyota Manufacturing Design Process*
- *Safety Engineering in Asphalt Paving Equipment*
- *Spray Polyurethane Foam*
- *Ambulance Re-design to Reduce EMS Injuries*

SBD EXAMPLE: ANCHORAGE POINTS

SBD EXAMPLE: ROOFS AND PERIMETERS

Skylights

Upper story windows

Parapet walls

SBD EXAMPLE: PREFABRICATION

Steel Stairs

Concrete Wall Panels

Concrete Segmented Bridge

SBD EXAMPLE: STRUCTURAL STEEL DESIGN

Detailing Guide for the Enhancement of Erection Safety

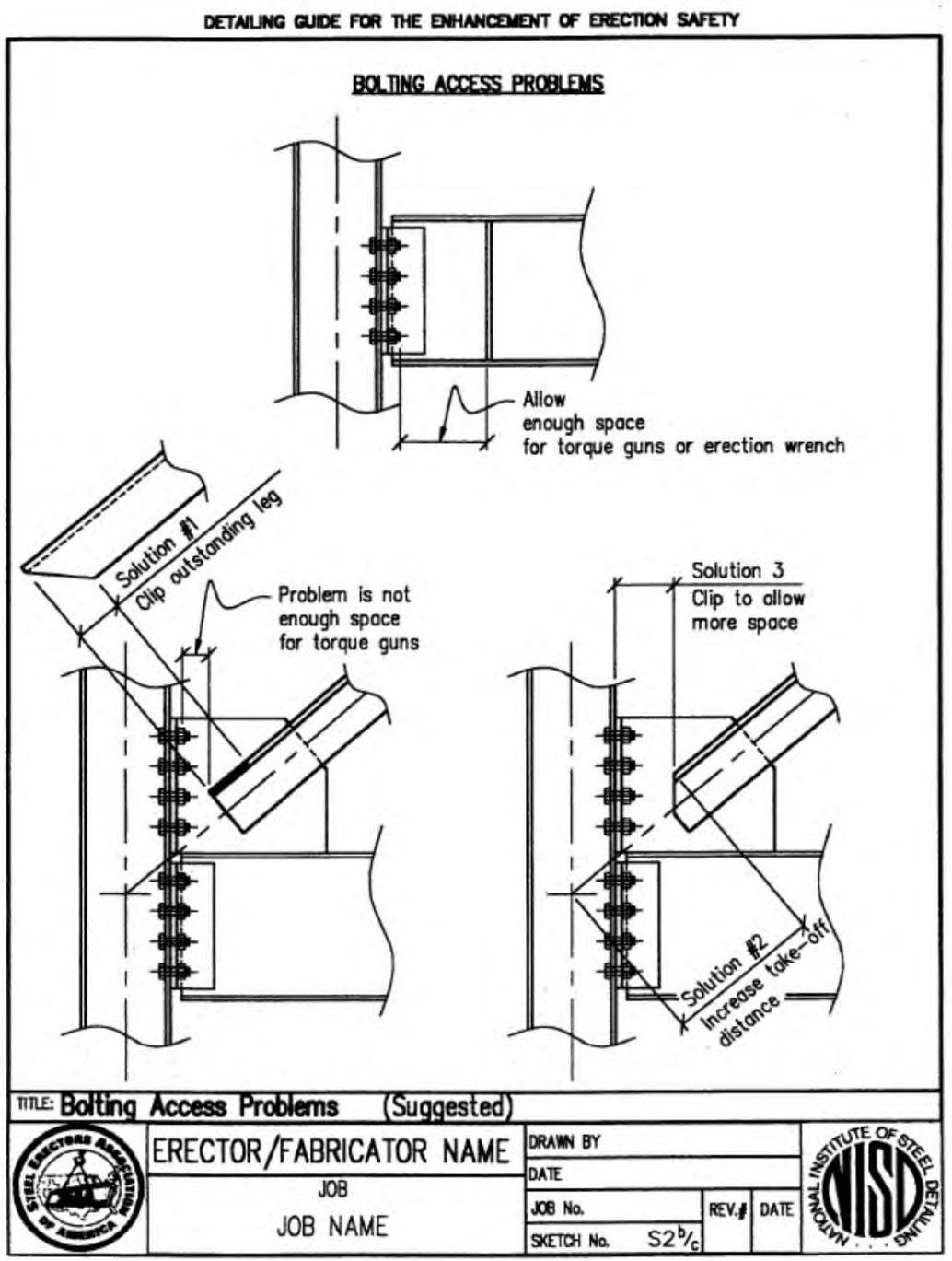
Published by the National Institute for Steel Detailing and the Steel Erectors Association of America

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

OVERVIEW

Concept

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SBD IN PRACTICE: DESIGN-BUILDERS

- URS
- WorleyParsons
- Bechtel

Photo credit: URS Corp.

URS CORP. DESIGN FOR SAFETY PROCESS

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

WorleyParsons
resources & energy

PtD Process Example
Facilitated Review Process

- Identify Participants
  - Operations/Maintenance
  - Project Management
  - Design/Engineering Leads
  - Risk Management/Safety
- Communicate and Train Design Team
  - Human Factors for All Participants
  - Relevant Project Documentation
  - Goals and Strategies for Hazard Management
- Identify Opportunities, Hazards and Assess Risks
- HAZID (Hazard Identification) Procedure
  - Develop Risk Register
  - Record Options/Directions for Risk Reduction Measures

SBD PROCESS

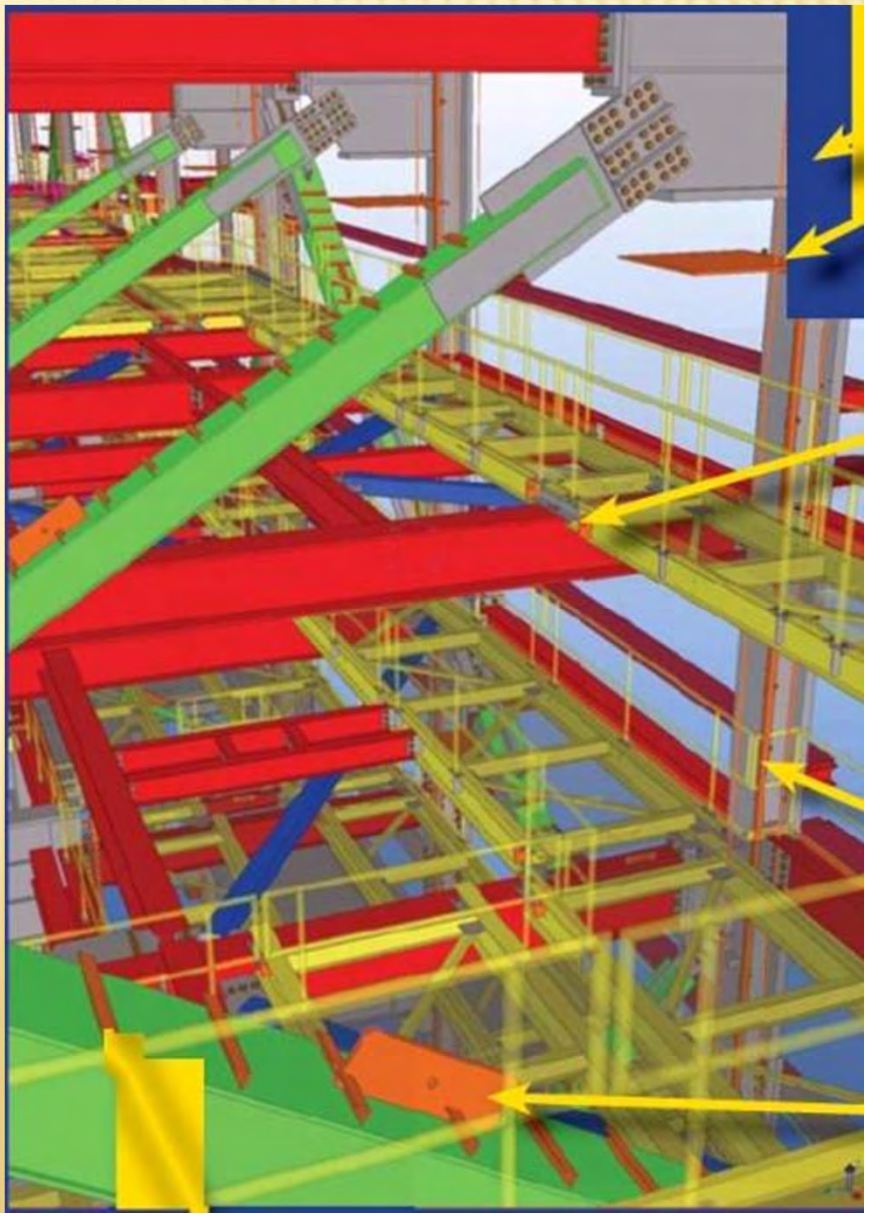
→ Get the right people talking about the right things at the right time!

www.seagrave.com/

BECHTEL'S STEEL DESIGN PROCESS

- Temporary access platforms
- Lifting lugs
- Shop installed vertical brace ladders
- Bolt-on column ladders and work platforms

- → Don't let safety items get cut out of budgets or schedules



SBD IN PRACTICE: OWNERS

- Southern Co.
- BHP Billiton

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
↓ ↓ ↓ ↓

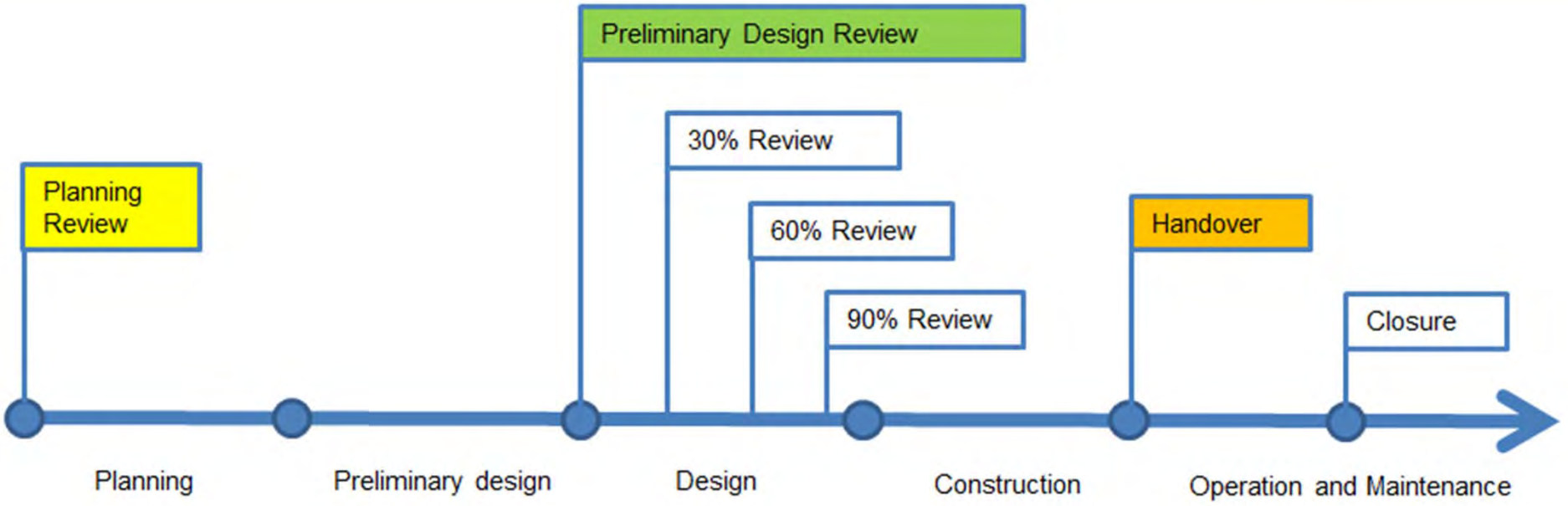
Design Lead: _____
Project No.: _____
Plant: _____
Date: _____

Double-click to add "x" to boxes. ⇩				Item No.	
	☐	☐	☐	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.)
	☐	☐	☐	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**.
	☐	☐	☐	3.	Construction people working near **fiberglass manufacturing** need to understand the **toxic air pollutants**.
	☐	☐	☐	4.	Locations are identified where guard posts, walls, or barriers should be provided to **prevent access** to potentially unsafe areas.
	☐	☐	☐	5.	**Underground hazards** and reference drawings locating any potential hazards are identified. (Examples: buried pipes, electrical cables, etc.)
	☐	☐	☐	6.	Process engineer, construction project manager, customer, and vendor representatives have identified **special loads** that should be considered in our design.
	☐	☐	☐	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.)

BHP BILLITON'S PTD INITIATIVES

- PtD staff embedded in procurement and design
- Communication and training
- PtD in technical specifications
- Design reviews includes 3D models

PTD EMBEDDED IN PROCESSES



- Vendor kick-off meetings
- PtD standard specification
- PtD online training for vendors

- Internal design reviews (PA)
- Client design reviews (PB)
- Vendor document reviews
- 3D model reviews
- Constructability reviews
- HAZID/HAZOP
- Technical integrity reviews

- Lessons learned
- Maintenance strategies
- PtD sign off and validation

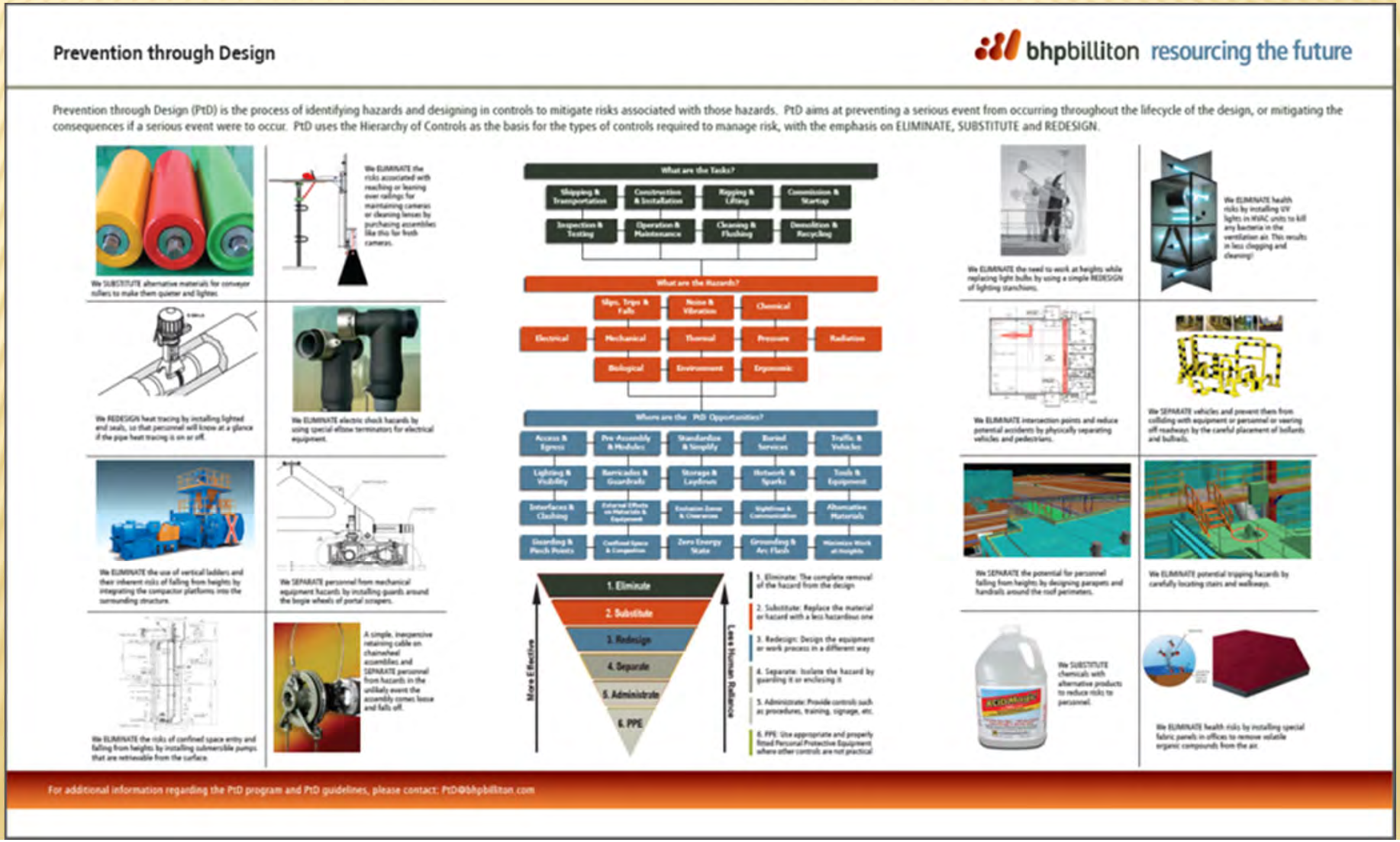
PTD TOOLS

1) PtD online training

2) PtD flashcards

PTD TOOLS, CONTINUED

3) PtD posters



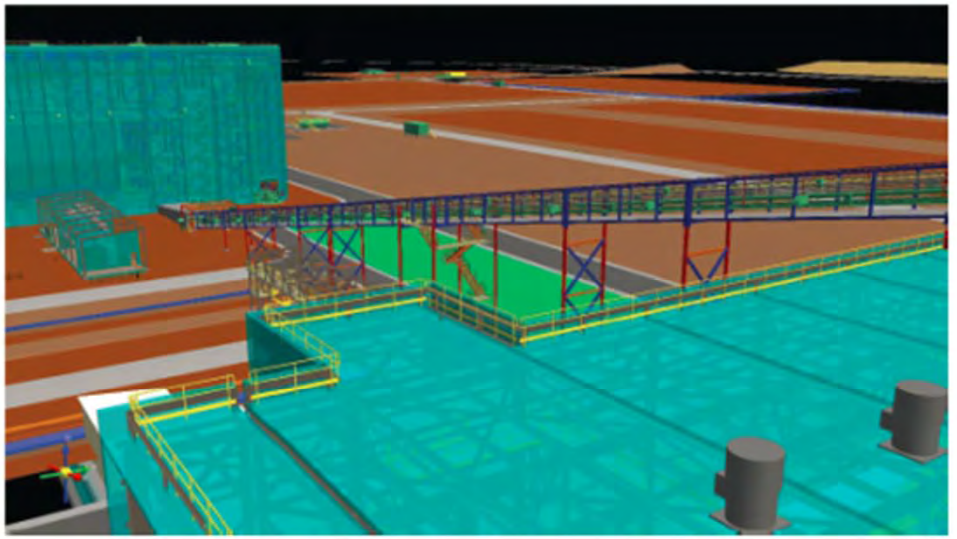
ELIMINATE HAZARDS

We ELIMINATE the use of vertical ladders and their inherent risks of falling from heights by integrating the compactor platforms into the surrounding structure.

We ELIMINATE the need to work at heights while replacing light bulbs by using a simple REDESIGN of lighting stanchions.

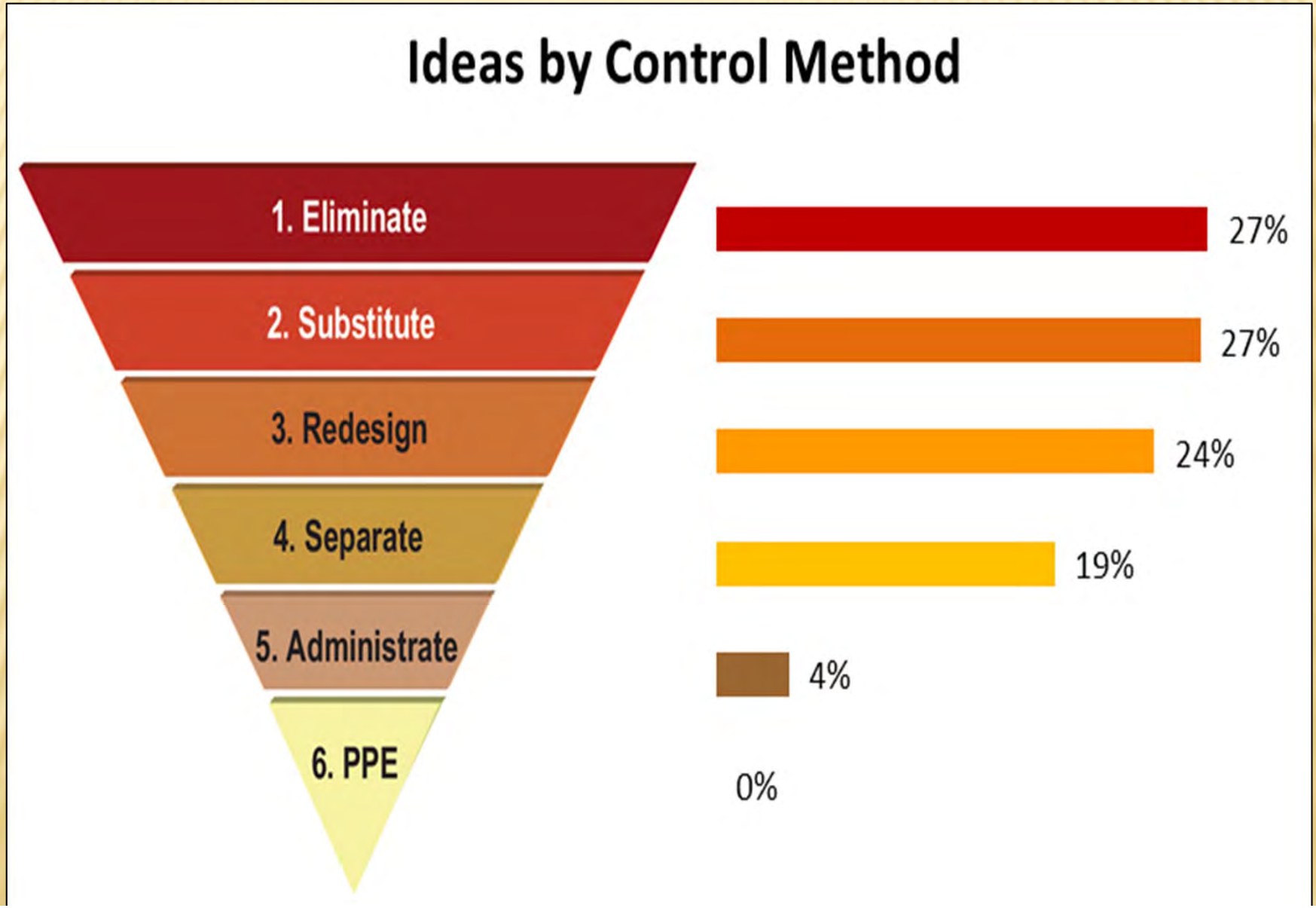
SEPARATE PEOPLE FROM HAZARDS

A simple, inexpensive retaining cable on chainwheel assemblies and SEPARATE personnel from hazards in the unlikely event the assembly comes loose and falls off.



We SEPARATE the potential for personnel falling from heights by designing parapets and handrails around the roof perimeters.

HIERARCHY OF CONTROLS



INTERNATIONAL INITIATIVES

- UK/EU since 1995
- Australia (2012 guidelines)
- Singapore (2008 guidelines)
- USA: OSHA workgroup and NIOSH Initiative since ~2005

OVERVIEW

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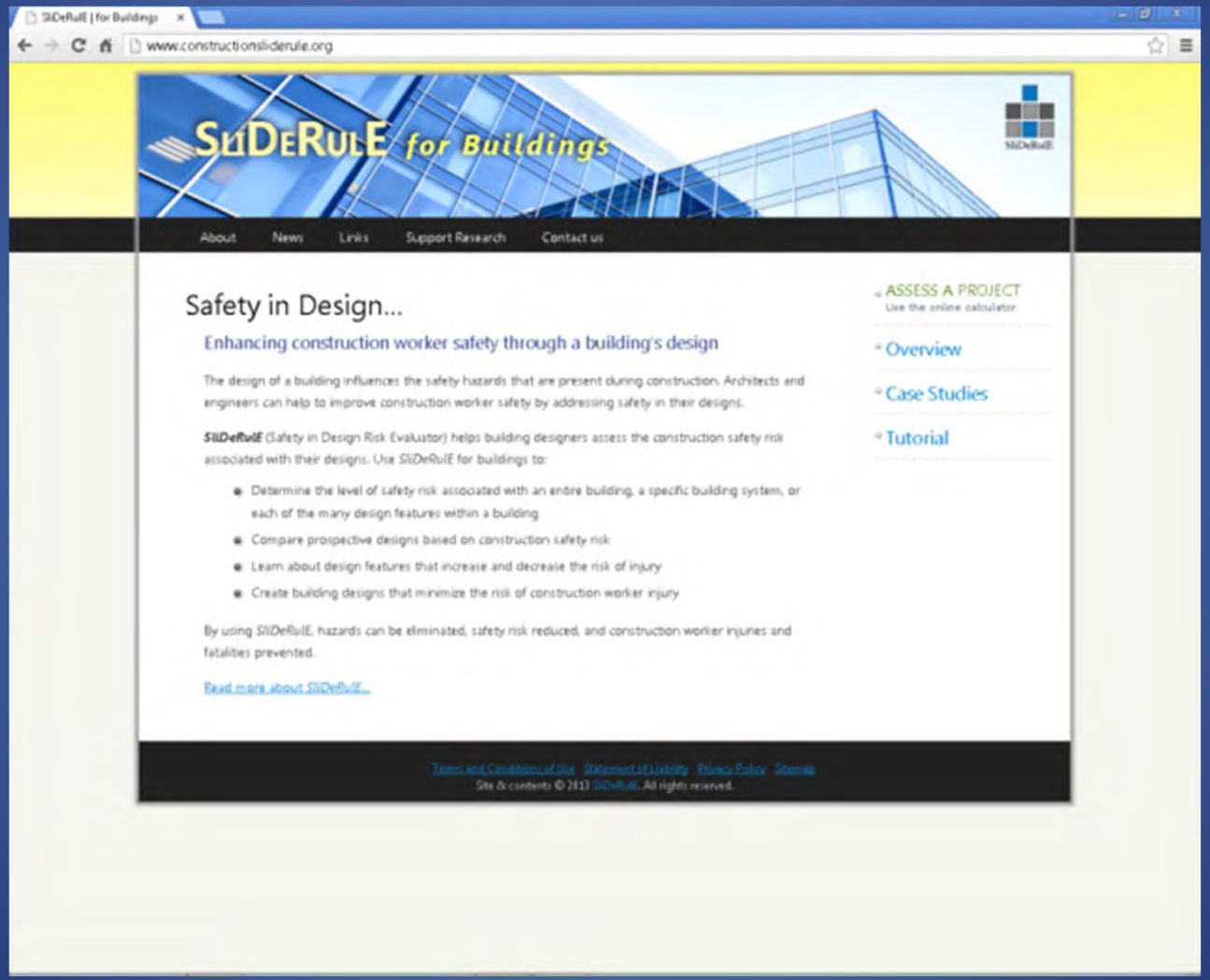
SBD DESIGN REVIEW

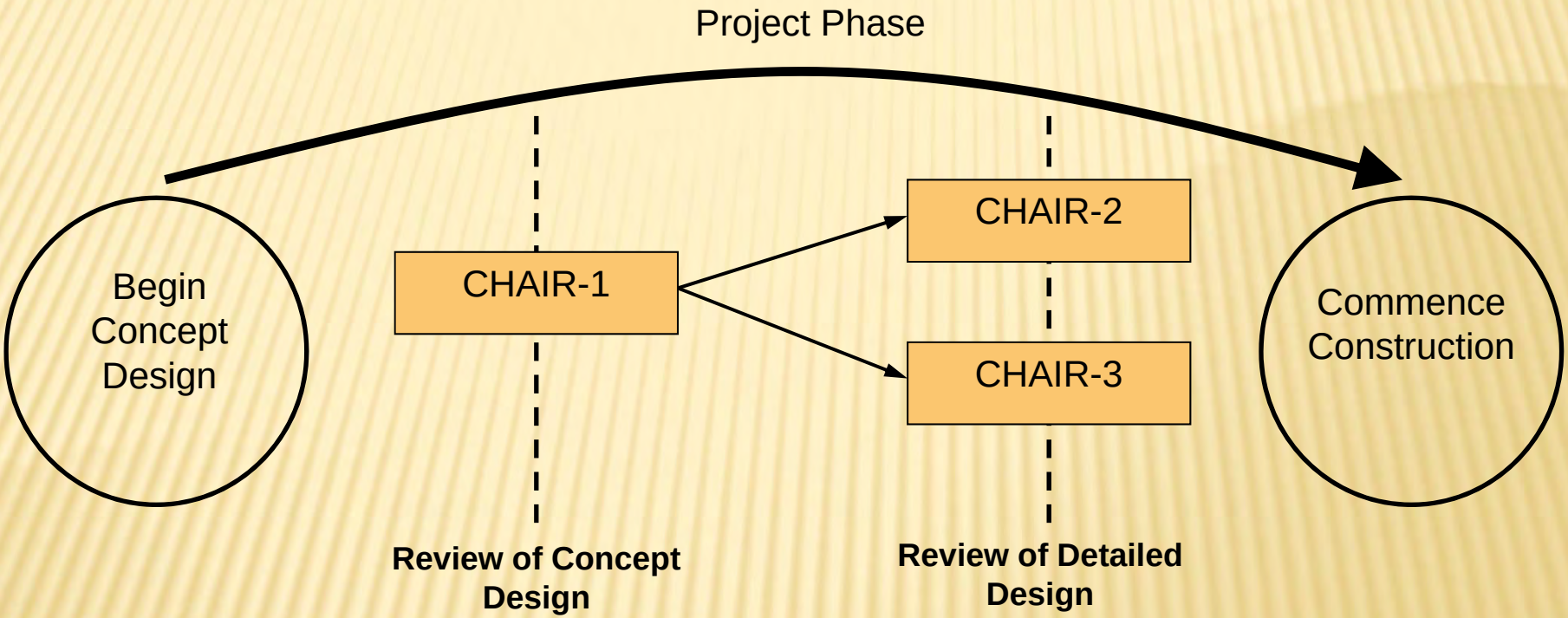
- Hazard identification
  - What safety hazards does the design create?
- Risk assessment
  - What is the level of safety and health risk associated with each hazard?
- Design option identification and selection
  - What can be done to eliminate or reduce the risk?
  - Remember the hierarchy of controls.....

DfS Tools – Design Risk Assessment



www.constructionsliderule.org

CHAIR SAFETY IN DESIGN TOOL



Construction Hazard Assessment and Implication Review (CHAIR)

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

Safety In Design

constructionskills All Sector Skills Councils are in the process of being relicensed by UKCES

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FEEDBACK Form

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.

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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
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- Roofs
- Spatial Designs
- Susp Access Equip
- Concrete Blockwork
- -- Building Services --

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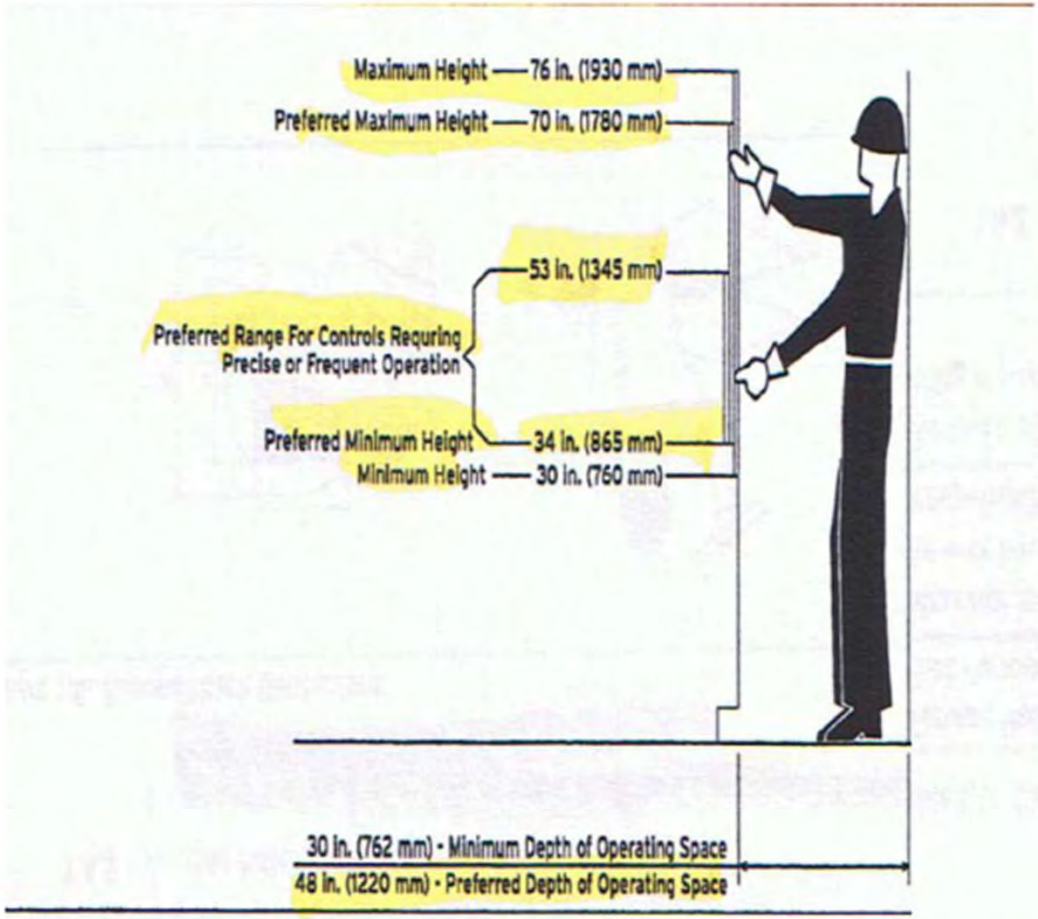
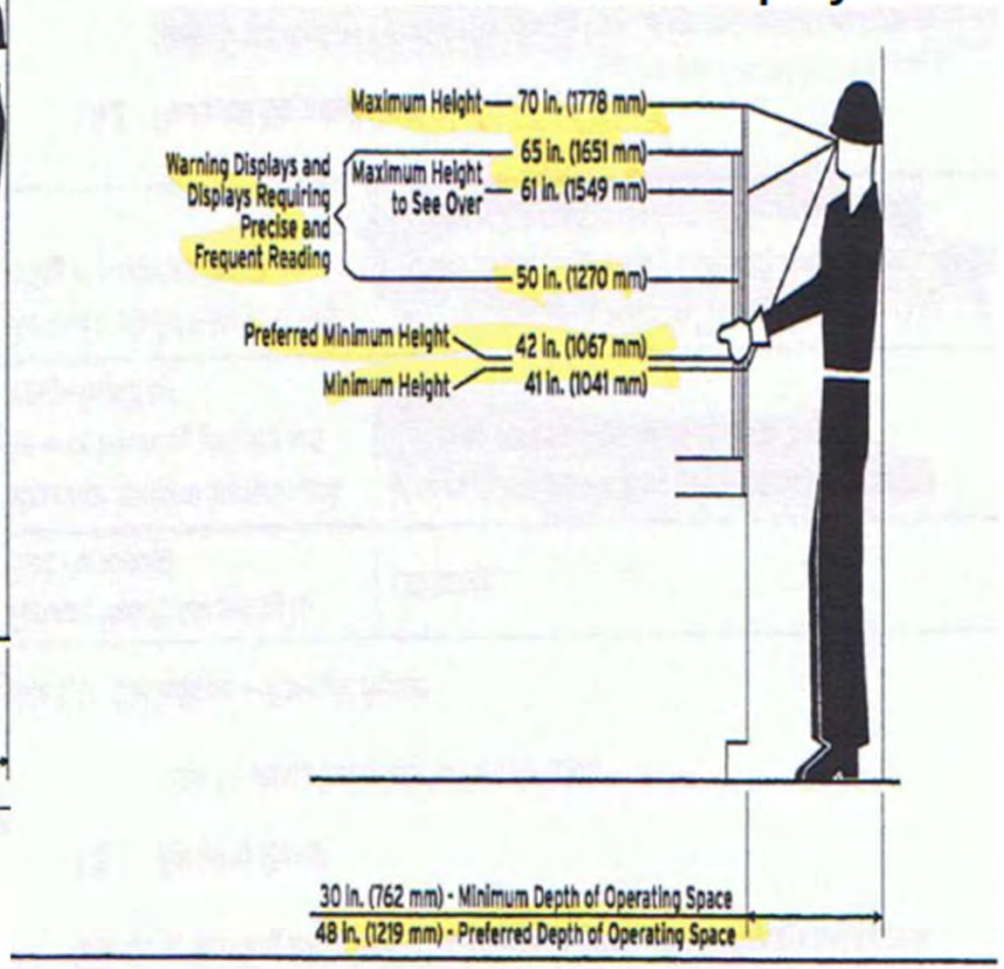
Requirements for Workspace Design & Layout

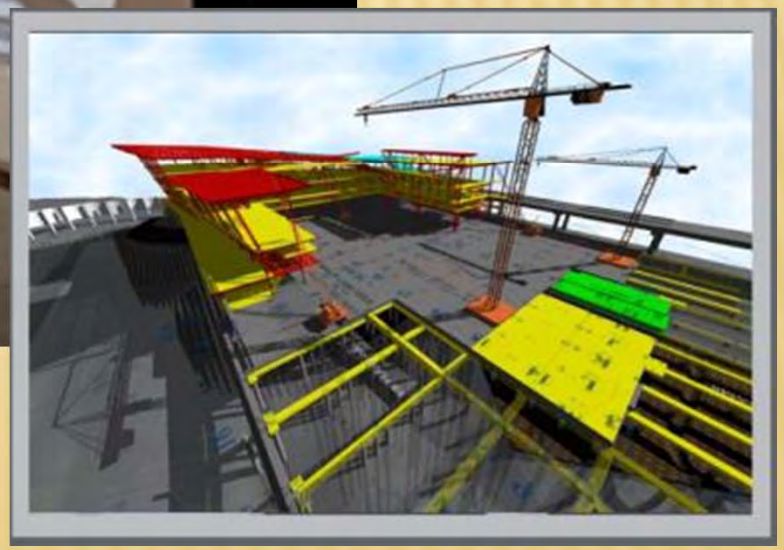


Location of Controls

Location of Visual Displays



SBD TOOLS – BIM AND VISUALIZATION



SBD INFORMATION SOURCES

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www.designforconstructionsafety.org

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THREE STEPS TOWARDS SBD

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

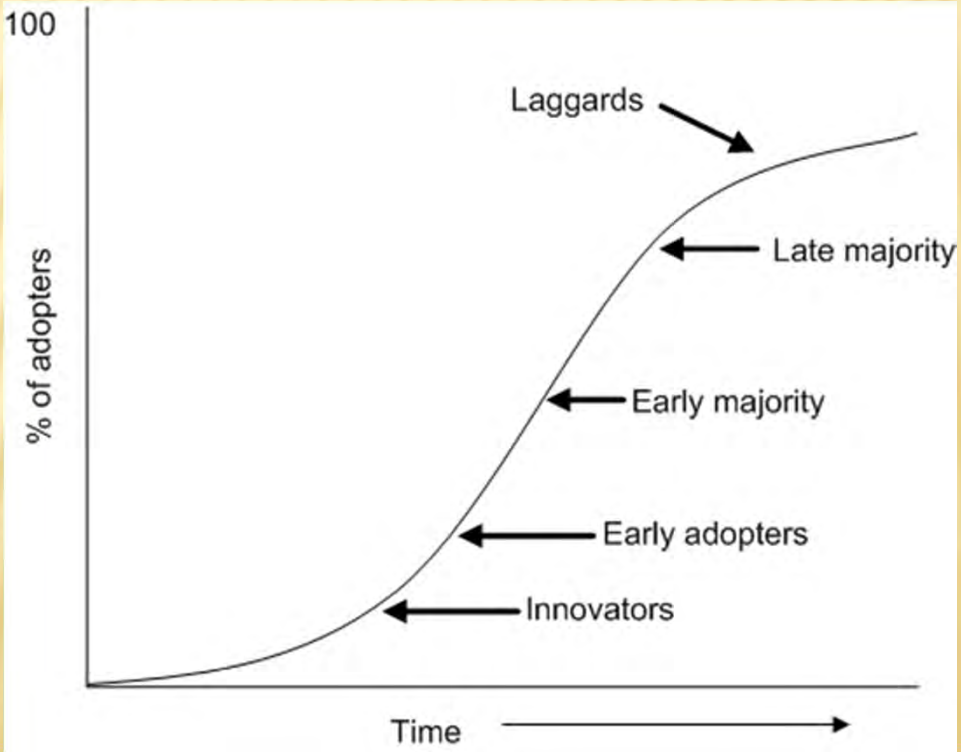
- Qualifications-based contracting
- Negotiated or Cost-Plus contracting
- Collaborative contractual process
  - Integrated project delivery or Design-build
- Designer training and tools

CHOOSE YOUR PARTNERS WISELY

- Collaborative culture and experiences
- Open to change

SBD: AN OPPORTUNITY FOR YOU

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



www.healthknowledge.org.uk/public-health-textbook/disease-causation-diagnostic/2h-principles-health-promotion/prevention-paradox

INITIATING SBD IN YOUR ORGANIZATION

- Leadership
- Sustainability
- Ethics
- Innovation
- Change management

SUMMARY

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

THANK YOU FOR LISTENING!

- Questions, comments?

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