

Prevention through Design

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PtD is NOT new ...

1750 B.C., Code of Hammurabi, Law 229:
*“If a builder builds a house for someone,
and does not **construct it properly**, and
the house which he built falls in and kills
its owner, then that builder shall be put
to death.”*

(Punitive code. *PtD implied!*)





“Hammurabi 2.0”

*“My company has had a safety program for 150 years. The program was instituted as a result of a French law requiring an explosives manufacturer to **live on the premises with his family.**”*

— Crawford Greenwalt
Former president of DuPont

Moses 1.0



<https://commons.wikimedia.org/wiki/File:Scroll.jpg>

1440 B.C., Bible, Moses, Deuteronomy 22:8: *“When you build a new house, make a **parapet around your roof** so that you may not bring the guilt of bloodshed on your house if someone falls from the roof.”*

(Design code. *PtD specific.*)

Great ideas endure



Prevention through Design (PtD)

PtD addresses worker exposure to hazards during the design stages of

Preventing Falls through the Design of Roof Parapets

Summary

Workers are exposed to risks from falls during construction, operation, maintenance, and demolition of buildings. Parapets are the parts of the wall assembly that extend above the roof [Raiendran and Gambatese 2013] and

building roofs during construction and for operation and maintenance tasks after the building has been completed. Workers may be close to roof edges when transferring material to and from the roof, accessing rooftop equipment, and communicating with coworkers on the ground. To prevent falls, parapets

www.cdc.gov/niosh/docs/2014-108/



Thinking about RISK ... to *self* ... to others





Thinking about RISK ... to *self* ... to others



*“A life without adventure is likely to be unsatisfying,
but a life in which adventure is *allowed to take
whatever form it will*, is likely to be short.”*

– Bertrand Russell



No *HEALTH* hazards here!



Central
Taurus
Mountains,
Turkey



No *HEALTH* hazards here!



Central
Taurus
Mountains,
Turkey



No *HEALTH* hazards here!

Contrary to my thoughts at the time, I was NOT the “G.O.A.T.” adventurer. My risk awareness was too specialized.



DISCLAIMER:

- *without* wife or daughter
- *before* work in safety
- would *NOT* do it now!



Central
Taurus
Mountains,
Turkey

Why PtD?

*“Anticipating and **DESIGNING OUT** hazards in tools, equipment, processes, materials, structures, and the organization of work is *the most effective way to prevent* occupational injuries, illnesses, and fatalities.”*

John Howard, M.D.

Director, National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention

NIOSH Prevention through Design

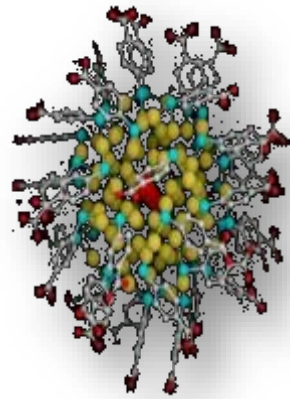
Mission: *Design out* hazards and minimize risks associated with:



**Tools &
Equipment**



Processes



**Materials,
Products, New
Technologies**

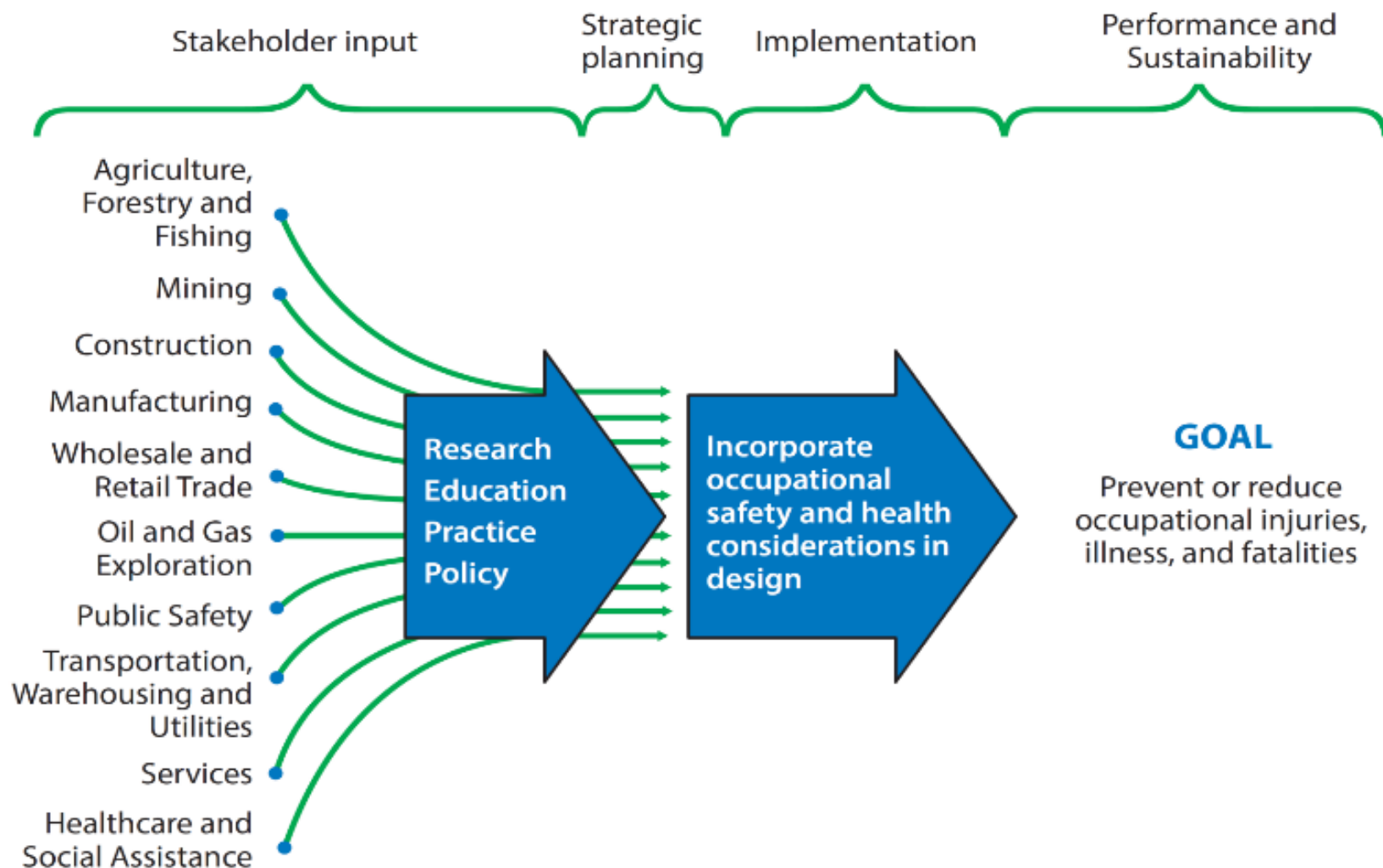


Structures

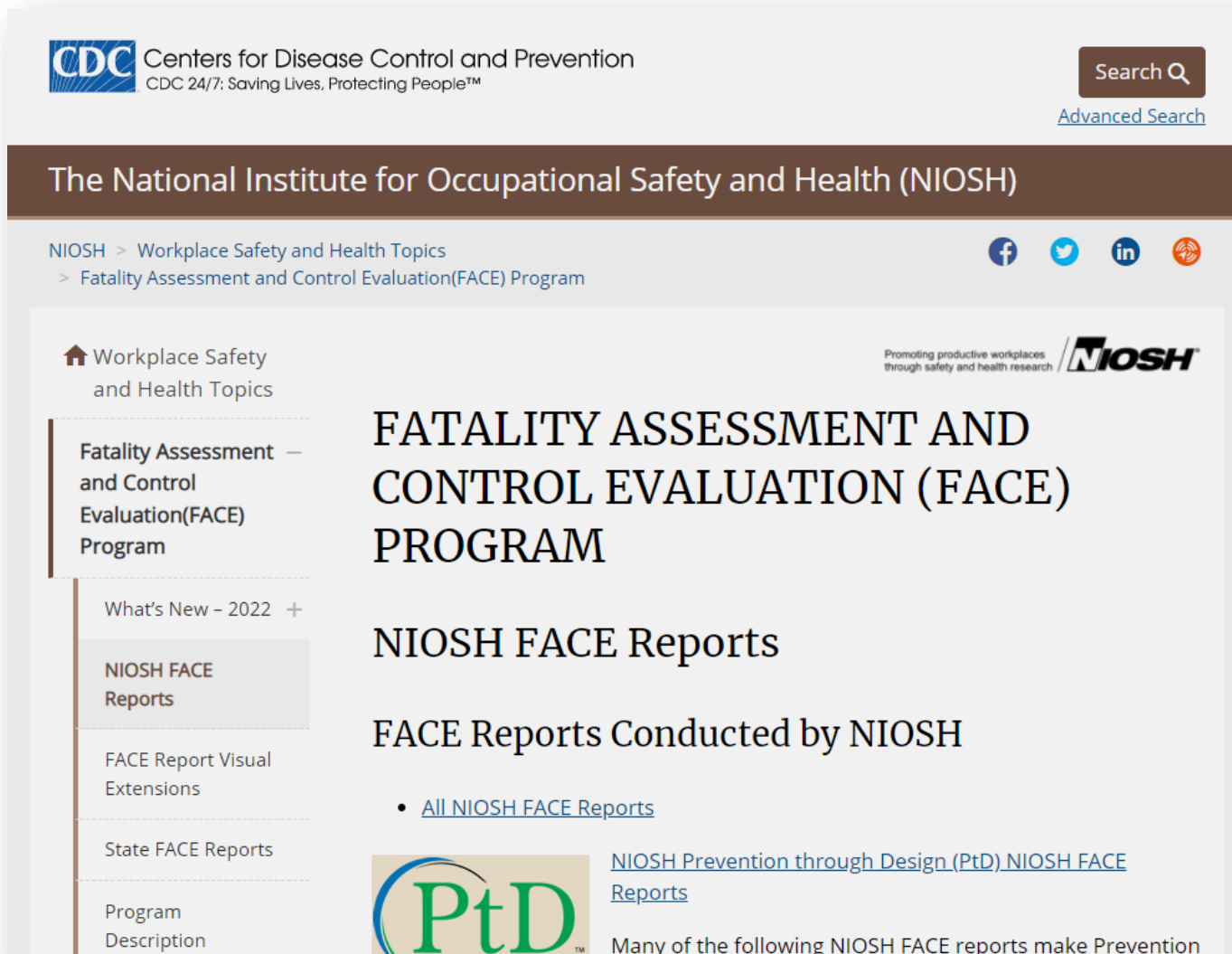


**Organization
of Work**

Prevention through Design National Initiative




Research: FACE Reports



The screenshot shows the NIOSH FACE Program website. At the top is the CDC logo and text: "Centers for Disease Control and Prevention CDC 24/7: Saving Lives. Protecting People™". A search bar with a magnifying glass icon and the text "Search" is on the right, with a link to "Advanced Search" below it. A dark brown banner contains the text "The National Institute for Occupational Safety and Health (NIOSH)". Below this is a breadcrumb trail: "NIOSH > Workplace Safety and Health Topics > Fatality Assessment and Control Evaluation(FACE) Program". Social media icons for Facebook, Twitter, LinkedIn, and YouTube are on the right. The main content area has a left sidebar with a home icon and "Workplace Safety and Health Topics", a section for "Fatality Assessment – and Control Evaluation(FACE) Program", "What's New – 2022 +", "NIOSH FACE Reports", "FACE Report Visual Extensions", "State FACE Reports", and "Program Description". The main content area features the NIOSH logo with the tagline "Promoting productive workplaces through safety and health research", followed by the title "FATALITY ASSESSMENT AND CONTROL EVALUATION (FACE) PROGRAM" in large, bold, black letters. Below this is the heading "NIOSH FACE Reports" and "FACE Reports Conducted by NIOSH". A bullet point links to "All NIOSH FACE Reports". At the bottom, there is a "PtD" logo and the text "NIOSH Prevention through Design (PtD) NIOSH FACE Reports" and "Many of the following NIOSH FACE reports make Prevention".





CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives. Protecting People™


Search 

[Advanced Search](#)

The National Institute for Occupational Safety and Health (NIOSH)

NIOSH > Workplace Safety and Health Topics
> Fatality Assessment and Control Evaluation(FACE) Program

 Workplace Safety and Health Topics

Fatality Assessment – and Control Evaluation(FACE) Program


What's New – 2022 +

NIOSH FACE Reports

FACE Report Visual Extensions

State FACE Reports

Program Description


Promoting productive workplaces through safety and health research 

FATALITY ASSESSMENT AND CONTROL EVALUATION (FACE) PROGRAM

NIOSH FACE Reports

FACE Reports Conducted by NIOSH

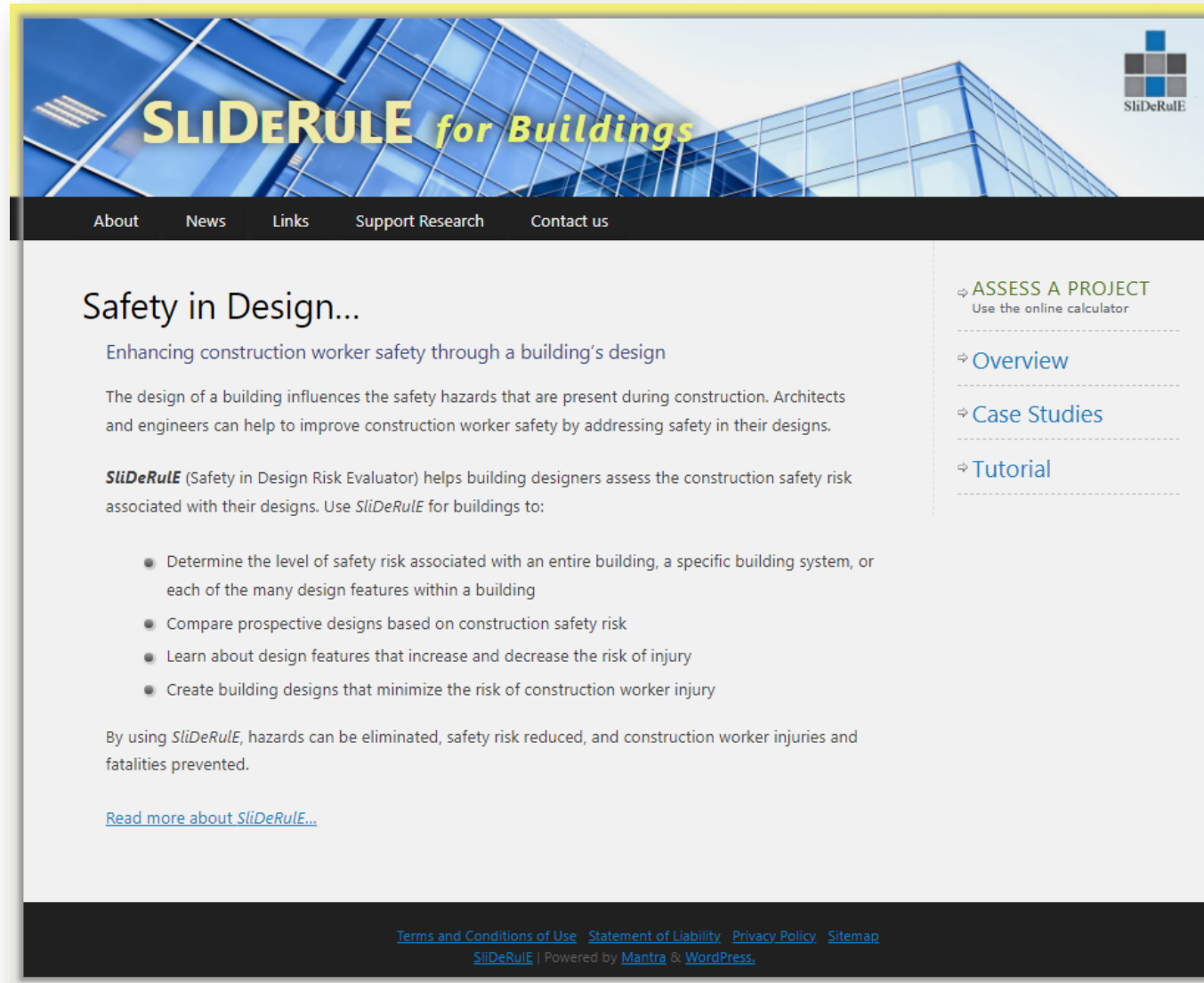
- [All NIOSH FACE Reports](#)

 [NIOSH Prevention through Design \(PtD\) NIOSH FACE Reports](#)

Many of the following NIOSH FACE reports make Prevention

NIOSH **FACE** Program
[www.cdc.gov/niosh/face/]

Research: Design Comparison Tool



The screenshot shows the homepage of the SLiDeRule for Buildings website. The header features a blue and yellow banner with the text "SLiDeRule for Buildings" and a logo in the top right corner. Below the banner is a navigation bar with links: "About", "News", "Links", "Support Research", and "Contact us". The main content area is divided into two columns. The left column is titled "Safety in Design..." and contains text about enhancing construction worker safety through building design, a paragraph about the design's influence on safety hazards, and a description of the SLiDeRule tool. It also includes a bulleted list of four key features: determining safety risk levels, comparing prospective designs, learning about design features that increase or decrease risk, and creating designs that minimize risk. A link "Read more about SLiDeRule..." is provided at the bottom of this section. The right column contains a vertical list of links: "ASSESS A PROJECT" (with a sub-link "Use the online calculator"), "Overview", "Case Studies", and "Tutorial". The footer contains links for "Terms and Conditions of Use", "Statement of Liability", "Privacy Policy", and "Sitemap", followed by "SLiDeRule | Powered by Mantra & WordPress."

SLiDeRule for Buildings

About News Links Support Research Contact us

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.

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

[Read more about SLiDeRule...](#)

ASSESS A PROJECT
Use the online calculator

Overview

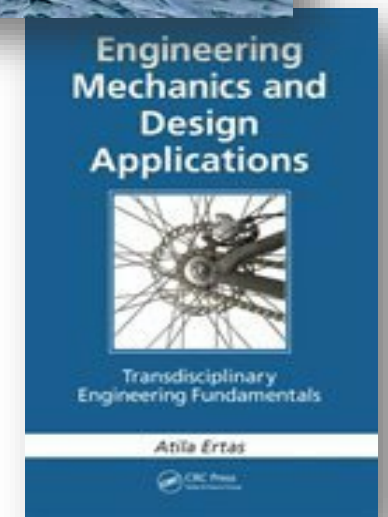
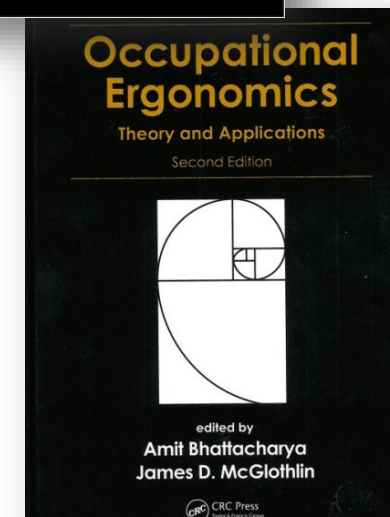
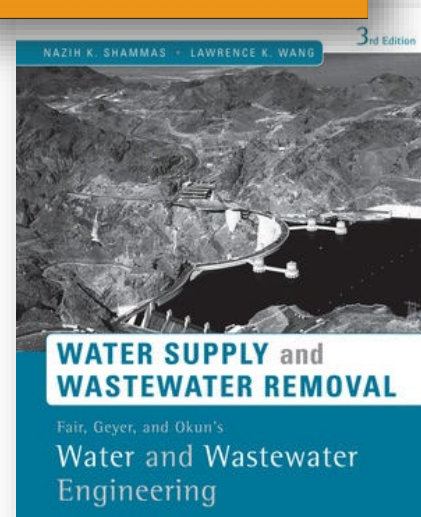
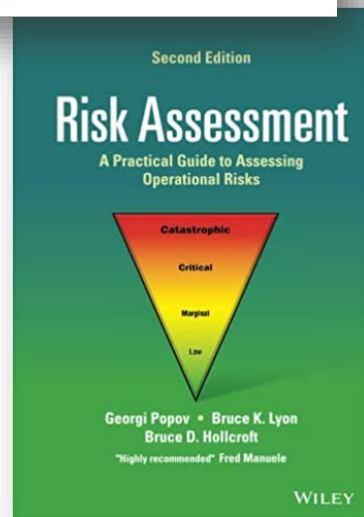
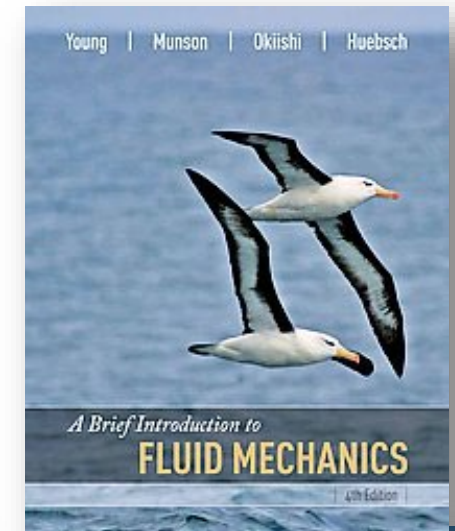
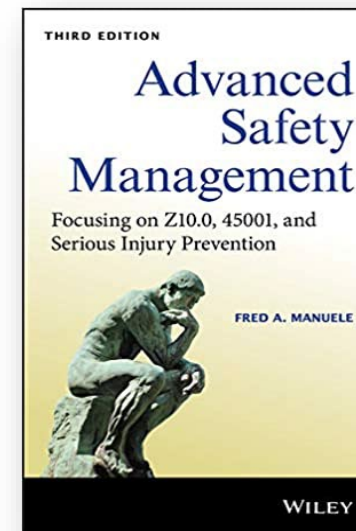
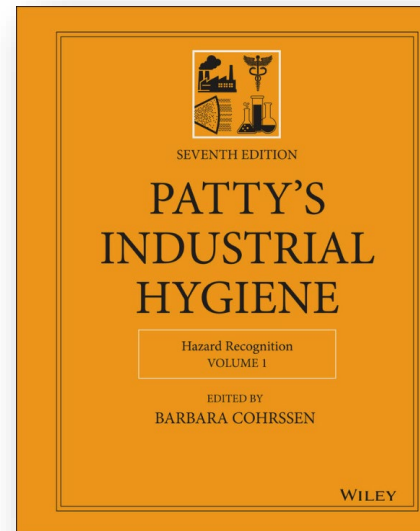
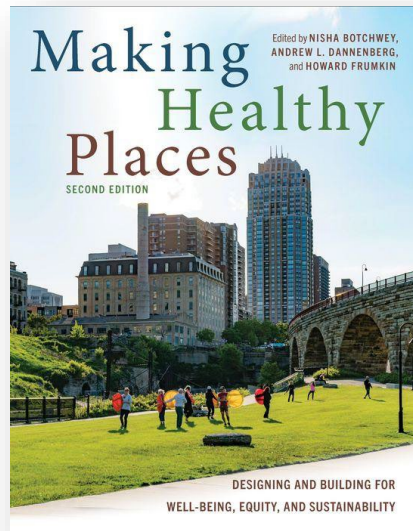
Case Studies

Tutorial

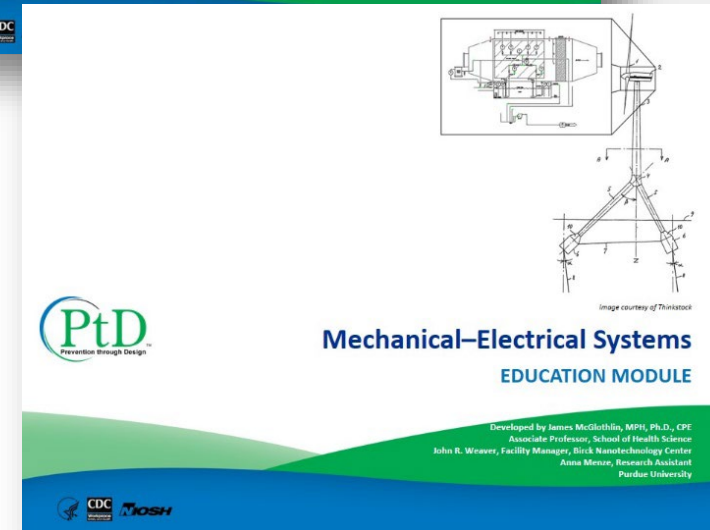
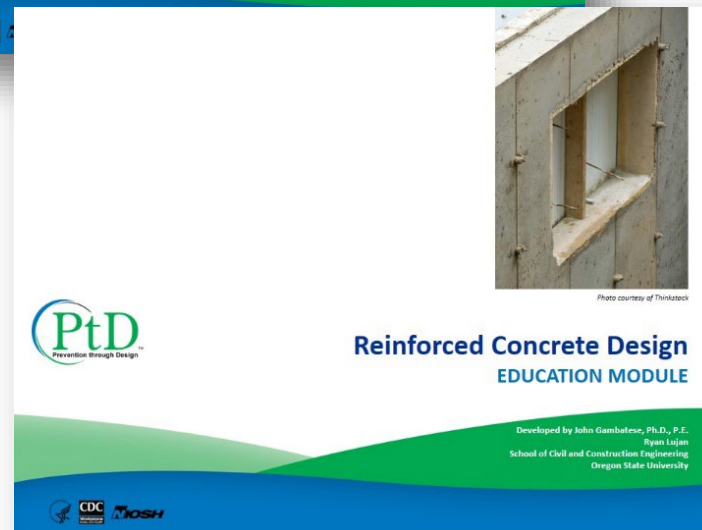
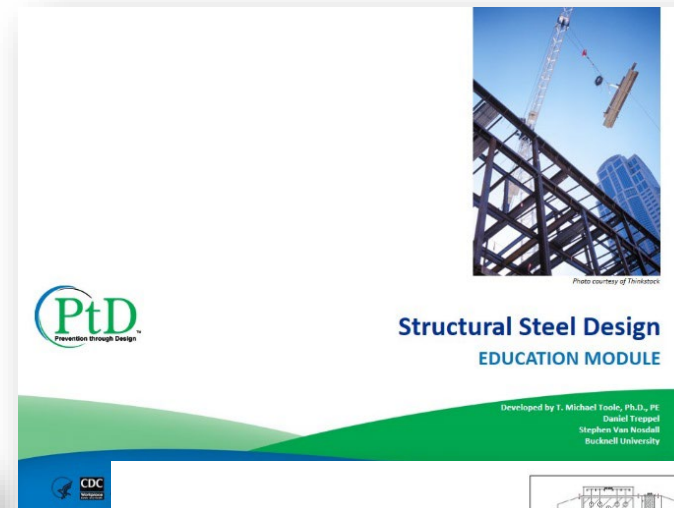
[Terms and Conditions of Use](#) [Statement of Liability](#) [Privacy Policy](#) [Sitemap](#)
SLiDeRule | Powered by [Mantra](#) & [WordPress](#).

Sliderule for Buildings
www.constructionsliderule.org

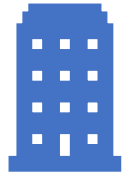
Education: Textbooks & PtD



Education: Instruction Modules

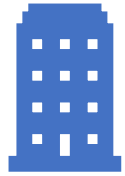


www.cdc.gov/niosh/topics/ptd/pubs.html



Education: Much available ...

- A PtD Risk Assessment Course from the ASSP: www.assp.org/education/online-learning
- PtD Webinars for Green Building Design from the USGBC:
www.usgbc.org/education/sessions/life-cycle-safety-basics-and-connections-sustainability-6679047
www.usgbc.org/education/sessions/leed-pilot-credit-prevention-through-design-ptd-background-requirements-10947289
- Many Papers, Guides, Checklists, and Slide decks: <https://designforconstructionsafety.org>
(hosted by Dr. T. Michael Toole, Dean of the College of Engineering, University of Toledo)
See the 1600 item spreadsheet under “Design Tools” that goes well beyond construction



Education

Dr. Edd Gibson and Dr. David Grau of Arizona State have had a PtD emphasis in their Global Safety Center for years.

They are now partnering with NIOSH in an exciting PtD Initiative.

Workshop participation is no-cost, and presentations can be freely viewed and downloaded. The 2022 workshop is on 25 & 26 May.

Dr. Gibson hopes to influence the growth of PtD well beyond construction, to all fields of Engineering.

ASU Arizona State University

Ira A. Fulton Schools of Engineering

Prevention through Design

Home PtD 5-year Initiative PtD Workshop 2022 PtD Workshop 2021 PtD Workshop 2020

Prevention through Design Initiative (2020-2024)

National Institute for Occupational Safety and Health
NIOSH

ASU Ira A. Fulton Schools of Engineering
Arizona State University

We built that.
Ded E. Webb ASU Engineering

NATIONAL ACADEMY OF CONSTRUCTION

<https://ptd.engineering.asu.edu/>

Practice: Workplace DESIGN Solutions

www.cdc.gov/niosh/docs/2014-108



Workplace design solutions
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

PtD
Prevention through Design

Prevention through Design (PtD)
PtD addresses worker exposure to

Preventing Falls through the Design of Roof Parapets

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www.cdc.gov/niosh/docs/wp-solutions/2015-198



Workplace design solutions
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

PtD
Prevention through Design

Prevention through Design (PtD)
PtD addresses worker exposure to

Supporting Prevention through Design (PtD) Using Business Value Concepts

Prevention through Design
Prevention through Design (PtD) can financial or non-financial measures.* [AIHA 2009; Occidental College 2002]. The National Institute for Occupational Safety and Health (NIOSH) launched a



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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

PtD
Prevention through Design

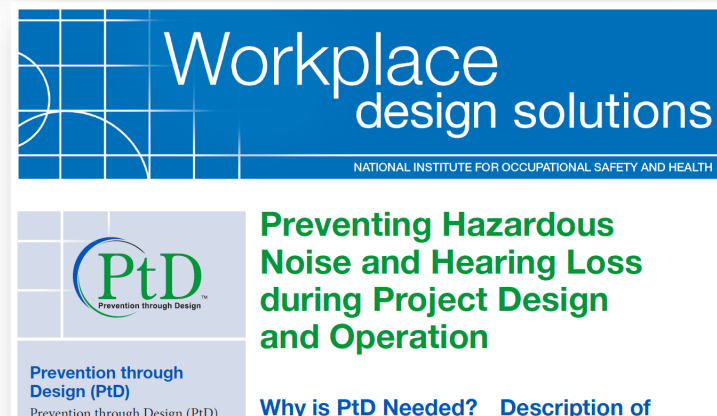
Prevention through Design (PtD)
PtD addresses worker exposure to haz-

Preventing Falls from Heights through the Design of Embedded Safety Features

Description of Exposure
Construction is one of the most danger-

Standards
OSHA Standard 29 CFR 1926.502 covers requirements for fall protection systems. One of the following is always

www.cdc.gov/niosh/docs/wp-solutions/2014-124



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PtD
Prevention through Design

Prevention through Design (PtD)
Prevention through Design (PtD)

Preventing Hazardous Noise and Hearing Loss during Project Design and Operation

Why is PtD Needed? **Description of**

www.cdc.gov/niosh/docs/2016-101

Practice: Workplace Design Solutions NANO

www.cdc.gov/niosh/docs/2018-120

Workplace design solutions

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Protecting Workers during Nanomaterial Reactor Operations

Summary

Engineered nanomaterials (ENMs) are materials that are intentionally produced to have at least one primary dimension less than 100 nanometers (nm). These materials have new or unique properties different from those of larger forms of the same materials.

Background

The toxicity of many nanomaterials is presently unknown, but initial research indicates that there may be health concerns related to occupational inhalation exposures. Only a few types of ENMs have undergone extensive toxicological evaluation.

Prevention through Design (PtD)

Prevention through Design (PtD) can be defined as designing out or eliminating safety and health

www.cdc.gov/niosh/docs/2018-121

Workplace design solutions

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Protecting Workers during the Handling of Nanomaterials

Summary

Engineered nanomaterials (ENMs) are materials that are intentionally produced to have at least one primary dimension less than 100 nanometers (nm). These materials have new or unique properties different from those of larger forms of the same materials.

concerns related to occupational inhalation exposures. Only a few types of ENMs have undergone extensive toxicological evaluation by NIOSH, e.g., titanium dioxide (TiO₂) and carbon nanotubes (CNTs). Results from animal studies with TiO₂ and other poorly-soluble, low-toxicity particles of fine and ultrafine (nanoscale) sizes have

Prevention through Design (PtD)

Prevention through Design (PtD) can be defined as designing out or eliminating safety and health

Workplace design solutions

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Protecting Workers during Intermediate and Downstream Processing of Nanomaterials

Summary

Engineered nanomaterials (ENMs) are materials that are intentionally produced to have at least one primary dimension less than 100 nanometers (nm). These materials have new or unique properties different from those of larger forms of the same materials.

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Prevention through Design (PtD)

Prevention through Design (PtD) can be defined as designing out or eliminating safety and health

www.cdc.gov/niosh/docs/2018-122

NTRC NANOTECHNOLOGY RESEARCH CENTER

Controlling Health Hazards When Working with Nanomaterials: Questions to Ask Before You Start

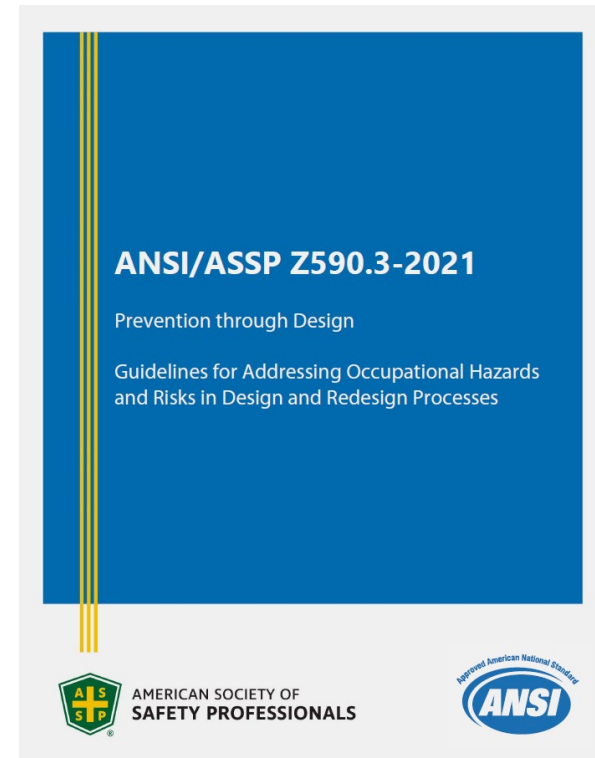
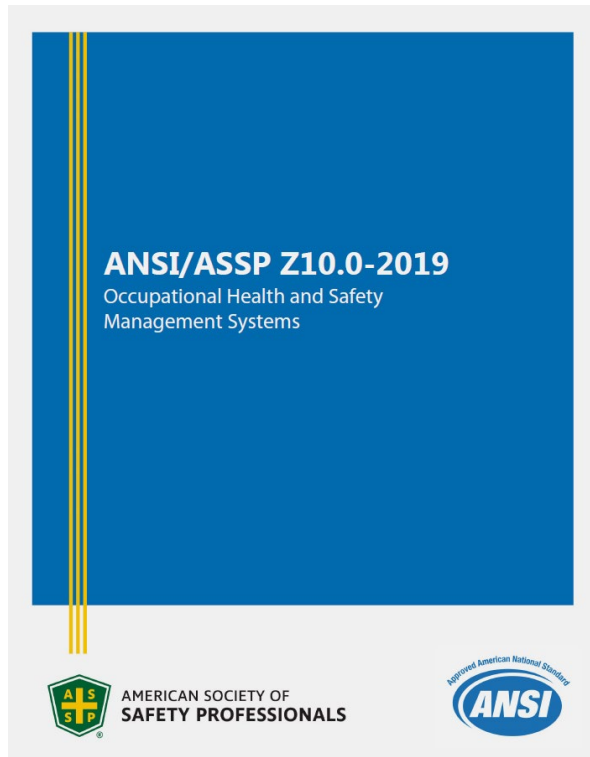
Here are some questions you should ask yourself before starting work with nanomaterials.

Here are some options you can use to reduce exposures to nanomaterials in the workplace. These options correspond with the questions on the left.

(1) FORM	DRY POWDER (typically highest potential for exposure)	SUSPENDED IN LIQUID	PHYSICALLY BOUND/ ENCAPSULATED (typically lowest potential for exposure)
(2) WORK ACTIVITY	Applies to Dry Powder Nanomaterials • Higher potential for exposure: Dumping bags of powder, bagging or sieving of products • Lower potential for exposure: Scooping/weighing of product, transporting containers with tight surface contamination or closed barrier/bottle/bags	Applies to Nanomaterial Suspended in Liquids • Higher potential for exposure: Spraying, open top sonication, producing a mist • Lower potential for exposure: Cleaning up a spill, pipetting small amounts, brushing	Applies to Physically Bound/Encapsulated Nanomaterials • Higher potential for exposure: Cutting, grinding, sanding, drilling, abrasive blasting, thermal release • Lower potential for exposure: Manual cutting and sanding, painting with a roller or brush
(3) ENGINEERING CONTROLS	Applies to Dry Powder Nanomaterials • Chemical fume hood • Glove box • Nanomaterial handling enclosure • Ventilation (tagging or dumping stations) • High efficiency particulate air (HEPA) filtered local exhaust ventilation	Applies to Nanomaterial Suspended in Liquids • Chemical fume hood • Glove box • Nanomaterial handling enclosure • Local exhaust ventilation • Ventilated spray booth	Applies to Physically Bound/Encapsulated Nanomaterials • Chemical fume hood • Glove box • Local exhaust ventilation • Downstream filter • Ventilated tool shed • Blasting cabinet
(4) ADMINISTRATIVE CONTROLS	Have you considered the role of administrative controls? Have you set up a plan for waste management? Have you considered what to do in case of a spill or how you will maintain equipment? • Establish a chemical hygiene plan • Perform routine housekeeping • Train workers	Have you considered the role of administrative controls? Have you set up a plan for waste management? Have you considered what to do in case of a spill or how you will maintain equipment? • Use signs and labels • Restrict access to areas where nanomaterials are used	Have you considered the role of administrative controls? Have you set up a plan for waste management? Have you considered what to do in case of a spill or how you will maintain equipment? • Handle and dispose of all waste materials (including cleaning materials/gloves) in compliance with all applicable federal, state, and local regulations • Use sealed closed bags of containers, and secondary containment • Label containers, such as "contains nanoscale titanium dioxide"
(5) PERSONAL PROTECTIVE EQUIPMENT	Applies to chemical-related duties • Respiratory protection when indicated and approved	Applies to All Nanomaterial Forms • Respiratory protection when indicated and approved	Applies to All Nanomaterial Forms • Respiratory protection when indicated and approved

www.cdc.gov/niosh/docs/2018-103/

Policy: Z10 *has* PtD, Z590.3 *IS* PtD





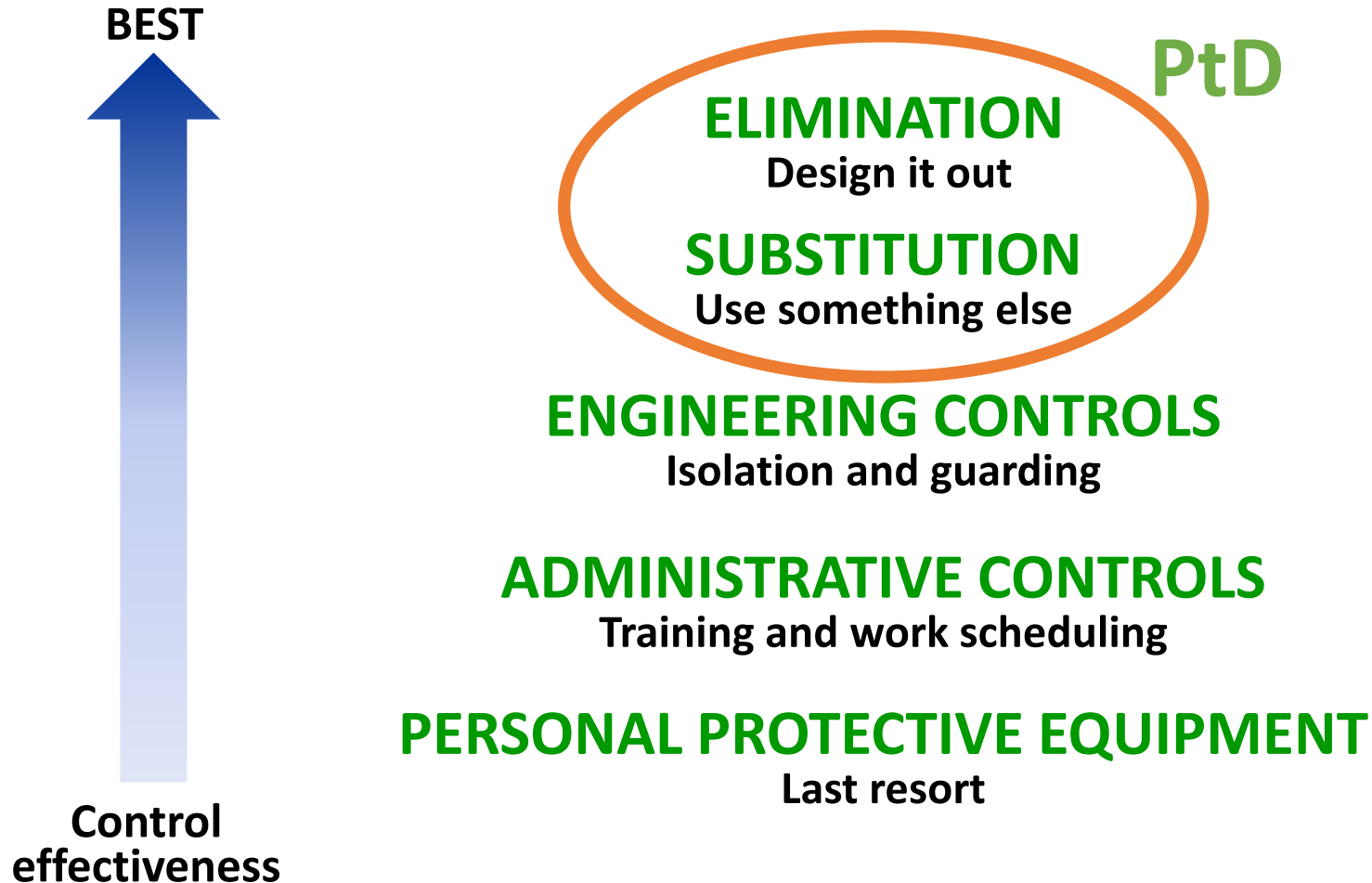
Prevention through Design

How should I
THINK about PtD?

How can I actually
DO PtD?



The *Priority* of PtD is “Prevention”



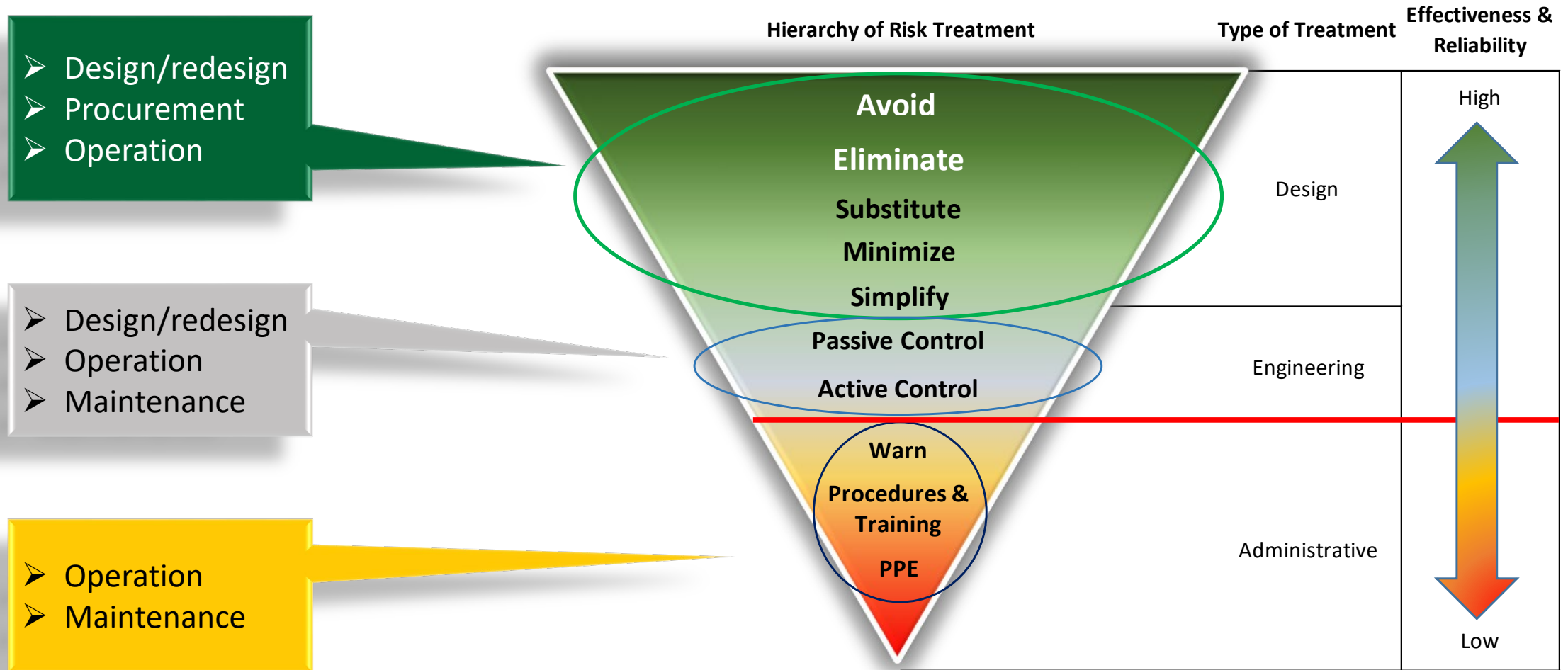
Hierarchy of Controls (HOC)



The *Priority* of PtD is “Prevention”



Hierarchy of Controls (HOC)



Hierarchy of Risk Treatment

Lyon, Popov, 2019

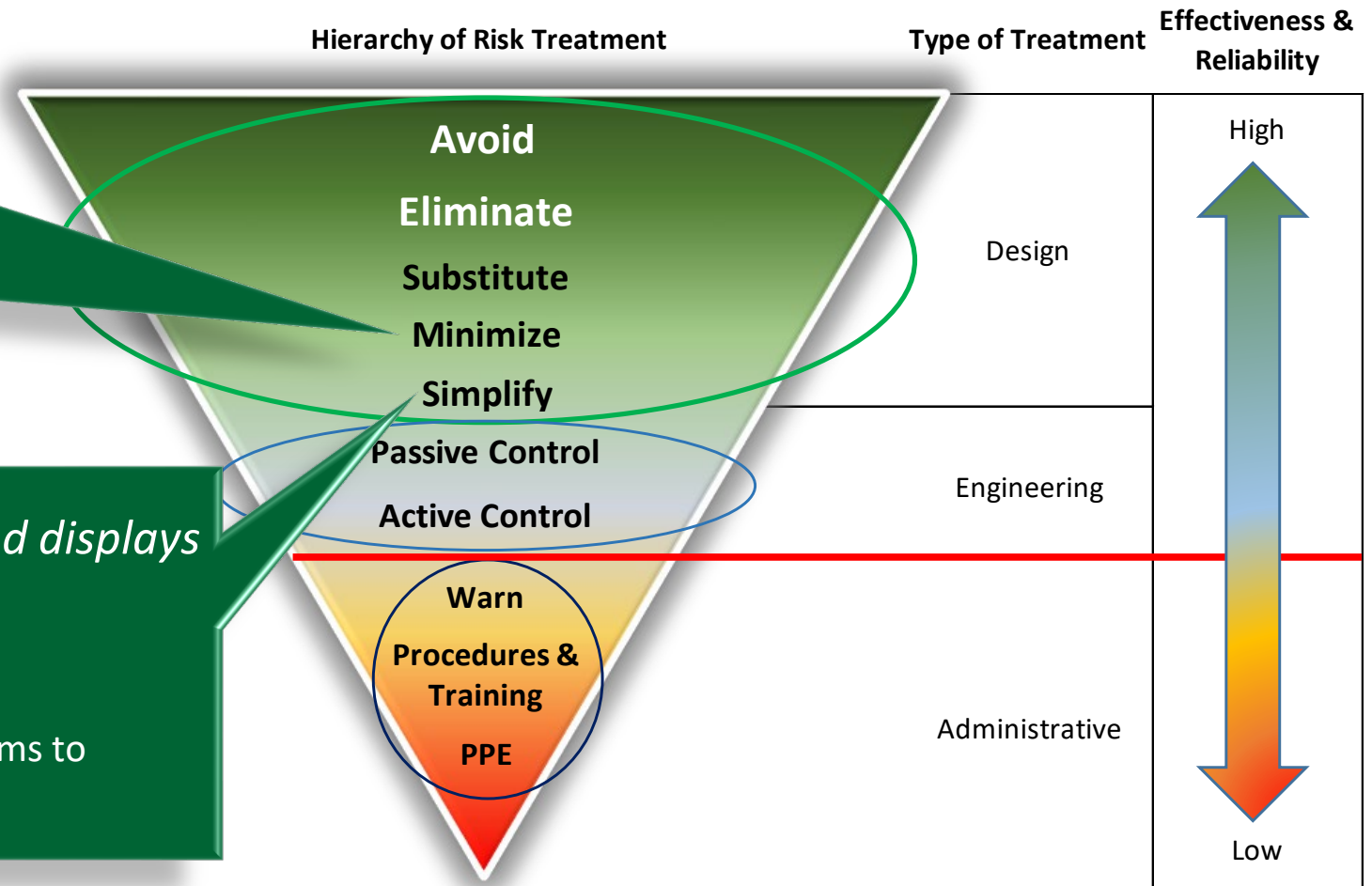
ANSI Z590.3-2021

Minimize. *quantity of hazard minimized to lower severity*

- size, weight, amount of hazardous materials
- lower voltage or energy required
- reduced operating temperatures and pressures

Simplify *systems, methods, controls and displays to reduce likelihood*

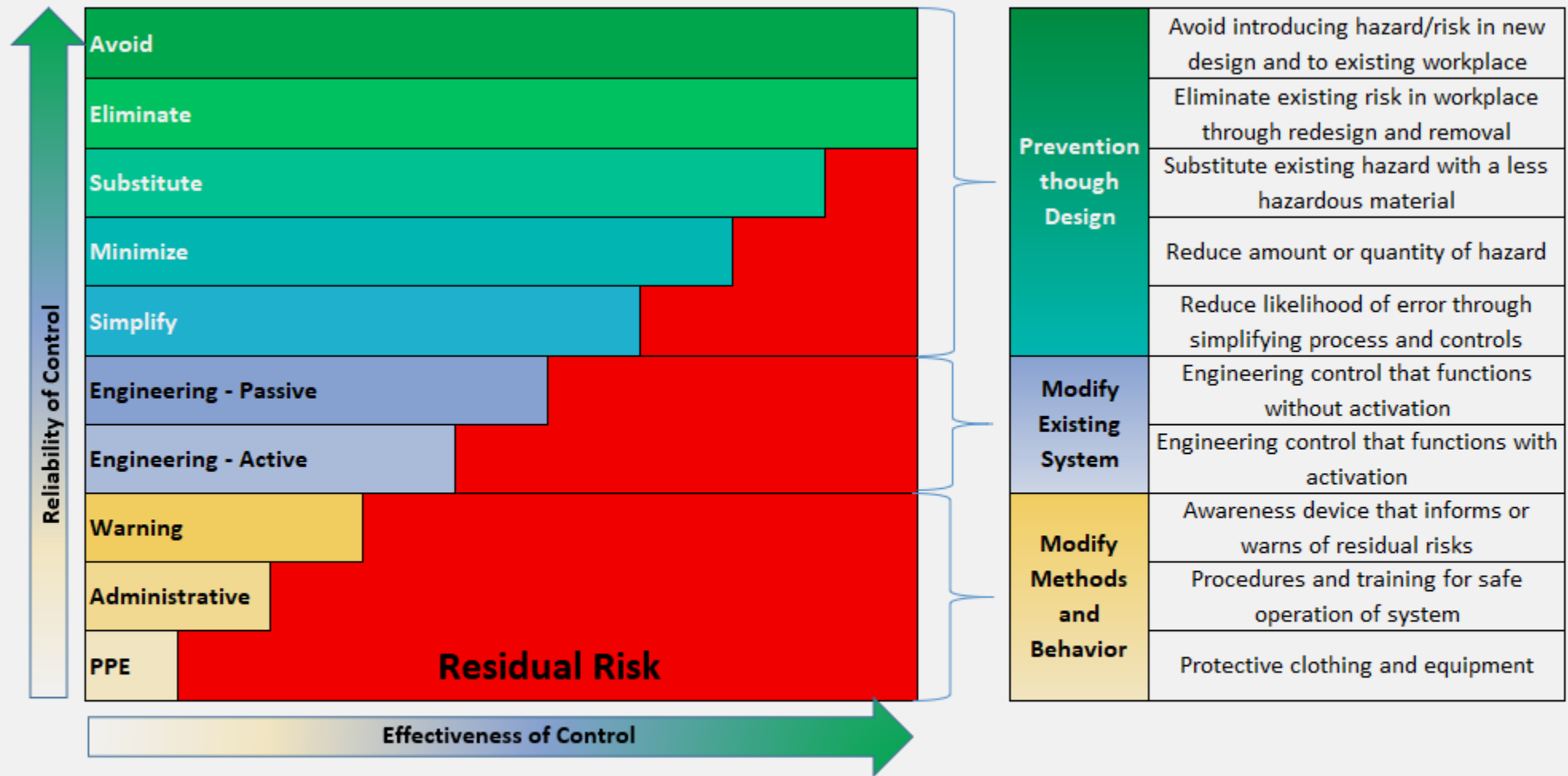
- reduce complexity in controls & displays
- reduce steps to complete task
- human factors engineering design into systems to reduce human error potential



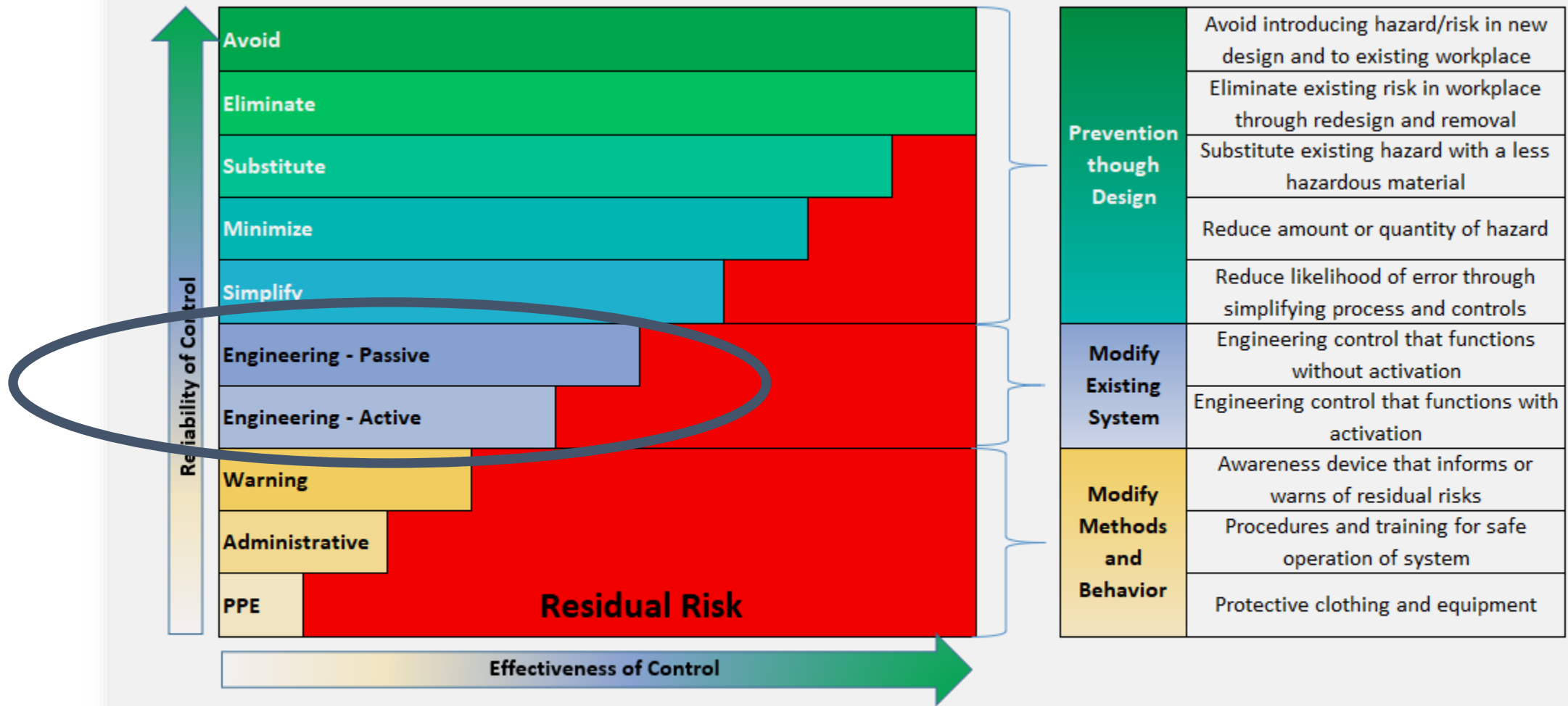
Hierarchy of Risk Treatment

Lyon, Popov, 2019

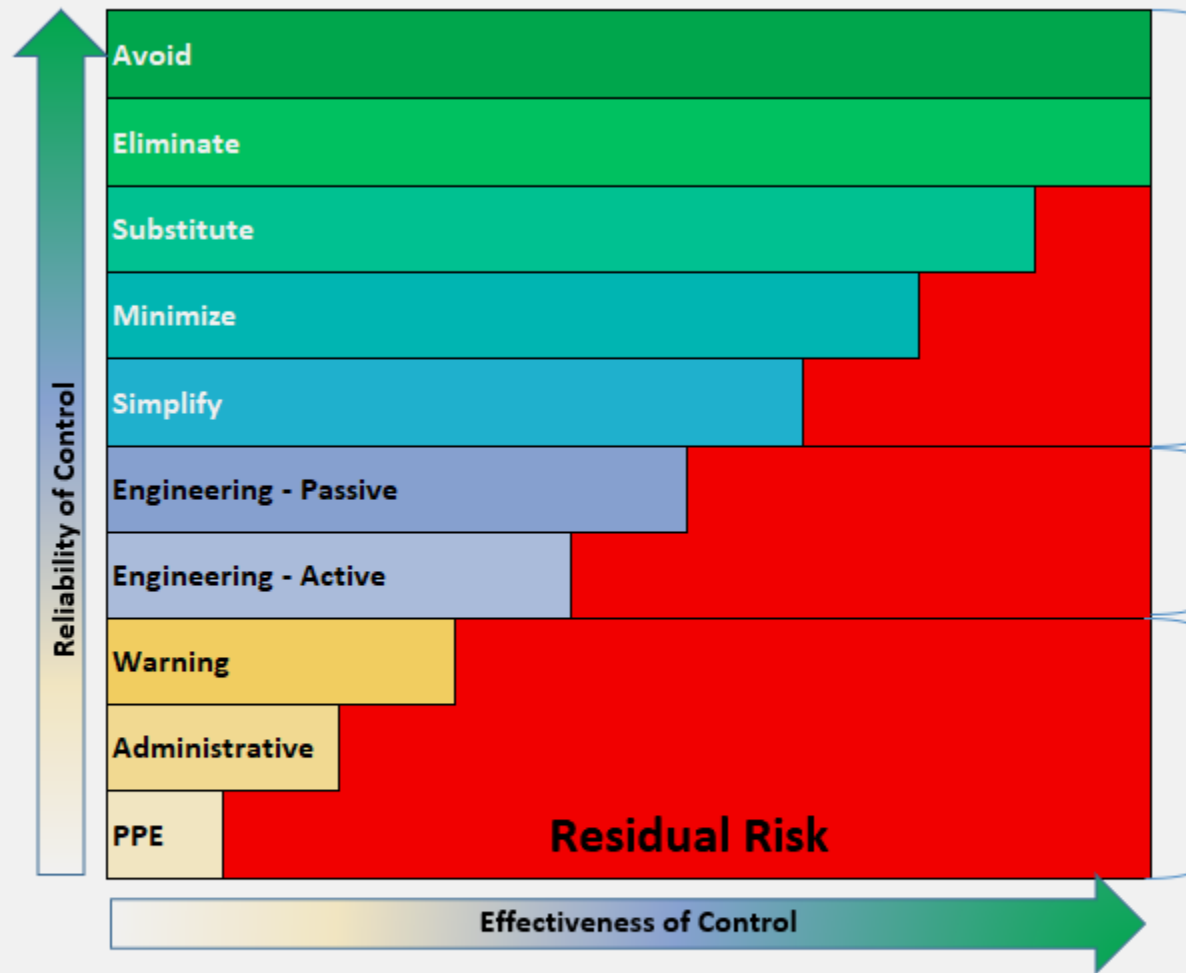
ANSI Z590.3-2021



Risk Reduction Hierarchy Model

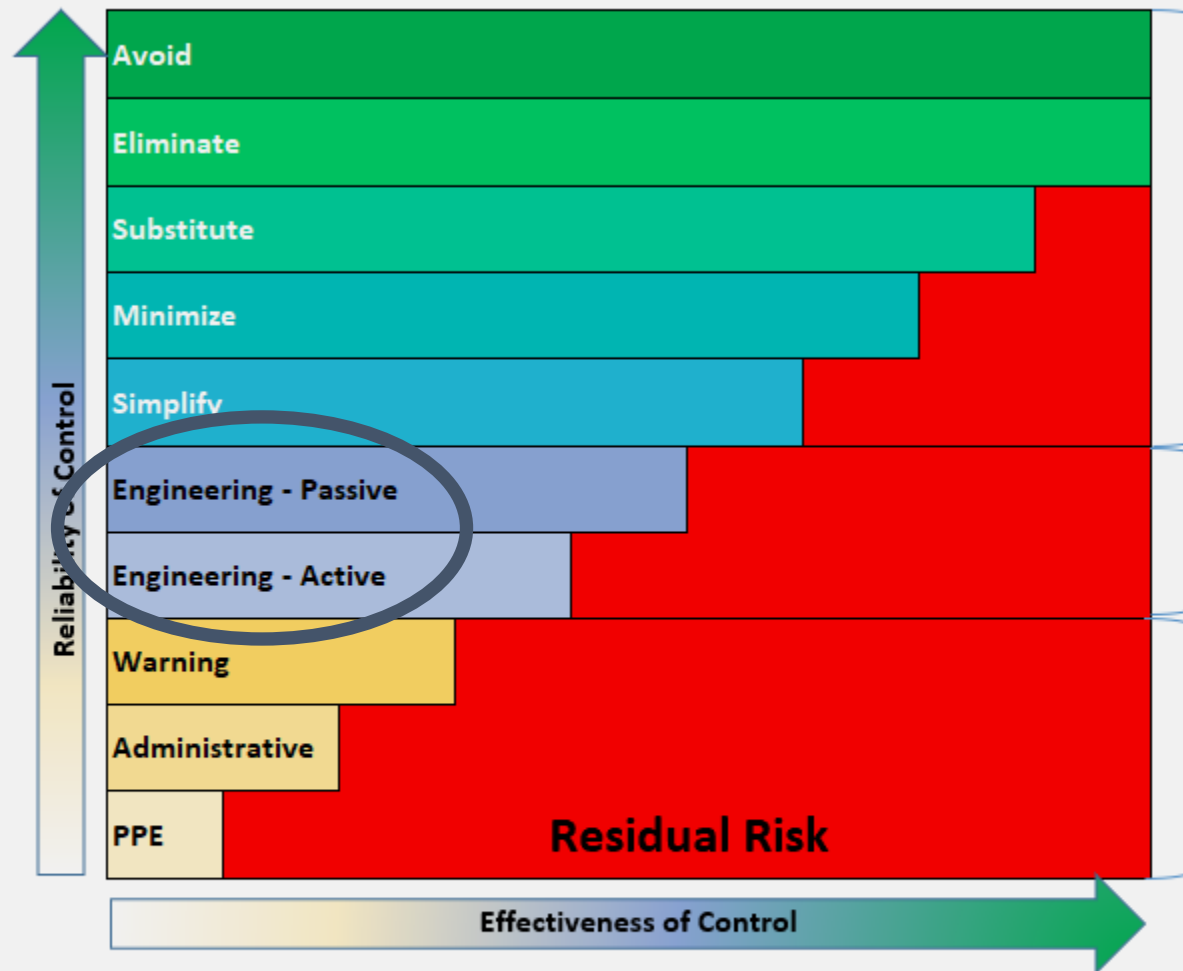


Risk Reduction Hierarchy Model



Prevention through Design	Avoid introducing hazard/risk in new design and to existing workplace
	Eliminate existing risk in workplace through redesign and removal
	Substitute existing hazard with a less hazardous material
	Reduce amount or quantity of hazard
	Reduce likelihood of error through simplifying process and controls
Modify Existing System	Engineering control that functions without activation
	Engineering control that functions with activation
Modify Methods and Behavior	Awareness device that informs or warns of residual risks
	Procedures and training for safe operation of system
	Protective clothing and equipment

Risk Reduction Hierarchy Model



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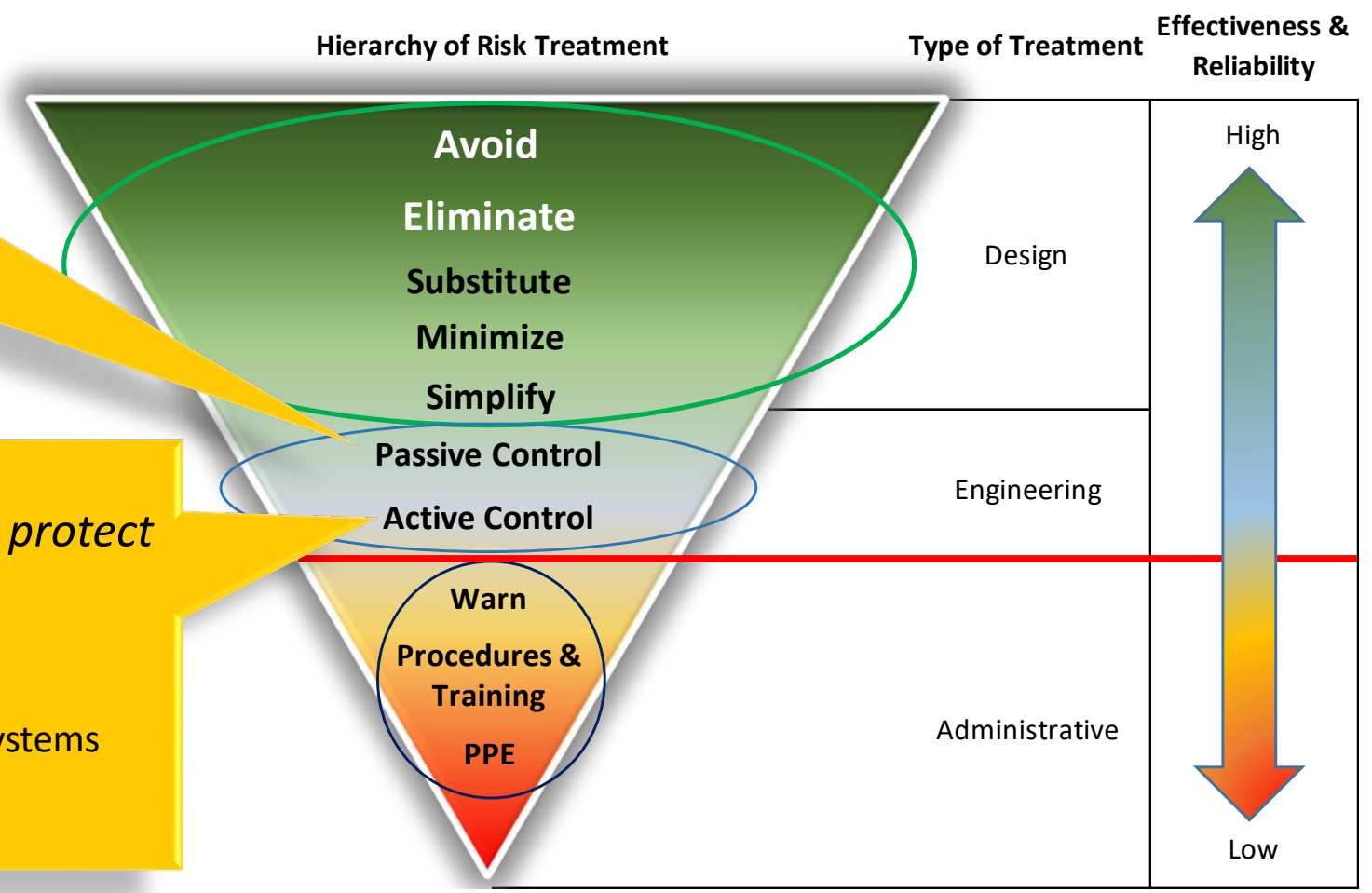


Passive Controls *protect without activation*

- containment dike
- permanent guards
- physical barriers

Active Controls *require activation to protect or function*

- presence sensing devices
- Interlocks
- process controls & safety instrumented systems
- fire suppression systems



Hierarchy of Risk Treatment

Lyon, Popov, 2019

ANSI Z590.3-2021

Old Ways of Thinking



1940/50: NO fall protection,
and later HVAC placed near edge
(old hospital wing)

- These workers, inspecting something near the edge of the roof, are in danger.
 - We ***must trust*** them to “be careful”
 - An OLD way of thinking
- A worker who needed to maintain the HVAC system would also be in danger because it is near the edge of the roof.
 - Quite common, as it is easy to have utility connections run up the outer wall.
 - An OLD way of thinking.

Photos courtesy of [TJ Lyons](#), Total Facility Solutions

Old Ways of Thinking, improved



1940/50: NO fall protection,
and later HVAC placed near edge
(old hospital wing)



2015: *New hospital wing was designed
with anchors in the roof for a harness and
lifeline.*

What level, or levels, is an
anchor, lifeline, & harness
system?

- ELIMINATE
- SUBSTITUTE
- ENGINEERING CONTROLS
- ADMINISTRATIVE CONTROLS
- PERSONAL PROTECTIVE EQUIPMENT (PPE)

Photos courtesy of [TJ Lyons](#), Total Facility Solutions

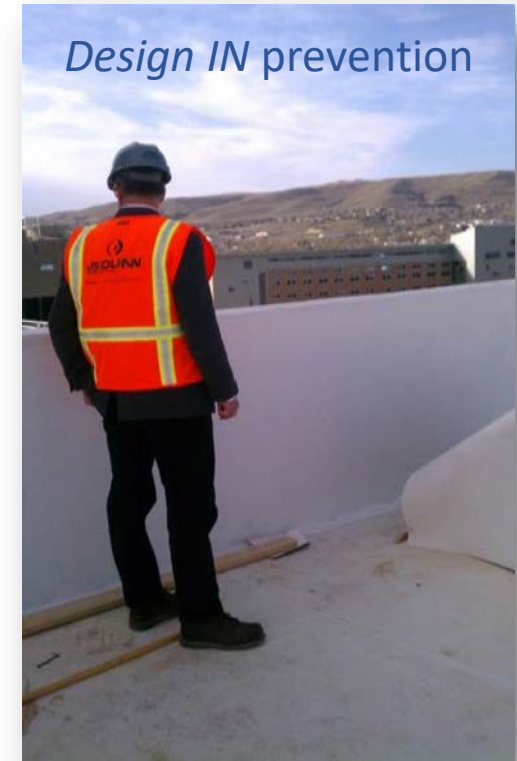
A Different Way of Thinking



1940/50: NO fall protection,
and later HVAC placed near edge
(old hospital wing)



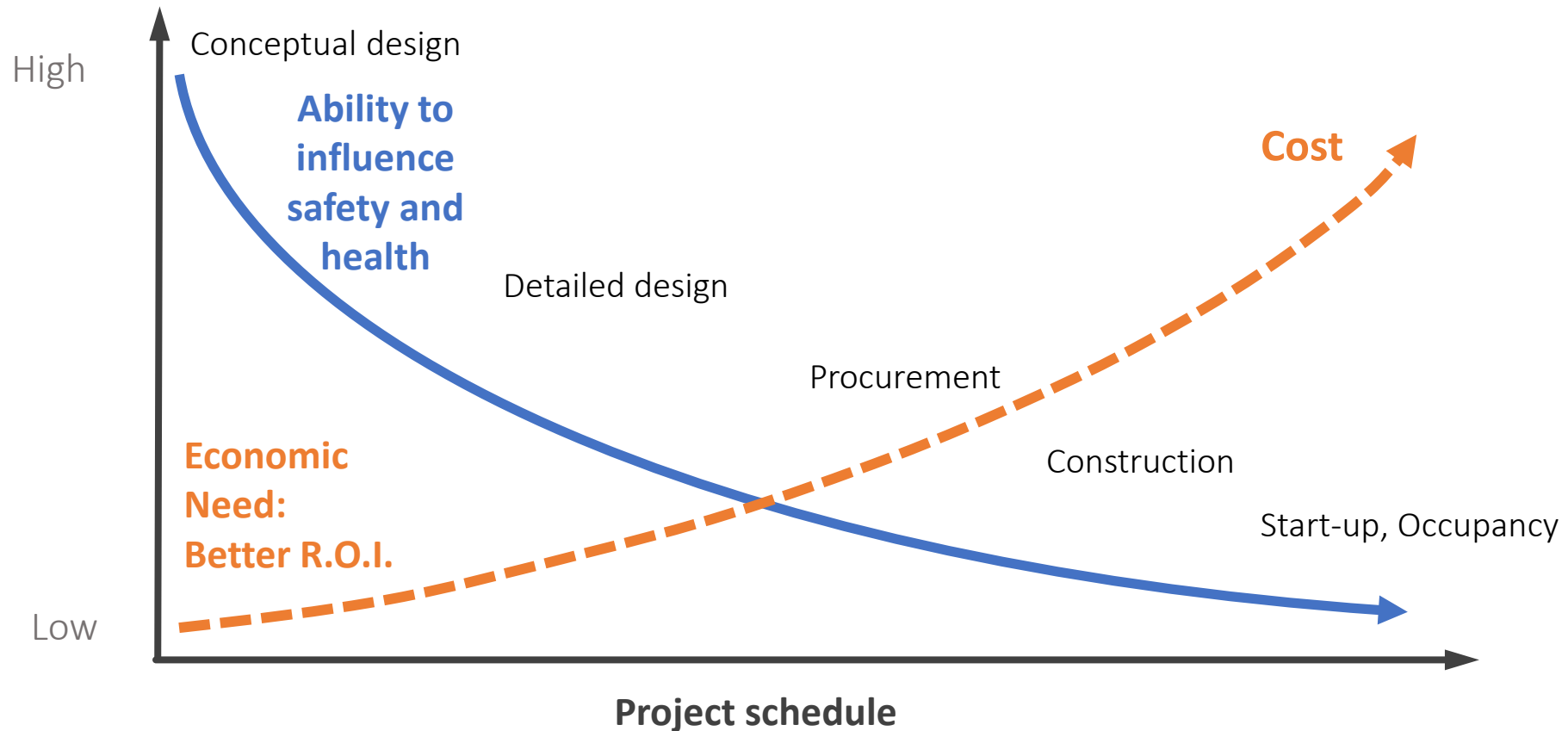
2015: *Partial* PtD ... it still relies on PPE or
“**MUST TRUST**” systems
(new hospital wing)



2015: Best PtD, Parapet
ELIMINATES fall hazard
(different facility)

Photos courtesy of [TJ Lyons](#), Total Facility Solutions

Business: “What’s in it for me?”



(Adapted from: Szymberski, R., “Construction Project Safety Planning.” TAPPI Journal, Vol. 80, No. 11, pp. 69-74.)

Good: Protect the Receiver ...

Courtesy of
[TJ Lyons](#),
Total
Facility
Solutions

WORKING SAFER BY DESIGN

PtD During Construction




Conventional pedestrian protection
(rooftop mechanical upgrades – NYC)

Better: Stop it at the Source !

Courtesy of
[TJ Lyons](#),
Total
Facility
Solutions

WORKING SAFER BY DESIGN

PtD During Construction Must Answer “What’s in this for me?”



Rooftop barrier instead –
1/3 the cost (six figures) ✓

\$

Photo by Jeff Hutchens

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Fresh Thinking for Old Problems

Courtesy of
[TJ Lyons](#),
Total
Facility
Solutions

WORKING SAFER BY DESIGN

Field Study – Impalement Protection



Protection often removed to work

Fresh Thinking = *Better* Solutions!

WORKING SAFER BY DESIGN

Preventing through Design Risk Elimination



Copyright © 2011 Wayne Woodruff

Courtesy of
[TJ Lyons](#),
Total
Facility
Solutions

Better Solutions can cost *less*

Courtesy of
[TJ Lyons](#),
Total
Facility
Solutions



WORKING SAFER BY DESIGN

Answering “What's in this for me?”

*16' – 2 rows of 24 (48) Impalements (initial cost)	Candy-Cane	Carnie Cap	Wood Trough	Rebar Cap
Device or fasteners	\$0.51	\$12.04	\$1.00	\$60.00
Lumber needed		\$13.04	\$42.16	
Labor (55/hr.) Install/Remove/Store or assemble	\$0.35	\$21.84	\$15.90	\$25.48
Total Cost	\$41.28	\$46.92	\$59.06	\$85.48
Cost per impalement protected	\$0.86	\$0.97	\$1.23	\$1.78
	0.00%	12.00%	43.00%	106.00%

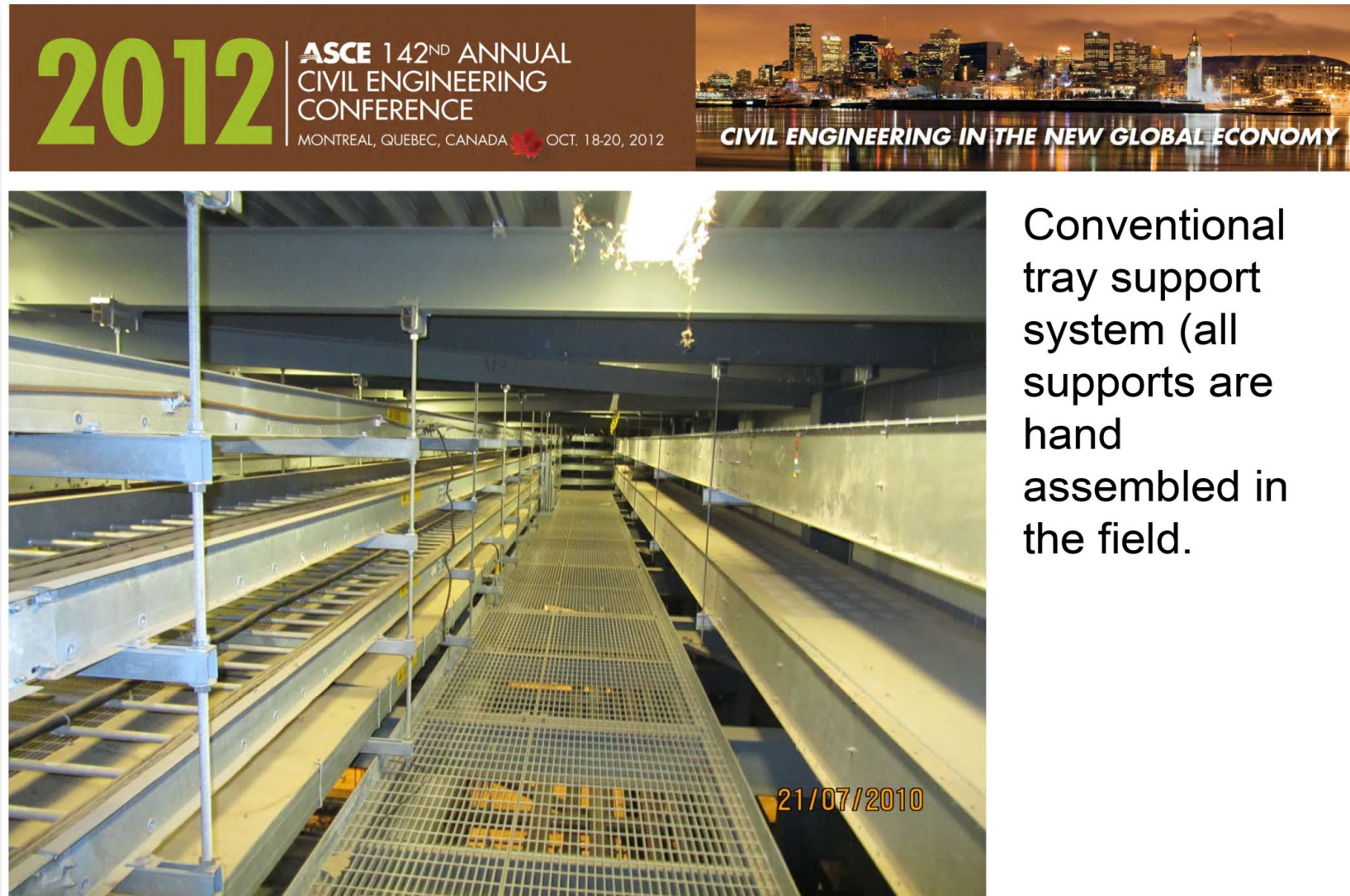
ADPROV – The “Get Bent” approach will be incorporated into the design of rebar incorporating a radius or right angle termination to eliminate impalement hazards.

Modular & Pre-fab can add Safety and Savings



<https://designforconstructionsafety.files.wordpress.com/2017/07/brad-giles-ptd-presentation-asce-montreal-2012.pdf>

Difficult work in tight spaces ...



Conventional tray support system (all supports are hand assembled in the field.

Re-design: Modular, Pre-fab ...




Planning: Prefab unit installed



Cable tray bundle being lifted into Absorber building Unit 1 by electricians and ironworks (timing correct – no overhead steel)

Costs can be considerably LOWER!

\$

<div><div>2012</div><div>ASCE 142ND ANNUAL CIVIL ENGINEERING CONFERENCE MONTREAL, QUEBEC, CANADA OCT. 18-20, 2012</div></div> <div><p>CIVIL ENGINEERING IN THE NEW GLOBAL ECONOMY</p></div>			
Cost category	Preassembly	Stick build	Savings
Craft hours	1,300	7,910	6,610
Craft related costs	\$79,812	\$477,391	\$397,579
Material and assembly costs	\$142,408	\$132,389	(\$10,019)
Engineering hours	743 (required to develop design of modules)	0 (original design based on typical details from previous project)	(743)
Engineering costs	\$92,291	0	(\$92,291)
Total costs	\$314,511	\$609,780	\$295,269

The above represents a 48% total savings and a 83% installation savings. Opportunities for future savings will be by the elimination of the added engineering costs by standardizing this method of supporting cable tray in long runs of vertically stacked tray and stacked tray in concentrated areas.

The constructability approach is being applied to 75% of project applications, duct work, cable trays, piping, handrail, stairwells, etc. The project has worked since August 2008 1.8 million safe work hours without a days away case.


Ground Assembly: low risk, high productivity

Courtesy of
[TJ Lyons](#),
Total
Facility
Solutions




WORKING SAFER BY DESIGN

Prefabricate, prefabricate, prefabricate...



Two construction workers wearing hard hats are sitting on a roof, working on the installation of prefabricated panels. The sky is clear and blue.

"We actually did it 30% faster than planned."
Alan Max Construction



A large yellow crane is lifting a massive, prefabricated roof section into place. The roof section is made of light-colored wood or composite material. The ground is covered in snow, and a yellow truck is visible in the background.

25

Prefabrication, Modularity



Steel Stairs



Steelwork



Concrete Wall
Panels

Dr. Mike Toole

www.DesignForConstructionSafety.org



Design Protects Miners' Hearing, Triples chain life

Design improvements to the onboard conveyor of a continuous coal mining machine to reduce noise exposures by 3 dB(A).

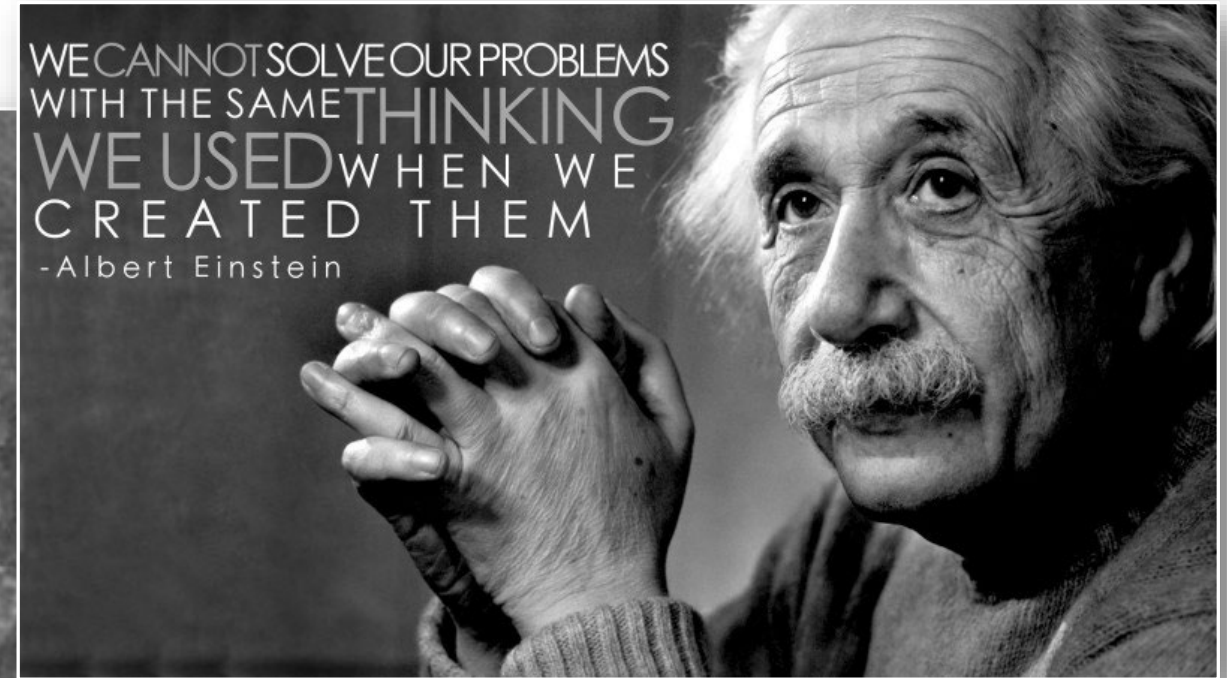
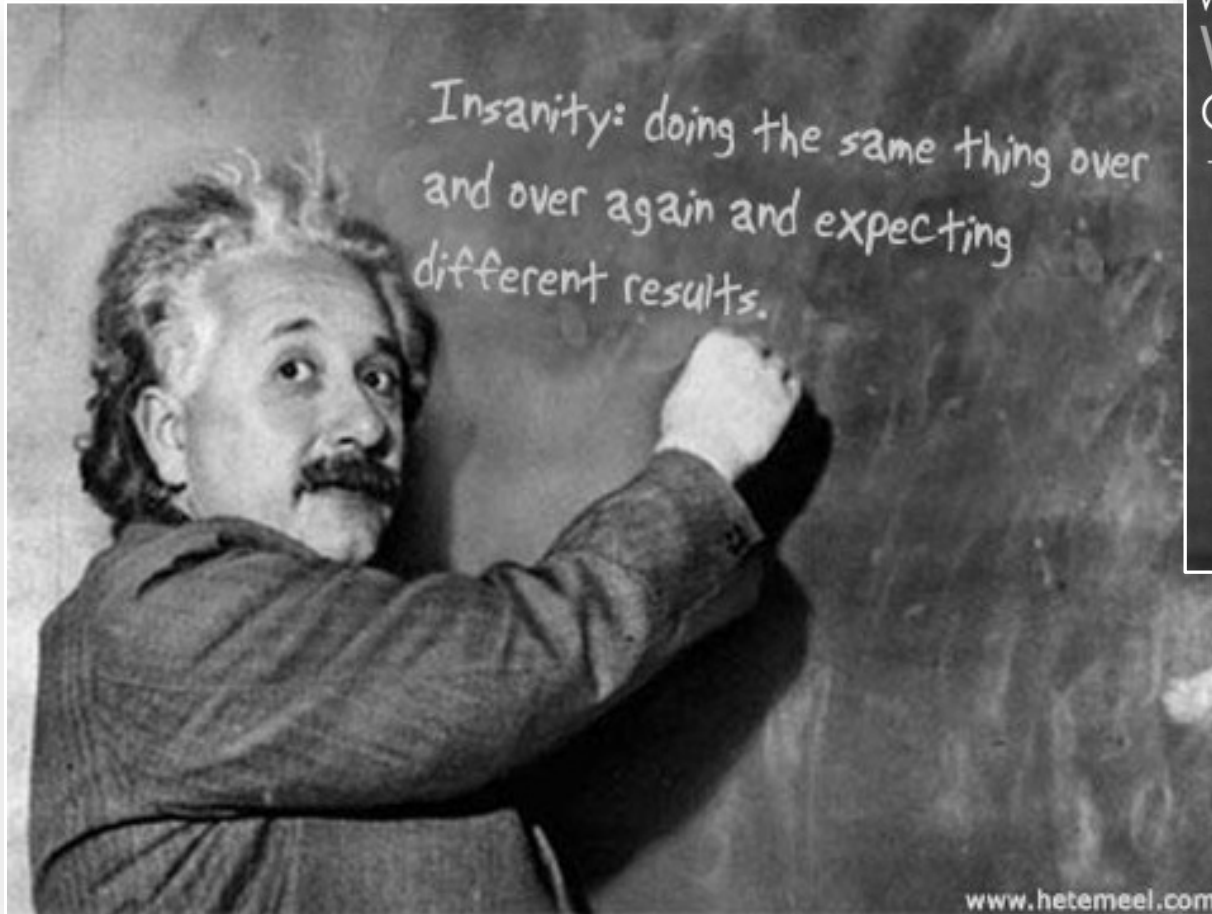
Coating the chain conveyor and flight bars protects mine operators' hearing and extends the life of the chain 3-fold, more than offsetting the 20% cost increase.

Source: Kovalchik PG, Matetic RJ, Smith, AK, Bealko SB [2008]. Application of Prevention through Design for Hearing Loss in the Mining Industry. Journal of Safety Research 39(2): 251–254.



It doesn't take an Einstein

"PtD requires a designer with a crystal ball!"

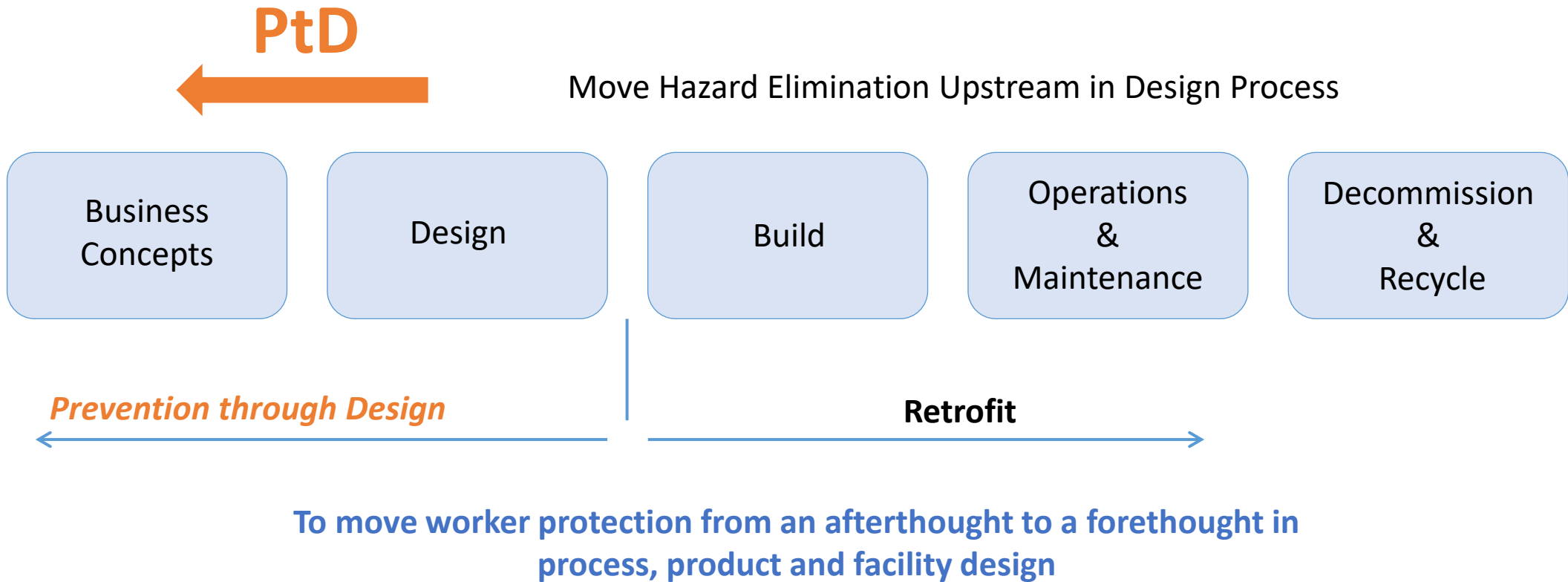


Some think of "PtD" as equipment designed by REALLY clever people

That isn't the way it works ...



The *Process* of PtD is “Design”



“Lessons Learned” are brought into Design Safety Reviews



This is PtD

1. More Passive protections

Interventions at the top levels of the Hierarchy

- Avoid, Eliminate, Substitute, Engineering Control

Interventions reducing the “Must Trust” factor

- more passive protections, depending less or none on worker actions
- at any level of the Hierarchy

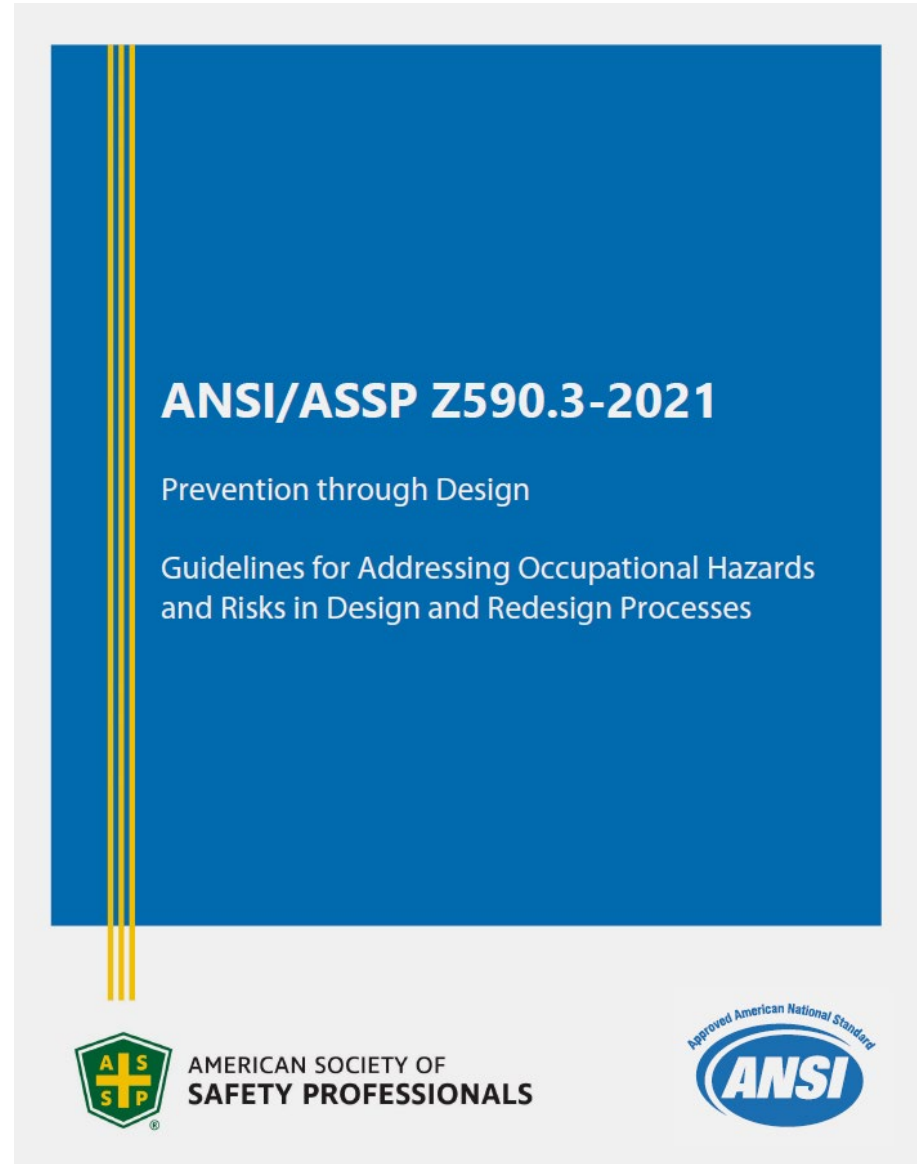
2. A process to get there

Using a collaborative Risk Management process

- to identify hazards, assess their risks, and choose alternatives
- focusing on the upper Hierarchy or more passive control

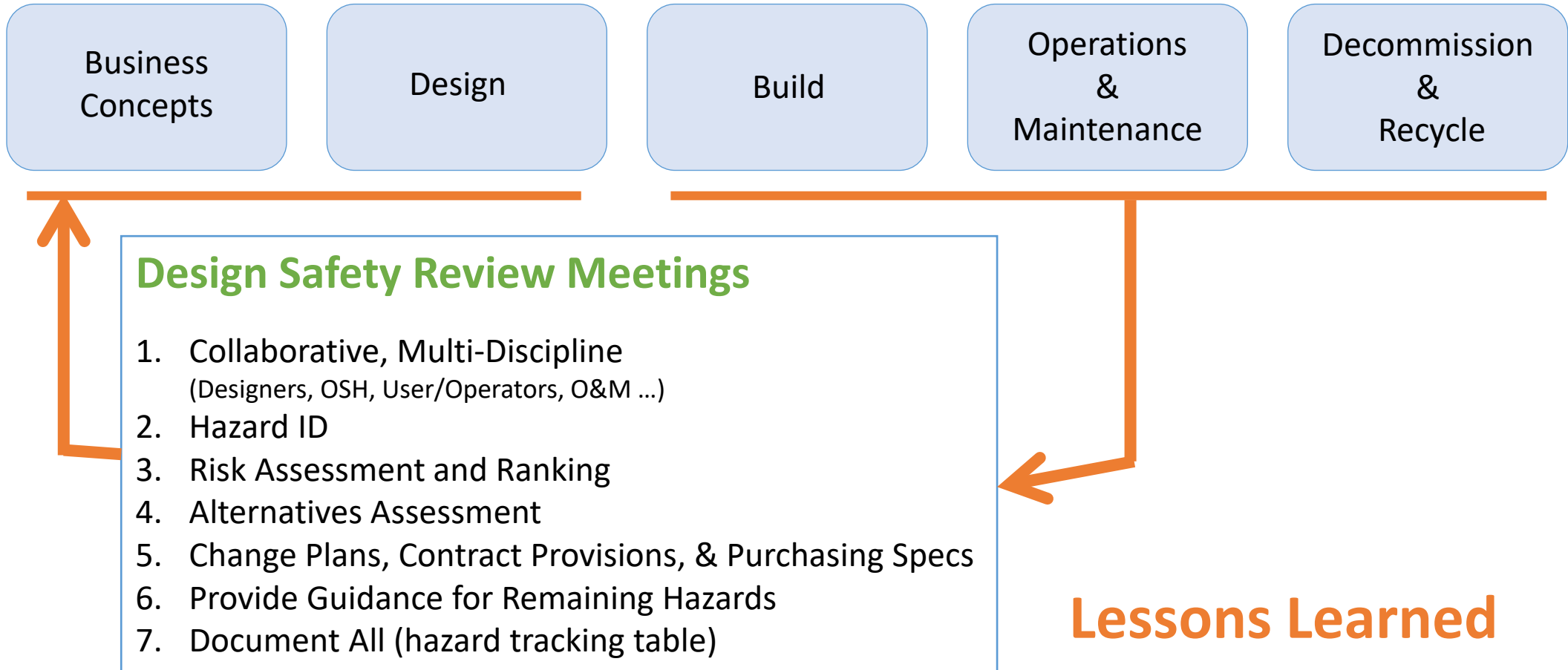
Use the PtD Design Process

- For a great PtD *PROCESS*, follow the Z590.3
- Just 21 main pages
- Plus 12 helpful Addenda
- It is “**System Safety** Light”
- It provides a design safety review *PROCESS* for any type of business





The PtD *Design* Process



A Table or Spreadsheet helps ...

Activity: <i>(your DSR team identified this work activity earlier)</i>	Hazard: <i>(your DSR team identified these hazards earlier)</i>	Risk before control <i>(DSR analyzed earlier)</i>	Control: <i>(your DSR team came up with these alternatives earlier, from experience, expertise, books, web search, checklists, etc)</i>	Risk after control	Non-financial Aspects: <i>(pro and con)</i> <i>(Worker participation, contribution, impact, satisfaction, morale; Social Responsibility; Community reputation; Reputation with Patients, Residents, Families; Product/service quality; Liability; Environmental Stewardship; Industry reputation; Competitive edge, etc)</i>	Financial Aspects: <i>(pro and con)</i> <i>(worker health & safety, lost work days, productivity, lawsuits, OSHA fines, PPE, training, equipment, facility mods, Increased or decreased demand/sales, initial vs. ongoing costs, etc)</i>
Resident Areas: Existing make-do resident lifting using available personnel	Back Injury, Patient Injury, Assaults on care-givers	HIGH	Provide lifting back belts			
			Lifting technique training			
			Require two person lifts and strongest persons			
			Designate separate "lifting teams" to perform lifts			
			Purchase mobile lifts			
			Install motorized lifts into tracks on the ceiling			

RISK ASSESSMENT MATRIX				
SEVERITY PROBABILITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

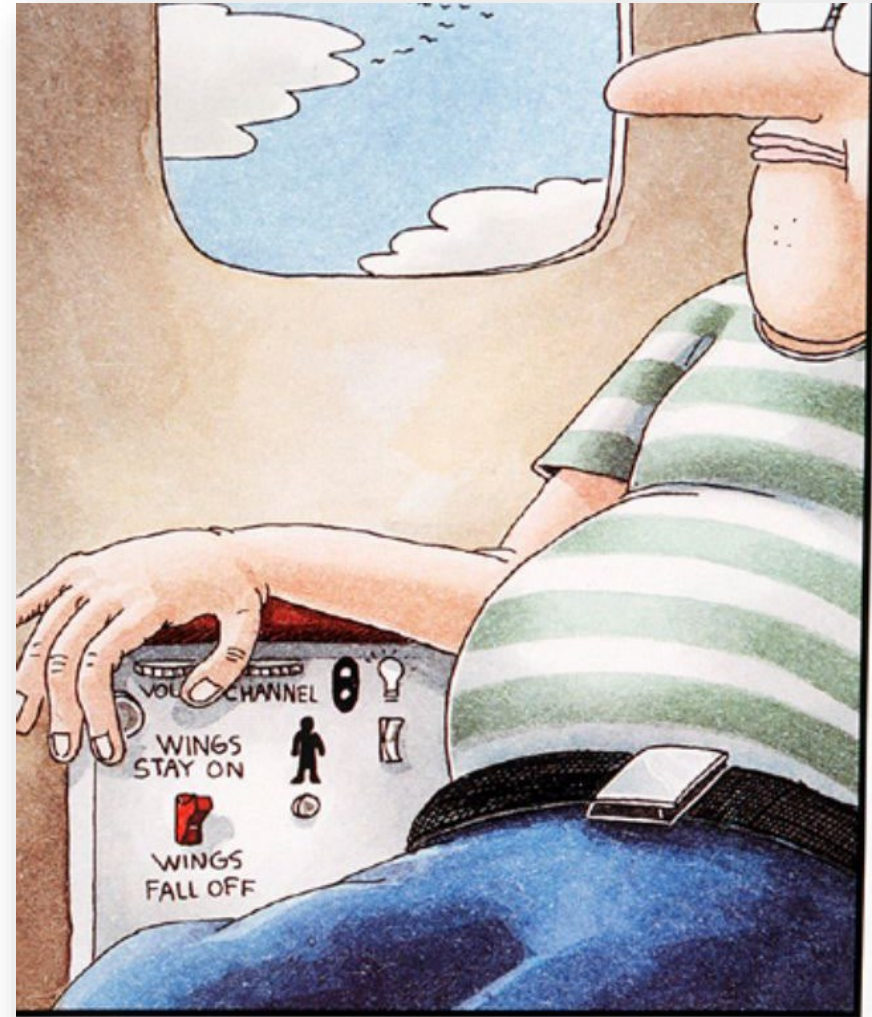


Do “Accident Investigation” Differently

- A *Blame Culture*? “88% human error” (H.W. Heinrich)
 - We “investigate,” find human error, and **STOP**
 - We short-circuit analysis and miss *system* problems, i.e. contributing factors, root cause(s)
 - Typical Corrective Action? ... “re-brief, re-train, re-mind”
- Better: A *FACT-finding culture* (not Fault-finding)
 - **START** at human error, don’t stop there
 - Find *system* conditions that *provoke* human error
 - **DESIGN OUT error-provocative conditions – PtD!**

Error Provocative?

*Identify, then
design out,
system conditions
that **PROVOKE**
error*



Fumbling for his recline button, Ted unwittingly instigates a disaster.

Error Provocative in the real world





Resources: Incident Analysis *Systems* model

- ASSP Professional Safety journal:
 - *Reviewing Heinrich: Dislodging Two Myths From the Practice of Safety*, Fred Manuele, Oct 2011
 - *Incident Investigation: Our Methods are Flawed*, Fred Manuele, Oct 2014
- Also see S. Dekker, J. Reason, E. Scott Geller:
 - The ASSP papers above summarize their work
 - Watch: “*Designing Out the Error Provocative*”
www.youtube.com/watch?v=2LVMafEljmw
 - Web Search: “Strategies to Prevent Serious Injuries & Fatalities Brent Cooley”
– Great slide deck



CPS is PtD

- Loss of Containment ... things that go BOOM ... are worker hazards
- The PSM regs are *OSHA* regs
- System Safety = CPS = PtD
- CPS is Hazard ID, Risk Assess, Alternatives Assessment, etc.
- Chemists and Engineers love to creatively DESIGN-OUT problems

Something to avoid:

“You should be talking to the Personnel Safety office, not us ... Personnel Safety (hard hats, etc) is taken care of by the office over there ...”

PtD helps CPS

- Worker daily exposures include a full range of industrial hazards ...
- Hazards, and work difficulties, in structures, equipment, tools, and work organization can also be DESIGN-OUT
- Improving Human Factors also improves worker ability to make sure mechanical integrity is known and maintained. Valves, gauges, and fittings will be easier and faster to access, check, and maintain

“As designers, we are key members of PtD Design Safety Review teams. Making work easier also helps assure CPS mechanical integrity.”

CPS/NIOSH 2011: Worker safety?

Exposing the Blurry Lines between Personal Safety and Process Safety Education: Contrasting NIOSH Prevention through Design (PtD) with CCPS SACHÉ

Trey Morrison, PhD, PE

- 

Ryan J. Hart, PhD

- 

Pamela Heckel, PhD, PE

- 



AIChE National Meeting

Minneapolis, MN

October 2011



Suggestions for how and where to plug this into SACHÉ

- Currently 53 Products on SACHÉ website
- None explicitly address worker safety

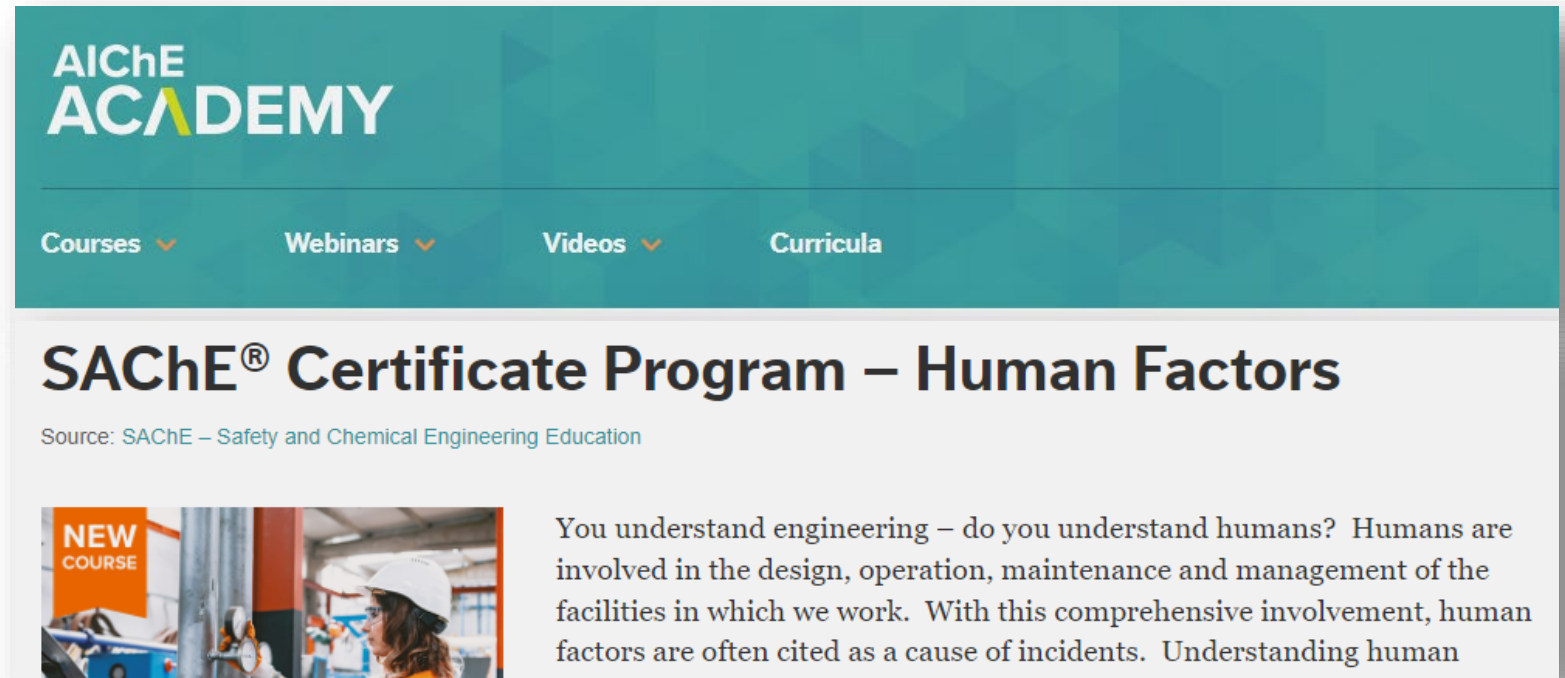


Outline for a SACHÉ Module

- Intro to Occupational Safety & Health
- Consider during Process Design, PHA, Risk Analysis:
 - Human Factors
 - Confined Space Entry
 - Hot Work
 - Line Break
 - PPE
 - Chemical Hazard Communication

Good News

AIChE now has a Course



The screenshot shows the AIChE Academy website. At the top is the AIChE Academy logo. Below it are navigation links: Courses, Webinars, Videos, and Curricula. The main heading is "SACHE® Certificate Program – Human Factors". Below this is the source: "Source: SACHE – Safety and Chemical Engineering Education". There is a "NEW COURSE" badge over an image of a person in a hard hat. To the right of the image is a paragraph: "You understand engineering – do you understand humans? Humans are involved in the design, operation, maintenance and management of the facilities in which we work. With this comprehensive involvement, human factors are often cited as a cause of incidents. Understanding human

Unit 1: Human Factors Introduction

- Section 1: What is Human Factors?
- Section 2: Where Human Factors Fits in Guidance and Regulation
- Section 3: Basic Human Factors Concepts
- Section 4: Human Factors Then and Now
- Section 5: Human Factors Experts

Unit 2: Human Factors Knowledge

- Identify and briefly describe selected human factors knowledge topics.

Unit 3: Human Factors Tools

- Section 1: Human factors engineering.
- Section 2: Critical task analysis.
- Section 3: Team meeting facilitation.
- Section 4: Incident investigation.
- Section 5: Process safety metrics.

Good News

AIChE now has
a Course

But who's it
for?

Who Should Attend

This course introduces the topic of human factors **which is not typically included in engineering curricula**. It is **appropriate for undergraduate** and graduate engineering students as well **as early career professionals**. The material is presented at an introductory level. ... no prerequisites.

SACChE Course Applicability Summary

ELA 981 is recommended for:

- ChemE Practice/Leadership for ChemE's
- Special Topics in Process Safety
- Graduate program (MS, PhD) ... **B.S. ??**
- Process Safety (standalone course)

Is it a default expectation? Is it used?

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LEAD the Effort!

FACTS

- You are central to the Business
- Safety is most REAL when integrated into required business processes ... not “added on”

Improving Human Factors also improves the capability of workers to make sure that your mechanical integrity is known and maintained. Valves, gauges, and fittings will be easy and quick to access, check, and maintain.

- You have a lot to do



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IDEAS and HELP

- Require the Human Factors course for your Chem E staff – and invite the OSH Office
- Share this PtD Design Safety Review slide deck
- During Process Design, PHA, and Risk Analysis, look at Confined Space Entry, Hot work, Line Breaks, PPE, and HazComm.
- Request the OSH Office run PtD Design Safety Reviews with you – for personnel/occ. safety hazards involving your Chemical Process ops



LEAD the Effort!

Unit 3: Human Factors Tools

- Section 1: Human factors engineering.
- Section 2: Critical task analysis.
- Section 3: Team meeting facilitation.
- Section 4: Incident investigation.
- Section 5: Process safety metrics.

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Risk Awareness can be **too Specialized**

- *Your expertise is unique and technical, but is Process Safety **TOO** specialized?*
- *Is CPS too separate from the Occupational Safety office?*
- *Are THEY too separate from you?*
- *It can only get better, with your leadership!*



Central
Taurus
Mountains,
Turkey

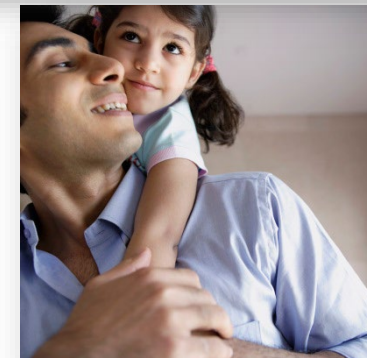


So
WHAT?





*Savings **Lives**, Saving **Families***



For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

