Educating Health and Safety Professionals in PtD

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PtD Principle

“We take our decisions on policy or submit them to proper discussions: **the worst thing is to rush into action before the consequences have been properly debated.** And this is another point where we differ from other people. We are capable at the same time of **taking risks** and of **estimating them beforehand.**”

Fortune 500 CEO?
Not really...

Source:
Need for PtD inclusion in course lectures and student projects

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

- **Research Strategic Goal:** Research will establish the value of adopted PtD interventions, address existing design-related challenges, and suggest areas for future research.

- **Education Strategic Goal:** Designers, engineers, machinery and equipment manufacturers, health and safety (H&S) professionals, business leaders, and workers understand PtD methods and apply this knowledge and skills to the design and re-design of new and existing facilities, processes, equipment, tools, and organization of work.

Source: [http://www.cdc.gov/niosh/programs/PtDesign/goals.html](http://www.cdc.gov/niosh/programs/PtDesign/goals.html)
Why is PtD important for EHS programs?

• In August 2007, the Engineering Practice Specialty group within the American Society of Safety Engineers published an article in a Special Issue of its Newsletter “By Design,” the title of which was “Prevention through Design: Addressing Occupational Risks in the Design and Redesign Processes.” The author of the paper was Fred A. Manuele, CSP, PE. That article was also published in the October 2008 issue of Professional Safety.

• PtD became an integral part of UCM’s EHS courses in early 2009
• Environmental Compliance
• Ergonomics
• Statistical Analysis for Risk Management
• Food Safety
• ICAP
AIHA/ANSI Z10 Adopted in ICAP Course

A provision in ANSI Z10 requires that processes be in place “to identify and take appropriate steps to prevent or otherwise control hazards and reduce risks associated with new processes or operations at the design stage.”

AIHA/ANSI Z10 also says that “The design review should consider all aspects including design, construction, operation, maintenance, and decommissioning.”
PtD EHS Educational Opportunities

Environmental

Safety

Health
Environmental PtD Back up Safeguard Devices

- Acoustic control – Back up
- Regulations – Norway & Brazil

Backup Switch
Oil wells have emergency shut-off valves, called blowout preventers, that can be triggered from the rig, and some also have remote backup triggers. The Deepwater Horizon didn't have a remote trigger. The rig did have a 'dead man' switch that should have automatically shut down the well in the case of a catastrophic failure.

- Acoustic control (backup)
  Acoustic pulses carry a signal through the water to trigger the blowout preventer.

- 'Dead Man' switch (secondary)
  Designed to automatically cut the oil if the connection between the rig and subsea unit is severed.

Note: Drawings are schematic and not to scale. Source: Skogsberg
## AIHA Exposure Categorization Scheme

<table>
<thead>
<tr>
<th>Exposure Category</th>
<th>Rule-of-Thumb Description</th>
<th>Qualitative Description</th>
<th>Recommended Statistical Interpretation</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Exposures are trivial to nonexistent – employees have little to no exposure, with little to no inhalation contact</td>
<td>Exposures, if they occur, infrequently exceed 1% of the OEL</td>
<td>$X_{0.95} \leq 0.01 \times OEL$</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Exposures are highly controlled – employees have minimal exposure, with little to no inhalation contact</td>
<td>Exposures infrequently exceed 10% of the OEL</td>
<td>$0.01 \times OEL &lt; X_{0.95} \leq 0.1 \times OEL$</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Exposures are well controlled – employees have frequent contact at low concentrations and rare contact at high concentrations</td>
<td>Exposures infrequently exceed 50% of the OEL and rarely exceed the OEL</td>
<td>$0.1 \times OEL &lt; X_{0.95} \leq 0.5 \times OEL$</td>
<td>2, 3, 4</td>
</tr>
<tr>
<td>3</td>
<td>Exposures are controlled – employees have frequent contact at low concentrations and infrequent contact at high concentrations</td>
<td>Exposures infrequently exceed the OEL</td>
<td>$0.5 \times OEL &lt; X_{0.95} \leq OEL$</td>
<td>2, 4</td>
</tr>
<tr>
<td>4</td>
<td>Exposures are poorly controlled – employees often have contact at high or very high concentrations</td>
<td>Exposures frequently exceed the OEL.</td>
<td>$X_{0.95} &gt; OEL$</td>
<td>4</td>
</tr>
</tbody>
</table>

Notes: 1—Category 0 was added to distinguish between highly-controlled exposures and situations where exposures are either nonexistent or trivially low. It was included in the 1991 AIHA rating Scheme. 2—“Infrequently” refers to an event that occurs no more than 5% of the time. 3—“Rarely” refers to an event that occurs no more than 1% of the time. 4—“High concentrations” are defined as concentrations that exceed the TWA OEL.

Source: “Rating Exposure Control Using Bayesian Decision Analysis,” by Hewett et al.
PtD - Health

<table>
<thead>
<tr>
<th>Substance Name</th>
<th>NOEL</th>
<th>Safety Factor</th>
<th>OEL=</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,3,7,8-TCDF</td>
<td>0.1</td>
<td>10</td>
<td>0.07 um/m³</td>
</tr>
<tr>
<td>2,3,7,8-TCDD</td>
<td>1</td>
<td>10</td>
<td>0.7  um/m³</td>
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<tr>
<td>2</td>
<td>2</td>
<td>4</td>
<td>3.5</td>
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<td>3</td>
<td>3</td>
<td>7</td>
<td>3</td>
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<tr>
<td>4</td>
<td>4</td>
<td>6</td>
<td>4.666667</td>
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<tr>
<td>5</td>
<td>5</td>
<td>9</td>
<td>3.888889</td>
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<tr>
<td>6</td>
<td>6</td>
<td>10</td>
<td>4.2</td>
</tr>
</tbody>
</table>

\[ OEL = \frac{\text{NOEL} \times 60 \text{ kg}}{10 m^3 (\text{Safety Factor})} \]

Some On-line Databases of Chemical Human Hazard Data Sources:

- Toxicology Data Network (TOXNET) (http://toxnet.nlm.nih.gov)
- TSCATS (http://www.syres.com/esc/tscats.htm)
- IPCS INCHEN (http://www.inchem.org)
- NTP (http://rtp-server.niehs.nih.gov)
- ATSDR (http://www.atsdr.cdc.gov/toxpro2.html)
- EPA HPV Challenge Program (http://www.epa.gov/chmrxk/volchall.htm)

CONTROLLING HAZARDS

“TRADITIONAL”

- Engineering Controls
- Administrative Controls
- Personal Protective Equipment

Textbooks???
Welding Fumes – PtD Ventilation Controls

Example
Welding Fumes – PtD Ventilation
Controls
Cr VI Exposure before PtD Eng. Controls

![Cr VI Exposure Graph]

- **Employee Name**: Welder 1, Welder 2, Welder 3, Welder 4
- **Cr VI Concentration**
  - Welder 1: 3
  - Welder 2: 3
  - Welder 3: 1
  - Welder 4: 6
- **8 Hour OSHA PEL TWA**
- **8 Hour OSHA Action Level**
Conditions before controls
Welding Fumes – PtD Ventilation Controls

Overall system, 12” reduced to “8, to 6”, into flex going into fixture top tube
- Welding Fumes – Ventilation Controls

Inlet pipe, 2-1/2 in dia with flare on end
Tailpipe tube, 4 in dia., goes into 4x4 pipe on backside of fixture
Outlet end welds collected by 4 in dia., goes into 4x4 pipe on front of fixture – also have a few perforated holes on underside of 4x4
8 Hour OSHA Action Level

Exposure after Eng. Controls
PtD – Safety

• HAZARDS ANALYSES AND RISK ASSESSMENT TECHNIQUES
• Preliminary Hazard Analysis (PHA): Initial Hazard Analysis and Risk Assessment.
• What-If/Checklist Analysis.
• Hazard and Operability Analysis (HAZOP).
• Failure Mode and Effects Analysis (FMEA).
• Fault Tree Analysis (FTA).
• Management Oversight and Risk Tree (MORT).
The Risk Assessment Process

1) Data gathering—Injury and proactive data
2) Set the limits/scope of the strategy leadership team sponsorship
3) Develop and charter risk reduction team
4) Identify tasks and hazards
5) Assess risk—Initial risk scoring system
6) Reduce risk—Hazard control hierarchy
7) Assess risk—Residual risk scoring system

Residual risk acceptable?

Yes
8) Results/documentation
9) Controls measurement system

No
10) New hazard ID

Identify current controls
Test/verify current controls
Identify new controls
PtD – Safety


**PRELIMINARY HAZARD ANALYSIS WITH TRACKING LOG**

<table>
<thead>
<tr>
<th>Hazardous Event</th>
<th>Casual Factors</th>
<th>System Effects</th>
<th>RAC</th>
<th>Comments</th>
<th>Recommended Actions</th>
<th>Controlled RAC</th>
<th>Standards</th>
<th>Action</th>
<th>Ref. Document</th>
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<tbody>
<tr>
<td>API Compound</td>
<td>API Release</td>
<td>CNS affected</td>
<td>15</td>
<td>Glove Bag</td>
<td></td>
<td>7</td>
<td>None</td>
<td>Compl.</td>
<td>Glove Bag SOP</td>
</tr>
</tbody>
</table>

- New API
- Prepared by: GP
- Methods Used: Checklist Review

Date:
PtD – Safety

- Failure Mode and Effects Analysis (FMEA).

<table>
<thead>
<tr>
<th>Part or Process Name</th>
<th>Suppliers &amp; Plants Affected</th>
<th>Prepared By</th>
<th>Design/ Mfg Responsibility</th>
<th>Model Date</th>
<th>Engineering Change Level</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Process Operation, Function or Purpose</th>
<th>Potential Failure Mode</th>
<th>Potential Effect(s) of Failure</th>
<th>SEV</th>
<th>Potential Cause(s) of Failure</th>
<th>OCC</th>
<th>Current Controls Evaluation Method</th>
<th>DET</th>
<th>S x O</th>
<th>RP N</th>
<th>Recommended Action(s)</th>
<th>Area/Individual Responsible &amp; Completion Date</th>
<th>Action Results Actions Taken</th>
<th>S x Y 2</th>
<th>DET 2</th>
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<tr>
<td>API Compound</td>
<td>Exposure</td>
<td>CNS affected</td>
<td>5</td>
<td>Respirator failure</td>
<td>2</td>
<td>Fit Test</td>
<td>3</td>
<td>10</td>
<td>30</td>
<td>Glove bag</td>
<td>Management</td>
<td>Reduced Exposure</td>
<td>5</td>
<td>1</td>
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FMEA Process  
FMEA Overview  
RPN Definition  

RPN also defined in: The Six Sigma Handbook, Revised and Expanded By Thomas Pyzdek.
PtD and Industrial Management

• Examples of lean and PtD conflict

Pneumatic press with adjustable guards pinned out of the way in conflict with safety standards

Need to “educate” Industrial managers

Leadership Responsibilities:
- Goals and objectives for PtD and lean
- Continuous improvement
- Define, Measure, Analyze, Improve and Control (DMAIC)

Lean
- One piece flow
- Cell / machine process
- Pull
- Fast Setup
- TPM

Safety
- Operator safety
- Maintainability / accessibility
- Layout / Environment
- Reduced downtime
- Task-based risk assessment

Inputs:
- Machines
- Equipment
- Material
- Humans
- Environment / Culture

Outputs:
- Throughput
- Cost of production
- Injury / Illness
- Defects
Need to “educate” Business Managers

Too often:

- Management has a reactive rather than proactive focus
- Lack of understanding (vocabulary – PtD, SAFETY)
- Risks & hazards are poorly communicated
- Safety is considered a cost ... not an investment
- Cost/benefit analysis is rarely applied to justify the EHS investments
- Business analysis tools are not commonly used to justify safety investments
- Retrofitting is never as cost-effective as designing it right initially. NIOSH PtD
- EHS professionals should be involved in the early design stages and life cycle assessments.
SAFETY FIRST