Rasmussen’s Risk Management Framework
Applied to Academic Laboratory Safety

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Today, I would like to say a few words about my master’s thesis, review Rasmussen’s model, and present some ideas how it can be applied to academic laboratory safety.
Introduction

My master’s thesis: I compared different laboratory accidents that occurred at primary educational institutions, colleges, and universities.

Figure 1 Lab Explosion (Chemical Safety Board, 2019).
Figure 2 Lab Explosion (Phifer, 2014).
Figure 3 Lab Explosion (Merlic, Ngai, Schroeder & Smith, 2016).
Introduction

Statistics
The U.S. Chemical Safety Board published list of incidents that occurred in laboratories.

Information was received from multiple sources, the media, and the U.S. Coast Guard’s National Response Center (CSB Releases Laboratory Incident Data [Jan. 2001 - Jul. 2018], 2018).

Total of 261 Incidents
<table>
<thead>
<tr>
<th>Case</th>
<th>Title</th>
<th>Institution Type</th>
<th>Author or Source, Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CXXV. An Accident with Acetic Acid and Bromine</td>
<td>University</td>
<td>Burnett, 1975</td>
</tr>
<tr>
<td>2</td>
<td>Hazards in a Photography Lab - A Cyanide Incident Case Study</td>
<td>University</td>
<td>Houk &amp; Hart, 1987</td>
</tr>
<tr>
<td>3</td>
<td>Injury and Fire Resulting from Benzene Vapor Explosion in a Chemistry Laboratory</td>
<td>University</td>
<td>University of California, Irvine Independent Accident Investigation, 2002</td>
</tr>
<tr>
<td>4</td>
<td>Mercury Spill Decontamination Incident at the Rockefeller University</td>
<td>University</td>
<td>Santoro, 2006</td>
</tr>
<tr>
<td>5</td>
<td>Texas Tech University - Laboratory Explosion</td>
<td>University</td>
<td>Chemical Safety Board, 2010</td>
</tr>
<tr>
<td>6</td>
<td>Laboratory emergency response: A case study of the response to a 32P contamination incident</td>
<td>University</td>
<td>Ashbrook, 2011</td>
</tr>
<tr>
<td>7</td>
<td>Case study - Incident investigation: Laboratory explosion</td>
<td>University</td>
<td>Phifer, 2014</td>
</tr>
<tr>
<td>8</td>
<td>Key Lessons for Preventing Incidents from Flammable Chemicals in Educational Demonstrations</td>
<td>Educational Museum</td>
<td>Chemical Safety Board, 2014</td>
</tr>
<tr>
<td>9</td>
<td>Report to the University of Hawaii at Manoa on the Hydrogen/Oxygen Explosion of March 16, 2016</td>
<td>University</td>
<td>Meric, Ngai, Schroeder &amp; Smith, 2016</td>
</tr>
<tr>
<td>10</td>
<td>Case study - A two-liter pyridine spill in an undergraduate laboratory</td>
<td>University</td>
<td>Eichler, 2016</td>
</tr>
<tr>
<td>11</td>
<td>Case study: Reaction scale-up leads to incident involving bromine and acetone</td>
<td>University</td>
<td>Chance, 2016</td>
</tr>
</tbody>
</table>
Introduction

- **Bowtie Methodology**

- **Similarities:**
  - Lack of Supervision
  - Deviation from Protocol
  - Inadequate Training
  - Inadequate or Delayed Emergency Response

*Figure 4 Bowtie Diagram (Dedianous & Fieves, 2006).*
ACS approved programs **should promote** a safety culture. However, there is **no required chemical safety class** (ACS, n.d.).

Researchers concluded that the **most effective way** of reducing incidents at academic institutions is the **improvement of engineering controls** (Hellman, Savage & Keefe, 1986).

Another group evaluated survey results and found that assigning **numerical values** to different **parameters for a safety climate** was a **difficult task** (Steward, Wilson & Wang, 2016).
Some good ideas for improving the safety

- Including a **JHA assignment** to an undergraduate laboratory course (Sigmann & McEwen, 2016).
- Forming student “**safety teams**” and including **hands-on safety training** to the teaching curriculum (Alaimo, Langenhans, Tanner & Ferrenberg, 2010).
- A **laboratory safety trivia game** (Gublo, 2003).
But let’s take a look at general system safety.
System Safety - Safety Maturity Level
The organization fixes the situation after undesired incidents occur. This level of a safety culture is defined as “reactive” (2 out of 5) (Hudson, 2001).

Figure 6 The evolution of safety culture (Hudson, 2001).
Some well established risk management models assume hierarchical orders and fixed positions for different categories of hazard controls.

Figure 7 Pecking Order (www.writeopinions.com, n. d.).
Literature Review

Figure 8 Swiss cheese model of accident causation (Reason, 1990).

Figure 9 Hierarchy of Controls (Center for Disease Control, 2018).
Economics and productions influence work practices → degradation of system barriers (Rasmussen, 1997 as cited by Walker et al., 2012).
Rasmussen’s Risk Management Framework & Academic Laboratory Safety

Figure 11 Risk management framework with the migration of work practices (Rasmussen, 1997 as cited by Walker et al., 2012).
Figure 12 Risk management framework with the migration of work practices (Rasmussen, 1997 as cited by Walker et al., 2012).
Rasmussen’s model can be helpful to evaluate the safety cultures of academic institutions.

Future research could investigate how local adjustments influence the risk management framework of the system.

Additionally, effective communication methods need to be explored.
As a instructional support technician for the Jordan College of Agricultural Sciences and Technology, I found that:

- **students** are very interested in learning about safety;
- **faculty and staff** are interested in improving the safety & risk management at their research & teaching laboratories;
- **university administration** is willing to provide resources for improving safety at the academic facilities.
Questions & Discussion

Thank you for your attention!

Figure 13 Cat (memegenerator.net, n. d.).