Speakers

• Tom Williams
  – Director of ASM since 2013
  – Global Operator Effectiveness Leader, Honeywell since 2008
  – Research & Development with Mobil (now ExxonMobil) 1976-1984
  – Three patents, two dozen published papers, presentations, and podcasts
  – BS ChE Princeton, MS ChE Rutgers

• Dr. Peter Bullemer
  – Senior partner, Human Centered Solutions, North American human factors consulting group
  – Specializes in human performance in process industry operations for over 25 years
  – Involved in the 1994 formation of the ASM Consortium
  – Has participated as Principal Investigator, Director and Technical Contributor
  – Over 100 published papers & conference presentations
  – Ph.D., Experimental Psychology, U of MN
• What is an Abnormal Situation?
• Why We Need to Improve
• ASM Brief History
• ASM Consortium Study Rigor
• Where are We Now?
• What Can You Do?
• Find Out More About the Consortium
What is an Abnormal Situation?

**Definition**

- An industrial process is being disturbed, and the automated control system can not cope.

- Consequently, the operations team must intervene to supplement the control system.

**Results**

- Loss of Life
- Personal Injury
- Public Relations Issues
- Environmental Impact
- Equipment Damage
- Reduced Production
- Product Quality
- Job Dissatisfaction

Major Accidents are Rare, But Even Small Mistakes May Have Some Consequence

*Piper Alpha Disaster July 6, 1988*
ASM Relation to PSM

- **Process Safety Incidents**
  - Major Incidents: Incident above threshold for Process Safety Incident
  - Minor Incidents: Incident below impact threshold for PS Incident
  - Near Miss: System Failures that could lead to an incident
  - Unsafe Behaviors: Insufficient Operating Discipline

Illustration from: CCPS *Process Safety Leading and Lagging Metrics*.

Abnormal Situation Incidents

Effective Operations Practices

ASM Seeks to Develop Proactive Methods Based on Human Factors Research
In 2009, 118 reported incidents led to 78 deaths and 213 serious Injuries

Serious Incident Reported Every 3 Days: Recent Data are Not Better

ASM Data from open media 2009
Based on available 1992-3 site incident reports, sources of abnormal situations were characterized as three basic types:

- People & Work Context: 35-58%
- Equipment: 30-45%
- Process: 3-35%

Based on a series of ASM Consortium studies from 2008-2012 of major process safety incidents:
Honeywell assembled a task force of 25 customers in 1989 to address Alarm Management

Phillips’ Petrochemical Explosion 10/23/1989 added urgency

Discussion with US NIST led to formation of the Abnormal Situation Management Joint Research Consortium (ASM)

US NIST Advanced Technology Development Program matched $8.5M member funds with $8.1M for a three year Research Program 1994-1996

Since 1997 all funding has been from members. A total of approximately $45M spent.

85% Research. 15% on Communicating Results
Abnormal Situation Management
Joint Research and Development Consortium

Founded in 1994 - managed and lead by Honeywell

- 16 User Members
  - Amoco
  - BP
  - Celanese
  - ConocoPhillips
  - Equilon
  - Exxon
  - ExxonMobil
  - Mobil
  - NOVA Chemicals
  - Petronas
  - Phillips 66
  - Sasol
  - Shell
  - Texaco
  - Total
  - Union Carbide

- 6 Associate Members
  - ATR
  - Brad Adams Walker Architecture
  - Gensym
  - Human Centered Solutions
  - KBC
  - UCDS

- 7 University Members
  - Mary K O’Conner Process Safety Center
  - Nanyang Tech. U
  - Ohio State U
  - Penn State U
  - Purdue U
  - U of Alberta
  - UCLA

29 Past & Present Members
• **Paradox of Automation**
  – Better automation leads to more sophisticated processes.
  – More sophisticated processes leads to more opportunities for error.
  – We tend to “fix” the increasing errors with still more automation.

• **Paradox of Reliability**
  – Better equipment reliability leads to fewer operator interventions
  – Fewer operator intervention leads to fewer opportunities to learn from experience
  – Less experiential knowledge and skill leads to more human errors
  – We attempt to “fix” the increasing human error with equipment reliability improvements

• **Consequently, when things go wrong, people have difficulty intervening to correct the problem.**

• **Need to better understand how to break the cycles and support human intervention activities**

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**Key Learning**

**Persistent Paradoxes**

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**Not By Technology Alone**
A general conclusion from the initial 1993 study was that the effective human-machine system solution involved more than developing the right technologies

- Cochran & Bullemer, 1996

**Improving human reliability** required addressing the

- Work culture
- Organization structure
- Work processes
- User acceptance and adoption
- Appropriately designed technology

Understand the user problems and design solutions that address the problem and fit the work context
• The ASM Consortium has conducted dozens of studies each year for past 25 years
• ASM Consortium research methodology is grounded in the field of human factors and experimental psychology
• The research has been led by human factors professionals working with personnel from member company operating facilities
• Data has been collected through on-site observations and interviews as well as simulator-based studies with plant operators
• Experimental studies are conducted both at Universities and Member plant sites
Research carried out to determine how operators do their work by tracking their eyes to see what information they need, when, and how long they must observe to obtain the information they need.

Next few slides provide examples of research projects conducted by the ASM Consortium in the seven operations practices areas.
• Shared understanding of abnormal situation causes and impacts, widely communicated across the site, in order to efficiently and accurately inform continuous improvement programs that mitigate and reduce abnormal situations.

• **Example project:** Root Cause Analysis of Industry Incident Reports
  – Develop understanding of operations practice failures in 42 industry incident reports

<table>
<thead>
<tr>
<th></th>
<th>Public</th>
<th>Site</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>21</td>
<td>8</td>
<td>29</td>
</tr>
<tr>
<td>Non USA</td>
<td>6</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>27</strong></td>
<td><strong>15</strong></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>
### ASM Incident Analysis Study

#### Common Operations Failures

- 42 incidents were analyzed using TapRoot incident investigation methodology.
- Organization/Management System Category **most significant impact**

<table>
<thead>
<tr>
<th>Rank</th>
<th>ASMC Operations Practice Category</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Organizational Roles, Responsibilities, and Work Processes</td>
<td>46%</td>
</tr>
<tr>
<td>2</td>
<td>Communications</td>
<td>16%</td>
</tr>
<tr>
<td>3</td>
<td>Process Monitoring, Control, and Support Applications</td>
<td>9%</td>
</tr>
<tr>
<td>4</td>
<td>Procedures</td>
<td>8%</td>
</tr>
<tr>
<td>5</td>
<td>Knowledge and Skill Development</td>
<td>7%</td>
</tr>
<tr>
<td>6</td>
<td>Understanding Abnormal Situations</td>
<td>3%</td>
</tr>
<tr>
<td>7</td>
<td>Work Environment</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>100%</td>
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ASM Incident Analysis Study
Common Operations Failures

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<th>Top Operations Practice Failure Areas</th>
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<td>Continuous improvement</td>
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<td>Task communications</td>
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<td>Initial and refresher training</td>
<td>5%</td>
</tr>
<tr>
<td>Comprehensive MOC</td>
<td>5%</td>
</tr>
<tr>
<td>Cross functional communication</td>
<td>4%</td>
</tr>
<tr>
<td>Compliance with procedures</td>
<td>3%</td>
</tr>
<tr>
<td>Design guidelines and standards</td>
<td>3%</td>
</tr>
<tr>
<td>All other failure modes</td>
<td>29%</td>
</tr>
</tbody>
</table>

- Top 10 covered ~70% of identified operations practice failures
- 6 of 10 practice failures associated with the organizational roles, responsibilities and work process category

ASM® Consortium Guidelines
Effective Operations Practices

Last Revision Date: 10 January 2014
Version: Version 7.00
Prepared by: Peter Bullemer
ASM Joint R&D Consortium

Contact Information:
Consortium Director
HL-ASM-Director@honeywell.com
• Management systems, work practices, organizational structures, and a continuous improvement culture that supports prevention and mitigation of abnormal situations.

• **Example project:** Improve first-line leadership role
  – Create plant manager’s audit checklist based on root cause analysis failure modes

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• Management systems, work practices, organizational structures, and a continuous improvement culture that supports prevention and mitigation of abnormal situations.

• **Example project:** Improve first-line leadership role
  - Create plant manager’s audit checklist based on root cause analysis failure modes

  - The supervisor maintains a presence in the control room and field areas with face-to-face contact periodically throughout a shift to ensure good situation awareness of operations and maintenance activities.
  - The supervisor assigns a stand-in responsibility when leaving the job site.
  - The supervisor enforces clear guidelines on when and how to conduct pre-job briefings.
  - .....

Knowledge and skill development establishes and maintains the competencies needed for effective abnormal situation response.

Knowledge and skill development is a continuous process that is supported by a performance evaluation framework.

**Example project:** Training ASM competencies

- Literature review of crew resource training in other domains
- Site Interviews of current effective practices in technical and non-technical training in abnormal situation management

Communications

• Successful communication between operational and functional team members enables situation awareness under normal, abnormal and emergency situations.

• Team members coordinate with respect to goals and activities, through the use of effective information media to ensure continuity in work conditions.

• **Example project:** Use of checklist to improve shift handover communications
  - Assess impact of handover checklist with structured electronic logbook
  - Develop recommendations for structured communications

Use of Procedures

• Procedure content (whether automated or manual) is up-to-date and provides the guidance and instruction needed to minimize, avoid and recover from deviations in operating intent

• A comprehensive usage policy and procedure development, deployment, analysis, and lifecycle management practices enable effective procedure use

• *Example project:* Procedure Execution Failure Modes during Abnormal Situations
  – Understand how and why failures occur
  – Identify solutions to mitigate failures

<table>
<thead>
<tr>
<th>Common Manifestations</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inappropriate action</td>
<td>15</td>
</tr>
<tr>
<td>Fail to detect abnormal condition</td>
<td>12</td>
</tr>
<tr>
<td>Lack understanding of impact</td>
<td>8</td>
</tr>
<tr>
<td>Fail to detect abnormal situation</td>
<td>4</td>
</tr>
<tr>
<td>Unaware of hazard</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>40</td>
</tr>
</tbody>
</table>

• The work environment enhances operations team situation awareness within their scope of responsibility, operator alertness, efficient work practices, collaborative interactions (including with other disciplines) and abnormal situation prevention and response.

• **Example project:** Vigilance Decrement on Alertness
  – Understand time course of alertness loss with console operations activity

A comprehensive and user-centered set of applications and tools that enables a single point of access to the information needed for operations team situation awareness and effective prevention and response to abnormal situations.

**Example project:** Visual Thesaurus
- Develop feasible and effective visualization techniques for console-wide overview displays.

• Illustration of progress in operations practice solutions & remaining opportunity gaps include:

- **Understanding Abnormal Situations**
  - Language, metrics, incident cause/impact reporting

- **Org. Roles, Resp. & Work Processes**
  - Roles, behaviors, MOC, continuous improvement

- **Training & Skill Development**
  - Competency-based, abnormal situations, non-technical

- **Communications**
  - Across functions, within operations, shift handover

- **Procedures**
  - Compliance, detect & respond to abnormal, design

- **Work Environment**
  - Layout, lighting, noise, alertness & fatigue mgmt.

- **Monitoring, Control, & Support Apps**
  - Situation aware, alarm mgmt, design for abnormal

### Improvement since 1993

- **Possible with Today’s Effective Practices**
- **Opportunity Gaps**

**Effective Practice Achievement**

None - Partially - Mostly - Fully
What can you do to reduce the risk?
Improve the Integrity of your Operations Practices

1. Understand the sources of abnormal situations in your facilities
2. Establish effective first-line leadership
3. Address the work culture of not using procedures
4. Improve communications
5. Improve operator competency for abnormal situation management
6. Provide a Control Room Environment conducive to alert and productive operations
7. Develop effective console operator HMI based on human factors principles
Conclusions

• Significant progress has been made since 1993 in improving operations practices to address the abnormal situation management challenges

• **Raising the typical industry practices** to known effective operating practices **is the opportunity gap to**
  – **Improve human reliability** and
  – **Reduce the associated process safety risk**
A Summary in Guideline Form of ASM Findings, Summarizes <10% of Research

- **Effective Operations Practices** to be released later this year
- Available for purchase, See ASM Consortium web site
What’s on the ASM Web Sites

• Public web site (http://www.asmconsortium.net):
  – Intro to ASM Concepts
  – Archive of Incidents
  – Published presentations, webinars, journal papers, etc.

• Members Site:
  – Substantial body of knowledge: Over 1000 reports: Status, Gate Reviews, about 250 Final Reports, substantial User Member In-kind report archive
  – Search Engine
• The Consortium is pivoting from Research Alone to Helping Members Apply Best Practices:
  – Seek to disseminate the Research, Guidelines, and Best Practices to a broader group. $45Million worth of research documented on Share Point Site
  – Assist members and former members to practice what’s been learned:
    » New “members-only” Share Point Site
    » Access to webinars
    » Fast track access on website to Guidelines, Best Practices
    » Write new guidelines where appropriate
    » Better quality webinars on a broader series of topics
  – Cultivate relationships with other Safety Organizations, like AIChE’s CCPS.
  – Expose next generation engineers to human factors and best practices to improve human performance.
Thank You for Attending

• For more information:
  – See the Public Website: [www.asmconsortium.net](http://www.asmconsortium.net)

• If interested in ASM Consortium membership, contact Tom Williams, [thomas.n.williams@honeywell.com](mailto:thomas.n.williams@honeywell.com)