HYDROCARBON PROCESSING

Improve safety and performance: Abnormal Situation Management Consortium celebrates 20 years

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This October and November represent two milestones in the process industries. The first is unfortunate: Twenty -five years ago, on October 23, 1989, a major polyethylene plant on the Houston Ship Channel (Pasadena, Texas) suffered a devastating series of fires and explosions which killed 23 and wounded 314. The second milestone was the founding of the Abnormal Situation Management Consortium (ASMC), which will celebrate its 20th anniversary in November.

At the time of the disaster, an alarm management task force of petrochemical producers convened by Honeywell had already been meeting to discuss means of reducing alarm overload. The accident galvanized the group to examine the broader issue of incident causes. Eventually, the group coined a new term, “abnormal situations,” to describe any circumstance in which the control system was unable to cope with a disturbance and the operators were forced to intervene. The group proposed the formation of the ASMC with the following justification:

> The largest economic disaster in US history (not due to natural causes) was a $1.6 billion (B) explosion at a petrochemical plant in 1989. This accident represents an extreme case in a gamut of minor to major process disruptions, collectively referred to as abnormal situations... Most abnormal situations do not result in explosions or fires but are costly nevertheless, resulting in poor product quality, schedule delays, equipment damage and other significant costs. The inability of the automated control system and plant operations personnel to control abnormal situations has an economic impact of at least $20 B annually in the petrochemical industry alone.
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> The proposal, submitted to the US National Institute of Science and Technology (NIST), was accepted by NIST’s Advanced Technology Program for matching funds. The new consortium was launched with funding from Honeywell and seven petrochemical partners totaling $8.5 million (MM). This figure was matched by the US NIST ($8.1 MM) to sponsor research and development over the time period of 1995–1997. Since 1998, the ASMC has been independently funded by its member companies, and more than $37 MM has been spent in research activities, both by universities on human factor fundamentals and by consortium members in plant studies to develop working prototype solutions and verify improvements.
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> **How big is the problem?**
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> The Abnormal Situation Management Consortium (ASM) did extensive studies in the North American petrochemicals industry to verify its mission and goals. Data drawn from 1992 showed that, in the US alone, abnormal situations cost industry $10 B annually. While only a few escalated to incidents, the annual cost of frequent minor losses due to abnormal situations (such as quality problems, reduced production, reduced yields and equipment reliability) were substantial. The studies showed that abnormal situations caused a 3%–8% loss in productive capacity, and that 2%–6% of this could potentially be recovered.
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> Recent data on global incidents are not encouraging. The ASMC has been tracking published accounts of incidents, and a significant incident occurs every three days on average. Marsh, an insurance company,

found that the 100 largest losses (1974–2013) from incidents cost the hydrocarbon industry $34 B in property damage alone. In all cases, the losses from lawsuits, fines and regulatory scrutiny were many times greater.

Human factors

Many studies have examined the causes of process industry incidents. They conclude that 40% of the errors are directly due to actions by human operators. Moreover, another 40% are caused by equipment failure, and a significant, perhaps even dominant, cause of those is operation outside of design conditions. All of these are often lumped under the category of "human error," but most of these "human errors" have root causes that go much deeper, to root causes including:

- Poor situational awareness
- Poor operator training
- Confusing circumstances caused by misleading instrument readings.

Given this state of affairs, human factors studies seek to understand, prevent and ameliorate the causes of these failures. From its beginning, the ASMC wanted to understand abnormal situations and the environments in which they take place. To facilitate this understanding, the consortium identified seven practice areas:

1. Understanding abnormal situation causes and effects
2. Organizational: Management practices and structure
3. Knowledge: Improving operator competencies and skills
4. Communications: Dialog between plant personnel
5. Procedures: Proactive use of procedures to reduce mistakes and respond effectively to abnormal situations
6. Environment: Design factors that impact personnel performance
7. Monitoring: Automation to support personnel, provide situational awareness and control.

The ASMC placed human factors at the center of its effort by bringing together university and industrial researchers with training and experience in human psychology and industrial safety to interact with and advise plant operators. Members of these groups share best practices and common issues from which roadmaps and program plans are derived. But ASMC's key discipline is its insistence on rigorous scientific methods to perform its studies followed by verification of the expected improvements in member plants. Another added benefit is that member plants are globally dispersed, so cultural bias is eliminated.

Do these methods work?

Members have collected an impressive dossier of improvements at many plant sites. And the ASMC has published specific studies that demonstrate the financial impact of its human machine interface (HMI) recommendations. It is easier to measure tangible metrics (like impact on production, yields and efficiencies) than the avoidance of incidents. Internal studies show considerable impact on situational awareness, alarm management, procedure improvement and operator competency. A striking example is the data from a 2005 study (**Fig. 1**) indicating that ASMC-compliant displays reduce the time to detect, evaluate, respond to and solve in-plant scenarios. Moreover, the advanced, human-centered displays greatly reduce the gap between the lowest performing operator and the highest performing one.

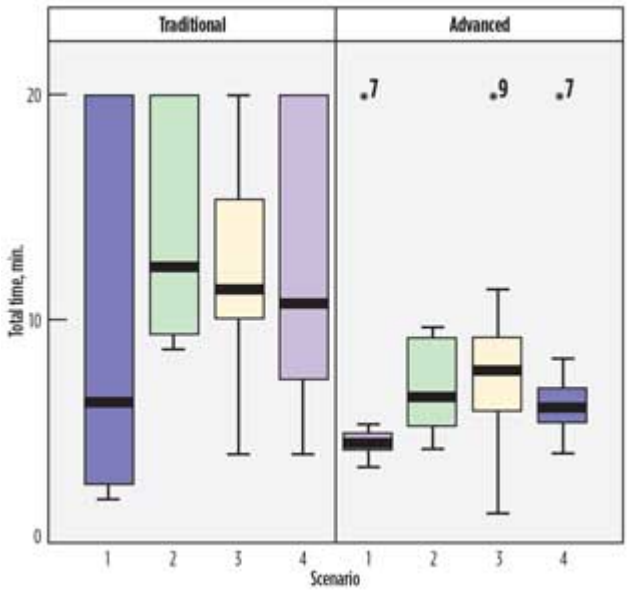

Fig. 1. Comparison in outcome for four scenarios. The total time includes all steps required to return operations to the normal state.

What about non-members?

The ASMC public website (www.asmconsortium.net) catalogs its open literature. These files contain results of dozens of studies, recommendations and white papers issued to provide compelling examples of the consortium's work, and provide links to original journal articles. The consortium has also released guidelines in key areas including displays, alarm management, and procedures.

New developments

The consortium continues to learn and research new areas. For example, it issued a revision to its "HMI Displays for Console Operators" guidelines in late 2013, updating the document for new findings and possible misconceptions. ASMC is also aware that there is a disproportionate percentage of abnormal situations occurring during startup, shutdown and transient conditions, so it is seeking to address HMI, alarms and procedures during those challenging operations.

What can be done?

To be clear, most errors are not "human error." Instead, most human error is related to poor situational awareness, like the poor presentation of information without proper context. By critically evaluating what console and field operators need to perform their jobs, and by evaluating what's known in open human factors literature, a plant can transform its workspace, reduce the risk of an incident, increase production and improve quality and efficiency. An environment can be changed from a reactive setting, with the operators becoming aware of a problem via an alarm, to a proactive one, in which problems are detected well before an alarm sounds and before immediate action is required.

The next step is to review all past incidents and all known potentially serious abnormal situations, and to ensure that the operators have up-to-date procedures readily available for those known hazards. Finally, operators must be fully trained.

The ASMC has spent 20 years researching the impact of human factors in process industries operations, including hydrocarbon processing. It uses rigorous scientific studies and in-plant verification trials to design proactive operations environments, including communications, control room design and the control system's human interfaces and applications. Its more important findings are available through its website and its guidelines.

Process industries must do a better job deploying human factors to reduce risks of incidents and to improve financial results. Human factors have a unique value proposition: Efforts to understand and deploy human factors to improve financial results lead to reductions in incident risk as well. **HP**

The author

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