

Tried and tested methodologies to improve reliability and to reduce operational and safety risks

Location, year	Estimated cost in billions of US dollars
Piper Alpha, 1988	3.4
Enschede, 2000	0.45
Toulouse, 2001	1.8
Skikda, 2004	>3
Buncefield, 2005	2
Texas City, 2005	1.5
Deepwater Horizon, 2010	40

Cost of Major Industrial Accidents

Source:

Deepwater Horizont catastrophe in the Gulf of Mexico in 2010

Corporate performance for process manufacturers is typically measured against criteria such as earnings and margin. However, other metrics such as regulatory compliance, process and worker safety, or sustainability recently have gained more importance as performance criteria. An holistic integrated asset management approach which also considers HSE and human behavior reduces risk and improves uptime of plant operation.

The costs of maintenance and process safety improvement measures are well known, but their impact on reliability and process safety are difficult to grasp because they are correlated and because accidents and incidents are infrequent and occur at irregular intervals, they are an independent statistical phenomenon. A recent published white paper shows (1) that the combined cost of accidents and incidents and lack of reliability could be as high as 1 to 3 percent of turnover on an annual basis, and in addition a cost in the range of 500 million to 5 billion US dollars per major disaster. For a super oil major, this would happen on average



Pictures: Wikimedia / Siemens

every 20 years, in a range of every four to 100 years depending on the safety and reliability practices.

Initiatives to improve safety and availability are strongly and positively correlated. Occupational safety improvement measures have little impact on process safety, but process safety improvement measures have a positive impact on occupational safety. Since the sources of most safety and reliability issues are human, to be effective, reliability and process safety measures need to integrate asset management and HSE (Health and Safety Executive) with the reliability of human behavior and of executing processes. For

effective and efficient reliability-centered maintenance planning and execution, asset information must be accurate and up-to-date. Any maintenance activity or plant change must be recorded and be made available to all personnel. This allows decision makers to concentrate on the analysis of the problem, knowing that they are already working with correct (“as-is”) data.

Many companies today are using metrics such as regulatory compliance, process and worker safety, or sustainability and environmental footprint as performance criteria in addition to purely financial metrics. Influencing the latter measures implies costs, but also contains benefit opportunities. For example, benefits of energy efficiency improvements as part of sustainability initiatives offer a quick payback on investments (2). The costs and benefits of sustainability improvement metrics are likely to evolve over the years, but are fairly stable can be predicted with confidence.

Process safety and asset availability improve-

ments have a direct impact on sales. Incidents, accidents and unwanted shutdowns, instead have the opposite effect, and in the worst case they can cause injuries, fatalities, damage to environment and assets, with the associated cost and negative impact on the brand. However, accidents and incidents are infrequent and occur at irregular intervals. They are viewed as operational and safety risks that can be managed, but cannot be reduced to zero.

Human error and safety

The ASM Consortium (3) estimates that about 40 percent of unwanted shutdowns in the process industry are attributed to equipment failure, 20 percent to failing to follow processes, and around 40 percent to human error (4). Investigations by Total on the impact of human behavior on process safety, together with comparisons with best practices from the nuclear industry and airlines, indicate that the risk of human error



Pictures: Siemens

Key feature of Comos Walkinside is its extreme ease of use. The user interface leans towards gaming, but with very serious commitment behind it. The tool is therefore very interesting for pre-workout. Naturally, it won't replace on-site training, but it can be used to thoroughly prepare staff to handle real conditions and scenarios once the plant has actually been built.

It is possible to simulate faults. Within Comos Walkinside, the user can go to the source of error and perform certain actions. He gets immediate feedback when the 3D model is connected via an OPC server to the process control system, e.g. by pushing virtual buttons. The user can retrieve the process data and guidelines for dealing with a faulty pump, for example. A link allows the user to jump directly into the corresponding P&ID to look for replacements. Back in the 3D model, it is possible to define the processes necessary to shut off the defective pump and start up the alternative one. With Comos Walkinside it is even possible to measure the time required to exit from a certain point of the plant in the event of an emergency

can be reduced by a factor of at least 100 by applying rules and principles (5), and, for sure, by establishing a safety culture. Efforts to improve occupational safety have strongly reduced the number of injuries and fatalities in recent years, but have had little impact on major industrial accidents, which have declined only very slowly over time. This is agreement with findings of Total and others that occupational and process safety should be treated separately.

The EU has recorded a frequency of about three major accidents per 1 000 industrial establishments per year (6) with at least one fatality and more than 2.5 million euros worth of damage. Major disasters, such as the Toulouse, the Texas Refinery or the Buncefield (7) explosions, are at another scale: the average cost are 2 billion US dollars and range from 500 million to 5 billion US dollars, with a record of at least 40 billion US dollars reported for the Deepwater Horizon spill in the Gulf of Mexico (8). For a typical super oil major with a turnover of 300 billion US dollars and an operating margin of 8 percent or 24 billion US dollars, the likely frequency of a

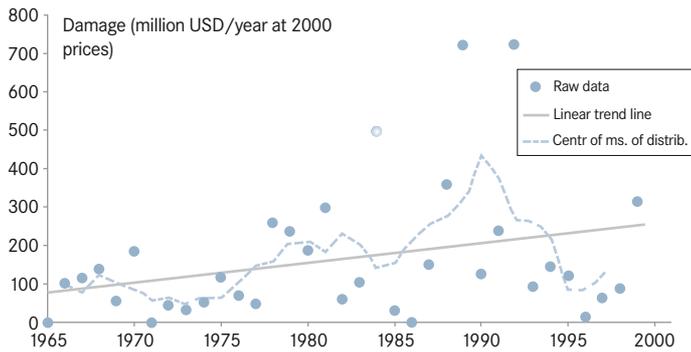
major accident according to the EU definition is around three accidents every two years. ARC (9) estimates that major disasters have a much lower frequency, possibly one every 20 years. The frequencies for major accidents and disasters vary by a factor of at least five depending on the safety culture and reliability practices of the company and could be as high as a major accident every two months, or a major disaster every four years. A typical super oil major could lose money a given year in the worst scenario, as happened to BP in 2010. For a smaller oil company, the worst case scenario would create such a loss that the company would probably not survive.

Processes and asset reliability

Since the correlation between expenses for maintenance and reduction of the number of accidents is not obvious, the temptation exists to reduce maintenance and inspection costs to improve profitability. A McKinsey study (10) reported that world class oil & gas producers have 95 to 98 percent asset

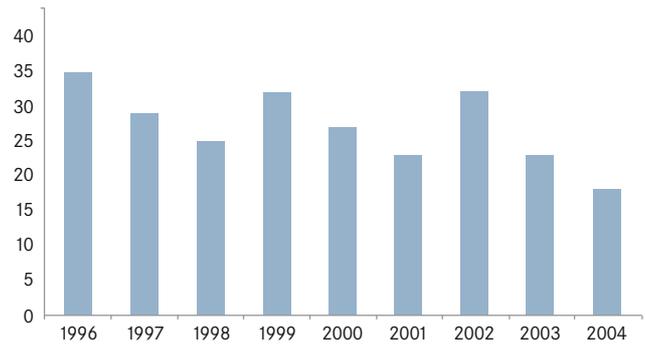
availability even for older assets. At the same, they make the right decisions about cost reduction, avoiding a downward spiral in reliability performance. McKinsey found that world-class companies apply preventive and condition-based maintenance approaches, and flawlessly execute plans and processes. A realistic improvement in plant availability is 1 to 3 percent while lowering maintenance costs by 25 to 30 percent. This translates to 1 to 3 percent of turnover in supply-constrained markets.

Asset reliability and process safety improvement measures both have an important impact on financial performance and risk. Initiatives to improve safety and availability are strongly and positively correlated. Since the sources of most safety and reliability issues are human, to be effective, reliability and safety measures need to integrate asset management, HSE, and human behavior. Although statistics for incidents, accidents and shutdowns are readily available, the advent of such an event always seems a surprise. The human mind can assess those risks, but intuitive estimations and decisions re-



Trend in world-wide refinery material damage costs

see also (1)



Number of major accidents in EU-15, 1996 to 2004

see also (1)

garding risks are likely to be incorrect (11). Management has the possibility to take the right decisions: the risk and the staggering average financial cost of accidents and unwanted downtime can be strongly reduced by relatively small efforts and investments. In a comparison to the aviation industry, Total showed that risks of human error could be reduced by relatively simple means such as dividing responsibilities among two people and double-checking decisions. In addition, operational and safety risks can be reduced considerably by having an accurate picture of the assets and their health.

Up-to-date asset information is paramount to making correct decisions in maintaining assets. It is equally important when training people on processes and behavior. Both appropriate behavior and up-to-date knowledge become critical when making decisions in emergency situations.

Siemens' asset data hub

The Comos software solution of Siemens Industry Automation based in Nuremberg/Germany for engineering, maintenance and operations enables with its central asset data hub this real-time visibility on asset state and health. Within the Comos infrastructure, existing 3D models of installations are kept up-to-date and can be used for immersive operator training in a safe environment. The technology reduces training time and cost and improves operational readiness. 3D viewing also supports maintenance and operation issues.

The use of a single, consistent and global data hub such as Comos, kept up-to-date at all times by all disciplines, creates instantaneous and complete transparency of information for each plant object and for all parties. Using configurable workflows, the different disciplines can collaborate using a structured process. As part of the Comos Lifecycle suite **Comos Walkinside** instantly links a virtual reality model with current plant information and enables the 3D visualization of the plant from the basic and detail engineering phases

throughout the entire asset lifecycle. **Comos Walkinside Builder** automatically creates complete 3D models of the largest industrial process plants by merging native files from diverse data sources and proprietary formats via provided converters. It automatically reads information on geometry, CAD hierarchy, engineering database and textures during the conversion process from the various CAD files. That resulting unified 3D virtual reality environment can be applied for simulation, review or, as in the following described, for training reasons.

Comos Walkinside ITS (Immersive Training Simulator) fully immerses operators in their plants. It simulates real-life scenarios and supports multiple avatars to test team performance and communication under realistic conditions.

To further increase the training realism, the 3D model may be enriched with all details of the existing plant. The 3D objects are procedurally added to the virtual reality model to flag evacuation routes, emergency and fire-fighting equipment signs, and others. Escape paths are represented in their full length for rehearsal of evacuation procedures. Sound effects complete the realistic setting.

Walkinside ITS is built around a so-called Standard Operating Procedure (SOP) editor functionality. It is complemented with a visual editor that helps customize specific operational situations. Instructors use the editor program to design real-life or simulated workflow situations with multiple training options. During the walkthrough, operators can directly see an up-to-date results list of all the content related to the equipment – data sheets, specifications, procedures, certification and test reports – by clicking on a piece of equipment in the 3D model. This allows the immersive visualization of ongoing work, planning of future projects and simulation of complex activities in a real work environment for maintenance teams. Control room operators can also be integrated into training scenarios and critical decision processes.

By placing the 3D virtual plant on the desktops of operation, maintenance and

engineering staff, plant operators can consolidate activities across a broad range of geographically dispersed user communities, focused on specific aspects of plant operation. Everyone shares the same, always updated model, thereby enabling full and effective collaboration. Users simply walk virtually through the digital plant to reach a specific area, “jump” to a specific element, extract data and documents connected to the 3D model through smart links to external databases, or update data and documents relevant to an element or area.

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- For further information concerning Comos Lifecycle and Comos Walkinside visit www.siemens.com/comos