

Lessons Learned – How to Make Them Stick

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ABSTRACT

After an incident investigation we gather the facts, assign causes and compile a set of lessons that should, if learned well, prevent a similar incident from occurring. Unfortunately, too often we see the same type of incident happening, sometimes in the same company that had the original incident, although not necessarily in the same facility, or in a company using the same process technology as the company that had the incident. What happened? We don't learn by listening to a talk or reading a bulletin, at least not for the long term. Our memory fades with time. Even if not, we still need to relate the incident findings to the planning and execution of our work. Thus, the way to remember those lessons is by making them vivid when training, incorporating them in our technology and daily operations, and periodically reinforcing them. If we manage to do that, there is a good chance that the lessons will be woven into the fabric of the company and incidents will not be repeated.

Introduction

Incidents that happened before happen again, showing that we either are not paying attention to incidents or are not learning the lessons from those incidents. On October 1989, Phillips 66 experienced a major explosion during maintenance operations at its Pasadena, Texas, facility which killed 23 people and left more than a 100 injured. This explosion precipitated the enactment of OSHA's PSM Standard, 29 CFR 1910.119 [1]. Among the causes of the incident, OSHA cited faulty maintenance procedures. Ten years later, in 1999, an explosion rocked the same Pasadena facility resulting in two fatalities. Although in this case it wasn't a vapor cloud explosion but a release of molten material, it was again during maintenance operations. And a year later (2000) another explosion occurred in the same facility during maintenance operations, resulting in one fatality and 71 injured. Although the immediate causes for all these explosions were different, the common thread was maintenance operations. In another case, at Hoeganaes Corporation [2], there wasn't even a significant time span before incidents were repeated. In 2011 the company experienced three incidents in the same year: in January (two fatalities), in March (one serious injury) and in May (two fatalities). All three were related to a dust fire or explosion. A recent editorial in *Process Safety Progress* shows examples and reiterates that we don't seem to learn from past history [3].

Why Are Lessons Not Learned?

Lessons are not learned, not because of lack of trying. The Global Congress on Process Safety (AIChE) which meets once a year and has an attendance of hundreds of engineers and process safety professionals, has a joint session of all its tracks dedicated to lessons learned. The Center for Chemical Process Safety (CCPS) has published books [44] and maintains a database of incidents for participating companies [5]. In the last twenty years 297 articles on lessons learned have been published in *Process Safety Progress* and articles continue to be published elsewhere [6]. A monthly bulletin from AIChE provides an account of an incident or near miss from which we can learn [7]. The US Chemical Safety Board (CSB) publishes online reports of its investigations and offers videos that demonstrate how the incident happened [8].

Companies typically circulate to employees the results of their own incident investigations and the reports are usually available internally. Sharing with other companies is limited due mainly to liability issues. But the lessons from those incidents may get lost, maybe because they don't have immediate impact or because the causes of the incident are not well defined, or because they get forgotten when they should be applied, during process design or a process hazards analysis (PHA). And, although many companies collect information on near misses, they are used as lagging-indicator metrics [9] for gleaning what are the factors that are liable to result in an incident, and mostly not thoroughly analyzed to learn the lessons they could have provided.

In essence, in spite of the wealth of incident information, the task of distilling a lesson from an incident, communicating it, and having people remember it when it's needed, is a very difficult task. Typically, in the long term we retain about 10% of the information we receive during training. And training is much more than sharing information where retention may be less than 2%.

How to Make Lessons Learned Stick

In order to really learn a lesson, the lesson needs to be delivered in a form that will be unforgettable, it needs to be woven into the fabric of the company, that is, translated into everyday use, and it needs to be periodically reinforced. There are various ways of accomplishing these objectives which will be discussed now.

A. The Delivery of the Lesson

Studies have shown that long term retention of knowledge depends on the method of delivery of the training. The amount retained can vary from 2% to 90% depending on whether the information was transmitted by reading, by oral presentation, visually, and/or by immediate application [12, 13] (the actual numbers have not been substantiated). Presenting the information in an impactful visual method will lead to be retained longer. The videos from U.S. Chemical Safety Board are an excellent example. In Figure 1 we can see two workers that have collapsed and died inside a reactor that had been inerted with nitrogen. The workers had finished the job when they discovered that a tape had been left inside the reactor. One of the workers tried to fish the tape with a wire while sitting in the

open manhole. He was overcome by the nitrogen and fell into the reactor where he collapsed from the nitrogen atmosphere. When seeing this, his fellow worker tried to rescue him by inserting a ladder into the reactor and lowering himself into it. He also collapsed. This was noticed by a supervisor, but by the time that the proper equipment had been obtained for a rescue, the workers had died. The full video is available from the CSB [10]. Showing the video will have much more impact than giving a lecture. It is very important, though, to provide the correct lessons learned from the incident, adhering to the top two or three. In this case they would be that (1) nitrogen is an insidious killer, and (2) do not attempt to rescue a fellow worker without first ensuring that you have the proper equipment to do so. Good examples of how to best communicate incidents are given by TJ Larkin [11].



Figure 1. Collapse of two workers in a nitrogen atmosphere (from the CSB video).

B. Integration into the Company's memory

If the lesson is well delivered but not applied, it may stay in people's memory but it won't be practiced and the value of the lesson will be lost. Thus, the lesson needs to be integrated into the practices of the company. A repository to capture the lesson is necessary and its essence applied to the company's technical, operational and safety procedures as detailed below.

1. **The Knowledge Repository.** Trevor Kletz, the world renown process safety expert, said that "Organizations don't have memory – only people do" and that is why incidents recur [12]. But, with today's tools it is possible to impart a memory to an organization [15, 16], and part of that memory would be the lessons learned. One of these tools is a knowledge repository. The

repository would be organized such that all aspects of the learnings from an incident would be available and be easily searchable [15]. Thus, our loss of memory of learnings from training or information sharing would be compensated by this repository. We would only need to have a vague idea about the incident and find all its details. This knowledge, though, needs to be incorporated into all the functions of a process plant.

2. **Expanding the Process Technology to Include Incidents.** The technology of the process being used would include any related incidents and the lessons learned from them. This searchable knowledge would go into the repository. For example, if the process used a hydrotreater, all relevant information on hydrotreaters would be added to the repository including any incidents, complete with the investigation reports. As part of the duties of the engineer supporting the process, he/she would follow incidents on hydrotreaters that occur in the world, within the company and externally. In addition, vendors would be asked to provide related incident data as part of the technical package. Some corporations have these technology experts that serve as a resource for the company, but it is not necessary to have a dedicated person to the technology since the information would be readily available in the knowledge repository.
3. **Integrating Incident Learnings into a PHA.** Although we are required to review the incidents that have occurred between two consecutive PHAs, this review is for awareness that things can occur. It takes some expertise to connect these incidents to potential causes and consequences discussed during the PHA. An experienced facilitator that is familiar with incidents that have occurred in the industry should be chosen. And, since we are required to have “at least one employee who has experience and knowledge specific to the process being evaluated” [13], the process expert mentioned above should be part of the PHA team. If the expert doesn’t have the time to participate throughout the length of the PHA, he/she should give a presentation to the team on the incidents related to the process being studied.
4. **Using a Hazards Register.** A Hazards Register is a database that contains all the pertinent information related to the risks assessed during all of the safety studies performed by the company, whether a Process Hazards Analysis, or a Management of Change review, or an incident investigation [18]. The resolution of each hazard would be available in the Register, and not only the latest resolution but also its evolution (history) starting from the original study. The lessons of all these studies are captured in the Hazards Register since it maintains the reasons and assumptions used in them. This solves the problem of the disconnect between recommendations from a safety study and their resolutions. At any time, we can learn why we use a particular design or operate in a certain way. In order to be effective, the Hazards Register should be easily accessible by all and be fully and effortlessly searchable.
5. **Integrating Incident Learnings into SOPs.** We are required to include the consequences of deviation when the performing of an SOP. This is a good place to add to the consequence a mention of an incident that occurred when not following an instruction. For example, on bypassing an interlock, a note saying “A bypassed interlock using emergency air resulted in an explosion that destroyed the facility and killed five people” [19]. A video or report of the incident should be available in the control room, or at least used in refresher training.

C. Reinforcing the Learnings

In spite of everything, memory fades with time. Also, there's turnover in the plant, new technologies are adopted, and procedures evolve. There needs to be periodic reinforcement of the lessons learned in terms of the rationale for doing things the way there are being done. The following are two ways of doing this reinforcement.

1. **Remembering the Anniversary of an Incident.** If there was a significant incident in the company, the lessons learned from it should be remembered every year. The anniversary of the incident is the right time to do it. The company should send a bulletin to all employees on that day with a summary of the event [20].
2. **Reinforcing Lessons in Safety Meetings.** For safety meetings or "tool box" meetings one of the topics should be the review of an incident, not necessarily something that happened in the company, but of actions that led to an incident. The videos offered by the US Chemical Safety Board are an excellent resource for this type of meeting.

Conclusions

By using the methods described in this paper, lessons are learned through visualization, constant application and reinforcement. Since the lessons become part of the knowledge of the company, and are integrated into its everyday activities which should include periodic refreshing, these lessons will stick.

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