

LEARNING LESSONS FROM ACCIDENTS - THE PROBLEMS FACING AN ORGANISATION

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To achieve improvements in health, safety and environmental performance it is necessary to have effective systems for learning lessons from accidents/incidents occurring both within and outside the organisation. These arrangements provide the opportunity for the organisation to implement the appropriate corrective actions, including those on management systems, throughout the organisation for implementation by line management. Learning lessons from past accidents either within or from outside the organisation presents a difficult challenge, as the arrangements need to encompass the various management structures and be active on a continuous basis. The research chemist, the design engineer, the process engineer, the maintenance engineer and others should all have a responsibility for networking on accidents on similar process activities. To meet successfully such an objective, the organisation needs to establish a culture that recognises and readily accepts responsibility for "sharing and acting upon information on accidents that occur within and outside the organisation". A detailed management system is also required to identify personnel and job function holders to refer to an accident database on specific occasions in order to effectively capture and apply lessons learned. This paper outlines the requirements of a database and management system to address this challenge and to assist the organisation in satisfying the immediate requirements of the new COMAH regulations.

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INTRODUCTION

It has been said that a wise man learns from his own experience but a wiser man learns from the experience of others. On the 14th December 1785 a dust explosion occurred in a bakery shop in Turin, caused by flour released from a silo. The explosion was not too serious but it was investigated by Count Morozzo (1) the final words of whose findings are as relevant today as they were 200 years ago:

> "….. it is therefore of great importance that these facts should be universally known, that public utility may reap from them every possible advantage."

More recently in his book *Lessons from Disasters. How organisations have no memory and accidents recur* (2) Trevor Kletz says:

> "It might seem to an outsider that industrial accidents occur because we do not know how to prevent them. In fact they occur because we do not use the knowledge that is available. Organisations do not learn from the past or, rather, individuals learn but they leave the organisation, taking their knowledge with them, and the organisation as a whole forgets."

While an organisation tries to learn from its own accidents, the loss of experienced staff with early retirement often makes this difficult. It is the learning of lessons from accidents occurring *outside* the organisation that presents a greater challenge. Recent events show that we must have a specific management system to address this problem. The first and second recommendations of the Texaco fire report (3) state:

- Safety management systems should include means of storing, retrieving and reviewing incident information from the history of similar plants.
- Safety management systems should have a component that monitors their own effectiveness.

The COMAH Consultative Document (4) gives interpretative guidance on the draft regulations for implementing the UK Directive 96/82/EC. In Part 2, "Minimum Information to be included in Safety Report", a section on "Identification and Evaluation of Major Hazards", Item 306 states:

> "The safety management system should describe the arrangements for considering lessons learnt from previous incidents and accidents (both within and outside the organisation concerned), from operating experience of the establishment concerned or similar ones, and from previous safety inspections and audits."

While accidents and near-misses occurring within an organisation are investigated to learn the lessons and hence prevent a recurrence, this involves communication to its employees and requires a memory so that all can learn the lesson. Generally we rely on a single person to take the necessary actions but this is now not enough. A management system is necessary, under the COMAH Regulations, to ensure that all appropriate persons take the necessary actions to learn lessons from all relevant accidents both within and without an organisation. This system has to:

- Set the responsibility for this action to a particular person.
- Set a standard of performance expected.
- Define the places for obtaining this information.
- Ensure that the lessons are applied to:-
  - Design
  - Management procedures
  - Inspection systems
  - Operating procedures
  - Maintenance procedures

MAINTAINING CORPORATE MEMORY

An accident has been described as the invasion of the Unaware by the Unknown. The problem for the loss prevention process lies in making a person aware of the hazards that are not known to him. But they may be known to others and can be found in an effective accident database. Corporate memory can be captured and maintained within an establishment but it needs to be augmented by the experience of others, gleaned from an accident database.

To ensure that this enlarged experience is regularly tapped, a management system has to be devised and, as with all safety matters it starts with commitment from the top. Typical extracts from policy statements which demonstrate and embody such commitments include:

- "We will continue to expand our knowledge in health and safety. New knowledge will be promptly applied and shared with employees, customers, contractors and others potentially affected."
- "We will compete on quality of product and service, on efficiency and process know-how but not on safety or environmental knowledge. We will share information on safety and environment with others and expect others to do likewise."

The key elements of a safety management system are outlined in Figure 1.

A typical performance standard for lessons learned from accidents, internal and external, would cover the capture, analysis, impact assessment and the implementation of corrective actions. For example it would:

- Identify the personnel responsible for carrying out each phase of the task, together with required competency levels (e.g. professional qualifications, job function, knowledge/experience, training).
- Detail what needs to be done, information source, procedures, practices, and methodologies.
- Specify what needs to be done for implementing corrective actions to provide:
  - Safer plant, processes and equipment.
  - Safer systems of work.
  - Enhanced design codes, standards.
  - Enhanced procedures/methodologies.
  - Enhanced corporate knowledge.

PLANNING AND IMPLEMENTATION

Effective planning requires the systematic identification, elimination and control of hazards and risks through a co-ordinated effort by an organisation, the goal being to prevent injury, ill health and damage to equipment or the environment.

The planning process applies to all aspects of the process 'life cycle' (i.e. from conception to demolition) and involves:

- Designing, developing and installing suitable management arrangements, risk control systems and workplace precautions commensurate with the needs, hazards and risks.
- Operating, maintaining and improving the systems to take into account changing needs, process hazards and risks.
- Establishing appropriate performance standards to measure progress.

To maximise the benefit from this 'lessons learnt process' it is essential that authoritative and quality information on accidents be available. Accident databases are by far the most efficient and cost effective vehicle for communicating such information. However, for any accident database to be successful it is essential that they contain certain critical key information (see Figure 3).

MEASUREMENT

Performance measurement is the key to providing information on the effectiveness of a health and safety policy and its implementation. Performances can be measured against predetermined plans and standards. Active and reactive measurement techniques can be used to assess the overall effectiveness of implementation and for identifying shortcomings.

The measurement process for evaluating the lessons learned from accidents should cover:

- capture of information
- assessment of implications
- identification of potential shortcomings
- implementation of corrective actions
- monitoring effectiveness of implementation.

AUDIT

Auditing in general provides assurance on the appropriateness and adequacy of the management arrangements, risk control measures and workplace precautions in place. With regard to lessons learned from accidents/incidents arrangements for capturing, assessing and implementing lessons learned can also be audited. Assurance would also be provided on the effectiveness of implementation within and across disciplines, activities, processes, sites and businesses.

REVIEW

The review feature is the key feedback element for any effective management system. It examines whether the appropriate health and safety management system is effective and adequate. In relation to lessons learnt the element evaluates the adequacy and effectiveness of the performance as a whole and recommends remedial action to correct the deficiencies.

Internally within a company the process:

- evaluates the corrective action programmes
- evaluates the identification of immediate and underlying causes of shortcomings

External to the company the process:

- benchmarks the performance compared with other similar companies (i.e. information requirements, management systems and practices, techniques, methodologies, competency levels, etc.)

PRACTICAL ASPECTS

In practice the use of an accident database under the management system would work as follows:

Case 1. The Design Engineer.

A new plant is being designed and the design engineer is using a software package to specify a distillation column for ethylene oxide. Using the usual data the column can be specified to produce a product of the required quality. As the design engineer is not familiar with the problems of ethylene oxide he would consult an accident database and discover that there have been nine cases of explosions in distillation columns containing ethylene oxide. If he uses a good quality accident database he will additionally learn the lessons from these accidents and he can modify his design to avoid the problem. He has learnt from the experience of others.

Case 2. Project Review Team.

After the initial design of the plant, a project review team is usually formed to examine further the basis of the design. To carry out this review various scenarios are examined to see what control measures have to be introduced. An accident database is ideal for examining such a review.

Case 3. The Production Engineer.

Our new design of a plant involves the use of submerged pumps in a vessel. This arrangement is preferred as the material has to be kept molten and the use of submerged pumps removes the necessity to steam jacket the pump. There are no design codes that cover the maintenance of this equipment but during a HAZOP session when considering the maintenance of the pumps, the production engineer identifies the hazard of an open hole in the vessel if the pump has to be removed. Consulting an accident database would show a near-miss accident when a person partly fell into an open manhole covered by a piece of thin wood. The lesson learnt was for the provision of a temporary manhole cover of sufficient strength to prevent a person from falling into the vessel. It would therefore be prudent to have a metal cover of at least quarter inch plate attached near to the pump for when maintenance required it. The production engineer has thus used an accident database to learn the lessons of a past incident.

Case 4. The Maintenance Engineer.

A piece of chemical plant has been used on olefines duty. It is necessary to enter the vessel during the coming shutdown, and during the risk assessment of the job, someone has mentioned the problem of the presence of copper acetylide in the equipment caused by the use of some copper pipework in the instrumentation. The question has been raised 'How do we remove the acetylide before entry?' An accident database is consulted to see if anyone has previously had this problem and what lessons were learnt. A good accident database will contain details of an incident resulting from such a problem and the lessons learnt about cleaning such a vessel before entry. The maintenance engineer has had to address this problem and found the experience of another person to his and possibly others' advantage.

Case 5. The Product Engineer.

Our establishment has started the manufacture of formic acid and is preparing a Material Safety Data Sheet for the product. In order to find all the data on the product an accident database is consulted to find out what accidents have happened with formic acid. Two accidents involving the release of carbon monoxide will be found from 98% material and this is a hazard that has to be mentioned in the MSDS. The person responsible for that data sheet had to consult an accident database to find out such information.

Case 6. The Inspection Engineer.

During the inspection of some pipework, the inspection engineer was concerned at the amount of corrosion that had taken place and decided that this section of the pipework had to be replaced. He was concerned about other pipework that might have underlagging corrosion. He could not inspect all of the pipework immediately. How could he establish which pipework was most likely to be at risk and therefore to be inspected first? He consulted an accident database to see if anyone had previously had the same problem, and found an accident where a gasoline pipeline ruptured causing serious injury and fire. The cause was underlagging corrosion and the lessons learnt gave him information on which pipework was most susceptible to this type of corrosion. The inspection engineer was able to draw up a list of priority inspections resulting from another person's experience.

Case 7. The Safety Engineer.

A safety engineer has noted that the finfan coolers on the plant show signs of corrosion on the plenum chamber and at the forthcoming shutdown there is to be an inspection of these heat exchangers. Cleaning inside the plenum chamber has also to be carried out. He wonders if there has been any previous experience with this type of equipment so he consults an accident database and he finds that there is a case where someone has fallen from a finfan cooler due to excessive corrosion of the base of the plenum chamber. The Safety Engineer notes this and takes precautions to ensure that no one is exposed to this hazard.

Clearly an accident database with a lessons learnt field is an essential tool for many people in an organisation if accidents that have previously happened are to be avoided. No person can carry all of this information in his head nor can it be quickly retrieved from a filing cabinet. Every engineer must expect the unexpected and take action to find out what the unexpected might be.

THE FUTURE

We also have to ask whether people, when making decisions, will examine a database on each occasion that they create:

- A Work Permit
- A project Review
- A Hazard and Operability Study
- A design of new equipment
- An audit of various items

There can be no certainty that a decision-maker will refer to a database as a matter of course, but a solution to this is possible. Some report writers do not consult a dictionary when unsure of the spelling of a word and some are even unaware that they do not know the correct spelling. But modern word processors highlight a misspelt word and a correction can be made. Similarly when using a computer for design and other operational work we can have the database sitting in the background. This will highlight any accident that is relevant to the design or situation with which we are dealing. We would be made aware of hazards to which we would otherwise be unaware.

DESIGNING EQUIPMENT

Modern design work is done on a computer using various software packages. Let us, say, design a distillation column for ethylene oxide. We can make the software package recognise the two basic keywords, distillation column and ethylene oxide, and put a warning line in red under these two keywords to show that there is an accident record concerning both keywords. The designer can then hit the appropriate button to look at the record and the lesson learnt to incorporate into the new design. If there is only one keyword recognised in the database then it could either underline that keyword or give a green warning line.

In the example taken the lessons learnt from the explosion of the ethylene oxide distillation column at Antwerp in 1987 and another in 1989 would be relevant.

PROJECT REVIEW

At the design stage and before the Hazard and Operability Study is carried out it is essential that lessons learnt from previous incidents both within the organisation and without are examined for their relevance to the current design. This is carried out in a project review by a careful examination of the design in conjunction with other experts in the process and with an accident database. This ensures that the design covers all reasonably foreseeable hazards.

HAZARD AND OPERABILITY STUDY

During the hazop study of a distillation column the team were using the keyword OTHER and the team were considering maintenance work. The database could easily give a variety of scenarios.

EMERGENCY PROCEDURES

A good design will include consideration of various emergency scenarios and their requirement. An effective accident database will include emergency response lessons from previous accidents and this information is very useful for planning response in a new plant.

WORK PERMITS

These permits could be generated from a computer programme after the risk assessment has been carried out. The accident database can be used to assist in identifying the hazards involved and the precautions and control measures to be considered.

UPDATING CODES

Engineering codes and standards should be updated after consulting an accident database.

CONCLUSIONS

1. Organisations need to establish a management system for utilizing the lessons learnt from accidents both within and without the organisation.
2. Accident databases are available which incorporate a vast amount of experience. It is important that they should contain lessons learnt from the incident itself as well as from the emergency response.
3. Organisations should be encouraged to provide information on lessons learned so that databases can be enhanced, to the benefit themselves and of others.

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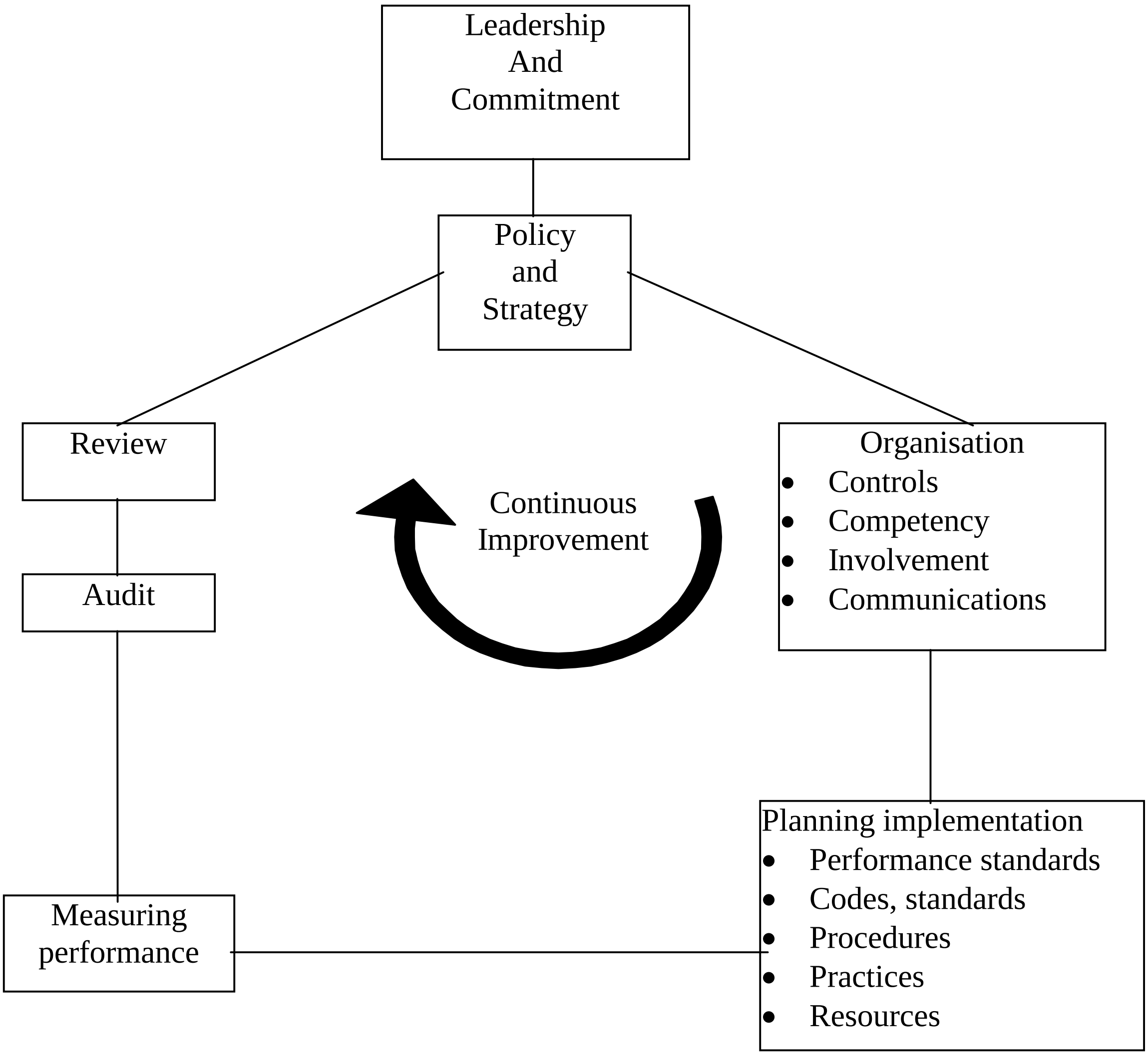

FIGURE 1 The Management System

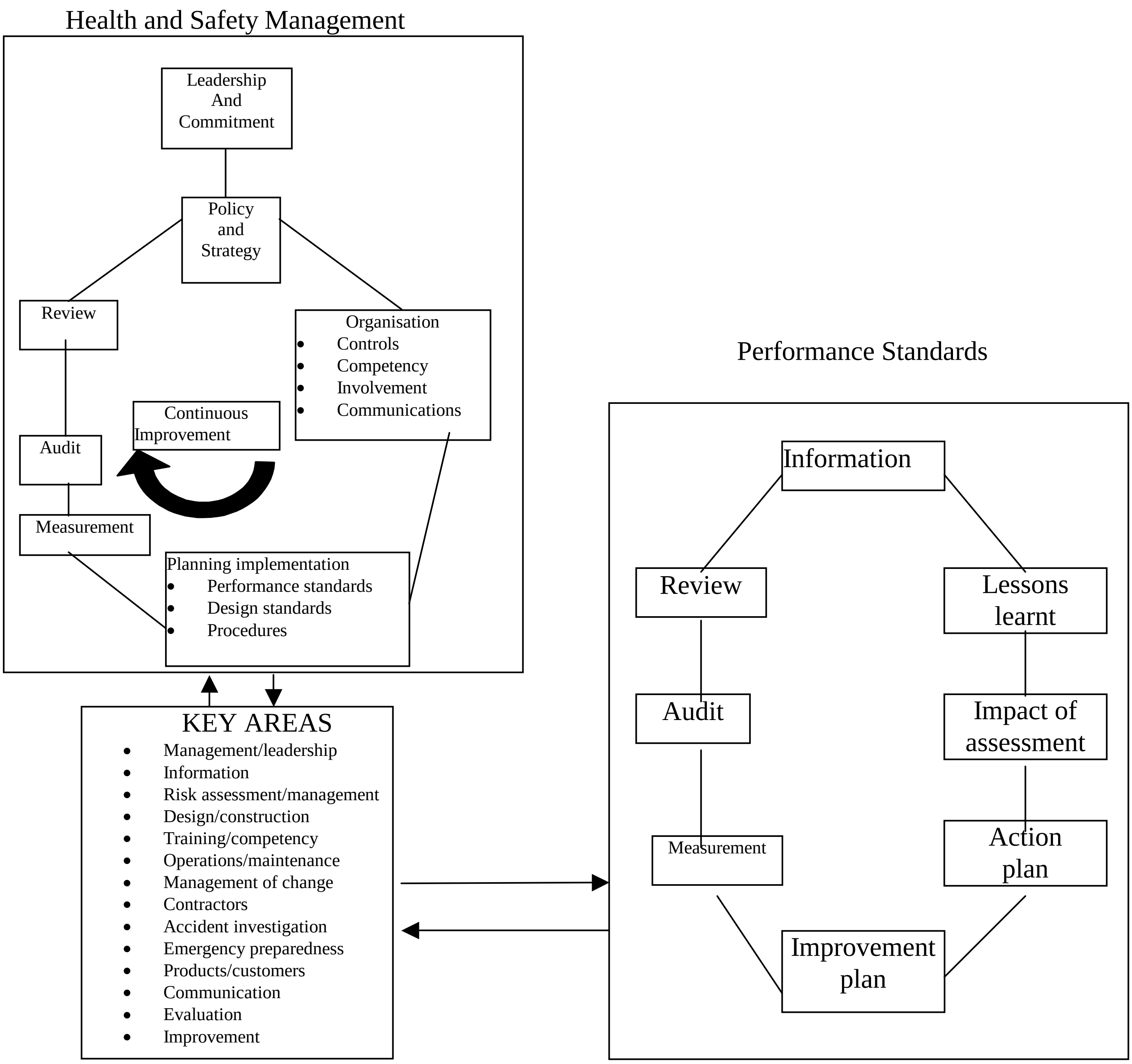

FIGURE 2 Implementation Process

Date
Source
Location
Type of Accident
Consequences
Costs

ACCIDENT/INCIDENT DETAILS
- Accident Scenario
- Accident Sequence
- Activity Involved
- Technology Involved
- Materials Involved

CAUSES Immediate and Underlying
- Technology deficiencies
- Safety protective device deficiencies
- Physical aspects
- Chemical aspects
- Human aspects
- Management system deficiencies

EMERGENCY RESPONSE EVALUATION
RECOMMENDATIONS
LESSONS LEARNED

FIGURE 3. Key Information Requirements Of Accident Databases