

SAFETY IMPROVEMENT THROUGH LEARNING FROM INCIDENTS

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Elementis, a specialty chemicals company, uses global incident reporting and investigation as a key tool for improvements in health, safety and environmental (HS&E) performance. Success has come through attention to the way in which the system was implemented as well as the incident investigation process itself. The system is based around a corporate electronic database deployed at all levels throughout the Company worldwide, There has been a marked and continuing improvement in HS&E performance.

Incident, investigation, root cause, improvement, database

PREAMBLE

Increasingly, as process safety improves, the opportunities for further improvements in occupational health, safety and the environment (HS&E) must come from elsewhere.

Priority must go to preventing the incidents that cause the most suffering, damage or pollution. It is not sufficient however only to work on serious incidents. All incidents matter to a greater or lesser extent. Also, the relatively infrequent occurrence of serious incidents means that if you only work on them there are insufficient data to allow comprehensive action to be taken to prevent other possible serious incidents. The strategy must be to remove the mass of underlying factors, present in more minor incidents that, under other circumstances, could become major.

It is a never-ending journey, which can be likened to breaking down a pyramid shaped iceberg that has the most serious incidents visible at its apex down to unseen or ignored minor near misses towards the base. A model for safety is shown in figure 1.

But to break it down you must first study why the incidents are there. There is nothing fundamentally new about incident investigation. But not all systems are successful. This paper describes how Elementis has implemented a comprehensive incident investigation process, based on a corporate electronic database deployed worldwide, to achieve significant improvements in HS&E performance.

BACKGROUND

Elementis is a specialty chemicals company with operations in the UK, USA, Europe, Asia, Africa and Australia. In the last century managers and employees were continually making efforts to improve, sometimes with great success. However, the process depended mostly on local initiatives. Improvement tended to be restricted either in the scope of problems solved or to the location where the work was done (and often both).

An exception was the increasing adoption of formal management systems for safe working. However, differences in perspectives between the UK and US (in particular) meant that their priorities were different. In the UK greater reliance has been placed on management systems to assure safe working that complies with all legal requirements. The

focus in the US is to have compliance systems based more directly on the detail contained in the comprehensive OSHA* and EPA℗ standards.

Clearly the Company must comply with the legal requirements of each country in which it operates. But beyond that the Company recognised that the only acceptable position to take is to conduct its business worldwide with the highest concern for the health and safety of its employees, contractors, customers, neighbours and the general public, and for the environment in which it operates.

Several steps were taken. To raise awareness and ensure that consistent high standards are achieved worldwide, the HS&E team instituted a series of corporate policies for life critical activities such as "Line Breaking", "Working at Heights" and "Vessel Entry". A corporate team checks that these are applied by conducting comprehensive compliance audits.

Another step was to introduce an employee led behavioural safety programme to address the large number of small incidents or hazards directly attributable to the way people work and behave.

The Company also recognised the importance of Product Stewardship. Responsibility towards others, such as those who use our products and the local community, is both ethically correct and one of the building blocks for sustainable development.

Nevertheless improvement in performance was only happening at an evolutionary rate. It was clear that these steps, while necessary, were not sufficient to take the Company to the level of HS&E performance to which it aspires. A step change to a new level of performance was required. An aim was set: reduce the lost time accident frequency by 50% within a year, in preparation for further reductions in all recordable incidents.

The target was set arbitrarily on the basis of being a level that would reflect a systematic change. But, however desirable or essential, an arbitrary target is meaningless unless there is a means to achieve it. The means to achieve the performance improvement was by rigorously correcting the root causes of incidents through greatly improved incident investigation. For further discussion on arbitrary targets see Appendix 1.

In 2001 Elementis plc reduced its lost time accident rate by 53%. figure 2 shows that the improvement is continuing.

IMPROVED INCIDENT INVESTIGATION

REQUIREMENTS OF AN INCIDENT INVESTIGATION SYSTEM

To be effective the root cause corrective action process requires:

- full reporting of incidents
- in-depth investigation of each incident to establish the root cause(s) – recognising that there may be more than one root cause per incident
- development of effective corrective actions (at least one for every root cause)
- making sure that all corrective actions are carried out

*Occupational Safety & Health Administration
℗Environmental Protection Agency

- checking to ensure that as far as can be ascertained the actions are effective
- learning from incidents including near misses to prevent similar incidents occurring elsewhere.

CONCEPTS FOR SUCCESS

One of the core concepts was that a large number of people should be involved with incident investigations. This is fundamental to demonstrating commitment to improvement and to tap the knowledge and ability that exists throughout the organisation. In any case safety and pollution prevention are everyone's responsibility (though the opportunities and levels vary). So anyone should be able to report an incident. A wide range of people with relevant knowledge, expertise or interest should then be involved with investigation. Plant and other managers must be part of the corrective action process. HS&E personnel have their professional role to play overseeing and participating in the process, and for ensuring that lessons are learnt and applied to advantage elsewhere.

Tangible benefits are achieved from correcting the causes of actual incidents. Intangible benefits accrue from a large number of people at all levels in the organisation developing and using the system collaboratively towards a common goal.

A key feature for success was the way in which the new system has been introduced. This can be summarised as a team approach between corporate HS&E and the businesses, allowing corporate requirements to be met in a way that was compatible with business needs. Central to this was development and implementation of a comprehensive incident investigation database.

DATABASE FUNDAMENTALS

GENERAL

Having a single corporate database in electronic format facilitates the process in several ways:

- it provides the framework in which to report all essential information and guides users in the necessary steps to follow. This is vital because many users are only involved infrequently
- data are consistent, for prioritising actions and for making trend analysis meaningful
- increasing the data capture to include all sites world-wide provides more experience from which others can learn
- using the database collectively acts as a focal point and catalyst, bringing the different businesses worldwide closer together on health, safety and environmental matters.

CHOICE OF DATABASE

The option of taking a proprietary database was discounted.

The company already had a number of Lotus NOTES databases. From this experience it was felt that a Lotus NOTES database for incident investigation could be created relatively rapidly at low cost. Further enhancements would not be constrained by software

limitations and licences. Widespread user familiarity with how to use the existing databases would make adoption much easier. The chosen method also provided the opportunity to link easily to the Company's email system and for future integration with other Lotus NOTES databases.

As it turned out there were other advantages. The process of developing the incident investigation system helped create understanding and shared ownership. Audit reports and risk management topics have been added to take advantage of the corrective action routines.

OPERATIONAL DEFINITION

Elementis is a global company. An important recognition was the need for clear understanding between sites in different countries.

The Company adopted US OSHA definitions for "Recordable Injuries and Illnesses". Lost time is recorded both as US definition (all lost time after the day of incident) and UK RIDDOR* (greater than 3-days lost time) An internal Company definition was used for different categories of environmental incident.

DEVELOPING THE DATABASE

PREPARATORY WORK

Sites already had incident reporting systems in place. Although these included sections on investigation and actions, no consistent format was used and the level of detail varied. The process followed was to explain the need for corporate involvement and the benefits a carefully designed common system could bring.

Benefits were broadly that the system would be:

- comprehensive - to guide investigations in an efficient and effective manner
- consistent - for corporate assurance that incidents were investigated properly to a certain standard

Making the system electronic would add further potential advantages:

- automated notifications and reminders, with remote access possible
- rapid visibility to authorised readers (an issue discussed below)
- search capability and opportunities for trend analysis
- learning through sharing

THE DEVELOPMENT PROCESS

All sites provided copies of their existing incident report forms. Comparisons established the scope of perceived requirements. A draft form was then created to take the best features for a comprehensive, logical workflow. During the process some existing requirements were questioned, other new requirements were added (in particular for analytical purposes).

Senior representatives of each Business reviewed the drafts so that when the process was completed they were satisfied that the system met their needs. Review was in two

* Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

forms. By email to give time for reflection and one-to-one comment, and by telephone conference calls to discuss ideas. At the end of this process senior managers in all Business were thus happy to implement the incident investigation system at their sites.

As the benefits of the database for improving health, safety and environmental performance become more and more apparent further enhancements and changes have been proposed. Being in Lotus NOTES means that the system has been able to evolve fairly readily.

Once the template was agreed it was converted into a Lotus NOTES database. A key objective was to get a database up and running quickly to maintain momentum. Enhancements were added later, and as the structure became more complex some parts were re-programmed. The nature of Lotus NOTES made all of this possible. As a result there was minimal lag between agreement to proceed and an operational system.

SOME ISSUES ARISING DURING DEVELOPMENT

There were some issues about the database, which had to be addressed. first, was security and confidentiality. As mentioned above any employee with a Lotus NOTES account can access the database to enter an incident report. This is a fundamental requirement. Other roles require appropriate authorisation, in some cases set by the manager responsible for the incident investigation, in others from predefined lists. Open access to the database generally means that all reports can be read. However, there is the option to make a report private. As people become familiar with the system and confident in the way in which it is used it has been found that there are very few incidents that fall into this category. It is however still available if there are particularly sensitive issues.

Secondly, all incidents are treated equally by the database, regardless of severity. There was some feeling that there ought to be a short version for minor incidents to encourage reporting. This has been resisted on the following grounds. Minor incidents including many near misses are a rich source for learning. The aim is to capture as much near miss and serious condition data as possible. If it is truly of minor importance it should be possible for a small team to deal with it swiftly. But we still want the record and corrective or preventive action.

IMPLEMENTING THE DATABASE

It was recognised at the outset that opening the database to all employees worldwide presented a huge education and training issue. Not just in the logistics but also in the way people respond. Previous work by the author suggested that the approach had to cater for two types of person. Practical people, who would initially take some persuading but would then be model users, and more intuitive types who might adopt more readily but would later need more anchoring to maintain the desired usage. Further description is given in Appendix 2.

Another consideration was that site personnel, who were not involved in the development of the new system, would still need persuading that the proposal was a good idea. The aim was to create understanding and acceptance that it was worth giving up their existing systems, even if their systems still appeared good. The same process had to be gone

though with the Businesses managers in the first instance but by implementation they had gone beyond that stage.

Three key steps were therefore taken.

First, a training package was produced. This covered the importance of thorough incident investigation, techniques for investigating incidents and how to use the new database. The training package was supported by comprehensive guidelines on how to enter data into the database. Details of how the database is used are shown in Appendix 3.

Secondly, large numbers of users were trained. Plant managers and HS&E staff, who all have specific roles in the process, were trained. So were the supervisors who need to raise reports. Additionally, and especially for near misses where the intention is that trades union/safety representatives and others can raise a report, these employees were also trained.

Thirdly, continual active support has been provided via telephone, email and in some cases face to face. Queries are encouraged and followed by a timely response. The database is checked routinely to ensure that it is being used fully and correctly. Concerns are followed up where necessary. It was important to recognise that the familiarity gained by the developer and administrator functions led that of the users. Also some users only need to access the database infrequently and may forget what they have been taught. A side effect has been that contact with users has been a fruitful source of ideas for database improvement.

CONCLUSIONS FROM INCIDENT INVESTIGATION

Benefits are being achieved in many ways.

Reports are comprehensive with many root causes found. A key observation, which should be of no surprise to systems thinkers, is the number of incidents where the root cause is due to some management issue, in contrast to an immediate cause seen as being due to "people". Ishikawa cause and effect "fishbone" diagrams have been highly advantageous for investigating root causes.

Analysing the types of incident occurring over the whole company has led to insights and suggested further actions, which would not necessarily be obvious from a single incident. Examples have been learning about slips and trips when using stairs, forklift truck safety, injuries to hands, and office safety.

The incident system has been fully adopted worldwide throughout all Elementis businesses from the large chemical sites to small depots serving mines in the Australian outback. This means that Business managers can keep in touch with the detail of what is happening as and when they wish, wherever they are in the world.

Reliable data are readily available for monthly and annual reports from a single database, with data input at source. Data are summarised in Pareto and control charts to show trends. Information presented covers lost time and other recordable incidents. This helps management to focus on the bigger picture as well as be concerned about single incidents. Also included are charts that indicate the health of the incident investigation process, such as number of reports generated (Figure 3) and times to investigate. This helps indicate the level of preventive actions being taken. Taken together these charts help predict, with risk of error, future short – medium term performance.

As confidence has grown in the database and investigation system, more near misses are being reported. This is encouraged. An initially increasing number of reported near misses is seen as the sign of a mature organisation recognising reality and working to improve, not the sign of deterioration in performance. One ratio used to measure near miss reporting is the number of near misses reported to recordable incidents. Another is the average number of near misses reported per employee. Creating visibility offers the opportunity to work on root causes, as shown in Figure 4. Ultimately, as near misses are tackled, the number reported should reduce, but that may be a long way off. Meanwhile HS&E performance should continue to improve.

APPENDIX 1 NOTES ON CONTROL CHARTS AND ARBITRARY TARGETS

The author uses control charts extensively to track HS&E performance as a means to understand and predict. Charts showed that there was a stable system for lost time accidents and other recordable incidents. As it stood any improvement target would be just a wish.

Those who are familiar with Shewhart's work on control charts[1] and the teachings of Deming[2], may therefore question the logic of setting an arbitrary target for improvement.

The first point to make is that setting a target was recognition that the status quo was unacceptable – something had to be done. The true goal must be zero incidents, but a sign of improvement would be a halving within a year.

A second point is that action would be taken to change the system to a new lower level. Conventionally one would only investigate when a point is outside the 3-sigma control limits (or possibly use a run rule). Action at other times on a stable system is uneconomic. However, the intention was not to try to explain a bad month that was just part of the variability of the system. If you (rightly) want to reduce the number of incidents you need to work on the mean, which is a change to the system. The only way to achieve that is to study the system that gives rise to the incidents (Wheeler[3]). All incidents every month need to be studied to provide the necessary insight.

APPENDIX 2 PERSONALITY TYPE THEORY

Why do some people take readily to incident reporting and investigation while others do not? Previous work by the author[4] investigated the reasons why some people adopt Shewhart control charts while others do not. The results of that study on competent people with proper training and facilities suggested that people then used either their experience or their intuition in deciding how to respond.

A way of showing how the effect of management encouragement on different thinking types is to use catastrophe theory. It should be noted that the dramatically named theory is a revolutionary way of understanding how things change. It does not necessarily mean a disaster!

Catastrophe theory was developed by René Thom and is described in a very simple way by Woodcock & Davis[5]. It describes change in systems having more than one stable state, or following more than one pathway of change. Change may be smooth. Where it is discontinuous a so-called "catastrophe" occurs. The theory provides a way of describing discontinuous transitions.

The mathematics is complex and need not be attempted to gain a qualitative understanding of a process. Elementary catastrophes exist as one of seven possible behaviour surfaces. These can be used as templates. A common one is the cusp catastrophe, which occurs in systems whose behaviour depends on two control factors. Its graph is a 3-dimensional curved surface with a pleat. The catastrophe is the jump from the edge of the pleat another part of the surface.

The particular catastrophe is chosen so that the process behaviour corresponds to some features of the model. One can then study the model to see what other, less obvious types of behaviour it suggests for the process under different conditions.

Figure 5 shows a cusp surface. Every point on the surface represents an equilibrium state.

Changing one or both control factors (Thinking and/or Encouragement) may result in one of two things: a smooth change or a jump to a very different state. The jump may not be instantaneous but, because it goes through an unstable state, it will be brief relative to the time spent in stable states. Note there is no scale. The diagram indicates paths, not measurements.

The following are the main possibilities:

a-b Intuitive types progressively report and investigate incidents in a tentative manner, which will be affected by the prevailing management attitude.

b-c With success the intuition is replaced by experience and practical thinking predominates.

d-e-f Practical types will need a certain degree of encouragement to gain benefit. Once convinced they go straight to full use. Point “e” is the singularity or point of “catastrophe” leading to a new stable level of operation (f).

Once at “c” or “f” stable operation will remain and encouragement can be reduced - up to a point (g). Representing perhaps that active encouragement is no longer necessary. However, if there is no management interest in incident investigation, encouragement is reduced further. The result for decisive types is a jump back in a discontinuous manner via “g” to “h” (non-use). Intuitive types may take a different path and meander more progressively, via, say, f-x.

Note that other paths are theoretically possible. Looking at alternatives may suggest other possibilities for consideration. All paths except those going over the cusp (e-f) or through it (g-h) are theoretically reversible. The path “e-f-g-h” shows that there is a lag (or hystersis) representing inertia to change for those who are guided by experience.

An insight is that “x” represents a critical point. Suppose encouragement from a starting point “a” reaches this point, and no further. As an intuitive type gains experience of incident investigation thinking moves towards a more fixed behaviour. The cusp catastrophe would indicate that diverging paths are possible. The direction will determine whether incidents are reported and investigated (f) or not (h).

APPENDIX 3 USING THE DATABASE

A basic requirement is that incidents should be entered and progressed in a timely manner. All incidents must be entered before the supervisor goes off shift.

The nominated manager for the area where the incident occurred is notified automatically by email. Having checked the content and satisfied themselves on the validity of the report, they must then set up an investigation team (who are notified automatically) and then accept the incident report. If they do not want to proceed e.g. if it is a duplicate of one already reported they "reject" the report. Note they do not delete it. Authority to delete is reserved for database managers. This maintains transparency of what is reported and helps prevent accidental deletion.

Due to the speed of implementation there were some early teething troubles. These were partly due to the database and partly due to the network server infrastructure. Database problems typically arose when the strict discipline for data entry was not followed. For example times had to be entered in 24-hour format, with hours and minutes separated by a colon, with no "return" after the entry. Making this more forgiving by adding selection boxes was a relatively easy cure. Network problems arose because, for speed of response, the database replicates onto the local server for each site. We learnt a lot about replication.

Despite these setbacks users were very supportive, possibly because of the time invested in showing the benefits that would accrue from getting it right.

The investigation team is charged with establishing root causes and developing effective corrective actions (at least one for each root cause). The report is then submitted to an HSE manager and the Plant Manager. This part of the process is strictly controlled. Both names can only be selected from a pre-entered list held securely in the database. The HSE Manager's responsibility is to check that in their professional judgement the actions are appropriate and that from their knowledge there are no other actions that might be included. The Plant Manager is asked to approve the corrective actions based on knowledge of the plant and crucially by approving to indicate a commitment to ensure that the actions are carried out.

In some cases either through the seriousness of the incident or the extent of the corrective action more senior management approval is required. A routine is provided for such eventualities.

A comprehensive corrective action system is included. Those with actions (who have Lotus NOTES email accounts) are notified of their actions. A tracking system shows open actions, separating out any that are overdue, and completed actions. As well as seeing actions against an incident it is easy to see all the actions against an individual person. This visibility helps the individual concerned and their Manager.

The report is not signed off until the Plant Manager (or Senior Manager) is satisfied that the corrective actions have been completed and are satisfactory.

A customised "HELP" section is included with the database A useful feature is a "Message for Today" page that pops up as the first screen whenever a new message is added. This provides a reliable way of e.g. notifying users of changes, alerting them to specific safety issues, or providing feedback on how the database is used.

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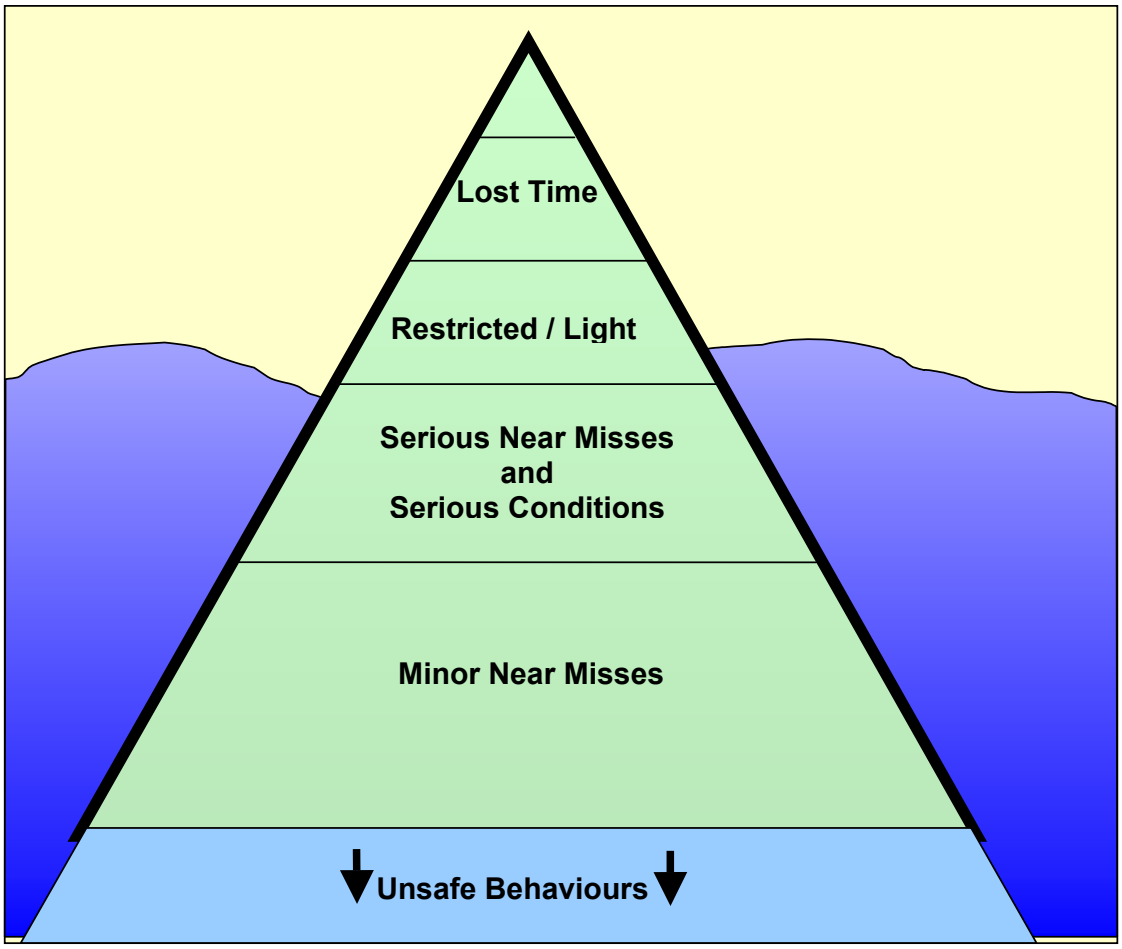

Figure 1. Iceberg pyramid for safety incidents

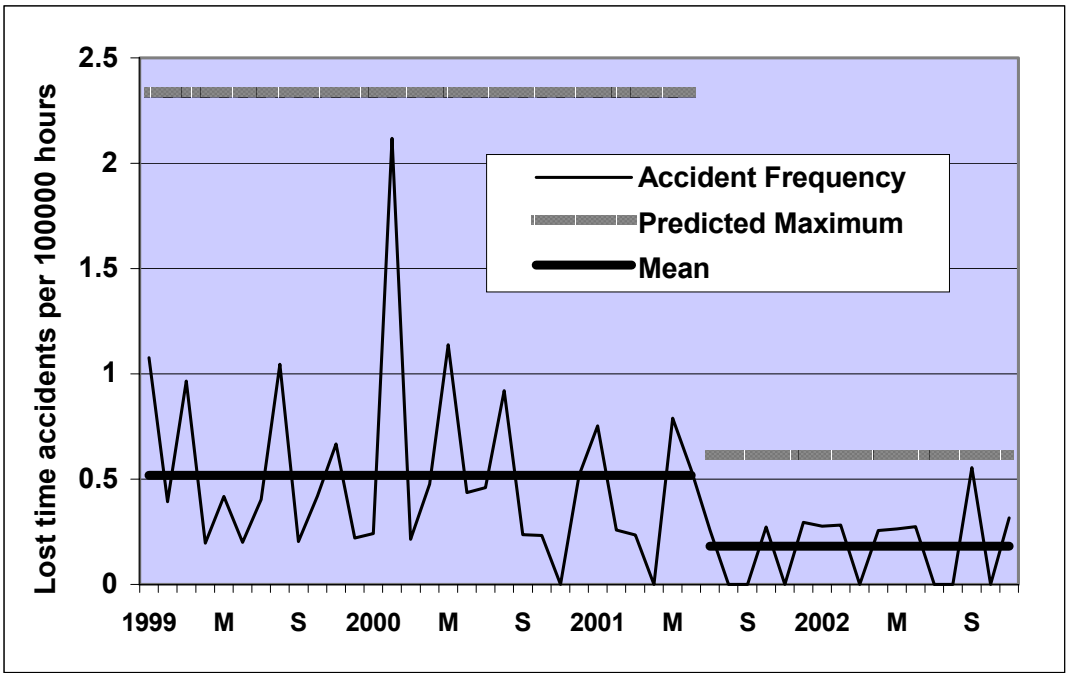

Figure 2. Greater than 3-day lost time accident (LTA) rate

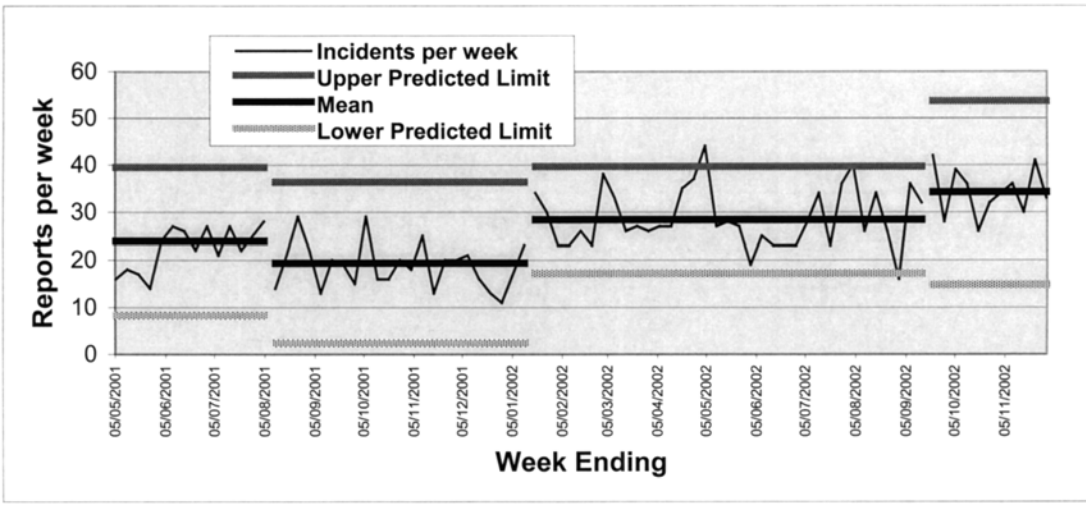

Figure 3. Incident activity reporting

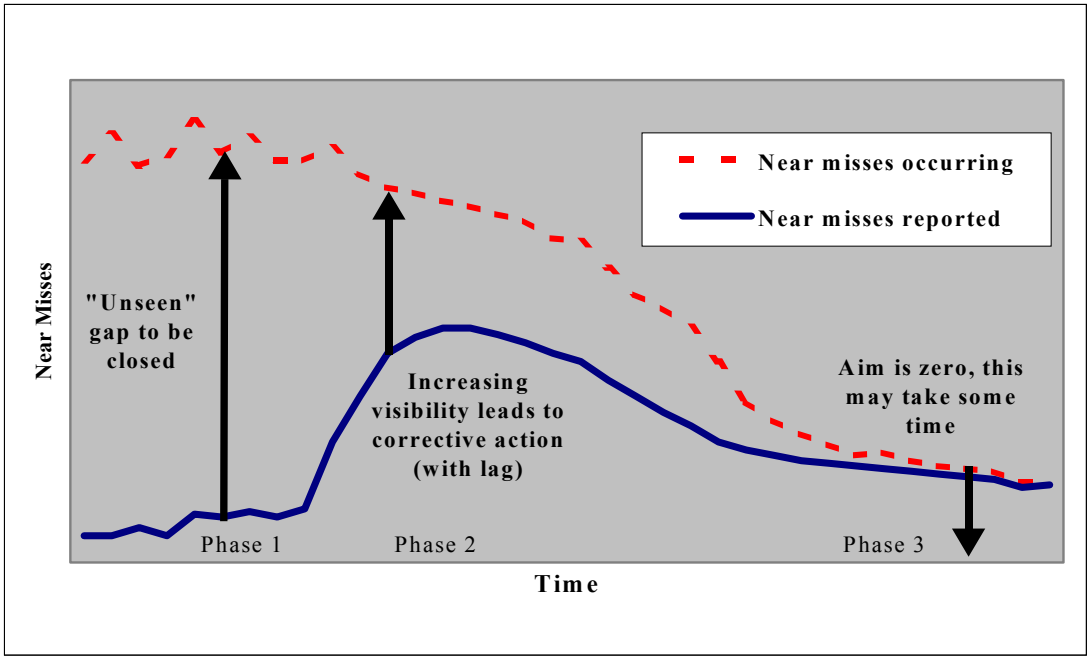

Figure 4. Near miss reporting – evolution

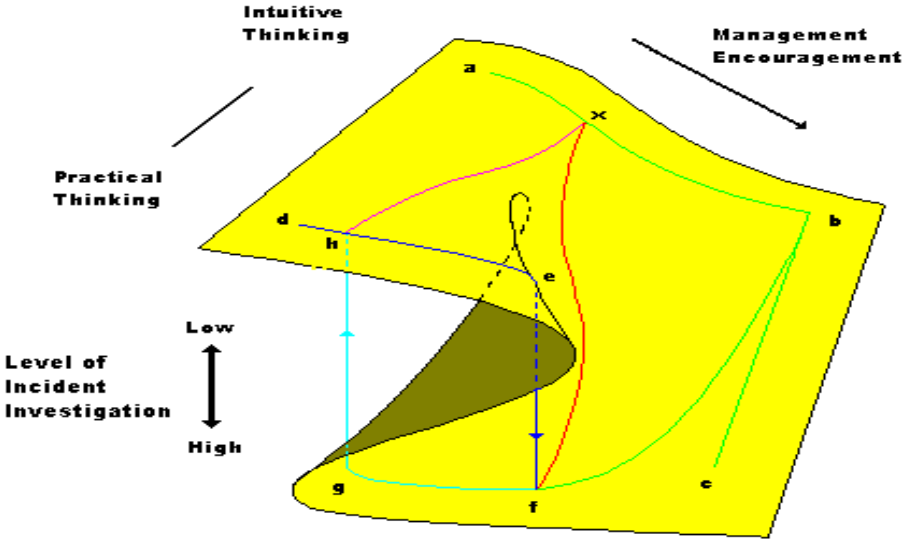

Figure 5. Catastrophe theory cusp surface for incident investigation