

CORPORATE MEMORY LOSS – A QUALITY CURE?

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Retaining corporate memory of how to avoid unsafe conditions and practices lies at the heart of sustaining good health, safety and environmental performance. Reductions in staff exacerbate the risks. Knowing that there is a problem is bad enough, but at least that may drive people to prevent it. The greater danger is being unaware that a problem may exist. It is proposed that what is needed is an enduring culture that systematically incorporates past experience, encourages safe behaviours and uses data to predict future outcomes. The model recommended is based on Deming's quality principles.

KEYWORDS: Corporate memory, management of change, Deming, knowledge, prediction, sustainable development.

CONDEMNED?

Manufacturing organisations are downsizing, outsourcing, re-locating, or re-structuring in many ways. At the same time safety and environmental performance are generally improving, sometimes dramatically (CIA, 2005; Elementis plc, 2004). But it would be unwise to draw a correlation. Add two other factors: the trend in the chemical industry for engineers to retire early and the difficulty of encouraging our brightest young people to enter the engineering profession (in the UK at least). We may be living on a knife edge.

We must find ways to retain the "know how" or unconscious, tacit knowledge (Sparrow, 1998) that contributes to good safety, occupational health and environmental practices, and to improve further. There is nothing new about this. A century ago George Santayana observed that: "Progress, far from consisting in change, depends on retentiveness. Those who cannot remember the past are condemned to repeat it" (Santayana, 1905). The trouble is it is the mistakes that tend to be repeated, rather than the preventative action. Some everyday simple examples from the chemical industry are given in Appendix 1. Among other things this advocates a healthy cynicism that things do not always go as intended.

This paper investigates the question "How do we preserve and consolidate our corporate knowledge at a time when industry is continually changing and becoming leaner, and how do we set about achieving better standards in future?"

ANSWERS ARE EASY – THE PROBLEM IS ASKING THE RIGHT QUESTIONS

PEOPLE

Preserving and consolidating knowledge is not a new problem. Consider religious teachings, military traditions, primitive societies, guilds and others with a long history of

passing on knowledge (as opposed to data or information)[1]. All of these make a point in keeping the past alive for novices by story telling, rituals or apprenticeships (in some form or another). These create unity and help groups survive from generation to generation. Past success or craftsmanship are celebrated and used to encourage current generations. The master – apprentice relationship in all of these may not be fashionable or followed these days but as a structured way of passing on knowledge it has been enduring. It could of course be argued that mentoring provides a modern substitute for traditional forms of instruction. The risk with mentoring is that it can be unstructured and optional. Effective mentoring requires a high degree of commitment, a structured programme to cover all necessary aspects and to be driven by the mentor. How can the mentee know in advance all the questions to ask? Wisdom takes time. Knowledge comes from outside (Deming, 1986).

If personal interaction with a real person who has experience and wisdom to share is becoming less common, we need to find new substitutes that almost force people to be aware of the issues. An example in the chemical industry is taking time to learn from in-company incidents and external disasters. However, unless revisited regularly this practice may only have short term benefits. One way to overcome this is to provide direct links in design and operational software to sources that provide advice and justification from experience (Bond, 2003). Beware though, even engineered solutions or additional maintenance intended to prevent a recurrence of the incident are at risk. They may get removed in later years in a cost saving exercise unless the reason for their inclusion is remembered. Maybe we should take more time to listen to the old men!

WRITTEN PROCEDURES

Written procedures are one way to help retain knowledge – if they are written, or drafted, by experienced and safety conscious masters of the subject. Crucially, they must be written so that both the instruction and the reason for the instructions can be understood by those who need to use them.

Procedures, if followed, provide consistency but as Professor Kletz warns: “Procedures are subject to a form of corrosion more rapid and thorough than that which affects the steelwork”. He notes that: “Procedures lapse, trainers leave. . .” (Kletz, 1985).

You still need to know you have a problem before you search for a solution. How many people read through the whole of an instruction manual when it is possible to get started and operate by reading the quick start section? Most read the instructions for flat pack furniture assembly – because you have to to succeed. But is that true if you hire an unfamiliar car? Frequently, people are in a great rush to drive off – they know how to drive (even if they do end up washing the screen when they want to turn right). There are parallels in an industrial manufacturing context.

[1]Knowledge in this paper is used to mean the ability to predict future outcomes based on past experience – with risk of being wrong (since experience is never complete). Information is taken to mean data organised in a way that can be interpreted, but without a theory on how it might vary in future i.e. without knowledge.

TECHNOLOGY

Maybe we can use IT (Information Technology) to replace story telling as the way to help prevent harm to people and the environment in the twenty first century? Specialist external organisations, websites and other information sources can be interrogated to come up with advice on a huge range of problems. Of course you must first be aware of the potential for a problem to arise. Plus you must be sure that the source is trusted to be wise, and appropriate for your circumstances, not a hack. There are horror stories of 14 year-olds providing plausible on-line medical advice. Who, other than a doctor, would know if it is safe and effective? On the other hand, trusted sources such as the UK's Health & Safety Executive and Environment Agency websites[2] are mines of useful information.

In-house web based solutions are used increasingly to store highly specific and relevant information that can be accessed via search parameters. There are obvious advantages but it is not a perfect solution. You still need to know that it is worth looking for something you do not know. An analogy is the Microsoft Excel Help facility. Great, if you have a question. But how many people are creating spreadsheets in a sub-optimum way unaware of the full functionality of the software?

A different issue is that databases are sometimes set up with great enthusiasm but are not maintained, or are buried and lost like the Dead Sea Scrolls. We need something else to keep things alive.

SUSTAINABLE DEVELOPMENT

The increasing commitment that some companies are making to sustainable development provides a comprehensive, integrated approach that could assist corporate memory. Appreciating that meeting the needs of the present without compromising the ability of future generations to meet their own needs[3] has profound implications: an organisation must seek first to understand how it achieves its current performance if it is to improve.

To endure, the whole process has to be anchored in an appropriate corporate culture that goes beyond short term interests, important as they may be. Top performing companies as diverse as Proctor & Gamble, Intel, Avon Products, and Deere & Company are demonstrating that good corporate citizenship makes strategic sense (Business Ethics, 2004). It enhances reputation and shareholder value. It also provides a sense of purpose and urgency that many employees will appreciate. It should also be attractive to environmentally conscious young people who might not otherwise consider a career in the chemical industry.

The next section describes a possible model for creating a corporate culture that preserves knowledge and fosters continual improvement.

[2]http://www.hse.gov.uk/ http://www.environment-agency.gov.uk/

[3]From the Brundland Commission definition of sustainable development (Brundland, 1987)

A MODEL TO PRESERVE KNOWLEDGE AND PROMOTE IMPROVEMENT

A QUALITY BASED SAFETY PROCESS

Many people are familiar with the concepts and techniques used so successfully to ensure that the quality of manufactured product is retained and improved. Specifically, the teachings of Dr W. Edwards Deming provide many ideas on how to create an enduring safety culture with continual improvement. The approach should be applicable similarly to occupational health and environmental protection.

Deming crystallised his thinking into a System of Profound Knowledge[4]. His "14 Points for Management" follow naturally as a way to apply the knowledge gained from study of Profound Knowledge (Deming, 1986; Neave, 1990).

The following paragraphs in this section attempt to interpret Deming's 14 Points in a safety context. The word "safety" will be used as shorthand to include safety, occupational health and environmental protection.

CONSTANT PURPOSE

The starting point is that an organisation must have aims, values and beliefs on what health, safety and environmental protection mean to the organisation. Without an aim there is no direction, everything is left to chance. It may work out, it may not. How would you know?

These aims, values and beliefs must be constant (or extending, but not changing direction). Furthermore, they must be long range; not flavour of the month or changing with a new manager or structure. There will always be short term priorities to reflect current issues (both HSE and business) but these must still fit into an overall aim that is unchanging towards ever improving levels of performance.

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

Note that responsibility goes beyond plant operation. Chemical companies must also recognise the importance of subsequent safety (Product Stewardship). Responsibility towards others, such as those who transport and use the chemical products, and to local communities who might be affected, is both ethically correct and one of the building blocks for sustainable safety.

A SUSTAINABLE DEVELOPMENT PHILOSOPHY

The purpose described above must be constant but adopting this approach calls for a change in mindset[5]. Safety is not a job done in isolation. It has to be integrated

[4]Profound Knowledge comprises the *interaction* of four subjects: Appreciation for a system; Knowledge of variation; Theory of knowledge, Psychology

[5]Peter Senge provides a comprehensive discussion under what he calls "metanonoia" (Senge, 1990).

throughout all activities in the organisation, led from the top, involving everyone. It must be seen as fundamental to the future of the organisation. The embracing concept is sustainable development, a journey which, if there is true commitment, will be never-ending. A corporate commitment to sustainable development should foster an environment where work of the past is kept alive and either celebrated or rectified as appropriate. Such a philosophy should guide an organisation to ever higher levels of performance.

A key reason why a new philosophy is required is the need to break down barriers to improvement. Barriers can be many things but include unwillingness to change, fear of failure, lack of time, lack of knowledge, lack of support, financial pressures and so on. These must be recognised and addressed to remove the barriers, permanently.

A NEW ROLE FOR SAFETY INSPECTION

Safety must be built into everything we do and maintained by everyone. Relying on inspection to find and correct problems is unreliable and, inevitably, will sometimes fail. Do we abolish safety inspections? No, of course not, but progressively the right culture should lead to safer workplaces through eliminating hazards, operating good systems and embedding safe behaviours. The need for inspections changes from one of being the way to assure safety to one of helping to improve.

Management inspections still provide many useful benefits. Extend them to include a range of managers unconnected with the area in question. This can bring new views on safety to operators and others who, through familiarity, may unknowingly have become complacent.

Management of change is recognised as important[6]. A procedure that requires experienced production and engineering managers to review and sign off changes before a modification can be made is a form of inspection that adds to safety and acts as a coaching method for more junior engineers with bright ideas that may not have stood the test of time. The problems are exacerbated when the organisation is downsizing. There is much evidence of the risks associated with organisational change (Kletz, 2003).

LOOK AT THE WHOLE COST

If things do go wrong the cost to the organisation is not merely the cost to fix it. Remember the hidden costs arising from loss of working, management time, and possibly fines and claims. There may also be an impact on reputation affecting sales and even the ability to recruit the best people. In the longer term the reduction in investor confidence could lead to closure of the business. How you respond to an incident may be crucial in differentiating those who recover well and those who do not (Knight R.F., and Pretty D.J., 1996).

[6]For anyone in doubt the lessons from Flixborough show the potential for disaster (HSE, 1975)

Of course it may be necessary to take immediate action to contain a problem. Thereafter however the hierarchy of controls should still be followed. The emphasis must be to remove the hazard but if not feasible to work down the steps:

- Substitute a less hazardous alternative
- Reduce the scale or inventory of the hazard
- Engineer to contain the hazard or foolproof the operation
- Adopt administrative controls to limit exposure
- Control work practices
- Protect persons who might be affected
- Training to avoid the hazard

CONTINUAL IMPROVEMENT

Our job is to improve safety constantly and forever. It has to be everywhere but, with limited resources, priorities must be established. Such decisions should be based on sound data.

Data allow you to understand the real problems in terms of factors such as severity (actual and potential) and likelihood. Having identified the areas to be tackled, a determined effort must be made to establish the underlying or root causes[7] and corrective actions. Remember that each root cause will require at least one corrective action. These must be implemented and subsequently verified as being effective. Learning from the incident should be communicated and applied wherever a similar problem might occur.

Note that "fire fighting" safety problems may be necessary. The first priority may simply be to bring things back to the status quo. Time should be taken after that find and apply effective actions to correct root causes. Used correctly Deming's Plan-Do-Study-Act (PDSA[8]) cycle is a powerful tool if one remembers to spend sufficient time on the "Plan" and "Study" phases. Studying the effectiveness of the corrective action may lead to ideas to "Act" for further improvements. Too often it is virtually straight into "Do" and then, when it goes wrong, straight back into fire fighting stage – more "React" than "Act".

Formalised systems such as the international standards for safety management systems (OHSAS 18001) and environmental management systems (ISO 14001), and regulations such as COMAH[9] and PPC[10] in the UK, may provide insight into areas to improve,

[7]Mopping up a wet floor does not necessarily mean it will not get wet again. Fix the leak! Note: fixing the leak may require more than replacing a corroded pipe, closing the valve, or whatever. Find out why these causes occurred. The technique of asking "Why?" progressively five times is a simple, effective technique to get to root cause. Why was the pipe corroded? Wrong material of construction. Why was that? And so on until a root cause is found. Empirically, asking "Why" five times seems to get to a root cause.

[8]Also known as Plan-Do-Check-Act (PDCA), Deming preferred the rigour of "study" over "check". He attributed the cycle to Walter Shewhart rather than himself.

[9]Control of Major Accident Hazards

[10]Pollution Prevention and Control

but should not be relied on as the only motivation or tool to achieve lasting improvement. They provide systems or frameworks that address specific aspects. It is possible to comply and still lack the knowledge required for a sustainable safety culture. It has also been observed that safety cases are frequently written for regulators by specialists-disconnected from the operators who need to understand the risks subsequently. Hazard management information is thus "locked up" in the safety case (Dalzell and Ditchburn, 2003).

TRAINING

Training is essential for giving people the skills, and sometimes the knowledge, required for making things safer for themselves and others. Some important points to note are that:

Training addresses specific tasks. The purpose is to bring people to a state where they perform tasks accurately with minimum variation from the desired method.

Procedures help set the context for training but, while procedures may be necessary for safe working practice, they are not sufficient to provide good corporate memory.

The training content is fairly easy to define but delivery requires careful consideration. It is worth investing in good training and good trainers. People learn in different ways and at different speeds. A good leader will know their people and take time to make sure each is trained in the way that is most effective for the person concerned.

Once trained, it is important to check that the training has been effective (competency).

Statistical process control (SPC) theory tells us that, once a person is operating consistently in statistical control, further training is unproductive (Wheeler, 1993). A corollary of this is that if this statistical control reflects consistently unsafe behaviour it is unlikely that they can be trained out of their unsafe ways. However, it may be productive to re-train someone who is not in a state of statistical control viz: having occasional lapses, or lapses arising from external factors outwith their experience.

LEADERSHIP

Supervisors and managers need to help people to do the job safely. This goes beyond the idea of a manager who allocates or controls people as resources. Not everyone can be truly inspirational but a leader must set high standards, and lead by example. They must listen and be prepared to learn but not compromise their values. A good leader will understand the things that get in the way of people trying to work safely. Often this will be system factors outwith employees' control. Leaders must be a coach and counsel to those who work for them to help them do a good job. Passing on knowledge and developing people is a key role of leader. Deming had this and more to say on leadership (Deming, 1993).

Do not expect perfection. People are different. Some will be in control doing a good job safely, others may need help. Remember also the pressures people are under. Take for example targets against KPIs (key performance indicators). Pressure to achieve the

numbers creates a risk of under-reporting incidents. “Wherever there is fear, we get wrong numbers” (in Neave, 1990).

DRIVE OUT FEAR

Do we have fear in the organisation?[11] Is there an institutionalised “blame” culture? Is there a “don’t complain” culture? Are manning levels, working conditions or systems such that workers are under undue stress yet do not feel able to speak up? None of these are conducive to safe working. People make mistakes; people have genuine concerns to air. A Leader will recognise the symptoms and work to remove them.

At a local level an individual may be suffering fear of a supervisor or anxiety about their job. Local management must be alert to recognise and act on the symptoms, both for the safety and welfare of the individual and for the potential impact any unsafe work may have on others. Experience from using SPC control charts for time of response of AA patrols[12] (Wood (1), 2001; Wood (2), 2001) shows twin benefits. Greater understanding is achieved of the process (and hence the opportunities for sustainable improvement), and individual feedback can be given in a much fairer way leading to performance improvement. Only special causes require attention with the individual. The inherent variability of the system (common causes) can only be addressed by management action on the process. This is effective and fair.

ALL ONE TEAM

Different departments and functions must work together to improve safety.

Collaboration needs to be between people at many levels and aspects. For example on a shift to look after each other, and between shifts to provide continuity of safety. Thorough handover is essential to share learning for best practice not just to pass on plant operating conditions. Operations, Maintenance and Contractors must collaborate beyond essential things such as work plans, method statements and Permit to Work systems. Each function has a wealth of knowledge about the plant, process and equipment which can help others understand how to work more safely. This helps keep learning alive.

ELIMINATE EXHORTATIONS

Slogans, posters etc. need to provide guidance. Exhortations on the lines of “Work safely” or “Safety is your responsibility” are not helpful. Instructions on how to lift safely, use a computer without strain, or protect hands all pass on useful information. Similarly, safety

[11]Ryan & Oestreich provide a comprehensive discussion on what forms this may take and how to overcome it (Ryan, 1991)

[12]Trained mechanics with equipped trucks who attend to car breakdowns of Automobile Association members

statistics showing trends can be helpful and provide useful feedback. Posters produced by people relating to their own workplace can be particularly powerful.

ELIMINATE ARBITARY NUMERICAL TARGETS

The key word is "arbitrary". People need figures and targets, but also a way to achieve them.

As Deming said, you should ask two questions: "what is your aim?" and then, "by what methods?" If you have a target you should be predicting the outcome from some set of events. Predictions need knowledge, coming for example from SPC charts. A stable system will give you the same result, on average, in the future. Note that within that stable system there will still be random variation (or "noise"). It is not economic to react to correct individual events in a stable system (Deming calls this "tampering"). If you want to hit a previously unachieved target you will have to do something that changes the system not the variation. It should be obvious but how often is a target set to improve, by say 10%, with no idea how that might happen, except by luck? As the saying goes, even a blind squirrel finds a nut once in a while.

Facts of life are an exception - if we don't reduce by "x" we will not survive, we will be prosecuted etc. Set the target by all means but you will still have to figure out a way to achieve it. It will not happen just because it is vital.

PERMIT PRIDE IN SAFE WORKING

Remove barriers that make people merely do their job. Everyone needs to be enthusiastically engaged. This is not the same as "empowerment" - if that implies delegating responsibility. We are not "encouraging" pride. We want to create an environment where pride flourishes naturally. Once achieved, beware though: it can be crushed much faster than it can be created.

Positive reinforcement contributes to the process. Managers should acknowledge and reinforce safe working; they should explain the importance of near miss reporting. People who report near misses should be congratulated for highlighting a problem.

There may of course be instances where a properly trained, competent individual has knowingly flouted safe working practice. In this case, discipline, applied fairly, is warranted. Some action may have to be taken with the person involved, but that should normally be to help them work more safely in future. Bear in mind that what may appear to be an unsafe act often has roots in an unsafe system.

Behavioural safety programmes, correctly implemented, should allow people to take pride in safe working. An assumption here is that success requires an environment where management neither abdicates all responsibility nor fails to allow enough freedom. Regular and visible management support helps give legitimacy to spending time identifying and correcting unsafe behaviours and conditions. Managements that give employees the freedom to act on behavioural issues will reap the benefits of individuals to contributing their local knowledge and presence to prevent unsafe acts when Management is not around.

ENCOURAGE EDUCATION

Practical people concentrate on training. Training is necessary but so too is education[13]. Education can show people the limitations of their knowledge and encourage them to seek greater understanding of what they do not know. Education provides the environment for improvement rather than stable operation.

A good example of the need for education (as opposed to training) is in the use of SPC control charts. Control charts provide a common language that can show where there is a stable system with just random (common cause) variation and where there may be a special cause requiring immediate attention. Unfortunately, despite training courses it appears that, in the absence of a company system requiring their use, control charts are not used voluntarily as much as they might be. A study by one of the authors (Gardener, 1999) suggests that more awareness is needed by managers of the way to implement control charts. Factors include personality type, management support and how they perceived their role in the organisation.

Improvement may of course be to a person or for an organisation. Improvement to an individual person can come through mentoring by experienced employees. A point sometimes missed is that such mentors should be chosen for their enthusiasm and ability to pass on tacit knowledge, not dictated by their formal position. For example a person's supervisor is not necessarily a good mentor. A good supervisor should be a leader. It may be that the supervisor needs training first in mentoring skills.

TOP MANAGEMENT COMMITMENT AND ACTION

Safety is made (or not) in the Board room. It is not enough to be committed. Top management must know what they must do, and do it.

Actions can of course be delegated but there must be an active interested link all the way through the organisation. Timely reporting is essential.

A common statement is that The Board believes that "all accidents are preventable". What are they going to do to achieve that? Or, more likely, will they accept a level of risk based on some economic judgement that an optimum position has been reached.

Perhaps a more realistic statement is that all recordable injuries are considered preventable and that the following actions (x,y,z) will be taken to achieve that level of performance. Logically that will include investigating and reducing the incidence of lesser incidents to reduce the likelihood of recordable incidents, as suggested by the Heinrich Safety Triangle[14] (Gardener, 1993).

KPIs such as lost time incident rate are, of course, lagging indicators showing results after the event. Ultimately that is what matters but, to help the process, monitoring and publishing leading indicators, such as near miss reporting can provide confidence that improvements can be sustained.

[13]In case of doubt about the difference between training and education consider a parent's response if their child come home from school saying they had had sex training rather than sex education!

[14]Heinrich's theory proposes that for every 300 unsafe acts there are 29 minor injuries and one major injury. Work on the unsafe acts and you will reduce the likelihood of a more serious injury.

MONITORING AND REPORTING – AN EXAMPLE

OPERATIONAL DEFINITIONS

A global company needs clear understanding on HSE standards between sites in different countries[15].

For example, Elementis, a specialty chemical manufacturer with operations worldwide, 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[16] (greater than 3-days lost time). An internal Company definition is used for different categories of environmental incident. Tier 1 is where there is no environmental impact with complete clean-up achieved if appropriate. At the other end of the scale Tier 3 is where there is significant environmental harm. The intermediate Tier 2 covers minor releases where there is little environmental harm and technical breaches where regulators are informed without incurring anything more than a notional penalty.

SITE

Operating sites have day to day responsibility for HSE performance. They record incidents on the global HSE Reports database. Incidents are investigated promptly. The aim is to establish root causes so that effective corrective actions can be developed and implemented. Learning from these investigations is disseminated around the site, to other similar sites in the Business and, if appropriate, throughout the Company. Even if not actively communicated the reports are available for all to see throughout the Company (with a few exceptions where details are particularly sensitive).

It does not stop at reporting. Despite all that may or may not have been done previously something undesirable has happened. Hazards need review. Pro-activity is the key to prevention but pragmatic decisions must be made on what level of risk assessment is required. The Risk Rainbow (Figure 1) developed by one of the authors at the site provides guidance on whether the assessment can be merely a mental judgement or whether a more formal process is required. The latter ranges from control by "permit to work" through to a fully documented risk assessment.

Documented risk assessments follow a pro-forma on a database. This has worked successfully for over five years and been copied worldwide around the Company. The form leads the risk assessor through a comprehensive list of credible hazards. Skill and knowledge is still required to make the risk assessments but the user is guided to consider possible causes and controls.

Behavioural safety programmes are operated in conjunction with safety meetings, toolbox talks, safety flyers, and other local initiatives. The success of the behavioural

[15]Differences in perspectives between the UK and US (in particular) mean that priorities are somewhat different. As a broad generalisation: in the UK greater reliance is placed on management systems to assure safe working that complies with all legal requirements. The focus in the US tends to be compliant systems based more directly on the detail contained in the comprehensive OSHA and EPA standards.

[16]Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995

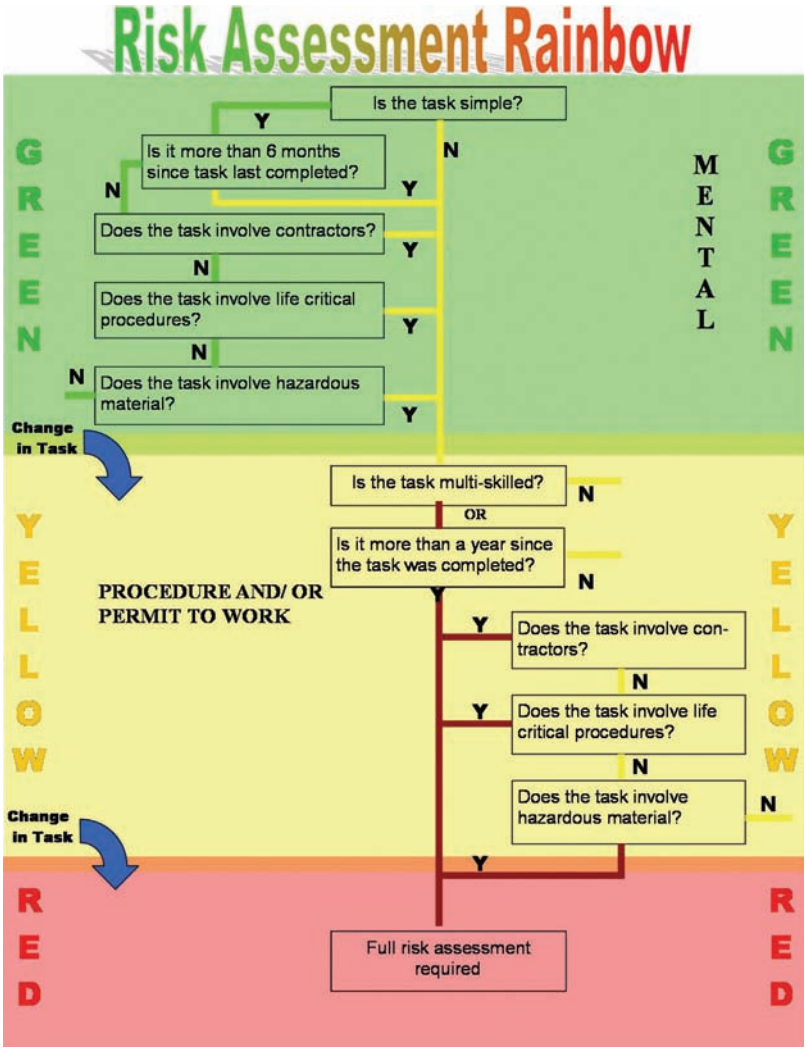

Figure 1. Risk rainbow

safety programme comes from the continual reporting of the myriad small local issues, which are corrected either on the spot or shortly afterwards. The wider message is that people see that they are in control, are thus encouraged and keep looking for other things to improve safety.

BUSINESS

Sites are grouped into product based Businesses. The Businesses effectively set their own HSE programmes and initiatives to comply with regulations and Corporate requirements in a way that is appropriate to their Business. The Businesses have weekly and monthly reporting, conference calls, audits and produce their own bottom-up improvement targets.

CORPORATE

Corporate reporting covers both internal reporting to the Executive Board and external reporting via the Annual Report and a more recently introduced Sustainable Development Report. Data are collected via the Company-wide incident reporting system (Gardener, 2001), from corporate audits and from direct interaction with the Business HSE and Manufacturing representatives. These data are plotted on control charts and used to predict whether the system is stable and if improvements are sustainable. For a discussion on control charting and arbitrary targets see Appendix 2.

Formal interaction comes from a monthly report and telephone conference call with all the Businesses. The conference call provides a forum to share learning from incidents and ideas for improvement. Good working relationships ensure that there is also much informal contact and collaboration.

A corporate monthly HSE report is issued to the Executive Directors, Senior Managers and distributed widely within the Company at Business and Site level. The fortunately rare more serious incidents (recordable injury or pollution that cannot easily be cleaned up) are reported to the Executive immediately.

The Annual Report and Sustainable Development Report are produced corporately via an iterative process involving key functional representatives in the operating Businesses.

KNOWLEDGE FOR IMPROVEMENT

Regardless of changes in our industry, and loss of individuals with accumulated expertise, we must continue to improve to prevent harm to people and the environment.

Improvement requires knowledge. US Secretary of Defense, Donald Rumsfeld suggested a trilogy of possibilities in connection with military intelligence: known knowns; known unknowns; and unknown unknowns (Rumsfeld, 2002). It is worth considering them when we are looking for ways to reduce accidents and incidents. As industry changes and experienced people leave the problem is exacerbated. There is a real risk that some of the previous “knowns” revert to “unknown”.

For the known knowns, are we sure that we are correct? Is our degree of belief based on knowledge from data or is it just an assumption: the incident has not happened, yet? Sustainable safety performance requires predictability that we can continue at least as safely as we have been in the past. This then provides a stable base to work from for improvement.

We must accept that on some things our knowledge is poor. These "known unknowns" present a great opportunity to learn and improve. We have acknowledged that we need to find out more. Assuming we have time, there are many sources that can be tapped to help find an answer. We still need to ensure the reliability and validity of any advice received. In the meantime we can take precautions that recognise the uncertainty.

If we are prudent we will also realise that there must be yet more things we haven't even thought about, far less understood and taken action on (the unknown unknowns). Keep looking and learn from others. Risk assessments, HAZOP (Hazard and Operability) studies, FMEA (Failure Mode & Effect Analysis) and incident investigation are examples of how previous unknown risks can be unearthed internally.

CONCLUSION

Industry is changing. Knowledge of how to operate safely must be preserved. Beyond that society requires continual improvement, and rightly so, if we are to protect the future with sustainable development.

Achieving good performance with minimum variation is the datum for continual improvement. In times of change we need to be acutely aware that there are things we will have forgotten. Our aim must therefore be to recognise just where we are in the spectrum of things we know – do not know and then move towards greater certainty.

The task cannot be left entirely to individuals, however competent. Even where there appears to be continuity there may be drift to less safe conditions as people leave or memories fade. Measurement via wisely chosen KPIs should allow prediction of future performance.

It is proposed here that a successful way to foster a knowledge culture is to adopt Deming's quality principles in a safety philosophy. The essence of this is to embed a way of working where everyone wishes to learn, shares good and bad experiences without fear of reprisal and uses data analysed so that the root causes are understood and acted on. The more experienced employees should pass on knowledge routinely as a key part of their job.

In this way an antidote to corporate amnesia can be created for never ending sustainable improvement in heath, safety and environmental performance.

APPENDIX 1 SOME EXAMPLES FROM EXPERIENCE

Lessons from commissioning new plant are always instructive

- motors, especially with pumps can be electrically wired the wrong way (sods law, they usually are)

- non-chemical resistant temporary joints, blinds/blank flanges and other temporary items used for pressure testing are sometimes left in by mistake.

After that no matter how good the design, how comprehensive the HAZOP and how detailed the procedures you still need process engineers and chemists because you'll never anticipate every scenario. You have to learn from your experiences (good & bad). Each event if properly evaluated can be avoided or the risk greatly diminished if the lessons are learnt and incorporated into tribal knowledge of the site.

Sites rarely have entirely novel incidents, most are variants on a theme that has been seen before but for various reasons not necessarily wrestled to the ground. The role of the experienced manager is to remind the organisation that "we've seen this before" and ask why the learning isn't yet cast in stone in procedures.

There's also a general lesson about whether an engineer feels the plant runs him/her or they run the plant. If there is an unusual problem then you really have to believe that there is a cause that can be found and can be cured. If it is a more general run of problems, such as a pump gland that need repair say every 6–9 months, you can have all sorts of sophisticated analysis of failure frequency and preventive maintenance or you can make a quantum leap in the design or operation of the system to remove the problem altogether.

The skill that merits most honing and refinement for a young engineer is "listening". Spend time looking for answers to problems in the field not at your desk. Invariably process or maintenance personnel spend far more time interacting with their plant than any engineer. They will probably have seen and know most things that can and do go wrong. They also know how the plant is actually operated rather than how the Organisation thinks it is run. A bonus is that there are usually many people to listen to so it's a huge resource. They may not know they know the answer directly but patient open ended, structured questions and really hard listening often brings that "Eureka" moment when the engineer really truly begins to make the right connection.

Change is good if it represents progress but it can be dangerous if the consequences are not thought through via a rigorous review. "What's changed" is always a good question to ask in troubleshooting. Sometimes it can be the subtlest of things. Any process works best with stable and quality assured inputs. For example, the purchasing group might find a new (cheaper) hot water hose that met hose standards. If however it resulted in more frequent failure in service it could increase the risk of scalding and increase maintenance costs.

A change to filter aid/precoat medium has been known to introduce trace quantities of unwelcome crystal growth modifiers to a large crystallisation process with serious impact on finished particle size.

APPENDIX 2 NOTES ON CONTROL CHARTS AND ARBITRARY TARGETS

Control charts can be used to track HS&E performance as a means to understand and predict. A target of zero harm has to be the only acceptable target. Charts may show that there is a stable system of non-zero lost time accidents and other recordable incidents.

Those who are familiar with Shewhart's original work on control charts (Shewhart, 1931) and the teachings of Deming (Neave, 1990) may therefore question the logic of setting what might appear to be an arbitrary target for improvement to zero.

The first point to make is that setting such a target is recognition that the status quo is unacceptable – something has to be done. A second point is that action has to be taken to change the system to the 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 is not to try to explain a bad month that is 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.

The Elementis Businesses and sites investigate all or most of their incidents every month providing the necessary insight to make changes that allow them to predict improved performance. These projections are fed back to Corporate HSE for consolidation into an improvement target that is working towards the goal of zero recordable incidents.

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