Safety management in context – Cross-industry learning for theory and practice
19–21 June 2013

White book

Swiss Re
Centre for Global Dialogue

Safety management in context – Cross-industry learning for theory and practice
19–21 June 2013

White book

ETH Zurich

MIT

Swiss Re
Centre for Global Dialogue

Introductory letter

In 2004 Swiss Re and the Swiss Re Centre for Global Dialogue published "The better the team, the safer the world: Golden rules of group interaction in high risk environments." Roughly 10 years later, and despite the many achievements in safety management across a spectrum of industries, we continue to suffer a wide range of disastrous man made accidents. The need to steadily improve safety management persists.

It is in this spirit that Swiss Re is pleased to publish a new oversight of safety management. The report is based on a conference held at Monte Verità in June 2013. The conference brought together participants from academia and a wide array of experienced industry practitioners from sectors including aviation, nuclear, oil and gas, rail, health and insurance. The conference was organised as a result of a desire to disseminate and communicate impressive recent scientific advances in the field of safety management research amongst a diverse and multi-industry audience.

A decade ago the focus was on team performance and improving communication; today's focus is on managing complexity in a highly interconnected world. Simple one-size-fits-all solutions are no longer appropriate. Improving safety includes discussions about different values and different cultures; and about trade-offs between flexibility and standardisation. The conference clearly demonstrated that no single safety model is superior. Safe environment can be ensured by a combination of the right protocols; the right data; the right working conditions; the appropriate risk assessment; the right learning from errors; rich face to face communication; and the integration of local cultural particularities.

In times of tight cost management and efficiency gains across industries, risk management should lie within the CEO's responsibility as well as that of the board. Regular safety updates belong on the agenda of top management. A good safety performance will automatically translate into higher long term profits. A prerequisite to achieving this is proactive investment in prevention and safety management planning.

Swiss Re has always been committed to reducing the damage and harm resulting from poor safety management and negligent human behaviour. We hope that this publication will foster joint dialogue about safety between academia, hazardous industries, regulators and the public; and in so doing, help to create a safer world,

Reto Schneider Head Emerging Risk Management, Swiss Re

Publisher: Swiss Re Centre for Global Dialogue
Editors: Gudela Grote, ETH Zurich; John Carroll, MIT

global_dialogue@swissre.com
www.swissre.com/cgd

Table of contents

Introduction and overview

Gudela Grote & John Carroll

In response to a continuing array of catastrophes in high-risk industries, such as oil and gas, nuclear power generation, aviation, railways, medicine and finance, concepts and methods to better manage risk and safety are sorely needed. Over the years various industries have led the way to improved safety management, with other industries following them, but often also reinventing practices that were well established elsewhere or adopting practices that did not fit their new context. The aim of a three-day conference at the Centro Stefano Franscini in Ascona, Switzerland, in June 2013 was to discuss both effective ways to foster cross-industry learning and limits to generalizing concepts and methods for safety promotion. Team interaction and training, learning from failure, socio-technically based risk assessment, and organizational and regulatory structures were specifically addressed as central aspects of safety management. The results of the discussions form the basis for the insights and recommendations presented in this White Book.

The aim of the White Book is to provide safety professionals and policy makers in diverse industries with a general understanding of important factors to consider when developing, implementing, and operating safety management activities. The authors of the White Book do not claim to cover all relevant factors in a fully systematic and comprehensive manner, but sufficiently so to help practitioners make more informed decisions on a variety of issues in safety management, thereby also making a modest contribution to a safer world.

Overview of main issues addressed in the White Book

Diverse industries have developed a multitude of components and standards for safety management systems. However, the following list can be considered a common denominator of what comprises a good safety management system:

- Safety policy
- Safety resources and responsibilities
- Risk identification and mitigation
- Standards and procedures
- Human factors based system design
- Safety training
- Safety performance monitoring
- Incident and problem reporting and investigation
- Learning from operating experience
- Information sharing internally and externally
- Auditing
- Continuous improvement
- Management of change

The particular ways of designing and implementing these elements of safety management first of all depend on the nature of the risks to be managed and on the general approach taken to managing risk and the underlying uncertainties. While reducing uncertainty appears to be the most straight-forward approach, there are industries and work domains where uncertainty has to be retained and acknowledged or even increased in order to achieve an organization's objectives. Overall, the right balance between stability and flexibility needs to be achieved, which for a nuclear power plant requires a different management of uncertainty compared to the emergency unit of a hospital or the early stages of oil exploration. In these considerations, safety concerns and the risk assessments detailing those concerns clearly play a crucial role, but they should be embedded in a broader perspective on overall organizational effectiveness. The contributions by Amalberti and Vincent, Kirwan and Hale, Larsson, and Nieminen and Bruyere address these issues and make a number of more specific recommendations also.

Two fundamental building blocks of safe operations in organizations are well-performing teams and the capacity to learn from failure. Again, how both of these should be implemented and supported depends on context factors such as the nature of the task to be performed, diversity of occupational backgrounds within teams, the formal structure and informal culture in the organization, the resources and capabilities of the organization and last but not least the nature of risks involved and the chosen approach for handling those risks. This implies that prioritization of improvement initiatives and implementation of particular safety management methods such as team training, incident reporting or information sharing after accidents always need to be adapted to the specific contexts. The contributions by Zellmer-Bruhn and Kolbe and by Ramanujam and Carroll as well as the more detailed recommendations from a number of additional authors are aimed at helping practitioners to design and implement tailored team training and organizational learning schemes.

Contextual factors operate both within organizations and in their environment. Regulatory regimes, for instance, set the stage for the level of standardization in organizations, which in turn affects the decision-latitude of teams and individuals working in these organizations. Likewise, external pressures on risk control and accountability, often steered by public risk perception, will impact performance monitoring, auditing, and continuous improvement within organizations. Decision-makers in organizations need to be aware of these influences and aim to proactively address them in order to keep safety management focused on the requirements originating from the risks and uncertainties inherent in the organization's work processes. The contributions by Gittell, Schulman, Hayes and Sutcliffe describe contextual factors and their influences in more detail, thereby raising awareness for the cross-level dynamics at play within organizations and between organizations and their environment.

Frequently, the concept of safety culture is invoked as the ultimate goal of safety management. In some industries, foremost the nuclear power industry, regulators even require of organizations to show proof of their efforts to establish and maintain a safety culture. In view of the elusiveness of this concept such requirements may lead organizations to spend more energy on debating its meaning and relevance than on called-for safety management activities. This is not to say that the influence of culture on safety and its management can be neglected. Rather any activity within an organization and especially the implementation of any change is embedded in and shaped by basic cultural assumptions, norms, and beliefs. The concluding essay by Schein provides a thought-provoking account of these processes and their relevance for establishing and maintaining safe operations in organizations.

Further reading

Carroll, J.S. & Quijada, M.A. (2007). Tilting the culture in health care: Using cultural strengths to transform organizations. In P. Carayon (ed.), Handbook of Human Factors and Ergonomics in healthcare and patient safety (pp. 823-32). Mahwah, NJ: Lawrence Erlbaum Associates.

Carroll, J.S., Rudolph, J.W. & Hatakenaka, S. (2003). Learning from organizational experience. In M. Easterby-Smith & M.A. Lyles (eds.), Blackwell Handbook of organizational learning and knowledge management (pp. 575-600). Malden, MA: Blackwell.

Goodman, P.S., Ramanujam, R., Carroll, J., Edmondson, A.C., Hofmann, D., & Sutcliffe, K. (2011). Organizational errors: Directions for future research. Research in Organizational Behavior, 31, 151-176.

Grote, G. (2009). Management of uncertainty – Theory and application in the design of systems and organizations. London: Springer.

Grote, G. (2012). Safety management in different high-risk domains – All the same? Safety Science, 50, 1983-1992.

Grote, G., Weichbrodt, J.C., Günter, H., Zala-Mezö, E. & Künzle, B. (2009). Coordination in high-risk organizations: The need for flexible routines. Cognition, Technology & Work, 11, 17-27.

Grote, G. & Weichbrodt, J. (2013). Why regulators should stay away from safety culture and stick to rules instead. In C. Bieder & M. Bourrier (eds.), Trapping safety into rules: How desirable and avoidable is proceduralization of safety? (pp. 225-240). Farnham: Ashgate.

Künzle, B., Zala-Mezö, E., Kolbe, M., Wacker, J. & Grote, G. (2010). Substitutes for leadership in anaesthesia teams and their impact on leadership effectiveness. European Journal of Work and Organizational Psychology, 19, 505-531.

Schein, E. H. (2009). The corporate culture survival guide (revised edition). San Francisco: Wiley.

A continuum of safety models

René Amalberti & Charles Vicent

Note : this chapter heavily draws from an excerpt of the book "Navigating safety, Amalberti R." published by Springer in 2013.

The idea of a single model of safety that applies to everything and aims to have zero accidents is naïve. There are many different responses to risk, which provoke many different authentic models of safety, each with their own approach, advantages and limitations. The differences between these models lie in the trade-offs between the benefits of adaptability and the benefits of the level of safety. Ultimately safety is a social construct and it adapts to demand.

We commonly assume that safety is achieved by imposing rules and restricting the autonomy of management and workers. Everyone will agree however that writing a safety plan, including compliance to legal requirements, offers no guarantee that the plan will be put into practice. The literature is full of demonstrations of non-compliance to rules for a number of recurrent reasons (too many, not understood, not known, not adapting to non-standard cases, contradictions among rules, etc). Moreover, workers' and system adaptation (and intelligence) to non-standard conditions are commonly found to be necessary to guarantee efficiency and safety in work.

Concrete safety results are therefore the product of apparently contradictory actions: rules and constraints that guide work on the one hand, and on the other hand good and bad reasons for not complying with these rules, including regular reliance on the adaptive capacities of operators when the situation goes outside the area covered by regulations. The setting and balance between these contradictory dimensions frame a continuum of safety models fitting various economics needs, from those giving priority to adaptation to those giving priority to rules and supervision. It is important to acknowledge that these various models considerably vary in safety solutions but all share the same ambition of reducing risk.

Approaches to risk and hazard: avoid, manage or embrace

The metaphor of the climber and the rock face may serve as a framework for describing the variety of these safety models. One can consider hazards as rock faces. They are an inevitable part of nature. In industry, such rock faces may represent sick patients in hospital, the chemical properties of compounds, solar radiation, oil-shale, etc. Risk management depends on the willingness to deal with these rock faces and the way in which this is done. One can refuse to climb them under current conditions, therefore waiting for better conditions (plan A), one can limit oneself to climbing only known rock faces and follow all the required procedures in normal and well-explored abnormal conditions (plan B), or one can attempt rock faces in non-standard situations (without equipment, without training, under poor or changing conditions), or worse still, daring to climb unknown rock faces in a context of an increasingly competitive work (plan C).

Outside a small number of ultra-safe industries (Aviation, Public transportation, Nuclear), the majority of human occupational activities rely heavily on plan C. Industries exhibit a range of adaptations from those that heavily limit but tolerate plan C risks (process industry) to those living everyday with plan C to some that consider these adaptations to be an essential part of their knowhow (oncology and emergencies in healthcare, international finance and trading, fishing industry, most military actions in war time). Strangely enough, however, all the literature on the Quality and Safety of systems offers prescriptions only for plans A and B.

It is not because those relying on plan C do not follow all the procedures and therefore rely on improvisation that it is not possible to make their practices safe. The problem is that the solutions that would make these practices safe at the same time as accepting their reality do not consist in developing procedures. (If they did, one would change to a plan B approach). Instead, the response is ad-hoc and does not cover all the situations that arise during the work, whose very economic rationale often demands that it rely on plan C. Plan C solutions are found in quite resilient models: becoming more expert, becoming able to judge the difficulty of the task according to one's own skills, learning to learn, drawing from experience, acquiring generic knowledge schemas which allow adaptation to borderline circumstances.

Systems that have a relatively modest level of safety (lower than 10^{-4}) have considerable exposure to risk because they literally make a living from that exposure. This is true of fighter pilots, sea fishing skippers and professional mountaineers. In these occupations, accepting exposure to risk and even seeking out risk forms the essence of their work. These occupations do, however, still want to improve safety. A number of studies carried out among fighter pilots[1] and sea fishing skippers[2,3], show a real desire for safety. Fishing skippers, for example, would like to have an intelligent anti-collision system to offer them better protection in high seas with poor visibility and with the mobility required for trawling (Automatic Radar Plotting Aid). Fighter pilots would like an electronic safety net to offer them better protection when they are undertaking maneuvers that are likely to make them lose consciousness (Electronic Safety Net).

1 Amalberti R, Deblon F (1992) Cognitive modelling of fighter aircraft's control process: a step towards intelligent onboard assistance system. International Journal of Man-Machine studies 36: 639-71.
2 Morel G, Amalberti R, Chauvin C (2008) Articulating the differences between safety and resilience: the decision-making of professional sea fishing skippers. Human factors 50: 1-16.
3 Morel G, Amalberti R, Chauvin C (2009) How good micro/macro ergonomics may improve resilience, but not necessarily safety. Safety Science 47: 285-94.

In contrast, the high levels of safety in civil aviation are achieved by very different means. Here, the solution is radically different and most commonly involves not exposing crews to the hazardous conditions or risks that are thought to be the cause of accidents. For example, the eruption of the Eyjafjallajökull volcano in Iceland in 2010 led to all aircraft immediately being grounded based on a simple approach: no exposure to risk. These different examples highlight two completely opposite strategies to dealing with risk: one, which is supported by small-scale systems involving skilled trades or highly competitive activities, involves relying on the intelligence of operators and giving them aids to deal with risk; the other involves relying on the organisation and supervision and ensuring that operators are not exposed to risks. It is easy to understand that both of these models have their own approach, but in that case it is also necessary to accept that the safety solutions are not identical in both cases.

Three authentic models of safety rather than only one

Taking into account the risk exposure strategies already mentioned, it make sense to take the view that each one has given rise to an authentic way of organising safety which is original, with its own approach and its own possibilities for improvement[4,5].

The ultra resilient model involves occupations in which seeking exposure to risk is inherent in the economic model of that occupation. Skilled-trade occupations in particular sell their services on the basis of their expertise which allows them to deal with new risks, or even deal with the unknown, by innovating, mastering new contexts, and coping, thereby winning through and reaping benefits where others fail or are afraid to go. This is the culture of champions, winners ... and losers (the losers are part of the context, but they are not perceived as failures of the system but rather as a reflection of the knowledge and skill of the champions). Sea fishing skippers, for example, are capable of seeking out the riskiest conditions in order to prioritize catching the most profitable fish at the best times (sales economy); traders constantly have to maximise their profits and military fighter pilots[6] always have to win... All these occupations have objective accident statistics that are more or less disastrous. They are not, however, insensitive to their occupational risks, and they deal with these through safety and training strategies that are very well thought-out, but of course within a different culture.

4 Amalberti R, Barach P. Improving healthcare: understanding the properties of three contrasting and concurrent safety models. Submitted.

5 Grote G (2012) Safety management in different high-risk domains – All the same? Safety Science, 50, 1983-1992.

6 The case of fighter pilots is a special and interesting case of a dual context: in peacetime, their administration (the Air Force) operates essentially on an ultra-safe model, but once the aircraft are deployed on active service, the operating model suddenly changes and returns to its fundamentals of resilience. These very contrasting contexts do generate surprises in terms of safety in both directions: persistence of resilient, deviant behaviour (as compared with the model that would be desired in peacetime) after returning from military campaigns, and important opportunities that are missed during the first few days of engagement due to lack of practice in the resilient model, when pilots are suddenly thrust from peacetime into operational theatre.

In these occupations, the individuals' autonomy and expertise take precedence over the hierarchical organisation of the group. In many cases the group is very small (consisting of two to eight individuals) and works in a highly competitive setting. The boss is recognised for his technical ability, his past performance and his charisma more than for his official status. Every operator is constantly invited to use a very wide margin of initiative. A correct assessment of his own skill, courage and accumulated experience are the keys to recognition as „a good professional and a winner"; safety is mostly about winning, surviving, and only winners have a chance to communicate their safety expertise in the form of champions' stories. To summarise, there are a small number of procedures, a very high level of autonomy and a very large number of accidents. It is still possible to make progress in terms of local safety, however, by becoming better trained through contact with the best masters, learning from their experiences and adding to one's own mental capacity to adapt to even the most difficult situations. The differences between the least safe and the safest operators within a single resilient, skilled trade are of the order of a factor of ten[7], which proves that it is possible to make progress through safety interventions, even while remaining within the „micro-Gaussian" distribution of professionals engaged in these hazardous types of work.

• **The HRO model (High Reliability Organizations)** uses the same idea of resilience[8], since it also promotes adaptation, but this is a kind of adaptation which is more local and controlled, involving human activities which are clearly better organised,. The HRO model is in fact relatively averse to individual exploits that are not controlled by the group. HROs typically apply to occupations in which risk management is a daily affair, though the primary aim is to manage risk and avoid unnecessary exposure to it. Firefighters, merchant navy and naval armed forces, professionals in the operating theatre, and those operating chemical factories all face hazards and uncertainty on a daily basis and typically rely on an HRO model.

HROs rely on the leader and the professional group, which incorporates several different roles and types of expertise in order to maintain a constant perspective on progress being made towards the goal (while avoiding the risks of a local focus), where all the members of the group play a part in detecting abnormalities in a contextual setting (sense making), bringing them to the attention of the group, and adapting the procedure to these changes in the context. This includes deviations from procedures when necessary (but only when this makes sense within the group and is communicated to everyone). All members of the group show solidarity in terms of this safety objective. Combating adversity is an integral part of the HRO approach but the high level of collective regulation (not necessarily only by the leader) imposes considerable limitations on isolated individual initiatives and promotes prudent collective decision-making.

7 The rate of fatal accidents in professional deep-sea fishing varies by a factor of 4 between shipowners in France and by a factor of 9 at the global level, source: Morel, Amalberti, Chauvin, 2009, op. cit.

8 Weick KE, Sutcliffe KM , Managing the Unexpected: Assuring High Performance in an Age of Complexity, 2001, Jossey-Bass, San Francisco

The HRO model analyses its own failures and seeks to understand the reasons behind them. The lessons drawn from these accident analyses, however, are primarily about ways in which the situation has been managed and could be managed better in future. This is therefore a model which relies firstly on improving detection and recovery from hazardous situations, and secondly on improving prevention - which means avoiding exposure to these difficult situations. Training is based on collective acquisition of experience. Once again, the differences between the best operators and those that are less good within a single trade are of the order of a factor of ten[9].

• **The ultra-safe systems model** no longer makes it a priority to rely on the exceptional expertise of these front-line operators to escape from difficult situations; instead it requires operators to be identical and interchangeable within their respective roles, and in this case requires them to work at a standard level. This model relies upon the quality of external supervision, making it possible to avoid situations where these operators are exposed to the most exceptional risks; by limiting the exposure of operators to a finite list of breakdowns and difficult situations, the model can become completely procedural, both when working under normal conditions and under abnormal conditions. Airlines, the nuclear power industry, medical biology and radiotherapy are all excellent examples of this category. Accidents are analyzed to find and eliminate the causes so that exposure to these risky conditions can be reduced or eliminated in the future. This model relies on prevention first. Training of front-line operators is focused on respect for their various roles, the way they work together to implement procedures and how they respond to abnormal situations in order to initiate ad-hoc procedures. Once again, the best and the least good operators within a single occupation differ by about a factor of ten[10] .

Lessons from above

The three models of safety are radically different. They represent responses to different economic conditions, each one has its own approach to optimisation, its own approach to training, its own advantages and its own limitations. They can be plotted along a curve in which there is a trade-of between flexibility and adaptability on the one hand, and safety on the other. All three, however, have the same capacity for internal self-improvement, and safety can be improved by a factor of 10 (making them 10 times safer);

It is not possible to impose a completely new model of safety against the will of local actors and contrary to values that are considered essential to this system. These underlying values must be addressed first, before making any claim to make people adopt a different safety model. The lesson from this is simple: changing the safety model means changing the system. If the conditions are not met, and sometimes it is necessary to accept this fact, it is no good tilting at windmills or inventing solutions that have no chance of success.

9 The rate of fatal industrial accidents in the gas and oil extraction industry varies from 130 deaths per 100,000 workers in some African countries to 12 deaths per 100,000 workers for the best oil wells; the global average is 30.5 deaths per 100,000 workers, source: http:// nextbigfuture.com/2011/03/oil-and-gas-extraction-accidents-and.html

10 The rate of aviation accidents ranges from 0.63 per million departures in Western countries to 7.41 per million departures in African countries. These therefore differ by a factor of 12, source: IATA statistics, 23 February 2011, http://www.iata.org/pressroom/pr/pages/2011-02-23-01.aspx

There are two strategies to make a system safer. Either we use market leaders (champions) within the same category (same model), trying to understand what makes the differences between poor and good performers. As shown above, the range of expected improvement may reach up to a factor of 1 to 10 depending on where you start. Or we may change the category, which may result in potential improvement by an impressive factor. First, however, we need to change the working conditions imposed by the activity. If you cannot change these conditions, safety improvements will likely be more modest and consist of local improvement within the existing model rather than betting on a 'potentially higher performing model'

It is possible to switch from one model to another, but this requires a changeover event that will affect the entire occupation and its economy. The industrial chemical industry, for example, which in some cases is still based on resilience models dating from the 1960s and 1970s, made a definitive switch to an HRO model after the events that occurred in Seveso in Italy in 1976 and the European Directive that followed in 1982. It is often the regulatory mechanisms that impose such a transition to a new system. It will be noticed that in this case the system migrates gradually, loses the benefits of the previous model (a higher level of adaptation and inclusion of situations that are considered to be manageable within that occupation), but gains the advantages of the new model (mainly in terms of safety).

Some working environments have even more complex problems to solve since their activities cross the three models. This is typically the case of hospitals. Some sections of the hospital face very unstable and unpredictable daily situations (oncology, emergencies), some are scheduled although their activity need considerable hour-to-hour adaptation to the huge variety of patients, case complexity, and unforeseen perturbations (typically the elective surgery in the operating theatre), and some are highly stable and ultrasafe like biology or radiotherapy. Worse still, all of these categories of activities may rapidly move downward or upward from 'Tuesday morning' (metaphor for the best working conditions where for example emergencies may adopt the characteristics of a HRO system) to 'Sunday night' (the worst working conditions, where lab tests and delivery may become a bricolage, temporarily adopting traits of ultra-resilient system). In that sense, Healthcare is a fantastic model for studying safety, probably much better than any other setting, because all the complexity is to be found in the same place.

Conclusion

We need to acknowledge that there are three separate authentic safety models with different approaches to optimization. Different philosophical compromises assumed within each model will result in more or less censure when going forward under adverse or ambiguous conditions. These models provide a progressive trade-off between expertise and collective censure and supervision.

The imposition of a safety model does not change the task requirements, but changes in the task requirements may justify adopting a different safety model. If we do not change the constraints, it is more reasonable to select the most appropriate safety model for those conditions, and use the proper dimensions to optimize the outcomes, instead of pleading for another safety model. A different model may be intrinsically more effective, but we need to acknowledge that it may be inoperative in a particular context, or impossible to get from here to there. Many aspects of healthcare for instance primarily rely on an HRO model but could move towards an ultrasafe model. However, while some change could be effected within healthcare, a more substantial adjustment would probably require a radically different approach to managing demand which is currently not politically feasible. Models of safety are ultimately context dependent and will vary by discipline, organization and jurisdiction.

Socio-technically based risk assessment and management

Barry Kirwan & Andrew Hale
(with additional contributions from Corinne Bieder and Gilles Motet)

Know your risks

Dealing with personal risks is often straightforward, even instinctive. If a fire breaks out you move away from it; if a car swerves towards your car, you take avoiding action or brake or both. But managing risk in large organisations can be far more complex; risks are not always obvious and can manifest themselves in many ways, some of them unexpected. It is the job of the safety director or safety manager to oversee the assessment of risks in such complex organisations. The audience for that assessment is in the first instance the CEO and the executive board of the organisation, who need to understand the risks being managed, and broadly how they are being managed. They can then take the decisions necessary to set up and operate an effective safety management system which copes with the uncertainties and complexities.

Risks vary according to the organisation's function and processes. In a steel mill risk management may focus on avoidance of burns and a lot worse, eg falling into an open furnace. For a transportation system, risk management will often focus on collisions of any type. For a nuclear power plant, there are many risks but the primary one is the loss of containment resulting in release of radioactivity into the atmosphere. But all of these organisations also have many other types of risk, which all need managing, or they may catch you out with a fatality or serious injury. As Amalberti and Vincent say in their introductory essay, the model of safety may differ between these industries. In what follows we address mainly their 'ultra-safe systems model', but incorporate aspects of their 'high reliability organizations' model. Risk assessment is also important in their 'ultra-resilient model', but is likely there not to be done as explicitly as in the other two models and to be concentrated on novices absorbing knowledge about the risks of the occupation at the feet of experienced operators.

If an organisation is to manage its risks competently there must be a common understanding in the organisation of what risks it faces, and what actions and activities it can deploy to keep those risks under control. This may not be easy because different professions value and handle complex quantitative and qualitative information differently and therefore also interpret risk assessments differently. An organisation should have a comprehensive risk picture that encompasses all its safety risks, including how they can interact to make a bad situation worse. In risk assessments, safety and threat to survival of a company have to be combined. In this way the organisation can be prepared to face its daily challenges.

Hazards and risks

The general definition of a hazard is a situation that poses a threat to life, health, property or the environment. Most hazards in this general sense are considered 'dormant', unless they become 'active' in which case their threat is realised. Generic examples are kinetic energy from moving or flying objects, potential energy from working at heights where a fall of a person or object converts the potential into kinetic injury before impact, etc.

The formal definition of hazard when carrying out risk assessment and management is more precise. A hazard is any biological, chemical, mechanical, environmental or physical agent that is reasonably likely to cause harm to humans or damage to the system or the organisation, in the absence of control. This means that the organisation must determine its hazards and establish controls for them.

The risk associated with the hazard is then the probability of loss of control of the hazard, combined with the resultant consequences. This definition of risk encompasses a wide range of possible consequences, ranging across injury, disease, theft, physical damage, production loss, poor product quality and safety, environmental pollution, business interruption, bankruptcy, cybercrime, etc.

A company needs to decide which of these risks it needs to manage and how. If the organisation is regulated for safety, then some or all of these risks must be managed by law in order to maintain an operating license. Ultimately, at the level of the Board and the CEO all risks have to be managed and trade-offs decided where necessary between them and their controls. However at the level of line and staff departments and advisers, the responsibility for ensuring that the organisation controls its different risks may be allocated to different parts of the organisation. In some companies there is, for example, a separate quality manager, health and safety manager and environmental manager, whilst in others all of these areas may fall under one manager or director. The CEO and Board must decide how this allocation of responsibility will be made for their organisation. This can be based on the similarities and differences in the causes or controls for different types of risks (process and workplace), or according to organisational levels.. Ultimately these different 'risk managers' can only be advisers to and monitors of the line management and Board, where the ultimate responsibility lies.

How safe do you need to be?

Risk is first and foremost concerned with an unwanted event, usually considered as an 'accident', eg an air crash, a nuclear meltdown, a factory fire, a ship sinking, a train derailment, a man falling to his death from a ladder or a gantry, or being struck by a vehicle. Many industries have formal risk targets imposed and monitored by a regulatory authority. For example, a nuclear power plant core meltdown should have a probability of less than once in a million years that a nuclear power plant might be operating. This sounds comforting, until a quick analysis based on say, three hundred reactors worldwide and fifty operating years, means that we should have seen no meltdowns, but in fact there have been three (Three Mile Island, Chernobyl, and Fukushima). For commercial aviation (carrying passengers and freight), air crashes generally occur at a rate of one in ten million flights. This also sounds good, but because we fly a lot the number of fatal crashes annually worldwide is typically in double figures.

The consequences part of the risk concept used to concern just the number of fatalities, eg one person killed, several people killed, up to hundreds killed. If an organisation kills many people it is unlikely to survive. However, today this has become more complex. Damage to the reputation of a company may be a consequence for an organisation, eg where there is loss of confidence in the company resulting in loss of revenue and eventual bankruptcy. This element of risk is of serious concern for many organisations, especially given the rising influence of social media networks such as Facebook and Twitter.

How do you know your 'level' of risk?

There are formal methods for calculating safety risk. They provide answers to the following questions that the CEO of an organization should be asking:

- What are my hazards?
- What can go wrong with the controls in place?
- How likely is it to go wrong?
- Can I see these risks all together, qualitatively or quantitatively?
- What is my overall risk, and what are my top risks?
- How sure am I of the answers?
- Are we meeting the safety target?
- What can we do to reduce risks?

Below is an example of one approach, called a fault tree (Figure 1). This particular extract comes from the field of aviation, looking at the risk of a mid-air collision; such events are very rare, thanks to multiple independent safety systems in the air and on the ground, in terms of both automation and pilots and controllers. The probability (Q) figures are derived from experience or databases, feeding up from the base events or failures (the circular icons), through either 'and-gates' (icons with straight undersides) or 'or-gates' (icons with concave undersides) to the top event with its thus-calculated probability.

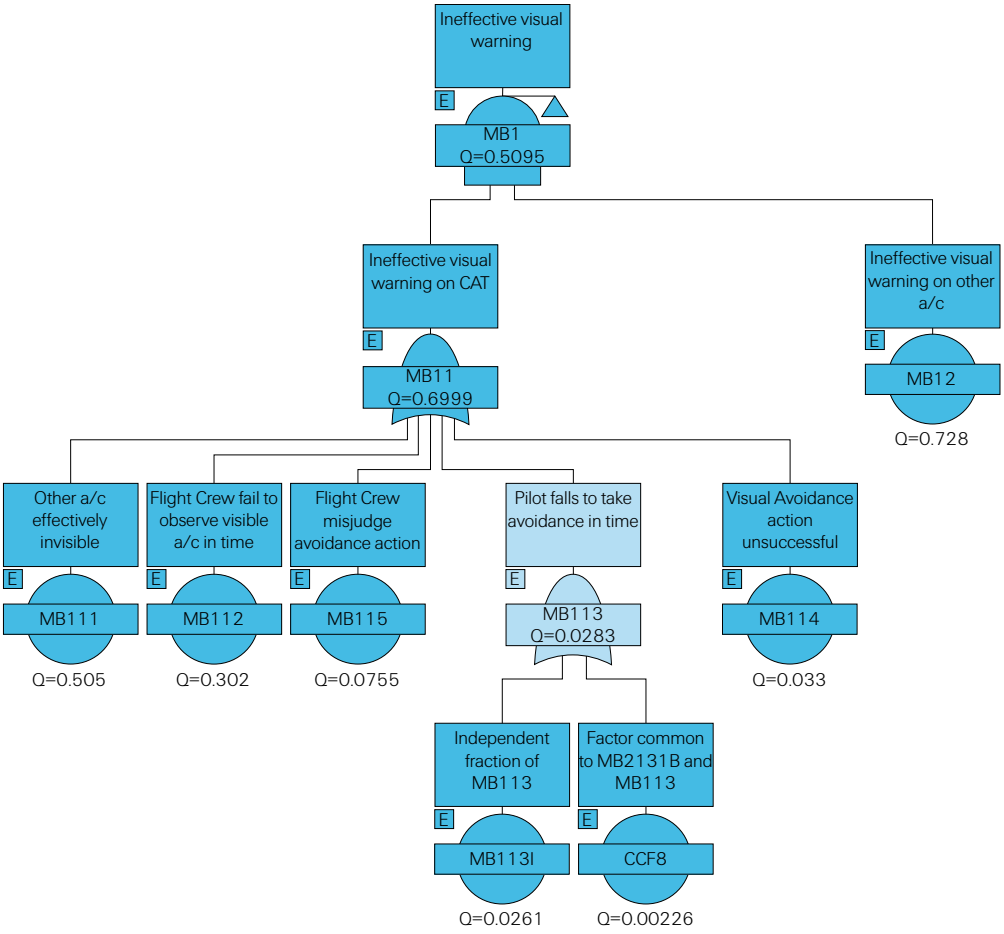

Figure 1. Example of a fault tree

Tools such as fault trees help with the difficult part of ‚determining what controls are or should be in place and how they might fail' and of 'putting the risks together' so that an overall risk picture can be gained, and total risk calculated. Typically the events in the fault trees lead up to the eventual loss of control of the hazard, and another 'tree', called an 'Event Tree' determines the range of consequences that are likely to occur. A generic illustration of this, called the 'bow tie diagram' is given below (Figure 2), with 'business upset' as the central event, which in safety terms usually equates to loss of control of a hazard.

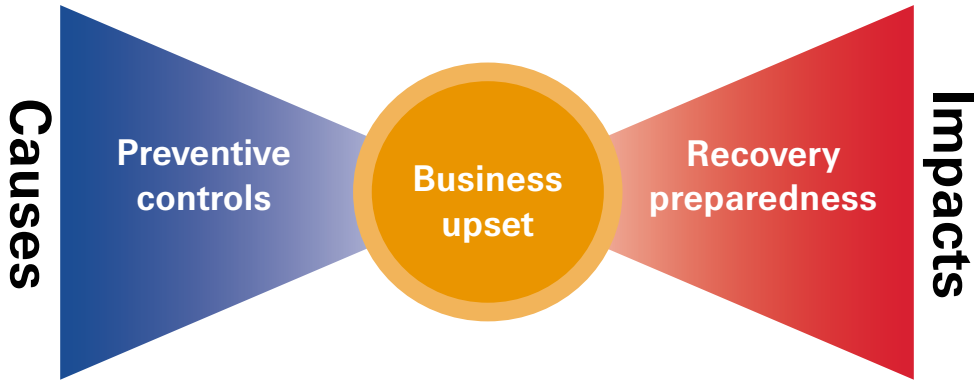

Figure 2. Example of a bow tie diagram

Manage your risk controls

The output of risk assessments consists of a description of risk controls which will have to be implemented to prevent and mitigate the unwanted consequences of the risk scenarios. Risk control mostly happens via barriers that keep the hazard under control or mitigate its consequences once control is lost. Barriers may be physical (machinery guards, edge protection on roofs, chemical bunds around storage tanks, ear defenders, safety goggles, pressure relief valves, sprinkler systems, fire extinguishers, etc.) or behavioural (skilled fire fighters, skill with a boning knife in an abattoir, keeping away from moving machinery, evacuation before an encroaching fire, etc.), or a combination of both (competent drivers of vehicles, activating a fire alarm, diagnosing an equipment failure and taking remedial action, etc.). Preventive barriers stop the scenario before the loss of control; mitigating barriers intervene afterwards to lessen the seriousness of the consequences. Risk management entails keeping the barriers on either side of the loss of control event effective, and looking for ways they could fail. In many activities there needs to be 'defence in depth', with many barriers controlling a given serious risk, so that, if one fails there are others tsill working.

The concept of barriers is crucial also for one of the most influential safety models of the past three decades, the so-called 'Swiss Cheese' model promoted by James Reason, as illustrated in Figure 3 below. The barriers are likened to blocks of Swiss cheese which have holes in them, meaning there are gaps which have appeared in the system's defences; the barriers are not working effectively. If the holes 'line up', meaning that a number of defects or deviations come together in an unpredicted way, an accident occurs. The successive layers may be technical barriers, eg in aviation there is a system aboard most aircraft to detect another aircraft on an intercept course; or they can be organisational, eg the training and selection processes that deliver a safe and competent train driver. The model has been particularly useful in demonstrating the systemic nature of accidents.

Successful management of risk controls, once they have been decided on, consists of managing the life cycle of those technical and behavioral elements making up the risk control; making sure that they are developed, fit for purpose, installed, used and maintained.
In the descriptions below we start from the point where the required risk control and its hardware, software and behavioural elements have already been specified to the best of the ability of the organisation. However even the best risk analysis can never anticipate and control all future risks. We are not prescient or inventive enough to guarantee that. Hence management of the risk controls must include monitoring and improvement to respond to learning opportunities when new risks or new ways for the risk controls to fail are discovered.

Technical elements

1. Purchase/construct. Is a suitable high quality hardware/software risk control available on the market, or can it better be fabricated in-company? In the first instance the procurement function needs to specify the requirements and find suitable suppliers meeting the design specification and dependability requirements. In the latter instance the construction function does that work and may need to call in adequate expertise on dependability.
2. Install/commission. This work may be done by a company department or sub-contracted to a supplier. It requires competence, coordination and monitoring.
3. Use. This is the link to the management of the behavioural elements of the risk control.
4. Inspect. The functioning of the hardware requires monitoring either continuously, or at planned intervals.
5. Maintain. If inspection shows deterioration of its functionality the hardware needs maintaining.
6. Monitor/ modify/improve. If the hardware fails to live up to its planned performance, or fails to control all risk scenarios experienced it may need modifying or replacing.

Behavioural elements

1. Specify procedures. The behaviour in using the hardware/software controls, and the additional required behaviour forming part of the risk controls themselves need to be captured in procedures which can be communicated to the users. If they are procedures for using technology, the technology and the procedures need to be designed together to maximise their usability.
2. Select/train: manage competence. Suitably qualified people need to be recruited and trained in the procedures until they test as competent. For unexpected risk scenarios, which are not able to be captured in procedures, a more general competence to improvise may need to be trained.
3. Provide manpower & communication. Being competent is not enough to ensure that the right behaviour is shown. The organisation must plan its manpower to be available when that behaviour is needed and must make sure that different individuals communicate and collaborate when the risk control depends on more than one person working in unison, such as at shift handovers or where risk depends on control room staff and field operators (maintenance engineers, pilots, train drivers, etc.) collaborating effectively.

4. Motivate. The organisation must also go beyond just ensuring competence. It must motivate people to choose the correct risk control behaviour over conflicting behaviour aimed at production, quality, individual effort/comfort, etc., which may seem more attractive at the time.
5. Maintain. As with hardware, behaviour may degrade or deviate over time, requiring inspection and feedback (behavioural safety), refresher training and behavioural campaigns.
6. Modify/improve. If the behaviour fails to live up to its planned performance, or fails to control all risk scenarios experienced it may need modifying or replacing.

Organizing safety

The detailed management of the performance of the risk controls which emerge from risk assessment has been dealt with above. The overall safety management system of an organisation needs to provide and coordinate those management processes. At a higher level of abstraction safety management consists of organising two interlocking management cycles (Figure 3):

- The first is the operational cycle (red arrows) that carries out the risk assessment, decides on risk controls, implements and monitors them and feeds back to modify the risk assessment and control.
- The second is the policy cycle (blue arrows) which sets the strategy, provides resources and allocates responsibilities to run that risk assessment and control cycle, monitors how it works and proposes and manages changes to achieve continuous improvement.

The second cycle needs to be driven in detail by the CEO and the Board of Directors because CEO buy-in into safety is key to risk-related decision-making in the organization. Moreover, risk and safety are always about trade-offs which need to be endorsed by the CEO and for which the CEO has to be held accountable. The first cycle is more the realm of the safety manager, by which board decisions are fed and supported. The setting up and monitoring of that cycle can be delegated to the safety manager's competence to collaborate with the line and staff in its implementation. The Board and CEO then monitor that first cycle and ensure it keeps on taking place. The CEO and Board also need to assess and review the competence of the safety manager to fulfil this role.

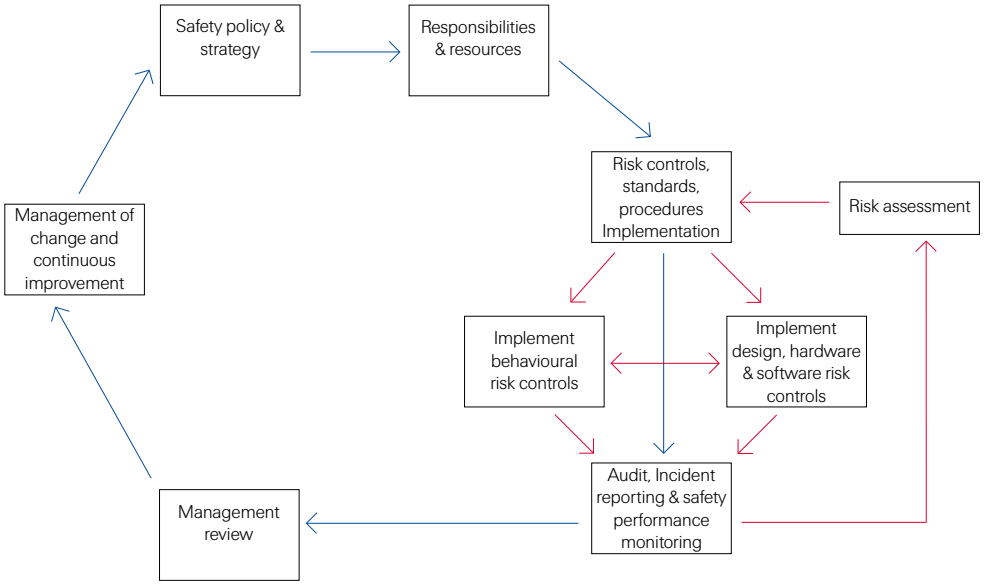

Figure 3. Two cycles for organizing safety

Board level management of safety

The main role of the CEO with respect to safety is in asking questions, for example:

- What are our top safety risk concerns?
- Are they increasing/decreasing/stable?
- What do the latest quarterly safety trend analyses show?
- Are we as safe, or safer, than our competitors?

These questions send the message that safety is important to the other board members. This does not need to be 'heavy-handed', but should simply reflect a genuine concern and understanding that safety is key to business health. However, this does need to be authentic; otherwise it is known as 'lip service', which people see as being insincere.

The CEO should also appoint a director who is the safety 'champion' (the safety manager will report directly to this person). This Safety Director, may also be the Director of Quality, and/or Environment, and/or Security. There remains debate about whether such a director should have only safety as his or her responsibility: sole responsibility allows clear focus and fewer conflicts, whereas joint responsibilities may enable better integration of safety into business models and decisions. The CEO should be able to challenge the Safety Director (eg over facts, figures and assumptions) to avoid other directors feeling that the Safety Director can 'play the safety card' all the time. Similarly, if the Safety Director is going to raise something significant at board level, the CEO should be able to expect that the Safety Director has 'done his/her homework', both in ensuring that there is enough evidence and/or concern to warrant raising the issue, and in talking with other relevant Directors, so that they are not surprised at the meeting. The second aspect means that the CEO should pick someone with a degree of 'political acumen'. As some CEOs have put it, they do not want a 'safety clerk' at board level.

When safety issues are raised at board level and determined to be important, the CEO should galvanise the board to explore them and put in place actions (not only on the Safety Director, but engaging other directors as appropriate), and demand progress on those actions at each successive Board meeting until the potential safety 'threat' has been reduced or eliminated.

The CEO should also speak to line and staff managers about safety, and what is being done about safety. This can be done directly, or indirectly, whether by email, or more commonly by 'Blog', or video, etc. These CEO-staff communications, aside from representing good safety culture, also affect the other board members. Other directors will be more likely to 'follow suit' and talk more openly with their subordinate managers and staff about safety. In fact this will be to some degree expected, as otherwise it looks odd to staff that the organisation's leader appears to care about safety but the directors do not. Put simply, this requires leadership by example.

One crucial prerequisite for board action on safety issues is adequate information. Beside the informal communication channels just mentioned, which are very important as the people „at the sharp end" often have an acute insight into safety, there are two main sources of safety information. The first will be events that have happened – incidents or accidents. For these there will be formal procedures and probably associated reporting requirements to a regulatory body, as well as analysis mechanisms looking for causes and contributory factors. Such systems offer relatively reliable indicators (called 'lagging indicators, since they relate to the past and are 'forensic' in nature) on how safety is doing. Secondly, there will be sources of safety information from safety cases, safety audits and surveys (including safety culture surveys), evaluations of Safety Management Systems, and steps to achieve safety certification levels associated with systems or projects. Such information can be seen as indicating present and future performance, and so indicators derived from such examinations are often called 'leading indicators'.

Safety Dashboards are an integration of key safety metrics that can be used by the CEO and Board to gain a quick overview of the safety health of their organisation and its operations. They contain both lagging and leading indications (ie data from past events, and information on current and future performance) of safety from metrics relevant to the organisation's operational and regulatory context. Sometimes they also contain indications of business volume or operational 'level' (whether it is up or down) since such degrees of 'output' are often (but not always) correlated with safety risk (eg in air traffic, if the amount of traffic rises, generally so do the safety risks). The dashboard should contain what needs to be there, and not just what is easy to measure and has ready-made statistics. Similarly it is important not to get into a pure 'target-chasing' approach by focusing solely on the numbers in an effort to increase or decrease certain statistics – this is because such an approach may lead to suppression of true statistics or reducing risks in one area by 'exporting' it to another. The Dashboard is a tool to be used in understanding and improving safety, and only represents the 'top tier' of safety information, much of which will be qualitative rather than quantitative.

One great worry: 'Drift into danger'

Drift into danger is like the proverbial frog who fails to jump out of a pan full of water that is brought to the boil slowly. A clear example of drift into danger is when, under economic pressure, resources for safety are slowly eroded, including operational safety personnel (through staff cutbacks or non-replaced staff losses) and equipment, as well as resources to carry out safety work. The problem is that, initially, nothing goes wrong, and all seems well. People adjust so that the new less-resourced system becomes the norm. Staff begin to adapt procedures and do things differently – they get the job done, but there are perhaps less safeguards. And then one day an accident happens, and it probably also escalates because there is less equipment and trained staff to deal with it.

It is not easy to detect that drift into danger is happening. It requires that the Board and Safety Manager look differently at safety indicators, with a longer term view, alert to trends, an attitude of 'creative mistrust', questioning in particular when all the indicators appear to be indicating that all is well. If there are good safety indicators these may detect it, although this may not happen if the system has 'normalised' around its new parameters of operation. Older operational staff are more likely to perceive the drift than younger and newer staff, and independent and external observers may also see the risk more clearly as they are 'outsiders'. Safety culture surveys can often pick up signals from comments or during workshops, and observational surveys or audits may similarly raise questions about whether safety margins have eroded or not.

Further reading

Andrews, J.D. & Moss, T.R. (2002). Reliability and risk assessment (2nd ed.) 2002. London: MechE Professional Engineering Publishing.

Haddon, W. (1973). Energy damage and 10 countermeasure strategies. Human Factors, 15, 355-366.

Hale, A.R., Ale, B.J.M., Goossens, L.H.J., Heijer, T., Bellamy, L.J, Mud, M.L., Roelen, A., Baksteen, H., Post, J., Papazoglou, I.A., Bloemhoff, A. & Oh, J.I.H. (2007). Modeling accidents for prioritizing prevention. Reliability Engineering & System Safety, 92, 1701-1715.

Hale, A.R., Goossens, L.H.J., Ale, B.J.M., Bellamy, L.A., Post, J., Oh, J.I.H. &Papazoglou, I. A. (2004). Managing safety barriers and controls at the workplace.

In C. Spitzer, U. Schmocker & V.N. Dang (eds.), Probabilistic Safety Assessment & Management (pp. 608 – 613). Berlin: Springer.

Health and Safety Executive (2011). Five steps to risk assessment. http://www.hse.gov.uk/pubns/indg163.pdf

Maguire, R. (2006). Safety cases and safety reports. Aldershot, UK: Ashgate. Reason, J.T. (1997). Managing the risks of organisational accidents. Aldershot, UK: Ashgate.

Safety Intelligence for CEOs – A White Paper. http://www.eurocontrol.int/sites/default/files/content/documents/nm/safety/safety_intelligence_white_paper_2013.pdf

Safe Work Australia (2012). Guide for major hazard facilities - safety assessment. http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/6 69/Safety%20Assessment.pdf

Vincent, C., Burnett, S. & Carthey, J. (2013). The measurement and monitoring of safety. London: The Health Foundation.

Some thoughts on the intricacies of risk assessment and management

Tore J Larsson

The organization of production at the sharp end of risk exposure will vary according to how the relevant hazards have been defined and operationalized for safety management. Risks not identified will be ignored, risks defined as outside the responsibility of the organisation will be delegated out and risks poorly understood will be inadequately managed.

The large international airport, running out of real estate, requiring recurrent movement of aircrafts between the international terminal and maintenance workshops across the main runway, is experiencing a deteriorated ground safety and one reported runway incursion a month. A major international event in the next 12 months will push the airport service demands to the limit. The new managing director of the airport is hired to improve the commercial potential of the airport and develop the tax-free shopping centre. In spite of the crowded conditions, he has decided to open the airfield to sightseeing and shopping bus tours for the general public.

Equipment, routines and standard modes of operation in the face of danger will be based on the tacit or explicit local norms regarding risk control, with variations between groups of operators with different subjective levels of exposure.

In an Australian study of safety management among 100 small business owners, fishermen operating in unrestricted areas were positive to the introduction of more quota systems, believing that moving to fixed quota would make it safer and improve productivity by 20%. Several divers commented upon the impact the introduction of fixed quota has had on risk coping and stress in the underwater search for Abalone.

The US client building their national head office in Sweden changed the safety management practices of the large building contractor by requiring all staff on site at all times to wear helmets. This was underpinned by economic sanctions and control. The Swedish contractor introduced a strict control routine for all employees and sub-contractors when crossing into the site, and later proclaimed this their own invention.

Production process logistics, often defined as unrelated to safety management, implies that the size of stock, flow of material, spares and repair facilities should be organized so that sudden increases in risk exposure can be handled without the loss of safety.

The railway system of the State has been modernized and re-structured; from one principal operator to 30 different organisations doing separate tasks in the state-wide rail system - rail, rolling stock, cargo, locomotives, signalling systems. The improvement in safety performance still needs to be proven; the vigilance control system in the locomotives is designed in such a way that it promotes conditioned responses possible to perform while asleep.

Changes and developments in the system of production - reorganising the production line, sub-contracting parts of activities out, introducing new equipment, moving to new facilities, scaling down, reorganising administration - will put acute demands on the management of safety.

The optimistic promises of 100% access within three weeks of installation of the new process line in the sawmill turns out to be as wrong as it was the last time the plant upgraded. Again, the old bloke who helped get things up and going the time before that is needed – for the third time – in order for all the necessary stops, connections between conveyors and other blacksmithery to be done.

Recruitment, selection and training are aspects of organisational decisions crucial to the management of safety. The level of competence required for an operation will include defined or latent abilities to handle risk.

Only 6% of the working time for a Swedish full time occupied fire-fighter is used responding to alarms, a mere 1.5% to fighting fires. 60% of fire-fighters are recruited from organised sports; 25% of fire-fighters say that the ability to continue sporting activities was their main reason for choosing the occupation. 55% of the occupational injuries among fire-fighters are sustained during sporting activities.

Learning in hierarchical organisations is seen as a one-way delegation of professional competency downwards in the organisation. With operational responsibilities distributed according to formal competency, understanding of potential failure modes dynamically generated in the operating processes tends to be restricted to higher levels of command and to specialised compartments in the corporate structure. Learning of professional capabilities in the stepped technician career seems to be strongly directed towards „skills" and „rules" and less sophisticated in the area of „knowledge".

If you don't measure, you can't manage. The quality of the organisation's book-keeping of failures, losses, deviations, incidents, accidents, injuries and fatalities, and its integration into the decision support system of production management is positively correlated to the health and safety of the organization and to the financial success of the company.

It is estimated that the medical care system in Sweden kills between 3500-4500 patients by mistake every year. The reporting system for medical mishaps, however, only receives 1200 reports on mistakes annually and only a small proportion of them are fatalities.

Further reading

Dell, G., Larsson,T.J. (1999). Investigation into the ground safety at Sydney Airport. Report to the Sydney Airport Corporation, Sydney.

Haworth, N. & Larsson, T.J. (1999). Investigation into effectiveness of driver vigilance control systems on locomotives. Report to FreightCorp Australia. Monash University Accident Research Centre, Melbourne.

Larsson, T.J. (1998). Decision Making in Relation to Occupational Health & Safety among Small Business - A Survey of 100 Small Business Owners/Managers in Victoria. Policy Research Report No 7, Victorian Workcover Authority, Melbourne.

Larsson, T.J. (2003). Is small business a safety problem? Safety Science Monitor, 7(1), 1-23.

Larsson, T.J., Hopkins, A., Dell, G., Hayward, B. & Rechnitzer, G. (2000). Outline Structure of Expression of Interest – Whole of System Hazard Analysis of Railways in Victoria. Department of Infrastructure, Melbourne.

It is all about safety – or is it?

Levi Nieminen & Urbain Bruyere

Organizations tend to react to, and address, the "proximal" (ie, the immediate, direct, and readily observable) causes of safety incidents, at the expense of considering underlying systemic factors. This often leads to a "pendulum effect" or shift in the organization's collective focus, back-and-forth between safety and financial performance over time. Periods of high vigilance following a major incident eventually give way to increasing pressures to perform, gradually opening up new and different types of risk exposure. In order to break the cycle, organizations must look for management techniques that simultaneously address safety and performance, as both are ultimately required for long-term effectiveness.

For safety professionals, this begs an important question: Can organizations be made safer by implementing strategies that focus on the fundamental elements of effectiveness, rather than (or in addition to) those that speak more proximally to safety behaviors and outcomes? Our proposed answer is yes they can, and our recommendation below follows from growing evidence illustrating the generalized importance of organizational culture for a range of effectiveness outcomes including safety and financial performance.

Organizational culture has proven to be a practically useful framework for understanding and acting on the deeper, systemic factors that influence safety and performance in organizations. Culture refers to the values, norms, and deep-seated beliefs and assumptions that are shared by the members of a group, such as an organization or subgroups within an organization. Though scholars and practitioners have recast culture frameworks in numerous ways to more directly address specific organizational concerns (eg, innovation, service, quality), the underlying elements of these domain-specific conceptualizations bear much in common.

The same can be said for "safety culture" frameworks, which often overlap considerably in their focus with more generalized approaches and models of organizational culture. In addition to creating an unnecessary distinction, looking at organizations solely through a "safety culture" lens has a few problematic effects in practice. The first relates to the pendulum effect already described. In order to achieve a sustained impact, the diagnostic process and corresponding interventions used should aim below the 'symptoms' toward the deeper 'causes' of function and dysfunction in organizations (see E. Schein's essay in this volume). A second is that by focusing on safety culture, safety professionals are likely to find their work positioned as somehow separate from, or worse, subservient to the set of core issues that are seen as driving business performance. This has the potential to undermine the impact of the work, from the top of the organization, where safety professionals struggle to earn a seat at the decision-making table, to the bottom of the organization, where safety interventions are introduced to workers as tangential to the performance of the job (eg, the "time-out" for safety).

For these reasons, our recommendation is for safety professionals to bring to the forefront of their work the close interconnectedness between safety and performance, or stated more directly: Safety professionals should focus on the underpinnings of organizational effectiveness in addition to safety.

Adopting a cultural lens, whilst avoiding the narrow treatment of only those elements proximally related to safety, will help practitioners shine a light on what is fundamentally healthy and unhealthy about the way organizations have learned to adapt, respond, and coordinate work in a high hazard environment. This approach holds several potential benefits in addition to those already mentioned: (a) engaging a broader and more influential network of stakeholders in the organization, (b) replacing a non-event goal or objective (eg, avoid safety incidents and hazards) with a more productive and tangible focus on continuous improvement of organizational capabilities, and (c) creating a number of practical efficiencies by using one approach to managing culture instead of many (ie, safety culture, innovation culture, service culture, etc.).

Finally, we outline four specific ways that safety professionals could implement our recommended strategy in practice:

- Use a diagnostic process–quantitative and qualitative–that focuses on the set of cultural factors that are deeply rooted in the organization's effectiveness as a whole;
- Involve people from all levels, functions, and areas of the organization to create broad understanding of culture and accountability for workplace improvements (as opposed to involving only those employees and/or managers deemed 'safety-critical');
- Build safety interventions into existing performance programs (rather than simply inventing new safety initiatives);
- Conduct research and document evidence (eg, case materials) of the linkages between organizational culture (measurements and interventions), safety, and financial performance.

Further reading

Denison, D. R. (1996). What IS the difference between organizational culture and organizational climate? A native's point of view on a decade of paradigm wars. Academy of Management Review, 21, 619-654.

Detert, J. R., Schroeder, R. G., & Mauriel, J. J. (2000). A framework for linking culture and improvement initiatives in organizations. Academy of Management Review, 25, 850-863.

Sackmann, S. A. (2011). Culture and performance. In N. Ashkanasy, C. Wilderom, & M. Peterson (Eds.), The handbook of organizational culture and climate, 2nd edition, p. 188-224. Thousand Oaks, CA: Sage Publications.

Schein, E. (1992). Organizational culture and leadership, 2nd edn. San Francisco, CA: Jossey-Bass.

Xenikou, A. & Furnham, A. (1996). A correlational and factor analytic study of four questionnaire measures of organizational culture. Human Relations, 49, 349-371.

Team interaction and training

Mary Zellmer-Bruhn & Michaela Kolbe

Teams are small to medium sized groups of people collaborating to accomplish a task or set of tasks. Teams play a pivotal role in today's organizations; they are a major form of structuring work, constitute an important channel through which organizations learn, and are central to delivering both direct and indirect safety outcomes in organizations. Teams may be assigned direct safety tasks, such as a nuclear power plant control crew, for whom a significant part of the task is to ensure safe operations. Alternatively, teams may be formed to carry out a specific task, and their execution of that task may indirectly create or prevent safety issues for the team members themselves, or for the stakeholders of their tasks.

Research has impressively demonstrated that teams can a blessing or curse for safety. On the one hand, teams are needed to perform dynamic, high-risk work in a safe way, for example performing a complex surgical procedure on an emergency basis or flying a commercial airplane from A to B. Here, a team as a whole can reach much more ‚than the sum of its parts'. Team members can monitor each other's performance and provide back-up if needed. On the other hand, if team members do not work well together as a team, then their work can create harm. For example, in surgery poor teamwork represents one of the major factors contributing to medical error. A lack of communication and collaboration can be deadly. Together, these benefits and challenges reflect the fact that teams are dynamic, complex systems, and can be more or less adaptive to novel, unexpected events. Acknowledging the potential pitfalls of teamwork has encouraged a variety of research that has enhanced our understanding of what teams need in order to function well.

At the most basic level, team safety relies on the foundations of effective teamwork, that is, delivering safety outcomes first depends on the things that support successful collaboration. Research has revealed a core set of practices universally contributing to good teamwork: clear goals, team orientation, mutual trust, mutual performance monitoring, back-up behavior, adaptability, thoughtful team leadership, a shared understanding of the task and how to work together, high-quality communication, effective conflict management, and a well-balanced mixture of stability and flexibility. A number of models of teamwork exist to provide background for the fundamental foundations of effective teaming. Staffing and training considerations ought to respect these basic principles.

Moving beyond the basics, evolving workplaces, new organizational models, and complex problems are generating novel teaming challenges. For example, globalization and technological advancements increase the use of distributed teamwork – where members are separated physically and sometime temporally (time zones) and rely on technology-mediated, sometimes asynchronous communication. Likewise, people are commonly members of multiple teams at once, or move in and out of teams across shifts or as task and problem demands change, and this multi-team membership is the norm for a majority of the workforce. Furthermore, complex, emerging problems and events often require the rapid formation, deployment, and dissolution of teams, such as in disaster-relief scenarios, or terrorist response incidents. These teams are quite different from traditional, stable teams, and such dynamic, ad-hoc teams, and multiple team membership require more training for „teaming" skills (ie quickly setting the stage for working well in any team), such as speaking up, collaboration, experimentation, and reflection.

Finally, in addition to the general demands of multi-team, dynamic, and ad hoc tasks from which core team skills can be derived that apply across most if not all team contexts, there are tasks with highly context-specific demands. In such cases, teams need to be able to recognize and perform behaviors and interactions that are specific for a certain task and context. For example, „talking to the room," that is sharing information to the entire team, was found to enhance performance in solving an ambiguous, diagnostic problem, but not during the management of a cardiac arrest. This highlights a need for sensitivity in any team training to unique interaction demands of specific contexts, and thoughtful attention to how and why effective interventions in one setting may or may not apply to another. This bears a note of caution, since this "not-invented-here" syndrome is often a reason for failing to adopt valid methods developed other contexts. There are many generalizable safety applications that can be readily transferred from one team context to another.

Team Training

It is a common misconception that teams are naturally skilled in teamwork. It is another misconception that „implicit" coordination—tacit, taken-for-granted coordination based on a presumed shared understanding—is always more efficient than explicit, open communication. The types of teams we tend to admire for their seemingly tacit, effortless coordination such as jazz orchestras or soccer teams can coordinate implicitly on stage and during a championship, respectively, because they have spent tremendous time in explicitly building shared understanding and routines allowing them to do so. Building core and specific team skills and behaviors requires formal training and also continuously experimenting with and reflecting on joint performance.

Recent research has demonstrated that team training can improve team performance and has also provided a variety of teamwork training tools, simulation-based team training among them. Simulating high-risk tasks in a risk-free environment has a vast potential for learning to deal with uncertainties within and as a team. A core element of simulation training is the reflection on the simulated case experiences during the debriefing which should be conducted in a well-defined way.

Based on evidence for team training, combined with the new trends in teamwork and potential for context-specific adaptation demands we noted above, when designing team-training interventions, it is useful to consider the following factors:

- How are the respective team and its task (eg, novel vs. complex) designed?
- What are the contextual factors that affect safety (eg, acuteness/proximity of risks)?
- What is the physical and temporal proximity within the team?
- What is the range of potential consequences of the task?
- What are the values and norms within the team?
- How are team boundaries managed?
- What is the level skill and authority differentiation?
- What is the priority for safety?
- What autonomy and control does the team have?

Further reading

Edmondson, A. C. (2012). Teaming: How organizations learn, innovate, and compete in the knowledge economy. San Francisco, CA: Jossey-Bass.

Künzle, B., Kolbe, M., & Grote, G. (2010). Ensuring patient safety through effective leadership behaviour: A literature review. Safety Science, 48(1), 1-17.

O'Leary, M. B., Mortensen, M., & Woolley, A. W. (2011). Multiple team membership: A theoretical model of its effects on productivity and learning for individuals and teams. Academy of Management Review, 36(3), 461-478.

Rudolph, J. W., Simon, F. B., Raemer, D. B., & Eppich, W. J. (2008). Debriefing as formative assessment: Closing performance gaps in medical education. Academic Emergency Medicine, 15, 1010-1016.

Salas, E., & Rosen, M. A. (2013). Building high reliability teams: progress and some reflections on teamwork training. BMJ Quality & Safety, 22, 369-373.

Salas, E., Sims, D. E., & Burke, C. S. (2005). Is there a „big five" in teamwork? Small Group Research, 36, 555-599.

Salas, E., DiazGranados, D., Klein, C., Burke, C. S., Stagl, K. C., Goodwin, G. F., & Halpin, S. M. (2008). Does team training improve team performance? A meta-analysis. Human Factors: The Journal of the Human Factors and Ergonomics Society, 50(6), 903-933.

Tschan, F., Semmer, N. K., Hunziker, P. R., & Marsch, S. C. U. (2011). Decisive action vs. joint deliberation: Different medical tasks imply different coordination requirements. In V. G. Duffy (Ed.), Advances in Human Factors and Ergonomics in Healthcare (pp. 191-200). Boca Raton: Taylor & Francis.

Waller, M. J., Gupta, N., & Giambatista, R. C. (2004). Effects of adaptive behaviors and shared mental models on control crew performance. Management Science, 50, 1534-1544.

Zellmer-Bruhn, M., & Gibson, C. (2006). Multinational organization context: Implications for team learning and performance. The Academy of Management Journal, 49, 501-518.

Recommendations for team interaction and training

1. Facilitate rapid relationship building in swift-starting action teams.

Mary Waller

Teams of highly knowledgeable individuals are often formed by organizations to quickly address critical, safety-related events. Such teams have been referred to as "swift-starting" action teams due to the need for immediate team task performance. Often, these team members have never worked together, but have worked in similar teams previously. Examples of swift-starting teams include commercial aviation flight crews, field-based news crews, and emergency medical teams. The ability of these ad hoc teams to quickly build the relationships that undergird team factors such as coordination, adaptation, and shared understanding is key to team and organizational effectiveness in dynamic situations.

Research suggests that the first few moments of interaction within teams sets the tone for subsequent interactions. Additionally, research indicates that more balanced, reciprocal initial interactions among swift-starting team members is related to higher performance on subsequent high-workload tasks. Therefore, a recommendation for organizations that deploy swift-starting teams is to develop a rapid protocol that increases the probability of positive relationship-building interactions very early in swift-starting teams. A similar protocol may also be developed to guide team members to reflect after their task is finished.

Contextual contingencies

Some contextual contingencies pertain to the nature of the team task. The longer the duration of the task and the higher the need for information transfer across team members, the more important relationship building through initial interactions may be. Other contextual contingencies pertain to the situation. The higher the time pressure, ambiguity, and dynamism of the situation, the more difficult it will be to implement a protocol for initial team interactions.

Examples

One type of fast protocol involves team members quickly introducing themselves and stating their area of expertise before the team dives into its task. An addition to this protocol might involve a designated team member or leader stating that every team member has the right to share information openly, much as suggested by Crew Resource Management training regarding "inquiry and advocacy." One updating protocol followed by many North American nuclear power plant crews is to periodically bring the crew together in the room during a critical event and quickly poll each member on his or her current understanding of the event, allowing each member equal opportunity to update the others.

Further reading

McKinney, E. H., Barker, J. R., Davis, K. J., & Smith, D. (2005). How swift starting action teams get off the ground. Management Communications Quarterly, 19, 198–237.

Vashdi, D.R., Bamberger, P.A., & Erez, M. (2013). Can surgical teams ever learn?: The role of coordination, complexity, and transitivity in action team learning. Academy of Management Journal, 56, 945-971.

Zijlstra, F., Waller, M., & Phillips, S. (2012). Setting the tone: Early interaction patterns in swift-starting teams as a predictor of effectiveness. European Journal of Work and Organizational Psychology, 21, 749-777.

2. For heterogeneous teams special attention should be paid to developing shared knowledge and situation awareness.

Mary Zellmer-Bruhn

Teams are created to complete work that cannot be completed by individuals. In some cases, this is work that simply requires more or more coordinated physical or cognitive effort than can be completed by independently working individuals. In such cases, teams may be composed of individuals who are more or less interchangeable in their knowledge, skills and abilities. More commonly, however, teams are required and created because the task is complex, uncertain, and evolving, and requires adapting and solving problems as they occur. In these cases, teams are typically composed of individuals with diverse knowledge, skills and abilities. Such diversity generates advantages as well as challenges for team safety.

Diverse knowledge, skills, and experiences provide a team with a wealth of information on which to draw to both detect and address safety challenges. Specific expertise and experience generates sensitivity to particular cues and insights about the situation, for instance. It follows, then, that variety in backgrounds provides greater ability to detect and prevent errors. Complex problems and systems also involve multiple knowledge bases. For instance, in open-heart surgery, the knowledge bases of the surgeon, perfusionist, and anesthesiologist are all specialized, but are necessary for the team to complete its task. Similarly, a team addressing a food contamination event in a large manufacturing facility may require specialized knowledge held by mechanical engineers familiar with the equipment, the line workers in charge of changing over the line from one product or set of ingredients to another, the supplier of the raw materials, and a food toxicologist, to name a few.

Research suggests that knowledge and experience diversity in teams can benefit performance, but also poses significant challenges. Despite the need to apply the distributed knowledge, team members often instead only focus on and apply commonly held knowledge—failing to recognize the presence or value of unique expertise and experience held in the team. Teams that are able to recognize the specialized expertise available, respect the inputs of individuals with specialized expertise, and efficiently access and apply that knowledge in coordinated action exhibit high performance, and should likewise be more effective at safety management. As a result, understanding the content of knowledge dis-

tributed in the team and helping the team develop shared cognition around specialized knowledge is an important consideration for team training. Team members need to develop a shared mental model of the task so that they are able to understand how their expertise can apply and how unique cues they notice and specialized behaviors they contribute relate to the collaborative effort. Likewise, it is important for teams with distributed, specialized knowledge to develop a shared understanding of who knows what, and trust and rely on the distinct perspectives when offered. And, it benefits such teams to build up an understanding of the individual mental models of each other as functional backgrounds and different education, training, and experience result in a variety of cognitive approaches to the same problem.

Contextual contingencies

Some contextual contingencies pertain to the membership characteristics of the team. First, teams vary in the authority differentiation and status of members. Individuals may have unique knowledge to contribute that could avert errors and improve safety, but may be reluctant to share it in the face of members with authority who dismiss the problem or who may be threatened by being revealed as having made a mistake. Likewise, low status individuals may even minimize the importance of their observation or perspective. Another composition-related contingency revolves around membership stability. Team mental models can take time to develop during shared performance episodes. If membership is dynamic, or teams are created on an ad hoc basis, the presence and availability of shared cognition to support application of diverse knowledge is limited.

Some other contextual contingencies are generated by the task. Tasks can require more or less implicit coordination. The more real-time coordination required, the more valuable are well-developed shared mental models, particularly of the team knowledge specialization and coordination.

Examples

To develop shared mental models for tasks that are ongoing with relatively stable membership, training teams together is the strongest method to support coordinated action and recognition and application of distributed expertise. For teams that are created ad hoc or do not have the benefit of training together, prior scenario training is needed so that all potential combinations of individuals into temporary teams share an understanding of subtle cues, commonly evolving problems, and special knowledge elements required in performing the task. Also, training in rapid development of situation awareness as teams are formed and engage a new situation is also important for individuals who may be staffed into temporary teams. Some examples of this are training on explicit verbal communication protocols that make the current situation clear and mutually understood, having a means to make goals and expected future situations clear and anticipated, and supporting discovery and sharing of experience.

Status and authority differences have the potential to blunt the benefits of knowledge variety and cognitive division of labor that can be very important to reliable and safe performance of tasks. Special attention and training for leaders of such teams is important, and high status/high authority team members should model learning leadership whereby they ask questions, admit ignorance or their own errors made, and emphasize the task or challenge as a problem to be solved rather than a judgment. Organizational socialization and training emphasizing a psychologically safe environment and an imperative to address errors and seek improvement is also important when teams face wide differences in both knowledge and status.

Further reading

Edmondson, A. C. (2003). Speaking up in the operating room: How team leaders promote learning in interdisciplinary action teams. Journal of Management Studies, 40(6), 1419-1452.

Gurtner, A., Tschan, F., Semmer, N. K., & Nägele, C. (2007). Getting groups to develop good strategies: Effects of reflexivity interventions on team process, team performance, and shared mental models. Organizational Behavior and Human Decision Processes, 102(2), 127-142.

Huber, G. P., & Lewis, K. (2010). Cross-understanding: Implications for group cognition and performance. Academy of Management Review, 35(1), 6-26.

Mohammed, S., & Dumville, B. C. (2001). Team mental models in a team knowledge framework: Expanding theory and measurement across disciplinary boundaries. Journal of Organizational Behavior, 22(2), 89-106.

Smith-Jentsch, K. A., Mathieu, J. E., & Kraiger, K. (2005). Investigating linear and interactive effects of shared mental models on safety and efficiency in a field setting. Journal of Applied Psychology, 90(3), 523.

Stasser, G., & Titus, W. (1985). Pooling of unshared information in group decision making: Biased information sampling during discussion. Journal of Personality and Social Psychology, 48(6), 1467.

Waller, M. J., Gupta, N., & Giambatista, R. C. (2004). Effects of adaptive behaviors and shared mental models on control crew performance. Management Science, 50(11), 1534-1544.

3. Learning should be encouraged by inquiry also, not only by telling.

Zhike Lei

In today's fast-moving, ultra-complex global business environment, safe performance is accomplished through collaboration. Yet it's not necessarily easy for employees to rapidly share relevant information and voice issues and concerns in these dynamic situations. This means that leaders must ensure that employees get over their natural desire to avoid personal risks associated with voice. More precisely, team leaders must actively ask for input and explicitly encourage members to be brave and speak up - and must not respond by expressing anger or strong disapproval of what may at first appear to be inappropriate or incompetent.

In addition to the bottom-up perspective of "voicing" (ie, employee speaking up), voice from the perspective of leaders needs to be considered as well and the inherent difficulties associated with inquiry in organizations need to be addressed. Specifically, I outline three suggestions regarding how to successfully use active inquiry in organizations and teams, which is at the core of safe performance and effective learning.

Suggestion 1. Explicitly invite input and participation. Leaders can create voice opportunities by asking thoughtful questions, asking explicitly for input, involving employees in discussions and decisions, and listening actively and intensively. When a leader exhibits a supportive style and open-mindedness, employees are motivated to speak up, take responsibility, and respond to the leader's inquiry. Andre Sougarret, the senior engineer at the Codelco mining company, did just that when he led the historic 70-day rescue operation of 33 Chilean miners in 2010. Sougarret shielded everyone involved from the media, asked questions and listened carefully to people regardless of rank, and demonstrated deep interest in new ideas about how to save the miners. The value of "inquiry" has been widely emphasized in the Crew Resource Management (CMR) training in the aviation sector and inquiry is considered as the first step to the CMR success. It is therefore strongly advised that aircraft captains, or pilots-in-command, actively invite other crew members to question, scrutinize, and investigate all that is happening. Through inquiry, crew members build mutual respect and confidence and foster an environment that is conducive to openness, candor, and constructive critique. As a result, synergy is achieved in the cockpit, thereby decreasing the risk of an accident or incident.

Suggestion 2. Strategically install and maintain the hardware of learning and inquiry. To facilitate effective learning, leaders need to scope out safety goals and challenges, manage team structures and boundaries, and provide learning incentives. By scoping out the safety standards and challenges, leaders become proficient at determining what expertise is needed, tapping collaborators, and outlining roles and responsibilities. Once a team is already assembled, leaders need to offer some structures, for example, in terms of skill differentiation, authority differentiation, and temporal stability, to help the team coordinate and function effectively. For example, an increasing number of hospitals have started experimenting with a so-called "pods" system to make ad hoc collaboration easier. In this system, emergency rooms are divided into subsections ("pods") incorporating a preset mix of roles (eg, an attending physician, a resident, three nurses, and an intern) for clinicians to slide into when they come to work. As a result, this teaming structure for each shift reduces coordination time, facilitates information sharing, boosts accountability, improves operational efficiency, and shortens patient waits. Moreover, teams and organizational units in face of dynamic task situations like organizational threat and crisis are often involved in various boundary-spanning activities such as scouting for information, contracting and cooperation. Leaders thus benefit from these boundary-spanning activities by gaining broader knowledge from a bigger network of potential collaborators, and a better understanding of their company and the different cultures at work. Finally, leaders should reward rather than "shoot" messengers who come forward with bad news, questions, concerns, or mistakes. Leaders should send the right message to avoid empty suggesting box and organizational silence.

Suggestion 3. Thoughtfully design and manage the software of learning and inquiry. The hardware of learning would not work smoothly unless the software, too, is thoughtfully designed and managed. Here I emphasize two software tools for leaders to achieve learning goals: (1) emphasizing purpose, and (2) building psychological safety. Articulating what's at stake is a basic leadership tool for motivation in almost any setting, but it's particularly vital in dynamic contexts that require intensive collaboration. Safety goals are fundamentally about shared values; they answer the question why we (this organization, this team, this project) exist, which can galvanize even the most diverse team. Where leaders can ask thoughtful questions and invite ideas and suggestions, people both feel comfortable and responsible for admitting ignorance or uncertainty and talking about sensitive issues and innovative suggestions without fear of ridicule or punishment. Therefore, managers must work to create a climate of psychological safety so as to mitigate interpersonal risks and make collaboration more likely to occur. Julie Morath, the chief operating officer of Children's Hospital and Clinics of Minnesota from 1999 to 2009, demonstrated a highly successful effort to build a psychologically safe culture and reduce medical errors. As soon as she joined the hospital, Morath shared her passion for patient safety and acknowledged her limited knowledge of how things worked at Children's as a newcomer. Morath also encouraged her people to embrace the medical incident data as good news, because the hospital could learn from failures, and made sure that teams spent time analyzing every incident. As a major milestone, Morath implemented "blameless reporting" at Children's - an approach that encouraged employees to reveal medical errors and near misses anonymously. Soon after the new reporting system was implemented, the rate of reported failures decreased. As savvy leaders insist that their organizations and teams develop a clear understanding of what happened- not of "who did it" when things go wrong, their organizations and teams are going to be rewarded not only for successful performance but also for continuous improvement and learning.

Further reading

Ashford, S. J., Sutcliffe, K. M., & Christianson, M. K. (2009). Speaking up and speaking out: The leadership dynamics of voice in organizations. In J. Greenberg and M. S. Edwards (Eds.), Voice and Silence in Organizations, 175–202. Bingley, UK: Emerald.

Edmondson, A.C. & Lei, Z. (2014). Psychological safety: The history, renaissance, and future of an interpersonal construct. Annual Review of Organizational Psychology and Organizational Behavior, 1.

Wiener, E. Kanki, B., & Helmreich (1993). Cockpit resource Management. San Diego, CA: Academic Press.

4. Speaking up should be both continually encouraged and formally trained as an interactive process.

Michaela Kolbe & Bastian Grande

Speaking up, that is voicing concerns and suggestions and asking questions, is crucial for problem-solving in teams, organizational learning, and for achieving safety. Without speaking up, problems cannot get managed, ideas will not get shared, and potential harm will not be prevented.

However, speaking up does not come easy. The personal and social hurdles to speaking up, such as fearing to be wrong or expecting negative consequences, are often daunting. Organizations focusing on task execution rather than on learning seem to make speaking up even more difficult. So do organizations with a strong hierarchical structure and hierarchy-enhancing culture. Ad-hoc teams may lack the mutual trust for its member to confide in each other whereas stable teams are at risk of establishing a norm that values harmony more than openly sharing divergent opinions.

Teams need encouragement and formal training in speaking up:
The encouragement for speaking up should be threefold. (1) Team leaders should explicitly invite team members, for example during a pre-briefing, to share ideas and concerns and to ask questions. (2) Team leader and members should show appreciation for team members having spoken up; regardless of whether their concern turned out to be a false alarm or actually prevented a mishap. (3) The team should establish a shared understanding of when and how to speak up and how to deal with being spoken up to. This includes the building of team psychological safety, that is a climate in which team members feel free to say what's on their mind without fear of repercussions and feel ready to be proven wrong. Leaders have a particularly important role to play in establishing team psychological safety by encouraging speaking up, acknowledging their need for information, showing humility, using inquiry skills, and responding affirmatively when team members speak up.

Formal training for speaking up should involve experience-based learning, for example participating in and subsequently reflecting on a simulation of a speaking-up case as well as implementing regular debriefings in everyday work. This kind of formal training should permit discussing (1) the hurdles and enablers of speaking up, (2) the specific social interaction processes involved in speaking up, and (3) the practicing of communication algorithms for how to speak up. For example, speaking up is most effective when it is conducted from a perspective of curiosity and concern and, thus, includes an open-ended inquiry allowing the recipients to offer and explain their point of view rather than justifying their actions.

Further reading

Bienefeld-Seall, N., & Grote, G. (2012). Silence that may kill: When aircrew members don't speak up and why. Aviation Psychology and Applied Human Factors, 2(1), 1-10.

Kolbe, M., Burtscher, M. J., Wacker, J., Grande, B., Nohynkova, R., Manser, T., Spahn, D., & Grote, G. (2012). Speaking-up is related to better team performance in simulated anesthesia inductions: An observational study. Anesthesia and Analgesia, 115, 1099-1108.

Kolbe, M., Weiss, M., Grote, G., Knauth, A., Dambach, M., Spahn, D. R., & Grande, B. (2013). TeamGAINS: A tool for structured debriefings for simulation-based team trainings. BMJ Quality & Safety, 22, 541-553.

Morrison, Elizabeth Wolfe. (2011). Employee voice behavior: Integration and directions for future research. The Academy of Management Annals, 5(1), 373-412.

Pian-Smith, May C.M., Simon, Robert, Minehart, Rebecca D., Podraza, Marjorie, Rudolph, Jenny, Walzer, Toni, & Raemer, Daniel. (2009). Teaching residents the Two-Challenge Rule: A simulation-based approach to improve education and patient safety. Simulation in Healthcare, 4, 84-91.

5. Taskwork and team coordination: Shifting attention between individual tasks and cooperation requirements within the group.

Franziska Tschan & Norbert K. Semmer

Working in teams requires each team member to pay attention to his or her own task, and, at the same time, devote attention to the coordination process to ensure smooth cooperation with the other team members. Taskwork and team coordination are two different processes that each consume attentional resources. If team members get caught up too much in their individual tasks, they may lose the team perspective, and coordination suffers. This is especially dangerous in emergency situations, because stress narrows the attention span. Under stress, the team perspective tends to get lost, as stressed team members concentrate on their own, individual task and neglect coordination and mutual information. The same may happen when something striking catches everybody's attention, as when all members of a team gather around one person trying to deal with a problem.

There are three ways to mitigate the potential threat of overconcentration on individual tasks. (1) Assign a team leader whose main task is to coordinate the group and to concentrate on the team task as a whole. Particularly in emergency situations, team leaders should stay hands-off and not be involved in executing parts of the task; their sole responsibility should be to coordinate. (2) Team members should be encouraged to actively inform others about what they think and what they do. Thinking aloud and talking to the room while performing individual tasks can help the other team members to be informed without having to ask for information. This can facilitate cooperation. (3) For well-known tasks, teams should install "reflection points", where taskwork is interrupted for a very short time to "lift the head", pay attention to the team level, and engage in mutual information and coordination within the team. In any case, after the task, teams should gather to review their work; this includes critical feedback about their cooperation.

Team training should prepare all team members to be ready to take the lead, to talk to the room, or to call for a reflection point. In specialized teams with stable membership, team members should be trained, if possible as a team, to take specific tasks and responsibilities, and teams should be trained to recognize coordination requirements, similar to a pit-stop crew in car races. But in many cases, team member may not all know each other, and roles may not be pre-assigned; in that case, everybody needs to be prepared to take the lead if necessary.

Further reading

American Heart Association
http://www.heart.org/HEARTORG/CPRAndECC/HealthcareProviders/CPR-Quality_UCM_450686_SubHomePage.jsp

Driskell, J. E., Salas, E., & Johnston, J. (1999). Does Stress Lead to a Loss of Team Perspective? Group Dynamics: Theory, Research, and Practice, 3(4), 291-302.

Cooper, S., & Wakelam, A. (1999). Leadership of resuscitation teams: 'Lighthouse Leadership'. Resuscitation, 42(1), 27-45.

Semmer, N. K., Tschan, F., Hunziker, S., & Marsch, S. U. (2010). Leadership and minimally invasive training enhance performance in medical emergency driven teams: Simulator studies. In V. G. Duffy (Ed.), Advances in Human Factors and Ergonomics in Healthcare (pp. 180-190). Boca Raton: Taylor & Francis Waller

Tschan, F., Semmer, N. K., Gautschi, D., Hunziker, P., Spychiger, M., & Marsch, S. U. (2006). Leading to recovery: Group performance and coordinative activities in medical emergency driven groups. Human Performance, 19(3), 277-304.

Tschan, F., Vetterli, M., Semmer, N. K., Hunziker, S., & Marsch, S. C. (2011). Activities during interruptions in cardiopulmonary resuscitation: A simulator study. Resuscitation, 11, 1419-1423.

Waller, M. J., & Uitdewilligen, S. (2008). Talking to the room: Collective sensemaking during crisis situations. In R. Roe, M. J. Waller & S. Clegg (Eds.), Time in organizations - Approaches and methods. London: Routledge.

6. Teams should be trained to switch between different forms of coordination depending on situational and task demands.

Tom Reader

Team coordination refers to the synchronous and concerted performance of work activities by team members. How team members coordinate depends on the structure of the team, the skills and experience of team members, and the situation. In particular, team coordination is shaped by complexity, risk, and time-pressure. In scenarios where time pressure is low and risk is reduced, participative and highly communicative activities are required to maximise team performance. Alternatively, during high pressure and complex tasks, top-down styles of leadership can be more appropriate.

In settings where situational and task demands are changeable, the ability of teams to switch from one style of team coordination to another is essential. Teams require to i) diagnose and understand the different contexts and situations in which they operate, and ii) to be trained to switch between different forms of coordination.

First, an analysis must be made of the core types of activities performed by teams (eg monitoring, emergency), the interdependencies between team members (eg information gathering, sharing expertise), and the constraints that are likely to shape how team members interact (eg time pressure and risk). This allows for broad principles on successful team coordination activities for different tasks within an industry to be established. Second, on the basis of this analysis, team training can be designed. This should focus on training the teamwork skills required for different situations and contexts. For example, participative decision-making (eg speaking-up behaviours, discussion facilitation), and rapid expert-led decision-making. Crucially, team members should have the opportunity to be i) trained in the different skills and coordination activities required for specific tasks and contexts, ii) develop a shared understanding of the interdependencies between team members, and iii) given opportunity to practice switching from one style of team coordination to another (eg in simulation). In particular, training should focus upon team leaders, as their ability to adapt leadership style to different tasks (and establish team expectancies) is a key determinant of whether teams manage to switch between different forms of coordination for different scenarios.

Further reading

Burke, C. S., Stagl, K., Salas, E., Pierce, L., & Kendall, D. (2006). Understanding team adaptation: A conceptual analysis and model. Journal of Applied Psychology, 91, 1189-1207.

Burtscher, M., Manser, T., Kolbe, M., Grote, G., Grande, B., Spahn, D., et al. (2011). Adaptation in anaesthesia team coordination in response to a simulated critical event and its relationship to clinical performance. British Journal of Anaesthesia, 106, 801-806.

Grote, G., Kolbe, M., Zala-Mezö, E., Bienefeld-Seall, N., & Künzle, B. (2010). Adaptive coordination and heedfulness make better cockpit crews. Ergonomics, 53, 211-228.

Klein, K., Ziegert, J. C., Knight, P., & Xiao, Y. (2006). Dynamic delegation: Shared, hierachical, and deinidivudalized leadership in extreme action teams. Administrative Science Quarterly, 51, 590-621.

Reader, T., Flin, R., & Cuthbertson, B. (2011). Team leadership in the Intensive Care Unit. The perspective of specialists. Critical Care Medicine, 39, 1683-1691.

7. Teams can manage situations with more or less pronounced task interdependencies and risk levels through mutual coordination and consistent leadership.

Laura Fruhen

Teams in risky contexts are often faced with the difficult task of adapting to novel, unknown and fast changing situations. These situations can be extremely challenging and require teams to coordinate their activities and to communicate effectively. Individuals are influenced by person as well as environmental factors. One of the most salient factors that many teams in safety related professions might face is the variant risk level in the situations that they have to deal with. These risks can be very evident and present, but in some cases they will be abstract and more distant. So how can teams deal with the difficult task of adapting to more or less risky contexts and thereby achieve good performance?

Some riskier situations can be more uncertain and stressful for team members. Studies have shown that in such situations task cohesion in teams is especially relevant for team performance. Task cohesion is a characteristic of a team and reflects the extent to which the team shares a sense of commitment to completing a task successfully. Strong task cohesion especially supports teams in situations where it is distributed and has to operate without continuous instruction from the team leader. To improve task cohesion in a team, one can clearly formulate team goals, rather than individual goals, and reward goal achievement collectively. By communicating that tasks have a high priority, task cohesion can be strengthened and the team can focus on goal accomplishment. Thereby the team can develop a shared sense of responsibility for task achievement which will support them in difficult situations.

A second factor that supports teams in dealing with more or less risky situations is the consistency of the leader's decision making. A clear and consistent decision-making pattern of the leader across various decision scenarios has been found to lead team members to develop a more coherent understanding of the team's safety norms and values, which contributes to their safety performance. Also related to the leader's influence on the way teams manage risky situations is his or her leadership style. While in non-risky contexts a leaders' ability to inspire his or her followers is most effective, we usually find that risk related contexts additionally require a leader to be directive and set clear goals. As with cohesion, it appears that in risky contexts, an explicit and clear focus on the task can go a long way in supporting teams to carry out their work safely.

For teams that manage risks that are more distant to their workplaces and consequently more abstract, a tendency in team members to critically evaluate these risks can be highlighted. This is the case for, for example, senior management teams who are often removed from the places where their decisions are going to have an effect. These teams can be encouraged to maintain a mental representation of the possible consequences of their decisions by considering a sense of unease about worst cases, anticipate that things might go wrong and remain vigilant to weak indicators of risks.

Further reading

Fruhen, LS., Flin, RH. & McLeod, R. (2013). Chronic unease for safety in managers – a conceptualisation. Journal of Risk Research. Published online 25 Sep 2013.

Pillai, R., & Williams, E.A. (2004). Transformational leadership, self-efficacy, group cohesiveness and performance. Journal of Organizational Change Management, 12, 144-159.

Zohar, D. (2002). The effects of leadership dimensions, safety climate and assigned priorities on minor injuries in work groups. Journal of Organizational Behavior, 23, 75-92.

Zohar, D., & Luria, G. (2004) Climate as social-cognitive construction of supervisory safety practices: Scripts as proxy of behavior patterns. Journal of Applied Psychology, 89, 322-333.

8. Managerial safety practices and team configuration should address the dilemma between active learning and error elimination.

Eitan Naveh

Active learning that views learners as active participants in their own learning experience is vital for professionals, and specifically professionals in high reliability industries such as physicians in healthcare organizations, pilots and air traffic controllers in the aviation industry, and engineers in nuclear power plants. Active learning involves trial-and-error processes, risk taking, deviations from standard routines, and trying out new work processes. Decisions about what to explore and when to seek guidance are made by the individuals, who thereby gain control of and responsibility for their own learning. Although minimal tolerance for errors is also a highly important part of their job performance, errors are a natural by-product, at least in the short term, of active learning. As learners actively explore their environment, errors will inevitably occur. These two contradictory situations present professionals with a dilemma: how to balance the need to actively learn and explore, which is at the core of high quality professionalism, against the need to adhere to high safety standards and eliminate errors.

Two suggestions for dealing with the active learning and error elimination dilemma:

1. Managerial safety practices. Research has shown that although active learning indeed may increase the number of errors, organizations can still encourage learning and reduce errors by using managerial safety practices to reinforce safety. It was found that the higher the active learning was, the fewer the number of errors were, when managerial safety practices were high.

Managerial safety practices refer to the extent to which supervisors execute safety-related activities and practices and express to employees the extent to which their supervisor is committed to safety. Supervisors maintain safety by turning it into predictable, situation-specific action directives or practices. For example, managerial safety practices include identifying and eliminating the root causes of failures and hazardous conditions, identifying and correcting safety problems and providing safety problem-solving information.

Organizations must both standardize operations to ensure the reliability of outcomes and at the same time keep themselves open to active learning and flexible enough to absorb it. Hence, while active learning and managerial safety practices may be perceived as contradictory, an argument can be made that employees should benefit from both.

2. Team configuration. Borrowing from studies on balancing between radical innovation and quality, my second suggestion refers to the configuration of team members' attributes, ie, the proportions of members with different attributes may influence the number of errors committed by a team as a whole because the individual attributes affect the knowledge, skills, and effort team members apply to their task. Team members with dissimilar cognitive styles differ in their focus on idea generation, which may be expressed in their tendency to actively learn, versus idea implementation, which may refer to an error elimination orientation. Managers should assign employees to a team not just on the basis of their expertise or their expected individual contribution to the team; rather, managers should take into consideration the team configuration. Specifically, managers should set up teams that have a significant number of active learners, so that an active learning team culture develops; but also conformists and attentive-to-detail members who will contribute to task safety, given their low tolerance of risk and mistakes.

To sum up, while some organizations may set priorities of either emphasizing professionals' active learning and exploration or concentrating on maintaining safety standards and eliminating errors, many organization need to prioritize both active learning and safety. These organizations may benefit to a less extent from implementation of current safety engineering methods that give preference to safety over other performance dimensions and thus need to apply different safety infrastructure perceptions.

Further reading

Katz-Navon, T., Naveh, E., & Stern, Z. (2009). Active learning: When is more better? The case of resident physicians' medical errors. Journal of Applied Psychology, 94(5), 1200-1209.

Miron-Spektor, E., Erez, M., & Naveh, E. (2011). The effect of conformist and attentive-to-detail members on team innovation: reconciling the innovation paradox. Academy of Management Journal, 54(4), 740-760.

Summary of recommendations for team interaction and training

Recommendation 1
Facilitate rapid relationship building in swift-starting action teams.

Recommendation 2
For heterogeneous teams special attention should be paid to developing shared knowledge and situation awareness.

Recommendation 3
Learning should be encouraged by inquiry also, not only by telling.

Recommendation 4
Speaking up should be both continually encouraged and formally trained as an interactive process.

Recommendation 5
Taskwork and team coordination: Shifting attention between individual tasks and cooperation requirements within the group.

Recommendation 6
Teams should be trained to switch between different forms of coordination depending on situational and task demands.

Recommendation 7
Teams can manage situations with more or less pronounced task interdependencies and risk levels through mutual coordination and consistent leadership.

Recommendation 8
Managerial safety practices and team configuration should address the dilemma between active learning and error elimination.

Summary of recommendations for learning from failure

Recommendation 1
Stay visibly committed to safety, including goals, assessment practices, and metrics.

Recommendation 2
Provide necessary resources, recognition, and rewards for safety-related learning.

Recommendation 3
Develop capabilities for storing and retrieving lessons learned.

Recommendation 4
Involve the right people.

Recommendation 5
Insist on interpersonal respect, fairness, and deference to expertise.

Recommendation 6
Develop and promote systems thinking capabilities.

Recommendation 7
Understand the organizational context.

Learning from Failure

Ranga Ramanujam & John Carroll

A key element of an effective safety management program (SMP) is the collective capability for purposeful learning from safety-related failures, ie, events that potentially can generate or signal the likelihood of major adverse outcomes, even if the events themselves are minor incidents or near misses. Failures—especially the ones that cause no immediate harm—represent the unavoidable reality of operating complex technologies under conditions of high risk, interdependence, and uncertainty. They also provide invaluable opportunities for regularly updating and improving all facets of a SMP in the face of a constantly changing work environment. A failure is a test of our existing knowledge and therefore an opportunity to update our understanding of the hazards and to learn how to better avoid, detect, and recover from problems. Organizations must undertake a multi-faceted approach to benefit from the "gift of failure."

By learning, we refer to an increase in the organization's repertoire of behaviors. That is, following a failure, if the situation that caused that failure were to re-occur, can the organization respond differently? However, in and of itself, improvement in safety performance is an insufficient indicator that learning has occurred. Any number of reasons unconnected to learning, including randomness, can potentially account for the prolonged absence of adverse events following a failure. Often, immediate responses such as increased vigilance or additional workload produce only temporary and unsustainable improvements (and overconfidence that the problem has been solved). Learning must be self-aware and accompanied by targeted changes, big and small, that are embedded in organizational routines, equipment, infrastructure, and cultural values and beliefs.

Broadly speaking, learning from failure can be viewed as a four-step cyclical process consisting of: noticing (ie, formal and informal processes for identifying a signal or potential indicator of an unsafe condition), encoding (ie, interpreting the significance of what is noticed by, for example, categorizing and or combining with other data), analyzing (ie, making sense of the information or extracting lessons, including carefully assessing the consequences of proposed changes), and implementing change (ie, making modifications to work processes and technology/equipment as the direct result of the analysis and in order to improve safety) (Figure 1).

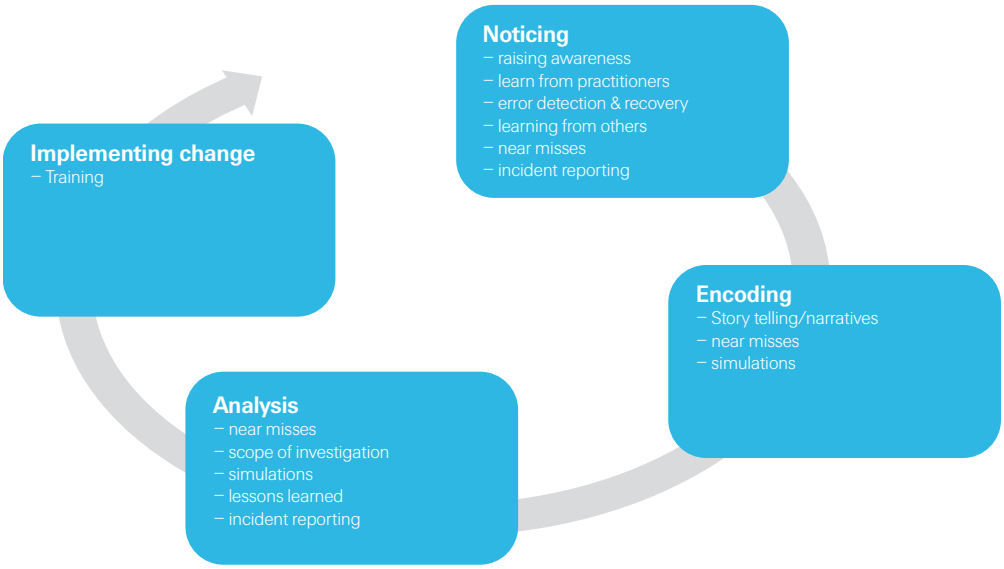

Figure 1. Learning from failure as a cyclical process

Learning is a far more complex process than this figure might suggest. Consider some basic questions that can be overlaid on this cycle: Who learns? From what? When? How? And, to what end? Effective safety management should promote learning by individuals as well as the collective. That is, responsibilities for and participation in the process must be shared within and across organizational units. Although the object of learning is preventing failure, what constitutes a failure can range from "incidents" and "near misses" (even these can vary in terms of how near) to major full-blown accidents and disasters. The timing of learning is related to the object of learning, ie, does the learning occur before the occurrence of an adverse safety event or in the aftermath of such events? The assumptions underlying the method of analysis, and hence its conclusions as well, can vary widely. Some methods focus exclusively on technical causes of failures, others on the human and organizational causes, and yet others on a combination of both. Has the learning process engaged a wide range of people in the organization or only a small set of investigators, which will impact the durability of changes and the development of organizational capabilities? Finally, the consequence of analysis can range from little more than documenting the results of an analysis to implementing a set of targeted changes in skills, routines, and technologies.

Despite such complexity, evidence from research studies and the experience of effective SMPs consistently point to several necessary conditions for effective learning from failures. The following is an overview of the conditions, which provides the basis for our recommendations:

1) Top management must commit resources to and be actively involved in efforts to enable and facilitate learning from failures. In particular, they must continuously signal the importance of safety as a key organizational goal and ensure that SMP efforts are not impeded by competing organizational goals such as efficiency and profits.
2) People at the sharp end must be directly involved in every step of the learning process. For instance, in effective SMPs, frontline employees and subcontractors are often responsible for reporting incidents, analyzing their causes, and implementing appropriate changes.
3) Effective SMPs require an organizational culture that respects and values the contributions of employees and does not attribute blame to individuals except in narrow circumstances of egregious conduct. Managers must demand and implement actions to shape and support such a culture.
4) The primary emphasis should be on anticipatory learning and real-time learning. Effective SMPs invest in learning from near misses and unsafe conditions before things get worse. In addition, they attempt to identify and address the underlying problems. In other words, they do not wait for the rare catastrophic event before implementing changes or for the regulator to request corrective actions.
5) Every aspect of the SMP—labels and categories for failures, formal analysis tools, and the types of corrective actions—must be chosen to promote a systemic or systems-based view of safety. That is, rather than direct attention narrowly to one set of causes (eg, technical error, human error), the analysis must routinely consider the multiple inter-related causes of failures. Such causes extend back through multiple chains of events to organizational, cultural, and institutional issues. This also means that the analysis must look beyond quantitative data, and additionally acknowledge the role of stories and emotions in how people make sense of and respond to failures.
6) The effectiveness of specific SMP practices is context-dependent. Although these preceding observations tend to generally apply across industries, their relevance and significance can be expected to vary with specific features of a given context, such as the relationship between workers and management in terms of trust (team psychological safety) and cultural expectations (power distance), the level of internal capability and complementary external resources (ie, where is the expertise? is it necessary to build more internal expertise?) and the intensity of regulatory and public/media scrutiny.

Further reading

Carroll, J.S. & Fahlbruch, B. (2011). "The gift of failure: New approaches to analyzing and learning from events and near-misses." Honoring the contributions of Bernhard Wilpert. Safety Science, 49, 1-4.

Carroll, J.S., Rudolph, J.W. & Hatakenaka, S. (2003). Learning from organizational experience. In M. Easterby-Smith & M.A. Lyles (eds.), Blackwell Handbook of organizational learning and knowledge management (pp. 575-600). Malden, MA: Blackwell.

Hofmann, D. & Frese, M. (eds.) (2011). Errors in organizations. Jossey-Bass: Society for Industrial and Organizational Psychology (SIOP) Frontiers Series.

Kohn, L.T., Corrigan, J.M. & Donaldson, M.S. (1999). To err is human: Building a safer health system – The Institute of Medicine report on medical error. Washington, DC: National Academy Press.

Recommendations for learning from failure

1. Stay visibly committed to safety, including goals, assessment practices, and metrics.

Effective safety management requires that people throughout the organization treat safety as a critical priority. To this end, top managers should convey their uncompromising commitment to safety in the face of competing priorities such as growth and profits. They should make safety integral to assessing overall performance and effectiveness at all levels in the organization. A balanced score card approach that includes safety performance as a key indicator, for instance, makes it much more likely that top managers and the governing board routinely review safety data, not just when things go wrong. In turn, this makes it more likely that safety will routinely draw the attention of people throughout the organization. An integrated approach should not undermine the importance of safety and should assure that trade-offs around safety are made explicit. For safety to emerge as a top management priority, it is essential that top managers become aware of the benefits, not just the costs, of SMPs as well as the costs, not just the benefits, of decisions that override safety concerns.

In addition to espousing a general commitment to safety, top managers should also set specific and challenging safety goals for all levels in the organization and continuously assess performance relative to these goals, which serve a critical function in learning. Organizations are much more likely to initiate learning if they believe that current safety levels fall short of what is formally expected. They are much less likely to initiate such efforts if they believe that current safety levels are satisfactory, which almost always happens when top managers fail to set safety goals or set goals that are vague or unchallenging (eg, avoid catastrophic failures). To counter such complacency and promote organizational learning, top managers in organizations with effective SMPs insist on "zero errors" as their goal. By endorsing such challenging, even if unrealistic, goals, they underscore their commitment to learning ("always becoming safer") rather than to compliance alone ("become safe enough").

A meaningful mix of safety metrics is essential for assessing progress toward these goals. Relying on a narrow set of safety metrics (eg, number of fatal accidents) can significantly restrict the opportunities for learning. However, an unrestrained proliferation of safety metrics—an ever present possibility given the tendency of managers to measure whatever can be easily measured—can overwhelm the organizational capacity for learning. Therefore, managers should periodically step back to think about some basic questions: What does safety mean in our context? How can we know, as best as we can, how safe we are? What do people care about and what should they be convinced to care about? Does our current mix of safety metric capture the key dimensions of our safety performance? What is missing from our current mix? How can we improve these metrics? Can learning effectiveness be assessed through our metrics? In other words, efforts to learn from failure must be accompanied by efforts to refine and update the safety metrics that play an important role in triggering learning. Also, safety metrics should capture both safety outcomes as well as safety processes (eg, workarounds). More generally, they should not be limited only to quantitative metrics and must additionally incorporate qualitative metrics such as narratives about current safety management practices.

Further reading

Kaplan, R.S. & Mikes, A. (2012). Managing risks: A new framework. Harvard Business Review, 90(6), 48-58.

Künzle, B., Kolbe, M. & Grote, G. (2010). Ensuring patient safety through effective leadership behaviour: A literature review. Safety Science, 48, 1-17.

Scanlon, M.C., Karsh, B.T. & Saran, K.A. (2008). Risk-based patient safety metrics. In K. Henriksen, J.B. Battles, M.A. Keyes et al. (eds.) Advances in patient safety: New directions and alternative approaches (Vol. 1: Assessment). Rockville, MD: Agency for Healthcare Research and Quality. Available from: http://www.ncbi.nlm.nih.gov/books/NBK43628/

Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. Accident Analysis and Prevention, 42, 1517-22.

2. Provide necessary resources, recognition, and rewards for safety-related learning.

Learning is resource-intensive. Investigations of incidents, near-misses, accidents, trends, and surprises provide essential information for improvement efforts, including maintaining and enhancing safety (reducing risk). The quality of those investigations depends upon having the appropriate resources, including time commitments by investigators (individuals or teams) and those who have to provide information (interviewees), a mix of relevant expertise and training of the investigators, and structured tools to collect, assemble, and analyze the information. The learning that is derived from event analyses by the individuals involved in the analyses, by the managers to whom they report, and to the organization that is seeking safety improvements, depends completely on the skill and training of the investigators, the cooperation of the workforce in supplying information, the openness of managers to support the analysis, the willingness of the organization to implement change, and the resources that are available for learning activities. In the absence of planned time and opportunities for learning, employees are more likely to rely on workarounds to safety problems than to attempt "second-order" problem solving.

To signal their commitment to safety, top managers should also actively protect learning efforts from the demands of competing priorities. Activities such as event analyses often compete for time and attention with other assignments. If someone is needed for an investigation, including possibly spending days or weeks on data collection and analyses, will his or her manager object? Even if the assignment is made, if the manager keeps asking for other work to be done, the distraction may be sufficient to reduce the quality of the analysis. Or, if managers avoid assigning their best people to analyses because they are needed for other work, less qualified and less expert people will likely produce a less effective report. Further, everyone will realize that event analyses are lower priority than "real work," and the reports themselves will lose legitimacy if they do not have the participation and backing of the most respected workers. If managers themselves are not visibly engaged either on the team or in active engagement with the team, then others will withdraw their participation, thus reducing the quality of information and insight. Further,

the transition from report to action will likely encounter resistance and confusion, including corrective actions that are not implemented, implemented partially or late, or implemented without full understanding.

In order for necessary organizational resources to be available, managers from the top down must give appropriate priority to event analyses, and the culture must support open inquiry and learning/change. Are there sufficient personnel, do the best people get assigned to event analyses, are outsiders used when their expertise is needed, are managers spending their time supporting investigations, is everyone open to discuss problems, genuinely curious about possibilities (eg, benchmarking), and willing to engage in change? Core cultural values around safety and learning should not only be widespread, but also supported in action when managers assign resources and make decisions. In addition, culturally-appropriate incentives should be given to those who contribute to learning form failure. These incentives need not necessarily be monetary and could take the form of informal recognition. Organizations must be mindful of the unintended effects of heavy-handed incentives that could undermine learning, such as by increasing the quantity of reporting while quality decreases.

Further reading

Dillon, R.L., Tinsley, C.H., Madsen, P.M. & Rogers, E.W. (2013). Organizational correctives for improving recognition of near-miss events. Journal of Management, online first, doi:10.1177/0149206313498905.

Hofmann, D.A., Morgeson, F.P. & Gerras, S.J. (2003). Climate as a moderator of the relationship between leader-member exchange and content specific citizenship: Safety climate as an exemplar. Journal of Applied Psychology, 88, 170-178.

Wachter, R.M. (2005). The end of the beginning: patient safety five years after "to err is human." Health Affairs, 24, w9-w20.

3. Develop capabilities for storing and retrieving lessons learned.

Effective learning is inseparable from effective memory. For learning to be effectively used, an organization has to be able to store lessons learned and then access those lessons at an appropriate time. All too often, a problem arises and is solved locally, but the results are not written down or shared systematically, so when the same problem arises a few years later, or with another shift, or at another work group, they have to solve the same problem all over again, and it may also mean that the underlying issues remain unaddressed. Even when lessons are written and disseminated, does anyone consult the knowledge repository (library, database)? Having bookshelves full of wisdom, binders full of training course materials, and experts full of advice, adds no value if they are not consulted or are too difficult and time consuming to be used by those in need.

In most organizations, much of the knowledge about operational safety resides in the heads of experienced individuals, or is embedded in the design of equipment and the written procedures. Over time, as people change jobs or retire, and new equipment and procedures are written, there may be gaps and misunderstandings. It is up to management to assure that there are knowledge management systems for storing and retrieving lessons

learned. Increasingly, such systems rely on searchable computer databases, user-friendly interfaces, listservs, blogs, moderated discussions, and other ways to encourage remote exchanges. However, the exchange of rich information (by rich we mean complex, unfamiliar, nuanced) requires a rich medium of communication such as face-to-face discussion. That is why the most successful knowledge management systems use bulletins and data repositories to create awareness and interest, but expect those who need extensive information and applicable knowledge to contact specific individuals for advice and help.

Of course, this places a substantial and continuing burden on the knowledgeable person to document what they know and then to act as a resource for others; if this is not supported by management (with resources, policies, recognition, and culturally-appropriate rewards, see Recommendation 2), then there will be reluctance to enter information and provide help. The reporting systems and processes should make it easy, not tedious, to report incidents. For instance, formal expectations about what should be reported must carefully balance the need for gathering as much information as possible with the need to make reporting efficient. If reporting requires considerable effort, employees may try to save time either by providing incomplete reports or by avoiding the formal reporting system and instead reporting incidents informally. Of course, some level of informal reporting is to be expected and even desirable in any context. However, if that becomes almost the exclusive basis for information sharing, it deprives the organization of opportunities to record, collate, and analyze information that are valuable for learning.

A common failing in the corrective action system of most organizations is that problem reports are entered into the system yet, from the viewpoint of the reporter and others, it can become a black hole with no information coming back. The report may be acknowledged, but weeks or months later the problem reporter hasn't heard what has happened. It may even be the case that the problem was analyzed properly and corrective actions were implemented with great success, yet these wonderful results were never shared with the problem reporter or the organization in general. The opportunity to celebrate success, to build confidence in the organization, to build support for reporting problems and implementing improvements, and to build trust between departments and between workers and managers, has evaporated. In short, lessons learned have to be disseminated and stored such that people know they exist, and people must understand the learning process, so that they can find the knowledge when needed.

Further reading

Argote, L. (2013). Organizational learning: Creating, retaining and transferring knowledge (2nd ed.). New York: Springer.

Pronovost, P.J., Thompson, D.A., Holzmueller, C.G., Lubomski, L.H., Dorman, T., Dickman, F., Fahey, M., Steinwachs, D.M., Engineer, L., Sexton, J.B., Wu, A.W. & Morlock, L.L. (2006). Toward learning from patient safety reporting systems. Journal of Critical Care, 21, 305-15.

Ramanujam, R. & Goodman, P.S. (2011). The challenge of collective learning from event analysis. Safety Science, 49, 83-89.

4. Involve the right people.

Learning is a cultural and political activity with a range of meanings to different individuals and groups and many potential conflicts. People have to report problems. People have to conduct investigations. People have to provide information to the investigators. Managers have to receive reports and act upon them. People have to learn and implement change. In short, the event investigation should be thought of in terms of the multiple activities that could be supported by engaging the right people (in terms of their knowledge and experience and their cultural and political attributes) and by using the investigation to connect people to knowledge repositories and to each other.

We can use incident investigations to connect people whose work is interdependent, to connect people who need to learn from each other, and to engage individuals who are not participating sufficiently in safety management. For example, safety events often involve a confluence of problems, including equipment designs that are ill-suited to actual operations, misleading or nonfunctioning instruments, delayed maintenance, and operator misjudgment. For important events (important for actual or potential consequences and/or learning potential), organizations can assemble a team with representatives from groups such as engineering, maintenance, instrumentation and control, operations, training, and process safety. If those team members are knowledgeable and willing to openly discuss problems and handle disagreements (which may require skillful facilitation from the team leader), then there is a lot that can be learned about the problem at hand. In addition, team members gain insight into individuals and professional groups whose work is interdependent with their own. They break down barriers, build trust, and gain contacts in other departments.

But what if those conditions for success do not hold? What if managers won't assign their best people to an investigation team? What if teams are small and therefore do not have a full range of representation? What if insiders lack sufficient expertise? What if there is so much conflict between departments that team members won't talk candidly to each other? What if there is a history of blaming operators or never criticizing managers? Should we put the same people who experienced the event on the investigation team or hold them in the background? Should there be managers on the team, or should the team just report independently to one or more managers?

Involving the right people, with sufficient support, in a recognized and successful investigation can be a very important way to both make improvements and build an effective, collaborative culture. This starts with a clear understanding of the work system, the atmosphere of cooperation (or lack thereof), the distribution of expertise, and so forth. There will be key people who are knowledgeable, respected, and collaborative in nature. They are critical for getting things started but they can be overused. What is desirable is a pathway to broad participation and understanding throughout the workforce. If insiders lack sufficient expertise, then insider-outsider teams can be a great way to transfer expertise (eg, hire consultants, borrow people from other organizations). If the culture is high on blame, it may be best to keep those involved in the event in the background; but if the culture can suspend blame, those involved in the event are the most knowledgeable about

what happened and have tremendous credibility to tell their stories and engage as role models in learning and change. If the culture is sensitive to power differences, it may be difficult to have managers on the team because others would defer to them, and it may be difficult to have candid reports that criticize managers. Reaching the point where managers can be effective on the team means that the organization has reached a level of maturity where expertise matters more than rank and those in authority are curious and able to inquire humbly.

Further reading

Bamber, G., Gittell, J.H., Kochan, T.A., von Nordenflycht, A. (2009). Up in the air: How the airlines can improve performance by engaging their employees. Ithaca, NY: Cornell University Press.

Reason, J. (2004). Beyond the organisational accident: the need for "error wisdom" on the frontline. Quality and Safety in Health Care, 13 (Suppl 2), ii28-ii33.

Weick, K.E., Sutcliffe, K.M. & Obstfeld, D. (1999). Organizing for high reliability: processes of collective mindfulness. In B.M. Staw & L.L. Cummings (eds.), Research in Organizational Behavior (pp. 81-123). Greenwich, CT: JAI Press.

5. Insist on interpersonal respect, fairness, and deference to expertise.

Many of the activities that employees undertake to participate in learning such as voluntary incident reporting are "extra-role," ie, these activities are not (and, by their very nature, cannot be) part of the employees' formal job description. They often take significant time and effort. Therefore, to engage in learning, employees must, as individuals, be motivated enough to go beyond the call of duty. They must be willing to change and adapt to new challenges and, ultimately, learn. The individual learning of employees contributes to organizational learning in part through learning activities that are interpersonally risky. In voluntarily reporting an incident, employees face the risks of being blamed or the risk of inviting reprisals from their co-workers and managers. By acknowledging doubt or even ignorance during an incident review, employees (including managers and "experts") face the risk of being deemed incompetent. Therefore, establishing a climate of psychological safety is critical for employees to feel that they will not incur an unfair personal cost to participating in learning.

An essential condition for employees to feel motivated and psychologically safe is an organizational culture that treats employees with respect and fairness. When employees perceive a lack of respect for their roles and for their ideas or that they are not being treated fairly, they tend to withdraw from the kind of extra-role behaviors that are critical for collective learning. In addition, they are more likely to see such behaviors as risky. Therefore, when employees share a common perception that their organization does not treat them fairly or with respect, voluntary information sharing suffers.

A culture of respect and fairness is also important for effective decision making. Given that people at the sharp end are uniquely positioned to observe failures and near misses, their expertise about the local context should inform organizational efforts to learn from failures. This, however, is easier said than done because in most hierarchical settings ex-

pertise is often equated with formal rank and authority. Often, the implicit assumption is that people higher up in the hierarchy have the information to make sense of specific failures regardless how far removed they may be from these events. Therefore, decisions about safety, including inferences from specific failures, tend to be primarily shaped by the understandings of people with authority, not necessarily of people with the relevant expertise. Consequently, there is an increased risk that learning from failure will be incomplete or even inaccurate. To counter this tendency, organizations should deliberately foster the value of deferring to expertise by training managers to routinely seek and take into account the inputs of people with relevant expertise regardless of their organizational rank.

Developing a culture of respect and fairness requires sustained efforts and commitment from everyone in the organization, especially from managers. To start with, top managers must go beyond policy statements and must actively model fair and respectful behaviors such as soliciting inputs from relevant people across levels in the organizational hierarchy and weighing these inputs based on their own merits without regard to the organizational status of the person providing these inputs. Schein articulates a concept of "humble inquiry," that managers accept their interdependence with others and respectfully seek knowledge from them. These behaviors are also the basis for mutual trust, which is the foundation for productive interpersonal relationships at work. In fact, an impressive body of evidence suggests that in organizational units or departments where the relationships between the manager and employees are characterized by mutual respect and trust, employees are significantly more likely to undertake extra-role behaviors that the manager views as a priority.

Further reading

Edmondson, A.C. (1999). Psychological safety and learning behavior in work teams. Administrative Science Quarterly, 44, 350-383.

National Patient Safety Foundation, "Through the Eyes of the Workforce:…" (http://www.npsf.org/about-us/lucian-leape-institute-at-npsf/lli-reports-and-statements/eyes-of-the-workforce/)

Schein, E.H. (2013). Humble inquiry: The gentle art of asking instead of telling. San Francisco: Berrett-Koehler.

6. Develop and promote systems thinking capabilities.

Every incident or accident has the potential of revelation if the organization "pulls the thread" to find the deeper, underlying, systemic causes of problems. For example, what appears to be an operator error in a chemical plant could be a symptom of a bad design of control room indicators, a deficiency in the hiring and training of operators, a lack of resources to staff the control room with attendant overtime and fatigue, an inability to fix known problems that have occurred repeatedly, a cultural expectation for workarounds and "getting by," and so forth.

Root cause analysis was created with the intent to avoid knee-jerk reactions such as blaming the operator or maintenance mechanic at the sharp end or making a quick fix that feels satisfying but does little to change the underlying causes (and may even make things worse or make workers more cynical about improvement efforts). However, many different tools and practices go under the label of "root cause analysis," such as a hospital that brings together a multi-discipline group for one hour to discuss an incident because that's the most time they can get from the doctors. The very label generates confusion in suggesting that there is a single root cause (one nuclear power plant had a database in which only a single cause code could be entered as the root cause). If personnel have insufficient understanding or training around the tool, or the tool is used to blame individuals rather than to seek underlying causes, or low quality analyses are accepted, then the opportunities to approach investigations with more rigor, structure, and insight may be lost.

Consider the following statement from the report of the space shuttle Columbia accident (CAIB, 2003, p. 97):
Many accident investigations do not go far enough. They identify the technical cause of the accident, and then connect it to a variant of "operator error" {...}. But this is seldom the entire issue. When the determinations of the causal chain are limited to the technical flaw and individual failure, typically the actions taken to prevent a similar event in the future are also limited: fix the technical problem and replace or retrain the individual responsible. Putting these corrections in place leads to another mistake – the belief that the problem is solved.

Organizations with more effective incident analysis programs have invested significant resources in long-term performance rather than fixing immediate symptoms, through training, peer assist visits to and from other organizations, and tools to identify more systemic causes. A systemic view supports investments in safety management systems that will enhance long-term performance (and profits). Further, they have committed to addressing systemic causes, so that everyone in the organization recognizes that progress can be made on these deeper issues. An organization that invests in reporting and analysis but cannot implement successful change will find that reporting dries up and analysis becomes ceremonial. Meaningful improvements resulting from the complete learning cycle reinforces every element of that cycle.

Recently, new approaches have arisen to understand system safety from a comprehensive viewpoint. For example, Leveson asserts a view of safety as a set of constraints maintained by a control system built from control actions and feedback structures. Incidents and accidents arise from inadequate control actions and missing feedback. The value of such a comprehensive approach is not simply to analyze the causes of problems after the fact, but even better to have a conceptual model of the safety systems and organizational activities that assure safety and maintain constraints. The safety management system can be analyzed proactively, defects identified, and changes made to strengthen control in order to prevent problems. Sharing such systems thinking approaches throughout the organization allows people to talk readily about safety with a common language, to identify gaps, and to support improvements.

In addition to reporting serious safety incidents, employees must also be encouraged to report "near misses." Serious events tend to be infrequent and therefore provide fewer opportunities for learning. Moreover, because of the costly consequences, the analysis of such events tends to be emotion-laden, thus increasing the chance of strong-but-wrong learning. Such events also tend to heighten concerns about individual blame and to raise political concerns about conflicts and disagreement among groups, which detract from learning. Near misses offer a way to learn ahead of major incidents in an atmosphere more conducive to participation. However, excessive reporting of trivial events and conditions that may not be relevant to safety can take time and attention away from more relevant events. Thus, organizations should attempt to continuously evaluate and modify their categories so that the categories are neither so narrow that they neglect learning opportunities and become complacent, nor so broad that people become mired in minutiae. Indeed, such changes to the reporting system by themselves represent important learning from failure. In addition to near misses, incident reporting systems should also provide opportunities to record safety successes whoever defined. In other words, these systems should also facilitate knowledge sharing about best practices and dissemination of success stories identified as a result of learning from failures.

Further reading

Columbia Accident Investigation Board (2003). Report available at http://spaceflight.nasa.gov/shuttle/archives/sts107/investigation/CAIB_medres_full.pdf

Corcoran, W.R. (2007). The Phoenix Handbook: The ultimate event evaluation manual for finding safety and profit improvement in adverse events. Windsor, CT: Nuclear Safety Review Concepts. Available at https://app.box.com/s/gxhc27hd6zq0a88druma

Dien, Y., Dechy, N. & Guillaume, E. (2012). Accident investigation: From searching direct causes to finding in-depth causes. Problem of analysis or/and of analyst? Safety Science, 50, 1398-1407.

Leveson, N. G. (2011). Engineering a safer world: Systems thinking applied to safety. Cambridge, MA: MIT Press.

Rasmussen, J. (1990). The role of error in organizing behavior. Ergonomics, 33, 1185-1190.

7. Understand the organizational context.

Not all organizations are alike. Industries vary, technologies vary, national practices vary, and even within these broad contexts, organizations can be as different as individuals, each with their own "personality" or culture. In our recommendations above, we have sometimes suggested contingencies for actions that might work well in some conditions and not in others. Our final recommendation is therefore to be mindful of organizational conditions, including variability within a single organization, that would facilitate or inhibit implementation and success of safety-related interventions.

Organizations with rampant safety problems most likely focus little attention and resources on safety. The infrastructure of metrics, training, reporting and investigation practices, and storage of lessons learned may be very weak. On the other hand, there will be many opportunities to find and fix problems, much "low hanging fruit" that can be used to build confidence and trust, and to engage people in the learning process. Of course, this will create a demand for more resources in the form of training and time for learning that managers must respect and support, or risk a return to cynicism and resistance. In contrast, organizations that already have a well-functioning learning system need to take the next step, whether that is more systems thinking, risk-based prioritization, directly addressing "soft" problems, etc.

For instance, a manager newly hired by an organization that has little appreciation for safety, little in-house expertise, few resources for investigations, and a history of failed implementations would have to work very differently from a manager in a more progressive, advanced, and resource-rich organization. In the former case, an improvement strategy might start small, with ways to build credibility and look for small wins with low-hanging fruit, engaging a few highly-regarded workers who may have been frustrated by their organization in the past, and developing some simple reporting and analysis tools and metrics. It may be necessary to persuade people to think differently, by sending them on benchmarking visits or hiring a few skilled investigators, with the intent of spreading these skills rather than building a separate department of experts.

Consider the implementation of voluntary incident reporting in an organization with a history of distrust where employees believe incident reports are used primarily to assign blame and 'discipline" employees for a failures and problems. In this case, it is critical that at least initially the reporting process provides anonymity to help employees overcome their fear of reprisal. Moreover, employees must be able to see how incident reports are producing changes that are beneficial and fair (in the sense of not blaming individuals for well-intentioned actions). To this end, organizational leaders need to constantly reiterate the goals of learning and safety with concrete examples, including vivid stories that illustrate how the incident data are being used to identify and address systemic causes of failures, and not to pin blame on individuals. By contrast, anonymity and top management involvement might not be as critical in the implementation of incident reporting in an organization with a history of mutual trust and respect.

Similarly, the implementation of event analysis must take into account the availability of expertise and capabilities within the organization. Event analysis techniques typically require a set of technical and analytical skills, which can be imparted through training. However, the extent of the required training—and hence the required resources—will vary with the current skills and experience of employees (eg, in many engineering working environments, there are few specialists of human and organizational factors). In organizations where employees have little or no prior experience in using such techniques, training will take longer. Therefore, until the benefits of training are realized, it might be necessary to rely on outside experts to assist with event analyses. Moreover, an often overlooked aspect of event analysis is that its effectiveness also depends on the capabilities for teamwork and collaboration. In other words, the implementation must also focus on developing such interpersonal skills especially in organizations with a history of command and control decision making.

As a last word, appreciation of context implies attention to organizations and industries beyond one's own. External learning from industrial accidents and best practices provides an opportunity to compare different industrial, national, cultural contexts, and sometimes to better see some blurred deficiencies within a system. The exemplary large-scale investigations of Piper Alpha, Columbia, and Texas City helped shape their own and other industries' safety management systems.

Further reading

Goodman, P.S., Ramanujam, R., Carroll, J., Edmondson, A.C., Hofmann, D., & Sutcliffe, K. (2011). Organizational errors: Directions for future research. Research in Organizational Behavior, 31, 151-176.

Grote, G. (2012). Safety management in different high-risk domains – All the same? Safety Science, 50, 1983-1992.

Reason, J. (1997). Managing the risks of organizational accidents. Aldershot, UK: Ashgate.

Multi-level contexts for organizational safety management

Jody Hoffer Gittell & Paul Schulman

Safety is a multi-level process extending from public perceptions regarding safety in an industry to regulatory approaches taken toward the industry to organizational safety management strategy and structures, to task performance and practices, including team dynamics. These levels can interact in ways that shape safety performance for better or worse. This shaping process is not unidirectional; rather there are feedback loops.

For example, whether there is a public dread over potential safety lapses in a particular industry, and how much public trust is accorded the expertise of operators and managers of organizations, can shape the regulatory context, that is, how much regulation exists and how adversarial or cooperative it will be. Regulatory approaches in turn can shape specific safety management regimes within individual organizations including systems for selection, training, job design, accountability, performance assessment, supervision, rewards, conflict resolution, protocols, information systems, and the specific safety structures and procedures they adopt. This in turn affects the specific operational practices adopted by these organizations, including the team dynamics among their members. At each level there are critical choices to be made, which then constrain the choices made at the subsequent levels. But the influence can run in different directions. For example, safety performance such as a major accident can lead to revised choices at each of the higher levels, in ways that can be reactive and dysfunctional or alternatively can take the form of a proactive learning process.

It was the view of our conference that we cannot understand safety performance and safety outcomes without accounting for these multi-level interactive effects. In our organizational and regulatory panel we drew upon participant expertise from multiple industries to explore variations in the contexts the public, regulators and organizations create for safety and how this drives team dynamics and safety performance. Figure 1 below displays this interactive relationship.

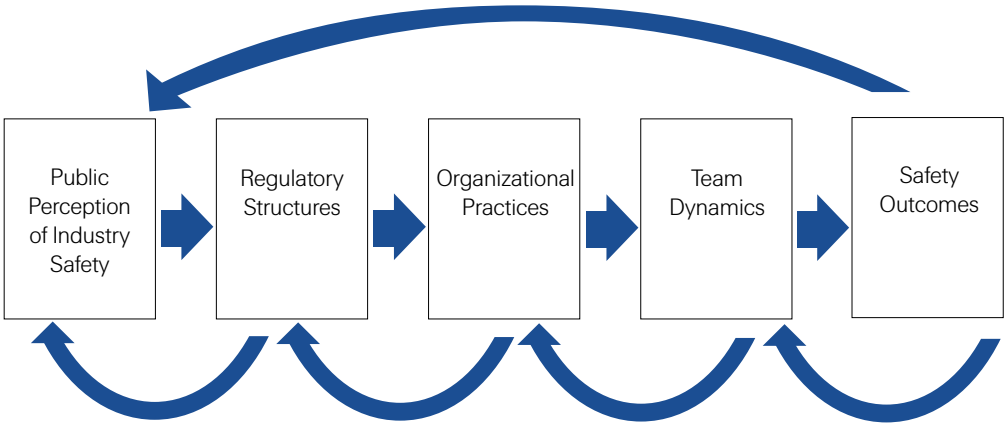

Figure 1: Multi-Level Model of Safety Performance

How do these multi-level processes play out? Consider for example the relationship between regulators and the organizations they regulate. The regulator/organization relationship can be a low trust punitive relationship, a laissez relationship with little engagement or oversight, or a high trust partnership in which regulators and organizations seek safety solutions together through frequent, timely, accurate, problem-solving communication supported by shared goals, shared knowledge and mutual respect. These differences in regulator/organization relationships may drive important differences in organizational safety regimes. A low trust punitive relationship with regulators may encourage an organization's leaders to develop internal accountability and reward structures that are low trust and punitive in nature. This in turn influences team dynamics in a harmful way. For example, we know from research on quality, learning and coordination that a low trust punitive organizational context encourages both managers and front-line workers to hide information, to fail to learn from their errors, and to engage in self-protection rather than coordination and learning. These poor team dynamics increase the risk of safety breakdowns as information falls through the cracks and as people hide information to protect themselves and their colleagues from punitive measures.

Public perception, regulatory structures and organizing practices provide very strong contexts for safety management in organizations. These will therefore be discussed in more detail in the following essays.

Further reading

Argyris, C. (1976). Single-loop and double-loop models in research on organizational decision-making. Administrative Science Quarterly, 21, 363-375.

Boin, A. & Schulman, P.R. (2008). Assessing NASA's safety culture: The limits and possibilities of high reliability theory. Public Administration Review, 68, 1050-1062.

Carmeli, A. & Gittell, J.H. (2009). High quality relationships, psychological safety and learning from failures in work organizations. Journal of Organizational Behavior, 30, 709-729.

Carrillo, R.A. (2012). Relationship-based safety: Moving beyond culture and behavior. Professional Safety, Dec. 2012.

Gittell, J.H. (2000). Paradox of coordination and control. California Management Review, 42, 177-183.

Gittell, J.H. (2001). Supervisory span, relational coordination and flight departure performance: A reassessment of post-bureaucracy theory. Organization Science, 12, 467-482.

Gittell, J.H., Seidner, R., Wimbush, J. (2010). A relational model of how high-performance work systems work. Organization Science, 21, 490-506.

Schulman, P.R. (1993). The negotiated order of organizational reliability. Adminstration and Society, 25, 353-372.

Public perceptions and industrial safety

Paul Schulman

In the panel on Organizational and Regulatory Structures at the Safety Management in Context Conference in Ascona, Switzerland, a set of researchers and practitioners familiar with a diverse set of industries came to a somewhat surprising agreement. Across the industries represented, from nuclear power to healthcare to oil and gas and construction, it was concluded that public perceptions concerning safety in the industry have a significant impact upon both external regulatory relations and the internal effectiveness of safety management regimes within that industry.

The evolution of the nuclear power industry in the U.S., for instance, has been dramatically affected by a public dread of nuclear energy, what Weart has called the "nuclear fear" arising from its weapons roots. This public dread has led to a long-standing adversarial relationship between the industry and its regulator, the U.S. Nuclear Regulatory Commission.

Public safety perspectives on an industry have two important dimensions: whether there is a public dread over potential safety lapses, and how much public trust is accorded the expertise of operators and managers of industry organizations. These perceptions can shape the regulatory context of an industry, that is, how much regulation there is and how adversarial or cooperative it will be.

High reliability organizations (HRO) research was founded on descriptions of organizations -- a nuclear aircraft carrier, nuclear power plant, and air traffic control center -- that managed hazardous systems whose potential failure aroused substantial public fear. This public attitude both constrained and supported these organizations in organizing around preventing a set of events and failures that simply must never happen. While public pressure resulted in a variety of regulatory requirements and elaborate procedures, these same regulations also ensured that competitive organizations couldn't undercut many of the safety measures and expenditures adopted by these HROs.

At the same time, the existence of strong external regulatory attention added to the internal organizational status of personnel with expertise relating to regulatory compliance. Safety management regimes and their officials can thus gain an enhanced role in organizations from public safety pressure and its impact on regulatory oversight. But whether this is a positive relationship again depends on public perceptions, this time on perceptions of the competence in safety management generated within these organizations. If there is substantial public doubt about the effectiveness of an internal safety regime, then the regulatory relationship will likely become so adversarial and prescriptive that it will limit discretion or independent initiative on the part of internal safety managers. Frequent external regulatory inspections may preempt and further diminish the authority of these internal safety managers.

Given its impact, it is important to understand the dynamics of public perceptions: their shaping and mediating factors. Obviously the media can have a major impact on public perceptions. The media tends to be event oriented so general perceptions about the safety of an industry may be based on single incidents. This means that it is difficult for an industry to „bank“ a positive safety image gained over the years against a sudden lapse in safety.

Public perceptions and pressures are also affected by the nature of the failures themselves. In HROs, proactive management is directed toward risks to safety that are external -- that imperil people outside an organization, not simply its employees and clients. In other industries, for example, construction and mining/fishing, threats may be primarily internal. In medicine, safety risks are largely individuated: medical errors do not spill out to the public beyond a hospital or health care center, and rarely extend beyond the individual patient.

Finally, public perceptions can be influenced by assumptions about the inherent safety possible within an industry. In some industries such as nuclear power, core technologies are assumed to be well understood in formal predictive principles and models. But in other industries -- again, such as medicine -- core technologies are not assumed to be as well understood and predictable. In these circumstances, where risk is individuated and core technologies less than certain, public perceptions may accommodate many lapses in safety with no strong pressures for regulatory change.

This very brief analysis suggests that public perceptions can be an important element in shaping regulatory and internal organizational approaches taken to safety management within an industry. But at the same time, it should also be clear that public perceptions of competency or risk are themselves are not easily shaped or managed. Individual events may, depending upon prior public assumptions, lead either to sudden downward revisions in estimates of competence and safety, and increased pressure for significant regulatory shifts, or instead could be fatalistically accepted by the public as an inevitable risk of operation. In the latter case this could lead to many missed opportunities for safety improvement.

It may well be advisable for managers in individual industries to try hard to educate the public over the long term to make more accurate estimations of safety and risk. Overselling the safety and competency of a safety regime to the public can lead to great vulnerability of these public estimations to sudden contrary events. After these events hasty reassurances will have little credibility or impact. Intense pressures can then push regulators into prescriptive approaches that might ultimately erode the status and competency of safety managers within their own organizations.

Further reading

Amalberti, R. (2013). Navigating Safety. London: Springer.
LaPorte T.R. and P. Consolini (1991). „Working in Theory But Not in Practice“ Journal of Public Administration Research and Theory 1 (1): 19-47.
Schulman, P. (1993). „The Negotiated Order of Organizational Reliability.“ Administration and Society 25 (3): 353-372.
Schulman P. (2005). „Medical Errors: How Reliable is Reliability Theory?“ In M.M. Rosenthal and K. Sutcliffe (Eds.), Medical Error. San Francisco: Jossey Bass.
Weart, S.R. (2012). The Rise of Nuclear Fear. Cambridge, MA: Harvard University Press.

Regulatory context

Jan Hayes

Regulation is the primary form of control exerted by government over hazardous industries on behalf of society – to protect both workers and the public. This short essay describes some of the key features of effective safety regulation in sectors where the hazards are complex. It addresses briefly both regulatory policy and practice.

Modern safety regulation is usually founded on a statement of a general duty that falls upon those in control of hazardous activities. Such a duty extends beyond simply obeying the law to a more fundamental objective – 'to maintain a safe workplace' and 'to reduce risk to a level that is as low as reasonably practicable' are two such examples. Specific requirements of legislation set out how a duty holder must go about meeting those responsibilities. These are based on combination of three approaches - risk assessment, quality assurance, and specific prescriptive requirements. Some features of each of these approaches are described below.

For hazardous industries, most safety regulation requires a risk assessment to be performed (and often submitted to the regulator for review or even approval). The most effective risk-based requirements have two key features. Firstly, there is a level of risk (be it qualitative or quantitative) that is intolerable and beyond which changes must be made. This ensures that there is a defined 'no go' zone and that regulators have a minimum acceptable standard on which to draw. The second feature of effective risk-based approaches to regulation is that they extend regulatory focus beyond simply measures of risk to those features of the system (hardware, procedures, and practices) that the duty holder determines must be in place to control risk. The specification of these measures effectively defines the boundary of acceptable operations that is specific to the facility or activity involved.

Safety regulations often require documented management systems to be in place in the general form of a quality system and the well-known Deming cycle (Plan-Do-Check-Act). Such systems are based on the premise that constant process leads to constant output. Whilst uniformity and compliance are key safety strategies when hazards are well-known and understood, the best management systems for complex, hazardous industries also have a strong focus on training, competency and learning from experience so that procedures remain relevant and useful. This requires a balance in writing system documentation between control / constraint and guide / support functions. Smart regulators understand this.

Regulatory requirements for risk assessment and preparation of management systems describe processes that must be followed by the duty holder in order to best manage safety. Some safety regulation directly prescribes specific things that must be done or put in place. Examples include requirements for safety signage or mandated separation between hazardous chemicals. This approach works well where hazards are well understood and simple controls are always appropriate. Prescriptive requirements can be both burdensome and ineffective in complex industries, especially where technology, and hence risk, changes rapidly. Prescriptive requirements can also foster a 'tick and flick' attitude to regulatory inspections which is not in the best interests of safety outcomes.

Many regulatory regimes include aspects of self-regulation. By this, we mean that the sector plays a role in setting the standards that the industry is required to meet (eg, via published industry standards or guidelines that are then called up in regulation) and also sometimes in ensuring that all members of the industry meet those requirements (eg, via self-auditing or industry benchmarking). This form of regulation can be efficient as it is responsive to changes in industry circumstances as new technology is introduced, but it is only effective where a societal culture of trust exists. This applies not only to the level of compliance, but also to the rigor of the standard itself. Standards that represent a minimum level or lowest common denominator, rather than best practice, are unlikely to survive as the appropriate benchmark in the long term. Major regulatory change can be triggered when such trust is broken such as following a serious accident.

Another key component of any regulatory regime is the extent to which members of the workforce are involved. Effective regimes specify that workers must be engaged relative to their skills and expertise in risk assessment processes and that they must be able to demonstrate their understanding of their role in ongoing management of safe operations. The best regimes also provide a mechanism by which worker concerns can be addressed directly to regulatory agencies for further investigation.

In addition to the review and acceptance (or sometimes approval) of submitted reports and procedures, the other primary role of regulatory agencies is inspection or auditing. Effective inspection focuses beyond a simple compliance check to the overall objective of the regulatory regime, ie, maintaining a safe workplace. In complex systems there is always room for improvement, so an inspection that produces no actions is just not looking in the right places. On the other hand, inspections that produce large numbers of unprioritised findings are also of minimal benefit to anyone. Effective regulatory audits focus on significant hazards and the controls that should be in place to manage them. Findings are prioritised and, critically, followup by the duty holder is stewarded so that escalating sanctions can be applied if necessary to ensure that problems are fixed in a timely manner.

Whatever the type of regulatory regime in place, regulators responsible for enforcement need a range of measures on which they can draw. Effective regimes include a role for regulators ranging from industry promotion of strategies for safe operations through to prosecution of recalcitrants. Between these two extremes other possible enforcement tools include the power to issue notices requiring specific action to be taken (including shutting down activities) and the power to publish information about incidents – ie the ability to 'name and shame'.

Regulatory agencies should also be an effective focal point for industry learning from failures. Most regimes require reporting, not only of deaths and injuries, but of precursor events such as leaks of chemicals, failures of major safety systems and similar. Separation of investigative functions aimed at learning to prevent recurrence, as opposed to collection of evidence for prosecution, is important. In many jurisdictions, these functions are assigned to different agencies to ensure both goals are met.

Regulating complex hazardous activities is a complex business in itself. Whilst we have focused so far on the regulations and their enforcement, the second major contributor to effective safety regulation is the regulators themselves. Regulatory agencies are often short on resources and remuneration scales may not attract high quality experienced people when they can earn much higher salaries in industry. In this environment, developing an agency presence founded on values of public trust, integrity and public service may be the most effective way to retain the knowledgeable, experienced staff needed to ensure that effective regulations lead, in turn, to the most effective safety outcomes.

In closing, we should point out that the regulatory arrangements described here are about directly controlling safety issues. Of course most organisations are subject to other forms of regulatory control such as corporate governance requirements. Effective societal control of hazardous industry requires all these strands to function effectively together to ensure the best outcomes for industry, workers and the public.

Further reading

Ayres, I. & Braithwaite, J. (1992). Responsive regulation: Transcending the deregulation debate. New York: Oxford University Press.

Baldwin, R. & Black, J. (2008). Really responsive regulation. The Modern Law Review, 71, 59-94.

Bieder, C. & Bourrier, M. (eds.) (2013). Trapping safety into rules: How desirable or avoidable is proceduralization? Farnham, UK: Ashgate.

Gunningham, N. & Sinclair, D. (2009). Organizational trust and the limits of management-based regulation. Law & Society Review, 43, 865-899.

Haines, F. & Sutton, A. (2003). The engineer's dilemma: A sociological perspective on juridification and regulation. Crime, Law and Social Change, 39, 1-22.

Hale, A., Goossens, L. & van de Poel, I. (2002). Oil and gas industry regulation: From detailed technical inspection to assessment of safety management. In B. Kirwan, A. Hale & A. Hopkins (eds.), Changing regulation: Controlling risks in society. Oxford: Pergamon.

Hayes, J. (2013). A new direction in offshore safety regulation. In M. Baram, P. Lindoe & O. Renn (eds.), Governing risk in offshore oil and gas operations. Cambridge: Cambridge University Press.

Hood, C., Rothstein, H., & Baldwin, R. (2004). The government of risk: Understanding risk regulation regimes. Oxford: Oxford University Press.

Hopkins, A., 2012, WP 87 - Explaining "Safety Case", National Research Centre for OHS Regulation, Canberra.

Organizing practices and safety

Kathleen Sutcliffe

Safety is enabled (or disabled) by a multi-level interactive process that extends through time and space. As the previous essays argue, public perceptions shape regulatory requirements, which subsequently shape internal organizational requirements such as safety management systems, organizing practices and team dynamics, and these elements recursively shape and reshape each other. In this essay we examine in particular, the role of organizing practices.

Several starting premises are critical to understanding the role of organizing practices in safety. First, system safety is an illusory concept. There are no safe systems/organizations because past performance cannot determine the future safety of any entity. Safety is in fact a moving target. Second, safety is a dynamic non-event. It is dynamic in the sense that safety is preserved by timely human adjustments (ie, problems are transitorily under control due to compensating adaptations). It is a non-event because successful outcomes rarely call attention to themselves. In other words because safe outcomes do not deviate from what is expected, safety is in some ways invisible. When there is nothing to capture people's attention, they see nothing and they presume that nothing is happening and that nothing will continue to happen if they continue to act as before. This can decrease vigilance, the sense of vulnerability, increase the propensity toward complacency and inertia, and decrease the quality of attention across the organization. All which can be deadly. That is, adverse outcomes sometimes occur because of mistakes in performance and execution, but mistakes in perception, conception, and understanding more often lead to unsafe conditions and ultimately to greater harm.

Broadly speaking there are two complementary logics to achieving safety. The first logic is one of anticipation/prevention. The second logic is one of resilience/containment. In the following paragraphs we consider each.

Anticipation/prevention requires that organizational members and other stakeholders (eg, public, regulators) identify the events and occurrences that must not happen, identify all possible causal precursor events or conditions that may lead to them, and then create a set of detailed operating procedures, contingency plans, rules, protocols, and guidelines for avoiding them. Through a logic of anticipation/prevention safety is achieved through using the tools of science and technology to better control the behavior of organizational members to perform safely and effectively and to avoid errors and mistakes. A commitment to anticipation and prevention removes uncertainty, reduces the amount of information that people have to process, which potentially decreases the chances of memory lapses, judgment errors or other biases that can contribute to crucial failures, provides a pretext for learning, protects individuals against blame, discourages private informal modifications that are not widely disseminated, and provides a focus for any changes and updates in procedures.

The logic of anticipation/prevention is based on the assumption that consistent error-free outcomes will be produced in the future if people repeat patterns of activity that have worked in the past. But it is impossible to write detailed operating procedures to anticipate all the situations and conditions that shape people's work. Moreover, even if proce-

dures could be written for every situation there are costs of added complexity that come with too many rules. This complexity increases the likelihood that people will lose flexibility in the face of extensive rules and procedures. Thus, although compliance with detailed operating procedures is critical to achieving safe performance in many instances, partly because it creates operating discipline, blind adherence to rules can sometimes reduce the ability to adapt or to react swiftly to surprises. Assuming that invariant operating procedures and routines are the only means through which safe outcomes occur conflates variation and stability and makes it more difficult to understand the mechanism of safe performance under trying conditions. Safety is broader and far reaching. For a system to remain safe and reliable, it must somehow handle unforeseen situations in ways that forestall unintended consequences. That is, it must continuously manage fluctuations in job performance, human interaction, and human-technology interaction, which necessitates capabilities for resilience/containment.

Resilience involves the ability to absorb strain and preserve functioning despite the presence of adversity, an ability to recover or bounce back from untoward events, and an ability to learn and grow from previous episodes of resilient action. Capabilities for resilience generally can be traced to dynamic organizing practices. These organizing practices enhance people's alertness and awareness to details so that they can detect subtle ways in which contexts vary and call for contingent responding. In other words, organizing practices serve to increase the quality of attention across the system/organization and to increase the flexibility and the capabilities to respond in real time, reorganizing resources and actions to maintain functioning despite peripheral failures.

Generally speaking safer organizations establish a set of micro-system practices aimed at (a) proactive and preemptive analyses of possible vulnerabilities, paying close attention to identifying and understanding what needs to go right, what could go wrong, how it could go wrong, and what has gone wrong and why, (b) avoiding simplified assumptions about the world through practices that actively seek divergent viewpoints that question received wisdom, uncover blind spots, and detect changing demands, (c) being sensitive to current operations and their effects, creating and maintaining an integrated big picture of current situations through ongoing attention to real-time information and making a number of small adjustments to forestall the compounding of small problems or failures, (d) enlarging response repertoires, through ongoing training and simulation, varied job experiences, learning from negative feedback, and ad hoc networks that allow for rapid pooling of expertise, and (e) understanding and locating expertise and creating mechanisms to shift decision making to experts when problems begin to materialize, increasing the likelihood that capabilities will be matched with new problems and that emerging problems will get quick attention before they grow bigger.

In combination, practices aimed at failures, simplifications, operations, resilience and expertise create flexibility that enables the system/organization to deal with inevitable uncertainty and imperfect knowledge. The point is that safety does not result from organizational invariance, but rather results from a continuous management of fluctuations. To be able to sense these fluctuations, organizations enact a set of everyday organizing practices that creates capabilities for organizational members both to become alert and aware of discriminatory details and to be able to act on what they see.

Further reading

Schulman, P.R. (2004). General attributes of safe organizations. Quality and Safety in Health Care, 13(Suppl 2), ii39-ii44.

Weick, K.E. (1987). Organizational culture as a source of high reliability. California Management Review, 29, 112-127.

Weick, K.E. & Sutcliffe, K.M. (2007). Managing the unexpected: resilient performance in an age of uncertainty (2nd ed.). San Francisco: Jossey-Bass.

Weick, K.E., Sutcliffe, K.M. & Obstfeld, D. (1999). Organizing for high reliability: processes of collective mindfulness. In B.M. Staw & L.L. Cummings (eds.), Research in Organizational Behavior (pp. 81-123). Greenwich, CT: JAI Press.

Wildavsky, A. (1991). Searching for safety. New Brunswick, NJ: Transaction.

The culture factor in safety culture

Edgar H. Schein

Safety culture as a concept has suffered the same fate as culture itself. Theoreticians, safety professionals, members of different occupations in different industries have chosen to define it in terms of their particular goals and have produced, therefore, a lot of confusion about what safety culture is and whether it can usefully be generalized to help understand safety problems in different industries and cultures. This confusion has been made most clear recently in Amalberti's (2013) excellent review of the history of the concept and his pointing out that the safety problem itself differs greatly by type of industry. In this paper I want to build on his analysis and show that there are many cultural factors that need to be taken into account when analyzing safety problems, but this understanding hinges first on understanding the concept of culture itself because it also has come to mean many different things. I will close with some thoughts on how to get beyond simplistic generalizations to a more grounded view of safety behavior.

Definition of culture

I want to begin by clarifying the concept of culture. The word can, of course, be used in any way that a given person chooses, but for culture to be a useful concept in socio-technical analyses of safety phenomena it is necessary to stick to a definition that anthropologists have evolved and that I have applied to organizational and group phenomena. Culture is best thought of as what a group has learned throughout its own history in solving its problems of external survival and internal integration (Schein, 2010). It is best conceptualized at its core as the shared, tacit assumptions that have come to be taken for granted and that determine the members' daily behavior.

These assumptions are usually not stated explicitly because they have come to be taken for granted. Where did they come from? In the history of the group there will have been founders and leaders whose own values were imposed on the group and, if that group survived and thrived, came to be taken for granted as the right way to think, feel and behave. Sometimes these assumptions are stated as norms of behavior or descriptively as the way we do things around here. A quick test of what some of those norms are is to observe how newcomers in the group are socialized and what kind of behavior is immediately punished.

A relevant question is how one deciphers these tacit taken for granted assumptions. I have argued that since culture is a shared phenomenon the best approach is group interviews of selected members of the group/organization (Schein, 2010). In these group interviews the culture model is first presented as a multi-level phenomenon best thought of as a lily pond. At the surface level the culture manifests itself in the kind of climate that exists in the organization and in the behavior that members exhibit. The behavior that is exhibited is usually justified by various espoused values but the group typically discovers that there are disconnects between what goes on and what the values espouse. For example, most organizations espouse teamwork but realize that all the reward and incentive systems are individually based. If one then asks why everything is individually based, the deep assumption comes out that we assume that only individuals can really accomplish things and be held accountable for whatever happens. The teamwork value is espoused but the deeper assumption is one of individual accountability. So, for example, in one company of this sort

they went through group exercises to reach consensus but decisions did not stick. The effective managers went outside the group after the meetings and made deals with all the others on whom they were dependent. The key to deciphering this was to ask groups in the organization why the group decisions did not stick to which members usually responded with "we espouse consensus, but that is not how decisions and deals actually get made." The assumptions are the root system and the climate is, in a sense, the water quality.

Even the ethnographer who spends a lot of time in the organization will need to ask groups why they do certain things. In the safety arena a common problem is why certain clear rules are sometimes violated by operators. In working with the front line people in an organization, the union, an innovative approach that is used by a consultant colleague of mine brings together groups of workers and asks the following series of three questions: 1) What are some of the important rules in doing this work safely? When a number of them have been identified, he asks the second question for a given rule: 2) Is it ever OK to break this rule? When? (Invariably he gets a bunch of examples). He then picks one example and asks: 3) Why is it Ok to break the rule in that situation? It is the third question that reveals the deeper layer of the culture of the operators as a group. What is then often discovered is that the operators don't believe in the rule or break it to get the job done. In one case in N.Y. operators did not wear their safety glasses on a hot day down in the manholes because they steamed up so they could not see what they were doing.

An interesting example along these lines from medicine concerns Atul Gawande's (2007) description of the program of getting doctors to wash their hands more frequently. After various kinds of persuasion programs and rules had been promulgated, the percentage of hand washing was still not high enough. Finally someone brought groups of doctors together and asked them sincerely: "Given all we know about the importance of hand washing, why don't you wash your hands at prescribed times and places?" The doctors then revealed all kinds of reasons about the inconvenience and the loss of time involved which led among other things to the installation of the many easy hand washing dispensers that are now mounted all over the place.

The crucial point about this definition of culture is that culture is a property of a group. It is a stable property of a group that serves important functions for the group and is, at the same time a perpetually emerging set of understandings among the members of the group as they interact with each other and make sense of their current reality. Culture is both, in the sense that as humans we have a skeleton and a set of memories that change very slowly, ie the equivalent of tacit assumptions, yet in our daily experiences we are constantly reforming who we are and how we operate, ie the surface sense making to both reinforce and redefine the cultural elements. For purposes of understanding safety, it is my contention that we must look at both the basic assumptions, the skeleton in each group's culture in terms of deep beliefs and assumptions about the importance of life and health, and the more surface contingencies that define immediate behavior.

What "cultures" are relevant?

If culture is a property of a group, what kinds of groups need to be analyzed in terms of their safety assumptions? Relevant groups can be a nation, an ethnic group, a religion, an occupation or profession, an industry, an organization, a subunit of an organization, or even a team if the members have enough of a shared history to have evolved shared assumptions about who they are. It would thus make sense to say that an airline, or a nuclear plant, or the oil industry in a given country each has a culture based on its unique history. Within that culture there will be a set of shared assumptions about how to manage the safety issues that may arise and how to feel about death and injury.

That subset of assumptions about safety in that industry or organization or group could be loosely labeled as its "safety culture." But note that "safety" is not a group that can be the locus of a culture. Safety is a goal that is presumed to be more or less reachable if the culture of that group has within it assumptions about behavior that will make the group more or less safe. Note also that, to the extent that cultures differ in different industries, the subset of assumptions about safety will also differ to an unknown degree (Amalberti, 2013).

Furthermore, each industry will have organizations with different histories and managements within it, leading to different organizational cultures that impact how safety will be handled. Clearly the culture of Tokyo Electric with regard to the Fukujima plant differed from how other nuclear plants in Japan handle safety. But most important of all, it is the key subcultures within an organization that have their own subsets of assumptions about safety which makes it dubious that one can even attribute a single set of safety related assumptions to an entire organizational unit.

Every organization has at least three generic subcultures—"executives" who are concerned mostly about the financial conditions, "engineers," the designers and technical staff of the organization who are concerned about process safety and how to minimize the human factor in operations, and the "operators," the line organization who runs the plant who are concerned with coping with all the surprises and anomalies that crop up even in the most well designed and standardized of operations (Schein, 1996). These subcultures have their roots and origins in the occupations and professions. They are connected to occupational reference groups that cut across organizations and larger cultural units, in the sense that some assumptions of the engineering culture or medicine supersede even national or ethnic cultural boundaries (or at least are supposed to).

To illustrate, the executive subculture in most organizations defines safety as maintaining an image of caring about the public and the employee, but the measurement of that "caring" is tied to minimizing public scandals and being below industry average on OSHA statistics of employee injuries. As one executive put it: "I want the world's best and cost effective safety program," not realizing that cost is what he was really concerned about. Engineers and designers would prefer to build in as many safety defenses as possible but they are typically not granted because budgets are limited. As one pilot who flew both Russian and American planes put it, I prefer the American planes because they have three back up systems while the Russian ones only have two." The operator wants good facilities, good

training, and, most important, plenty of manpower to get the job done. As one member of an electric company crew working on an outage put it: "When the company decided that a job that used to be done by two people can now be done by one, they may be right, but it cant be done as safely." The point is that within an organization tradeoffs and compromises have to be made in terms of the deep assumptions that the subcultures make about the ultimate safety issues. One executive who had not taken safety programs seriously enough changed his priorities when he could not face yet one more family to explain to them why a family member employee had died on the job.

Conclusion about culture

Rather than trying to develop broad criteria or processes and labeling them "safety culture" I would suggest that a more detailed analysis of how safety issues are viewed in different cultural units in a given industry will be more productive. Thus one would evolve a set of conclusions about the key safety issues in a given industry, taking into account national, ethnic and occupational cultures. Instead of a broad but relatively useless criterion like "there must be trust in the organization," one could compare the specific issues that differentiate the way Japanese, French, German and U.S. nuclear plants are run. If China and India are going to be big future nuclear countries one would develop some cultural criteria that would enable one to assess how safety will be managed in these countries. As a quick aside, I was once told by an American nuclear engineer that the problem with Iran is not their weapons program but that their domestic nuclear design is based on Russian engineering which this man thought was quite unsafe.

This kind of stereotyping is dangerous if it is not followed up by serious research on how different countries and occupations do things. It is alleged, for example, that the Norwegian off shore oilrigs are safer than those of other countries because of Norwegian attitudes. Does that imply that Norwegians are better at creating trust across hierarchical boundaries than other countries? Or should the more relevant finding be that each culture has different ways of dealing with hierarchy, communication and trust, and it is in the details of how it is worked out that we will find the secrets to safety. Or, thinking occupationally, is it enough to say that top management must drive the safety process? Or should the more relevant finding be that top managers who are ex-nuclear engineers impose a different kind of safety program than top managers who are financial experts or lawyers? In the medical arena there is a good deal of variation in hospital patient safety programs as a function of whether the top executives are doctors, nurses or hospital administrators.

In other words, if we are to take cultural factors in safety seriously we have to accept that the devil is in the details. Only a more refined look at those details will unravel the principles or processes that "safety culture" is supposed to reveal.

Conclusion about improving safety

The risks and dangers that make us want "safety" do not derive from cultural factors. They derive from the work itself, the actual tasks that have to be performed that bring various kinds of risks with them. Culture may have influenced the design of those tasks and cultural factors may influence the kinds and degrees of risk we want to take, but if we want to increase safety itself in a given work situation the members of the subcultures, the designers, operators and executives must align their interests and work together to minimize those risks that worry them most. That will produce an effective safety program which will consist of many components, sets of rules and regulations, training programs, and systems of monitoring. Such a program will gradually change behavior that will make things safer for both operators and public, and, as those behaviors become habits and standards, they will become embedded in the cultures of those organizations.

When one examines such programs, for example in the nuclear industry, one will find that the principles such as the ones listed by the Institute of Nuclear Power Operations (INPO, 2004)—"Everyone is personally responsible for nuclear safety; Leaders demonstrate commitment to safety; Trust permeates the organization; Decision-making reflects safety first; Nuclear technology is recognized as special and unique; A questioning attitude is cultivated; Organizational learning is embraced; and, Nuclear safety undergoes constant examination"—have embedded in the list items like trust and organizational learning that characterize any effective organization. And what will often be discovered is that the behavior changes invented by the group working to make things safer turn out to also make the organization overall more effective. The actual behavior changes, standards, rules and regulations that will derive from such local problem solving will, of course, vary immensely in terms of the kind of industry, the maturity of the technology and the economic conditions, as Amalberti has convincingly shown us.

Perhaps ultimately we will find some workable generalizations across the varieties of tasks that we engage in to make them all more safe. Principles such as those enunciated by INPO may be a convenient way to describe safety culture, but they are so general as to be useless when one asks the question: "How do I achieve the conditions that the principles describe?" My own answer to this question is that these conditions ultimately reflect the climate that the executive subculture creates through its own behavior. Only if people in the higher status positions begin to engage in more "humble inquiry" will they elicit enough trust throughout the organization to enable the operators and designers to speak up when they see safety problems (Schein, 2013).

Rules, regulations and training are, of course, necessary and appropriate, but for subordinates to speak up when they see a safety problem requires a climate in which they will feel psychologically safe to do so. This becomes especially important because all task performance is subject to operators discovering new things—better ways to do things, shortcuts, unanticipated safety factors, what Snook (2000) has so usefully labeled "practical drift." My own skepticism about the usefulness of broad principles and generalizations derives primarily from observing the practical drift in my own safety behavior and the behavior of those around me. As I go through my various routines of housework, of taking care of my health, of driving, of fixing things around the house, of taking care of an infant

grandchild, I realize that there are rules and standards for all of those activities but, in the end, I make constant choices based on my mood, who else is around observing me, how well trained I am in performing the task, whether I am in a hurry or not, the image I am trying to portray, who is helping me, and so on. The factors, principles or processes that show up in Safety Culture lists are too general to help me or motivate me. In the end it is the task and the people doing it that create their own standards, rules, and behavior patterns. I believe we have to accept such practical drift as being inevitable in all operations, have to observe it, have to analyze it, and have to decide how best to integrate it into our safety programs.

Further reading

Amalberti, R. (2013). Navigating Safety: Necessary Compromises and Trade-Offs-Theory and Practice. N.Y.: Springer.

Gawande, A. (2007). Better: A Surgeon's Notes on Performance. N.Y.: Holt, Metropolitan Books.

Instittue of Nuclear Power Operations, (2004). Atlanta, Georgia.

Schein, E.H. (1996). Three Cultures of Management: The Key to Organizational Learning. Sloan Management Review, 38, 1, 9-20.

Schein, E. H. (2010). Organizational Culture and Leadership, 4th Ed. San Francisco: Jossey-Bass.

Schein, E. J. (2013). Humble Inquiry: The Gentle Art of Asking instead of Telling. San Francisco: Berrett/Kohler.

Snook, S. A. (2000). Friendly Fire. Princeton, NJ: Princeton Univ. Press.

Appendix

List of participants

Track 1: Team interaction and training

Josef Asmin	Swiss Reinsurance Company Ltd	Switzerland	Practitioner
Laura Fruhen	University of Aberdeen	Great Britain	Academic
Bastian Grande	University Hospital Zurich	Switzerland	Practitioner
Ayse Gurses	Johns Hopkins University	USA	Academic
Michaela Kolbe	ETH Zurich	Switzerland	Academic
Zhike Lei	ESMT European School of Management and Technology	Germany	Academic
Tanja Manser	University of Fribourg	Switzerland	Academic
Brad Morrison	Brandeis University	USA	Academic
Eitan Naveh	Technion - Israel Institute of Technology	Israel	Academic
Paul O'Connor	NUI Galway	Ireland	Academic
Thomas Reader	London School of Economics	Great Britain	Academic
Julia Seelandt	University of Neuchatel	Switzerland	Academic
Franziska Tschan	Neuchâtel	Switzerland	Academic
Mary Zellmer-Bruhn	University of Minnesota	USA	Academic

Track 2: Individual and organizational learning from error

Urbain Bruyere	University of Pennsylvania	USA	Practitioner
Marlys Christianson	University of Toronto	Canada	Academic
Nicolas Dechy	Institut de Radioprotection et de Sûreté Nucléaire	France	Academic
John Flach	Wright State University	USA	Academic
Francesca Giuliani	University Hospital Zurich	Switzerland	Practitioner
David Hofmann	U. of North Carolina at Chapel Hill	USA	Academic
Ann Mills	RSSB	Great Britain	Practitioner
Erick Mondragon	Swiss Reinsurance Company Ltd.	Switzerland	Practitioner
Davide Nicolini	University of Warwick	Great Britain	Academic
Christoph Noethiger	University Hospital Zurich	Switzerland	Practitioner
Ranga Ramanujam	Vanderbilt University	USA	Academic
Reto Schneider	Swiss Reinsurance Company Ltd	Switzerland	Practitioner
Sven Staender	Hospital Maennedorf, Zurich	Switzerland	Practitioner
Michal Tamuz	North Shore-Long Island Jewish Health System	USA	Academic
Fred Voorhorst	SUPSI	Switzerland	Practitioner
Mona Weiss	ETH Zurich	Switzerland	Academic

Track 3: Socio-technically based risk assessment

Rene Amalberti	PARIS HAS	France	Academic
Michael Baram	Boston University	USA	Academic
Corinne Bieder	AIRBUS	France	Practitioner
Paul Carlile	Boston University	USA	Academic
Sifra Corver	ETH Zurich	Switzerland	Academic
Fabienne Felden	Swiss Reinsurance Company Ltd	Switzerland	Practitioner
Yang Miang Goh	National University of Singapore	Singapore	Academic
Andrew Hale	Delft University of Technology	Great Britain	Academic
Bernd Linsenmaier		Switzerland	Practitioner
Najmedin Meshkati	University of Southern California	USA	Academic
Barry Kirwan	EUROCONTROL	France	Practitioner
Marcel Zumbühl	Swisscom	Switzerland	Practitioner

Track 4: Organizational and regulatory structures

Rainer Egloff	Swiss Reinsurance Company Ltd	Switzerland	Practitioner
Mark Griffin	University of Western Australia	Australia	Academic
Jan Hayes	Australian National University	Australia	Academic
Jody Hoffer Gittell	Brandeis University	USA	Academic
David Hofmann	U. of North Carolina at Chapel Hill	USA	Academic
Claudia Humbel Haag	ENSI	Switzerland	Practitioner
Tore Johan Larsson	Royal Institute of Technology, KTH	Sweden	Academic
Jean-Christophe Le Coze	INERIS	France	Academic
Levi Nieminen	Denison Consulting	USA	Practitioner
Yvonne Pfeiffer	ETH Zurich	Switzerland	Academic
Teemu Reiman	VTT Technical Research Centre of Finland	Finland	Academic
Edgar Schein	MIT	USA	Academic
Markus Schöbel	University of Basel	Switzerland	Academic
Paul Schulman	Mills College	USA	Academic
Kathleen Sutcliffe	University of Michigan	USA	Academic
Charles Vincent	Imperial College London	Great Britain	Academic
Annalena Welp	University of Fribourg	Switzerland	Academic

Organizers

John Carroll	MIT	USA	Academic
Gudela Grote	ETH Zurich	Switzerland	Academic

Swiss Re
Centre for Global Dialogue

Gheistrasse 37
8803 Rüschlikon
Switzerland
Telephone +41 43 285 8100
Fax +41 43 285 8101
global_dialogue@swissre.com
www.swissre.com/cgd