Human Factors – Safety Culture

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Key messages

- Safety culture improvement initiatives are increasingly popular within Australian offshore petroleum companies.

- NOPSEMA research conducted in 2013 identified that there was no consistent definition or model of safety culture used within the industry. To address this gap, NOPSEMA proposed a definition and model of safety culture.

- NOPSEMA's safety culture model is presented as a means of understanding how safety culture develops.

- Organisations can use an understanding of safety culture to drive improvements in safety outcomes.

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Key definitions for this information paper

The following are some useful definitions for terms used in this information paper. They are a suggested starting point only and are not prescriptively defined, except where indicated.

Artefacts	*Observable manifestations of culture within an organisation, which are easy to identify, measure and change, but are difficult to interpret.*
Basic Assumptions	*"The taken-for-granted, underlying, and usually unconscious assumptions that determine perceptions, thought processes, feelings and behaviour which form the basis of an organisation's culture" (Schein, 1990, p. 112).*
Espoused Values	*An organisation's members' descriptions of organisational practices, values, norms and ideologies.*
Error Tolerance	*The ability of a system to function after an error has occurred.*
Hazardous Event	*A collective term encompassing safety, integrity, and environmental incidents, used for readability purposes within this information paper.*
Human Factors	*The ways in which the organisation, the job, and the individual interact to influence human reliability in hazardous event causation.*
Human Reliability	*The likelihood that an individual will experience an error while performing a task.*
Major Accident Event	*An event connected with a facility, including a natural event, having the potential to cause multiple fatalities of persons at or near the facility. [OPGGS(S) Regulation 1.5]*
Safety Culture	*The shared basic assumptions, held by most members of an organisation, which create and reinforce group norms of thoughts, language and behaviour in relation to major accident event prevention (NOPSEMA, 2013b).*

1.   Introduction to the human factors information paper series

'Human Error' has long been identified as a contributing factor to incident causation. Commonly cited statistics claim that human error is responsible for anywhere between 70-100% of incidents. It seems logical, therefore, to blame incidents on individuals or small groups of people and to focus remedial actions at the individual level (e.g. training, disciplinary action, etc.). However, by taking this approach in addressing human error, organisations ignore the latent conditions in their work systems that contribute to human error across the workforce. Rather, human error should be recognised as an outcome of combined factors, instead of the root cause of an incident. Organisational, job, and individual factors all interact to influence human reliability, that is, the likelihood that an individual will perform their task effectively or make an error.

This publication forms part of a series of information papers focusing on human factors. NOPSEMA defines human factors as "the ways in which the organisation, the job, and the individual interact to influence human reliability in hazardous event causation". Reliable behaviour results in desired performance, while unreliable behaviour may result in human error, which can lead to events and near misses. This interaction is represented in Figure 1.

Figure 1 – A Model of Human Factors
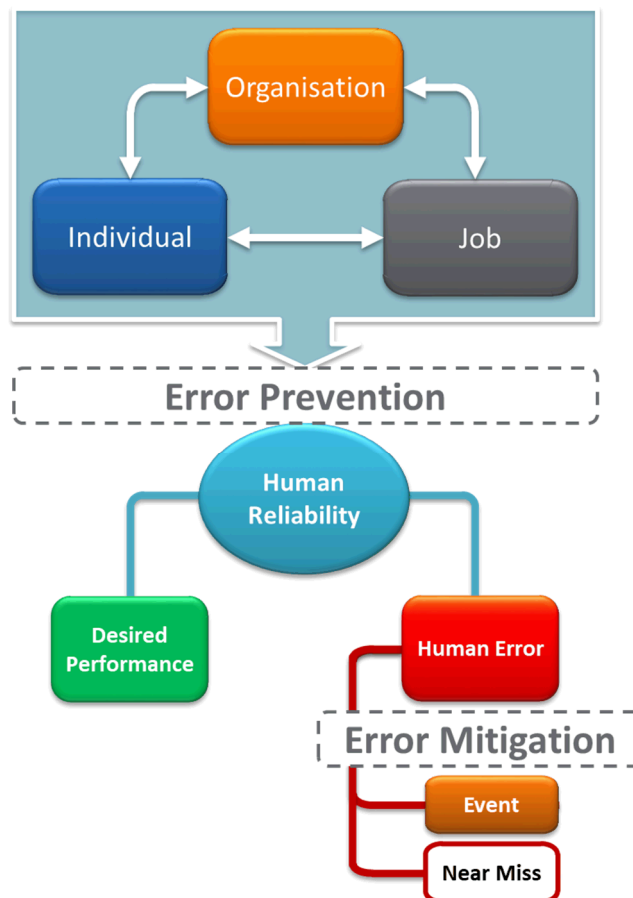
The Human Factors Information Paper Series is designed to provide information about the ways in which organisational, individual, and job factors influence human reliability, and how organisations can minimise or optimise the effect of these factors, to assist in the prevention and mitigation of hazardous events and drive continuous improvement in safety, integrity and environment performance.

2.   Intent and purpose of this information paper

Safety culture represents an ongoing concern and challenge for high-hazard industries worldwide. First identified as a causal factor in the Chernobyl nuclear disaster of 1986, safety culture weaknesses have consistently appeared in investigation findings following major incidents, including Piper Alpha in 1988, the Columbia space shuttle in 2003, the Texas City refinery in 2005, and Macondo in 2010. As a result, safety culture has served as a topic of increasing attention over the past two decades, with academics, consultants, governments, regulators, and corporations attempting to understand, operationalise, measure, and change the safety culture of organisations, as a means of improving safety performance. In 2012-13 NOPSEMA conducted a survey of facility operators regarding the types of safety performance initiatives implemented across the industry. Responses indicated that 92% of participating organisations had implemented a safety culture improvement strategy or were planning to do so in the near future (NOPSEMA, 2013a).

Through further qualitative research it became apparent that there was no commonly accepted definition or model of safety culture used to frame safety culture improvement strategies across the industry. This has led to a highly diverse collection of safety improvement practices being labelled "safety culture improvement" (NOPSEMA, 2013b). The labelling of safety improvement initiatives as safety culture when such initiatives do not target safety culture is problematic, and may in time lead to a perception that safety culture change is ineffective as a means of improving safety performance.

To facilitate the development of robust and effective safety culture improvement strategies across the industry, NOPSEMA recommended that the industry adopt a consistent definition and model of safety culture, upon which individual operators' safety culture improvement strategies should then be framed. NOPSEMA further proposed a definition and model of safety culture, designed to drive the development of better quality safety culture improvement strategies which are more likely to succeed in improving safety performance.

This information paper discusses safety culture as an organisation-level performance shaping factor within the human factors framework. It provides information about NOPSEMA's safety culture model and how it might be used to guide the development of safety improvement initiatives. It is designed to foster continuous improvement in the ways in which organisations understand and apply the concept of safety culture as a means of improving safety performance. It provides information that organisations may wish to consider in relation to their safety culture programs.

Further information regarding NOPSEMA's research and the development of the definition and model of safety culture presented within this information paper can be found in the NOPSEMA reports on the *Safety Culture* page on the NOPSEMA website.

Please note: Information papers provide information, background and practices to foster continuous improvement within industry. NOPSEMA acknowledges that what is good practice, and what approaches are valid and viable, will vary according to the nature of different organisations, offshore facilities and their hazards.

3. Safety culture

Safety culture tends to be understood as a component of organisational culture, with theories and models of organisational culture generally applied to the concept of safety culture. Schein's (1985) publications on organisational culture are often referenced in the published safety culture literature. NOPSEMA's safety culture definition and model is derived from Schein's model of organisational culture, which is briefly outlined below.

3.1. Organisational culture

Schein describes culture as being like an onion, having multiple layers. This is a common way of describing culture and is used by numerous culture researchers, with variation in the numbers of layers discussed. Schein refers to three layers of culture – artefacts, espoused values and basic assumptions.

Artefacts form the outer layer of the 'onion'. These are the physical things within an organisation, such as the condition of tools and equipment, what people are wearing, posters on the walls, and the layout of the work area. Artefacts are easy to observe but difficult to interpret. For example, if a facility has a large number of supervisors, each with a relatively small crew reporting to them, this may represent an organisational belief that in-field coaching and continuous feedback is the best way to develop a competent and capable workforce. It may also represent a belief that all workers are lazy and must be constantly supervised if they are to be productive. The artefact alone does not provide any meaningful information about the culture of the facility.

Espoused values are represented by the middle layer of the culture 'onion'. These are 'what we say we do' as an organisation, and as members of an organisation. Espoused values include the contents of policies and procedures, and the things spoken about within the organisation. Espoused values can often be incongruent with what actually happens at work. For example, an espoused value that is common to many organisations is that all personnel have the right to stop the job if they feel it is unsafe. This is regularly reinforced to members of the workforce, who typically agree that they do indeed have the right to stop the job and that they would do so if necessary. However there are many occasions where an emergency situation has emerged and no-one has actually stopped the job. Senior leaders later ask why this was the case, when personnel have been repeatedly told that they can stop the job. The reason for this incongruence lies in the central layer of the 'onion' – basic assumptions.

Basic assumptions represent the core beliefs of an organisation which drive the behaviour of members of the workforce. These are often unspoken and difficult for members of the organisation to recognise or articulate. Basic assumptions represent the central focus of culture analysis, as they explain why observed organisational phenomena occur. An understanding of an organisation's basic assumptions can help to explain, in relation to the examples above, why personnel didn't stop the job in an emergency situation or why a facility has a large number of supervisors in the field. An understanding of relevant basic assumptions when developing solutions to problems or improvement strategies can increase the likelihood of success.

Culture is built over time, where a definable group of people with a shared history experience and solve internal and external challenges. The solutions developed in response to these challenges work well enough to be considered valid by the majority of group members. These solutions are then taught to new group members as the correct way to perceive, think and feel in relation to that particular problem. Over

time, this repeated process results in the development of basic assumptions which then inform future behaviour.

How is culture built? (An allegory)

A group of scientists put five monkeys in a cage. In the centre of the cage was a stepladder, with a banana hung at the top. As the monkeys climbed the ladder to retrieve the banana, the scientists sprayed them with freezing cold water to prevent them from reaching it. Each time they tried to climb the ladder they were sprayed, until they stopped trying.

The scientists then removed one of the monkeys and replaced it with a new one. The new monkey saw the banana, and attempted to climb the ladder. The four original monkeys, afraid of being sprayed with water, assaulted the new monkey to prevent it from climbing the ladder. The new monkey had no idea why it was being assaulted, but didn't climb the ladder again.

A second original monkey was removed and replaced, with the same result. The new monkey attempted to climb the ladder and was assaulted. Except this time, the first new monkey participated in the beating of the newest monkey, without understanding the reason for doing so. This pattern continued until all of the monkeys had been replaced. No monkey attempted to climb the ladder out of fear of being assaulted, not of being sprayed with cold water.

3.2.   A definition and model of safety culture

NOPSEMA recommends the adoption of a common definition and model of safety culture across the industry, as a means of improving the rigour of safety culture improvement strategies and increasing their likelihood of success. NOPSEMA applies the following definition to the use of the term safety culture:

Safety culture refers to the shared basic assumptions, held by most members of an organisation, which create and reinforce group norms of thoughts, language and behaviour in relation to major accident event prevention.

NOPSEMA's model of safety culture is presented in Figure 2 – A model of safety culture. The model outlines the way in which safety culture is created and reinforced to drive safety performance. It highlights the process by which executive commitment to safety influences organisational safety outcomes. Safety outcomes exist as a direct result of organisational behaviour at all job levels. Organisational behaviour is influenced by executive decisions and behaviour, as well as organisation-level factors of leadership practices, systems, and working environment. These three factors interact with each other, and are created and driven by executive decisions and behaviour. Executive decisions and behaviour are a reflection of executive commitment to safety; however this relationship is mediated by executives' safety knowledge, and their understanding of organisational behaviour.

Figure 2 – A model of safety culture
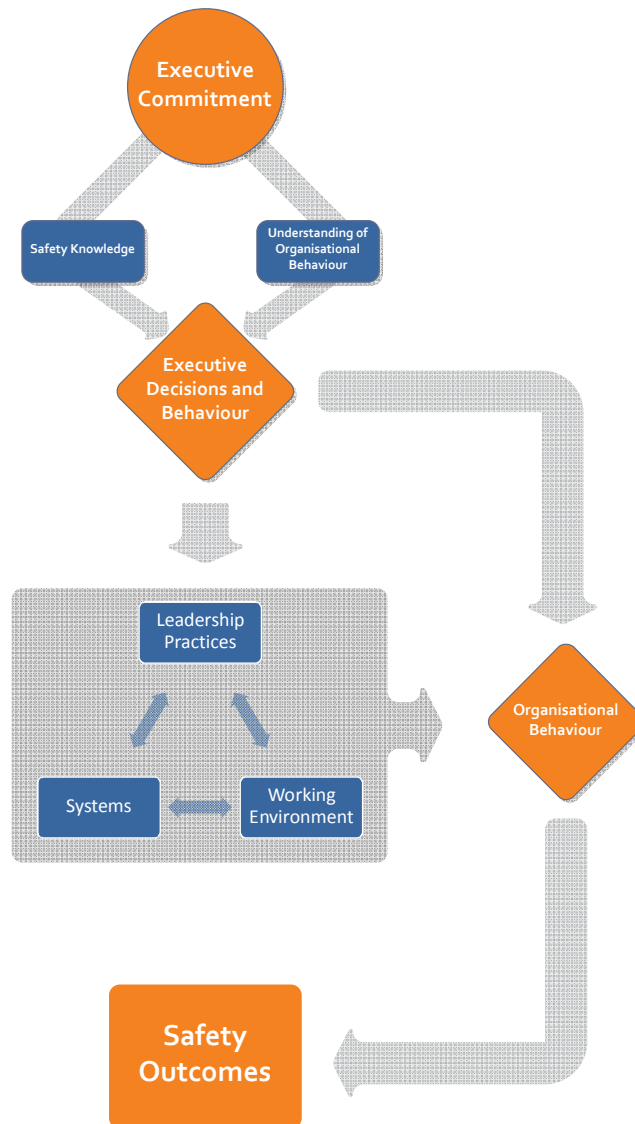
This model is designed to be used as a common standard by which to design and evaluate safety culture initiatives. Essentially, safety culture initiatives should consider each element of the safety culture model proposed above. The way that this is done will necessarily vary between organisations. Each organisation is unique and so requires a fit-for purpose strategy which is appropriate to its culture, history, strategy and people. However it is critical that there is some degree of consistency in the way in which safety culture initiatives are designed, if the concept of safety culture is to successfully deliver improvements in safety outcomes over time.

Note that operators are not obliged to use the model or definition presented above. These have been developed as a means of facilitating continuous improvement in the application of safety culture concepts to safety performance improvement, and do not represent a regulatory requirement. Operators preferring to utilise their own model or definition of safety culture are free to do so.

4. Elements of the safety culture model

This section describes each of the elements of NOPSEMA's safety culture model.

4.1. Executive commitment, decisions and behaviour

The culture of an organisation is created and driven by its executive. In relation to safety culture, basic assumptions about safety are created through the decisions and actions of members of the executive. From deliberate corporate level decisions such as allocation of resources and the structure of company targets, through to unplanned day-to-day interactions with employees, executive commitment to safety is expressed through the decisions that they make and the behaviours they demonstrate. Notably, this relationship between commitment and behaviour is moderated by safety knowledge and understanding of organisational behaviour. That is, the way that an executive's commitment to safety is expressed through their decisions and behaviour will be influenced by their understanding of accident and event causation, and their knowledge about the drivers of behaviour within organisations.

Executives aiming to improve the safety culture and safety performance of their organisations should first genuinely seek to consolidate or improve their own knowledge about the socio-technical complexities of accident and event causation, and their understanding of the ways in which organisational behaviour is created, supported and changed. Research conducted by NOPSEMA (2013a) suggests that the level of executive participation in formal safety education is not ideal given the importance of executive safety knowledge to overall safety culture. Survey responses indicated that 55% of participating organisations included their executives in personal safety training, 48% in process safety training, 52% in safety leadership training, and 45% in safety leadership coaching. While these findings are preliminary, the responses do suggest that executive-level safety education may represent a significant first step in the improvement of safety culture within some organisations.

Creating culture: compare and contrast (part 1)

Bob is a petroleum CEO whose company has a poor safety record. Bob has a simplistic understanding of incident causation and organisational behaviour. He is passionate about safety, and understands the importance of safety improvement from both a business and an ethical perspective. He has seen the statistics stating that 75-100% of accidents and events are caused by human error, and believes that all that is required is for the workforce to have greater motivation to work safely. Bob unilaterally decides to implement a safety bonus, stipulating that people who are injured are ineligible for the bonus. Further, supervisors and line managers of injured employees will receive a reduced bonus.

Barb is the CEO of a different petroleum company with an equally poor safety record. Barb is also passionate about safety, but has a sound understanding of incident causation and organisational behaviour. Barb understands that, while human error often precedes an accident or event, errors are facilitated by systems, equipment, and other organisational factors. Barb decides to improve the error tolerance of her company's major accident event (MAE) control measures. She engages with her executive team to generate the understanding, commitment and buy-in that will be required for the project to succeed. She recruits a team of suitably qualified and experienced personnel, and ensures that they are appropriately situated within the organisational hierarchy to be able to successfully create and drive change.

4.2. Leadership practices, systems and working environments
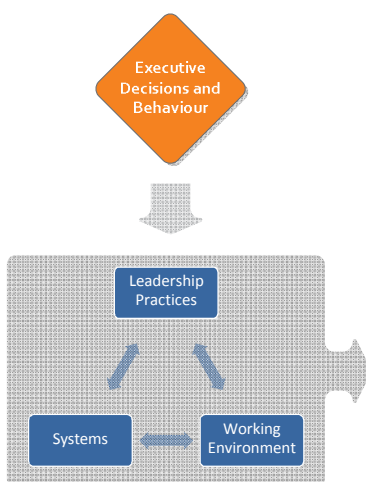
Executive decisions are typically translated into the development or modification of organisational artefacts (physical things) and espoused values (what we say we do) as a means of driving changes to organisational behaviour and consequently safety performance. Artefacts include the various components of the physical working environment/s such as plant, equipment, software, workstation setup, and behavioural norms such as dress codes and interpersonal interactions. Espoused values are disseminated via organisational charters, policies, standards, procedures, work instructions, presentations, training packages, and other sources of information designed to guide how something is done. The new or modified artefacts and espoused values are expected to change the behaviour of members of the organisation in a predictable way. The degree to which executive decisions create the desired changes in organisational behaviour can be enhanced or undermined by leadership practices throughout the organisation.

Research conducted by NOPSEMA (2013a) indicates that changes to artefacts and espoused values are commonly used to drive safety improvement within the Australian offshore petroleum industry. Survey responses indicated that all participating organisations had recently initiated safety improvement initiatives targeting this level of culture. Such initiatives included improvements to safety management systems (100% of respondents), procedures (96%), equipment (70%) and workplace design (62%), the use of

behavioural safety programs (88%), and the provision of safety leadership training (89%) and coaching (81%). Organisations seeking to introduce new or modified artefacts and espoused values should follow structured change management processes which address both technical and non-technical aspects of change. Leaders and frontline personnel should be engaged throughout the change process to improve the likelihood that changes will be successful and sustainable.

Further information on non-technical change management can be found in the **_Change Management_** information paper located on the **_Human Factors_** page of the NOPSEMA website.

Creating culture: compare and contrast (part 2)

Bob's decision to implement a bonus based on lagging indicators is built into a formal bonus system with supporting policy and procedure documents. Bob announces the new bonus system at the next 'town hall' meeting, delivering a slide package containing a detailed account of how the system will work. The policy and procedure are published on the company's intranet site and employees are encouraged to read both. An online reporting system is implemented to facilitate accurate recording of accidents. Frontline leaders and line managers begin to engage in 'creative reporting', actively seeking ways of manipulating injury records so that their bonuses are not adversely affected.

Barb's decision to improve the error tolerance of MAE control measures results in an in-depth review of accident and event data, site observations and interviews with personnel at all levels of the organisation. Control panel design, software logic and interfaces are identified as a key contributing factors to errors and events on the facility. Recommendations are made for initial software modification, with a long-term plan to replace the control panels. Recommendations are subject to risk assessment and modified where necessary. Leaders are engaged at every stage of the change process to ensure that changes are appropriate, likely to succeed, and supported and driven throughout the organisation. New design standards are established to incorporate human factors considerations into control panel design. Appropriate training and assessment packages are developed to ensure that operators are competent in the use of the modified software. Training packages are supported by the introduction of user-friendly procedures and quick-reference guides developed in collaboration with operators and line management. Management of change processes are initiated to ensure that the long-term plan to replace the control panels is implemented appropriately.

4.3.   Organisational behaviour
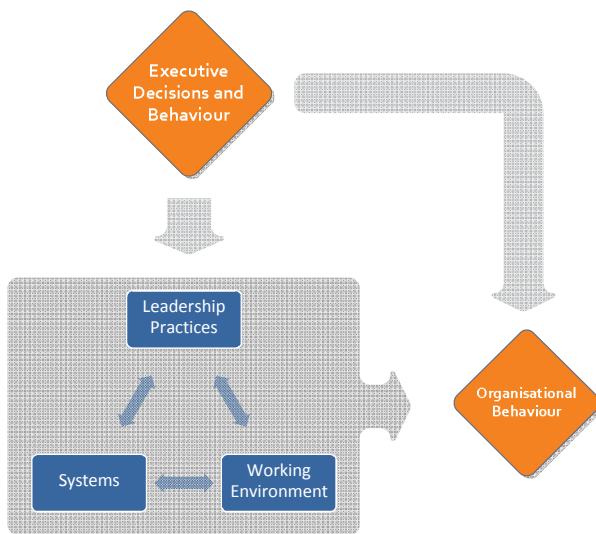
Executive decisions and behaviour drive organisational behaviour via corresponding espoused values and artefacts, and through leadership practices which either support or detract from the goal of the executive as outlined above. Organisational behaviour can also be immediately influenced by executive behaviour, when observed by members of the organisation. Of particular importance here is the degree to which executive behaviour is aligned with the espoused values of the organisation. Poor alignment between observable executive behaviour and espoused organisational values can create a variety of adverse psychological and behavioural responses in other members of the organisation, including cynicism, disengagement, diminished commitment to organisational goals and values, and increased frequency and magnitude of violations.

Executives wishing to improve the safety culture of their organisations should consider the potential unintended consequences of proposed changes to systems, working environment, and accepted leadership practices prior to implementation. It should also be noted that safety culture can be influenced by decisions that may seemingly have little direct relevance to safety.

Creating culture: compare and contrast (part 3)

Employees in Bob's company are keen to receive their bonuses, and so are reluctant to report injuries. Wherever possible they see their own doctors for injuries incurred at work. When this is not possible they participate in statistics-management behaviour initiated by their supervisors, such as going to classroom-based training rather than taking time off work after an injury. Employees and line managers are focused on statistics, and do not seek to identify or mitigate the hazards and error-inducing factors present in the workplace. At the end of the year, the bonus is awarded to the majority of employees and line managers. The organisational behaviours aiming to hide or minimise the severity of injuries are reinforced – people who successfully hide their injuries are rewarded while those who choose to report honestly or are unable to hide their injuries are punished.

Control panel operators in Barb's company see an immediate reduction in the frequency of their errors following the deployment of the new software. When the operators do experience error, these are reported along with information about their interactions with the software and the physical components of the control panel. Error reports are collated and analysed for patterns, findings are built into ongoing software fixes, and error rates continue to diminish.

4.4. Safety outcomes

The behaviour of individuals and groups at all levels of the organisation delivers safety outcomes. Where changes to artefacts and espoused values result in an acceptable outcome, those changes are deemed to be a **successful response to the original problem**, reinforcing the original decision. Over time, new practices become ingrained to the extent that they are no longer questioned. The explicit assumptions underlying the original decision inform the **shared basic assumptions** which underpin the culture of the organisation. As behaviours are repeated and reinforced they become **group norms** – that is, "the way we do things around here".

Creating culture: compare and contrast (part 4)

Bob sees a significant improvement in his company's injury statistics. The bonus system is deemed successful, thus reinforcing the original assumption about incident causation. Employees in Bob's company continue to be motivated to receive their bonus each year. Over time, "the way we do things around here" is that injuries are hidden through creative reporting to keep the statistics looking good. This behavioural norm has arisen out of a basic assumption that injuries happen when people aren't sufficiently motivated to work safely. The hazards existing within the working environment are not addressed. No real reduction in injuries has occurred. Although the injury statistics look much healthier, in reality the safety outcomes have not changed.

Barb's company experiences a reduction in process-related events following the introduction of the new control panel software. The process of improving the error tolerance of MAE control measures is deemed successful, reinforcing Barb's assumptions about the complexities of incident causation. The human factors team continues to analyse incident and event data to identify other MAE control measures requiring improved error tolerance. Over time, "the way we do things around here" is that employees report any errors that they experience. This behavioural norm has developed as a result of the basic assumption that errors reveal flaws within control measures. Error reports are analysed with results used to recommend improvements to control measures. Injury and event statistics improve gradually as control measures become more robust.

5. A final note

Safety culture influences safety outcomes. Organisations develop and implement safety culture change initiatives as a means of improving their safety outcomes. Such programs are typically initiated without any exploration or understanding of the basic assumptions underpinning the problematic safety outcomes (NOPSEMA, 2013b). Rather than seeking to measure, track and change safety culture, organisations may find the concept of culture more effective as a means of analysing and understanding a problem. An exploration of the basic assumptions underpinning a problem can guide the development of culturally appropriate solutions to that problem. Where alignment exists between new solutions and existing basic assumptions, members of the organisation are more likely to accept and adopt those new solutions than if the new solutions conflict with basic assumptions. Where basic assumptions are problematic it may be

appropriate to attempt to change them, however it should be noted that such change efforts will take a long time to implement, and that the outcome of such change processes may be unpredictable.

Creating culture: designing appropriate solutions (part 5)

A few years after initiating the safety bonus, Bob retires. His replacement, Steve, has seen the real implications of the safety bonus, and wants to change the culture of statistics-management that he has observed. Steve changes the bonus system to reward the achievement of lead indicators rather than the avoidance of lag indicators. He asks people to report errors and hazards, and sets a target for each person to submit a certain number of reports per month. Steve finds that, although the targets are met, people are reluctant to report errors and focus their reports on low-level hazards such as poor housekeeping. He conducts a number of focus groups with people from all levels of the organisation to explore why his changes are not working as intended.

The focus groups reveal two basic assumptions relevant to Steve's new initiative. The first is the assumption that people get injured because they aren't focused or motivated enough, which evolved from Bob's original explicit assumption when implementing the bonus system. The second assumption has emerged as members of the organisation observed their line managers actively engaging in 'creative reporting', namely that the company doesn't really care about safety; they only care about the statistics. Steve views both of these assumptions as problematic and decides to attempt to change them. Steve designs the following high-level plan:

- The executive team will participate in training on the socio-technical complexities of incident causation, including company-specific case studies and individual assessments.
- This training will be delivered throughout the organisation following the organisational hierarchy.
- Modifications will be made to the existing incident and hazard reporting tools to allow for anonymous reporting and the inclusion of performance-shaping factors in the report.
- The company's incident investigation process will be modified to incorporate human factors and root cause analysis techniques, and to require corrective actions linked to each investigation finding. Personnel are to be trained in the relevant investigation and analysis techniques.
- A tracking system will be developed to ensure that all corrective actions are implemented.
- Incident investigation findings and actions are to be published on the company's intranet site and available for all personnel to view.
- A summary of incidents, investigation findings, actions and closeout status is to be presented at each 'town-hall' meeting.

Steve recognises that this plan is the first step in a lengthy process to change the problematic assumptions created by the original bonus system, however he is committed to real safety improvement and believes that building a healthy reporting culture is the right first step for his organisation.

6. References, acknowledgments & notes

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