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Using Errors to Drive Safety, Quality and Production



In this white paper, we explore how errors and mistakes can be good for business if used as a tool for continuous learning and safety improvement.



Error Prevention and Management

Somewhere in the Mediterranean, an aircraft carrier stands poised for action. At a moment's notice, this mini-metropolis bustles with coordinated activity against an incoming threat. Within the control tower, the crew directs flight operations at a level of complexity greater than most commercial airports. Below deck, an army of service staff attend to the cadre of technical systems, equipment and machinery, ensuring nothing less than optimal performance. Taken together, the system operates like a well-oiled and aligned machine. Errors are rare—but when they do happen, their causes and consequences are dissected, and the system learns and adapts accordingly. Paradoxically, errors are crucial to its very survival.

For many organisations, this level of performance seems far out of reach. Yet, the secrets to success of what have been termed the 'high reliability' industries—military, nuclear and aviation—are starting to be uncovered and applied more broadly to other business sectors. Indeed, healthcare^{1,2}, and chemical process industries such as oil and gas³, have started to unpack high reliability success factors and implement relevant principles within their operations. Results to date have been promising, with many nuggets gleaned from fossicking through errors and mistakes, and the practices used by organisations to prevent and manage them.

Some of the benefits of fostering effective error practices include increased organisational goal achievement, profitability and safety.^{4,5,6,7} Despite this work, the fruits of these innovations are not quite ripe in some industries and yet to even be sown in others. Given that the lessons learned here could potentially translate into a competitive advantage for many organisations operating in challenging business environments, this represents a 'missed opportunity' to say the least.

Errors and mistakes represent a serious concern for all organisations. And so they should—in civil aviation, unscheduled aircraft maintenance costs anywhere from US\$140,000 for a cancelled flight and US\$17,000 per hour for flight delays.⁸ Within the Australian medical industry, the costs of patient treatment errors can be up to AU\$896 million, while patient harm due to medication safety can cost up to AU\$1.2 billion.⁹

Although difficult to quantify in other industries, uncontained errors can result in a range of adverse outcomes, for example reduced product quality, loss of reputation, property damage, customer complaints and unscheduled maintenance, to name a few. Importantly, errors also act as precursors to more serious events such as employee injuries and catastrophic failures.¹⁰ From this perspective, it is easy to see why errors are considered by some as undesirable and things to be eliminated at all costs.

On the other hand, errors afford organisations valuable opportunities to learn and improve. Indeed, the medical profession has long acknowledged that 'to err is human'—mistakes are inevitable.¹¹ But this is not a resignation; instead, it is about anticipation and containment of errors at individual, team and organisational levels.¹² From this angle, errors are important signals that uncover latent conditions that had previously evaded detection. In this way, errors are the breadcrumbs left by people, processes and equipment that suggest something is awry; and if left unchecked, system failure is ultimately possible.

What is less-widely acknowledged is that errors create valuable developmental opportunities. For an individual operator, an error highlights gaps in his/her knowledge or skill and offers a chance to develop new competencies; at a team level, errors between co-workers highlight friction in communication, coordination and planning activities; and finally, at the organisational level, common trends or patterns in errors suggest avenues to tighten up the framework of overarching procedures and processes that drive important business outcomes. In these ways, errors can be inherently good for business, driving improvements in the 'golden trifecta' of safety, quality and productivity.

Adopting a psychological perspective on error management—namely, by promoting a social environment that is conducive to discussing and learning from errors—is a critical, albeit often overlooked aspect of organisational functioning. Too often, organisations become caught up in the frenzy of daily work tasks and production-



focused goals; in essence, instead of becoming mindful, many employees, teams and/or organisations lose their perspective and become mindless.¹² To meet this pressing business challenge we present a case for a positive error management climate as a critical characteristic of organisations within the oil and gas, construction, mining and utilities sectors that seek to increase their reliability and performance.

People: The Lynchpin Between Systems and Performance

Error management climate defines the shared perceptions of what is valued and rewarded, and is necessary to establish a highly reliable organisation. In practice, this means that the error management climate should be both positive (favourable perceptions) and strong (consistent perceptions within and across all teams). Further, the 'schematic' offered by error management climate dictates that five dimensions must be established to elicit highly reliable performance:

1. Willingness to report errors (disclosing errors to leaders or official reporting of errors).
2. Learning from errors (identifying 'lessons learned' following an error).
3. Communicating about errors (talking to co-workers about errors).
4. Thinking further about errors (spending time understanding how/why errors occurred).
5. Effective error management (fixing errors when they occur).^{7,13}

On the shop floor, these climate dimensions manifest as specific types of error-related behaviour. In a team with a favourable error management climate, employees are more likely to volunteer their mistakes to supervisors and other leaders, as well as discuss them openly with co-workers. Also, employees may engage in ad-hoc group discussions about their performance, sharing information and ideas about previous mistakes in order to learn and grow. Finally, workers are more likely to fix their errors and invest energy in thinking about how to prevent them from happening again.

In practice, one would be hard pressed to find a manager who disagreed with these five error management climate dimensions being crucial cogs within a highly reliable team system. What might be less clear are the tangible actions that organisations, leaders and team members can take to translate these dimensions into specific work practices and behaviour. We now turn to each of these levels, offering interventions to help establish a positive and strong error management climate, and as a result, highly reliable performance.

Profile of a High Reliability Organisation

High reliability organisations (HROs) are unique. Complex, sophisticated and 'tightly-coupled' (efficient, sequential and connected systems of work), these organisations grapple daily with the prospect of catastrophic failure.¹⁴ This is because when something goes wrong (e.g. a core meltdown, an enemy attack), the consequences of failure are immense. Yet, despite this ominous threat and the ample opportunities for things to go wrong very quickly, HROs maintain an exemplary performance record.

So faced with these demands, what do HROs do or have that enables such unwavering peak performance? And crucially, what lessons can other industries learn from HROs to improve their own performance?

HROs have distinct ways of operating organisational systems and a corresponding way of thinking that set them apart from others.¹⁵ These characteristics have evolved in step with operating challenges such as increasingly dynamic work conditions, implementation of cutting-edge technology and increased pressure to perform at ultra-safe and ultra-productive levels during times of peak demand. In fact, it is through the continual reflection on and subsequent improvement upon errors—facilitated through the characteristics of this success profile—that HROs are able to maintain operational excellence.

THE SUCCESS PROFILE OF A HIGH RELIABILITY ORGANISATION

- Collective mindfulness.
- Organisational flexibility.
- Double-loop learning.
- Reluctance to simplify.

Collective Mindfulness

Key to a favourable error management climate is being ever-mindful in observing the goings-on across operations. In other words, there is a continuous and genuine interest from management in the activities of frontline workers as well as wide-reaching, regular and high-quality information transfer within and between teams. At this level, channels operating both vertically and horizontally across the organisation foster open and regular two-way communication. Measures of operational status and performance are dynamic and focus on 'leading' indicators such as errors, product quality and the frequency and effectiveness of employee behaviours. Crucially, these metrics are sufficiently detailed to allow organisations to detect the minor perturbations that precede more serious errors and potentially catastrophic incidents (e.g. aborted aircraft landings, component replacements).

Finally, frequent 'audits' (diagnostic employee surveys, group discussions) assess the degree to which mindfulness is being practiced across the organisation, which informs remedial actions.¹²

Organisational Flexibility

HROs ensure timely and effective error responsiveness by adopting a flexible approach to decision-making. In routine conditions, decisions are centralised, which ensures that information from highly-specialised segments of the process are integrated and considered holistically. Alternatively, when things change during non-routine and emergency conditions, decision-making authority seamlessly transfers to local teams at the scene of the crisis. In these situations, hierarchy and bureaucracy can mean the difference between an aborted core meltdown and a Chernobyl-style catastrophe. When it comes to effective error management, knowledge is most definitely power. Enabling this smooth transition of authority are organisational structures, procedures, role expectations, and recruitment and development systems that promote leadership capabilities in all employees, regardless of 'rank' or status in the company. One hint that an organisation is resilient to errors is scalability of operations: systems that operate just as effectively with either 10 or 10,000 people are also likely to manage errors well and bounce back from incidents with ease.¹⁶

Double-Loop Learning

It is one thing to contain errors, and another to learn from them and prevent history from repeating itself. Indeed, resilience in one sense means to return to a prior state of functioning following a setback; however, from another perspective, to be resilient one must also 'bounce forward'. In other words, setbacks are treated as a chance to improve. Following an error or adverse incident, organisations must move swiftly to shine light on the underlying root causes. Otherwise, as time goes by, details are forgotten, walls of defensiveness are erected, and justifications are made to preserve reputations and established work practices.¹² Put simply, following an error, an organisation's system is at its most malleable; but fail to capitalise on this and the structure again 'crystallises', making change more difficult to enact. For bounce-back resilience, organisations must ensure that several components are in place and functioning effectively: formal (e.g. a 'Good Catch' program) and informal (e.g. regular team meetings) error and incident reporting systems, non-adversarial investigation procedures, high-quality information management and two-way timely feedback to employees following error reporting.

Reluctance to Simplify

Finally, given the types of technologies and processes typically in use by HROs, complexity must be embraced to develop a more complete and accurate picture of current operations. Only by fully appreciating the intricacies of how things work can HROs ensure that potential 'error traps' are unearthed and countered. Relatedly, HROs also

possess a slightly neurotic tendency—a 'preoccupation with failure'. This outlook manifests as specific error-reducing processes and practices such as pre- and post-deployment planning, user-centred design, thorough and frequent training, automation to reduce the reliance on human operators, and multiple system redundancies and defences against failure. In summary, organisations should seek to implement and optimise the following systems and procedures:

1. Communication protocols and infrastructure that promotes timely, regular and two-way transfer of information within and between teams.
2. Collection and analysis of leading indicators of performance, with measures of functioning that can detect minor perturbations that often precede errors and adverse incidents.
3. Dissemination of performance metrics and feedback across all levels of the organisation in ways that make sense to all employees (even frontline workers).
4. Emergency protocols and procedures that enable decision-making to occur at a local level.
5. Emphasis on recruiting for and developing leadership capabilities among all employees, which enables local leadership transitions to occur seamlessly as required.
6. Through employee reward and recognition programs, encouraging employees to engage in extra-role behaviours that support effective error management (e.g. assisting a co-worker to fix an error, reporting errors through formal channels, engaging in additional non-mandatory training/learning to improve error management abilities).
7. Information/knowledge management systems that capture and disseminate error-related learning across the organisation (e.g. an e-learning platform).
8. Non-adversarial investigation procedures that help to identify root causes of errors and encourage growth through learning rather than compliance through punishment.
9. Regular in-team and cross-team meetings that focus on error-related discussions and information sharing.
10. Reporting systems that provide feedback to individual employees, which encourages future reporting and actioning of improvements that arise from error-related learning.

Together, these organisational characteristics intersect to create the essence of highly reliable (incident-free safety, impeccable quality and efficient productivity) performance. Implementing effective systems and processes will kick-start an organisation's journey towards a higher state of functioning. However, without consideration of team- and individual-level factors that promote a favourable error management climate, these systems and processes are doomed to failure.

Targeting Teams and Individuals to Achieve Exemplary Performance

Vitality, and what should now be apparent, is that the secret to high reliability involves far more than the latest technology, prescriptive procedures and complex systems.¹⁷ Without a corresponding social context that supports effective error management, organisations can implement systems as much as they want with little impact on performance. Common perceptions of what is valued and rewarded in relation to errors (i.e. error management climate), combined with a social environment that facilitates open discussions and learning (high psychological safety) are required to translate systems and processes into effective mechanisms for sustaining highly reliable performance.

Teamwork is critical for high performance, and especially so in today's fast paced and dynamic operating environment.¹⁸ Most contemporary working environments require individuals to work collaboratively in groups; often, the complexity of the job necessitates a multidisciplinary team, each member with a particular set of skills and tools at their disposal. Specifically, due to increases in knowledge-based work, market competition and economic conditions, teams are increasingly comprised of highly specialised and multidisciplinary personnel, engaged on temporary contracts or assignments, enlisted to solve technical, novel and sometimes poorly-defined problems, and expected to deal with continuous change.^{18,19,20}

These characteristics present numerous team-level challenges to securing high performance, most notably untested assumptions and social friction such as conflict, group think, siloing, low trust and poor cohesion. In this setting, errors and mistakes are more likely to result and less likely to be reported/discussed, leading to adverse and sometimes serious outcomes for the organisation.



Merely throwing workers together and directing them towards a common goal is not enough to elicit high performance. Not only does the team need the right technical knowledge and skills, but also the social context must be established, enabling the ingredients of high performance such as shared awareness, information sharing and collective learning.²¹

THE SUCCESS PROFILE OF A CULTURE THAT SUPPORTS ERROR MANAGEMENT

- Mindful team operations.
- High-quality communications.
- Developing psychological safety.
- Promoting team learning.

Mindful Team Operations

Dynamic operating environments can reveal lethal hazards at unexpected and inopportune times, leaving little time to respond if complacency or distraction are permitted to creep into operations. Highly reliable teams maintain performance under these conditions via mindful awareness—carefully monitoring the current situation and managing local conditions as risk levels wax and wane. Through this vigilance, teams spot errors either before they occur (anticipating) or as they happen (containing), rather than only finding out once their consequences surface. Importantly, mindful teams shatter unhelpful psychological 'ruts' like complacency and habituation by treating every situation as a potential warren of errors and thinking carefully not only about their own actions but also those of co-workers and other teams onsite.²²

Leaders

Frontline leaders form the first line of defence, closely monitoring crew actions, double- and triple-checking critical steps in the work process, managing work pace and helping workers to identify situations where errors are most likely to occur.²³ In addition, leaders can facilitate interventions such as introducing personnel or job rotations.²⁴ This strategy develops what is known as 'shared mental models' or shared ways of understanding job tasks and predicting what other team members will do.²⁵ Shared mental models essentially enable teams to adapt 'on the fly' as well as notice errors or error-producing conditions given the high collective understanding of each team member and how he/she contributes to team outputs.

Team Members

For workers, identifying typical errors encountered during operations, educating about performance barriers such as fatigue and habituation, and providing information about human perception and situational awareness (including limitations of the brain) assists them to develop the underpinning knowledge needed to contribute to highly reliable operational performance. Neuroscience-based tools such as mindful attention, the 'What's Important Now?' question and mental rehearsal are examples of specific strategies that can be taught to workers in an effort to enhance error-detecting abilities.

High-Quality Communication

To detect and trap errors, teams must develop an awareness of not only their own operations, but also any intersections or interactions with other activities occurring in their vicinity.²³ Further, teams must constantly update one another at critical decision and change points, as well as openly share when errors occur and what can be learned from the experience. This effective error communication is characterised by a summary of the current situation, anticipation of what could go wrong, communication of intent (what will be done next), and invitation of confirmation/feedback from colleagues.

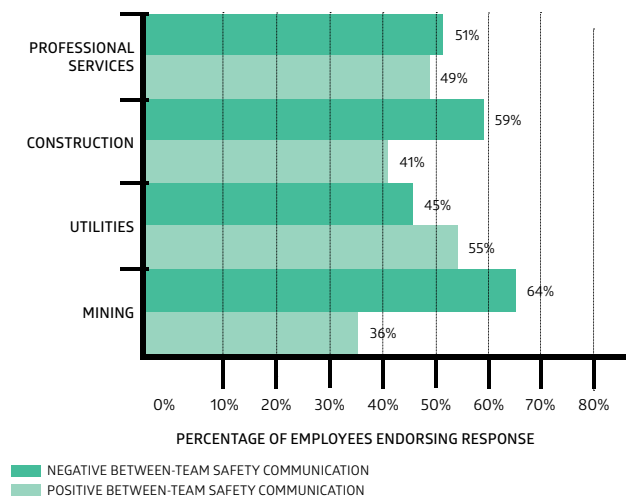
On the one hand, high-quality error communication enables teams to develop what is known as 'shared situational awareness'; and on the other hand, such communication contributes to a positive and strong error management climate.

Within our Sentis Safety Climate Survey, we routinely measure the quality of safety communication, as well as more error-specific communication patterns, and this research suggests that organisations typically struggle to establish effective channels, particularly between teams (see Figure 1). Therefore, organisations not only need to work within teams, but also across them to establish strong links that facilitate information transfer.

Leaders

Leaders help establish high-quality error communication through pre-shift briefings, role-modeling effective communication and encouraging team members to question their assumptions and confirm their intentions with others before acting. Leaders can directly improve workers' error communication skills by conducting in-field observations, which are later followed up by coaching and mentoring. Also, and quite simply, leaders can invite team members to contribute their opinions and ideas both during planning and operational tasks, and directly motivate error communication by painting a compelling picture and rationale as to why such behaviours are so important for team functioning.²⁶

FIGURE 1. PERCENTAGES OF EMPLOYEES REPORTING NEGATIVE AND POSITIVE BETWEEN-TEAM SAFETY COMMUNICATION QUALITY IN SENTIS' SAFETY CLIMATE SURVEY.



Team Members

Team members' skills at maintaining effective error communication can be improved through activities such as intact team training^{20,27,28} Structured communication tools help foster a favourable error management climate by providing an easy-to-remember framework to guide efficient information transfer between workers.^{27,29} At a basic level, team training should include principles of 'closed loop' communication, which essentially refer to information-sharing skills including conciseness, acknowledgement and confirmation.³⁰ And finally, crucial to the effectiveness of communication training are instructional strategies such as realistic simulations, role-plays and expert demonstrations. Without sufficient opportunity to practice team-based communication, these skills remain conscious and effortful—they must be routinised and automated (becoming second nature) through repetition to have a meaningful impact on performance.²⁸

Developing Psychological Safety

Important to a positive and strong error management climate is psychological safety, which encourages open reporting of errors in a formal sense, and also informally via error discussions between co-workers. Psychological safety is a term that refers to an employees' belief that he/she is able to freely express ideas, opinions and concerns without fear of negative repercussions.³¹ In the context of error management, this belief is an expectation of how other people on the team will respond when an individual discloses that a mistake has been made. Psychological safety is an essential requirement if lessons are to be learned from errors, and importantly, depends on high-quality social relationships within the team that are characterised by mutual trust and respect, shared goals and shared knowledge.³²

Our own research with organisations consistently identifies that 'willingness to report errors', which is an outcome of high psychological safety, is often the most negatively-perceived dimension of error management climate (see Figure 2). Hence, organisations serious about high reliability need to be diligent and work hard to not only measure psychological safety, but also take active steps to establish it.

FIGURE 2. PERCENTAGES OF EMPLOYEES REPORTING NEGATIVE AND POSITIVE PERCEPTIONS OF WILLINGNESS TO REPORT ERRORS IN SENTIS' SAFETY CLIMATE SURVEY.



Note: Percentages calculated by assigning 'negative' to all respondents who scored below 5.0 out of 7.0, and 'positive' to all respondents who scored at or above 5.0 out of 7.0.

Leaders

This is where leaders must become enablers of psychological safety by encouraging people to speak up and eliminating unhelpful or discouraging behaviours among team members (such as criticism or ridicule). Further, through transformational leadership behaviours such as showing an active and genuine care for team members' wellbeing, leaders can create high-quality relationships that encourage workers to reciprocate in the form of effective error management behaviours. Finally, leaders that are savvy to error management practices seek to reduce and eliminate power differentials within their teams—perhaps the biggest road block to candid discussion of errors—that drastically increase team members' perceptions of vulnerability.²⁶



Team Members

Team members contribute to psychological safety through 'backing up' behaviours such as assisting others to complete a task without being asked and checking in with each other informally when performance deficits are noticed.²² Team development activities that promote positive thinking about diversity (not only in culture or ethnicity, but also in knowledge, skills and experience) water the seedling of psychological safety by breaking down barriers to open communication and helping to build stronger relationships through exposing one's strengths and weaknesses to the team. Finally, teams with strong prosocial norms or implicit rules for interacting are more likely to have higher psychological safety, so organisations should look to establish such norms through team-building events and flexible task assignments that promote collaboration and cohesion.³³

Promoting Team Learning

In addition to psychological safety, highly reliable teams must have effective mechanisms to review past performance, identify shortfalls, formulate learnings and implement improvements—in essence, learn from what went wrong and swiftly integrate solutions into everyday team practices. In addition, high reliability teams must invest time in this learning process before work has even commenced. Teams can utilise this ‘future learning’ approach by casting a pessimistic eye over upcoming work to anticipate where and when potential problems could arise, and carrying out pre-emptive strikes on errors to neutralise them prospectively. At the backend, highly reliable teams dissect past performance with the goal of identifying growth opportunities.

Leaders

Leaders can promote such learning by facilitating pre- and post-deployment meetings that focus exclusively on learning. Such meetings are effective at improving team performance because they (1) involve active learning, (2) emphasise development and growth, (3) focus on specific and tangible events, and (4) integrate multiple perspectives and sources of information. Indeed, team-based post-deployment meetings have been shown to boost future performance by 25%.³⁴ Although sharing many similar features to the pre-start meetings or toolbox talks held across organisations in heavy industry, meetings that include a component about learning from past errors are slightly different. In addition to a review of operations or a team-based planning session that anticipates where things go awry (similar to a HAZOP process), these sessions consist of targeted questioning by leaders in a non-punitive and learning-conducive social environment.³⁵ Leaders create an effective learning environment by holding these meetings regularly, emphasising their informal nature, quashing blaming or scapegoating behaviours should they arise and managing team workloads to remove the perception of ‘busyness’ or work pressure.³⁶

Team Members

Teams can contribute to collective learning by ensuring that they share errors with their co-workers. Team development activities such as training can challenge existing beliefs and attitudes about the value of owning up to and talking openly about errors, as well as giving team members a common language with which to discuss their experiences (e.g. slips, lapses, errors of commission/omission).³⁷ Finally, teams can be provided with error-capture and analysis tools (e.g. a pocket book or smartphone application) that facilitate learning through on-the-spot structured data collection and review processes.

Conclusion

For many years, HROs have been held aloft with seemingly supernatural powers to evade the errors that should surely plague such complex and dynamic sociotechnical systems. Actually, if you spend a little time with HROs and other organisations that have formed a love/hate relationship with errors, the ubiquity of errors becomes apparent. Where these organisations differ (and indeed, the ‘secret ingredient’ in their recipe for success) is in what they do with errors. In stark contrast to most companies, a particular (and positive) error management climate along with a corresponding suite of prevention and management practices define daily operations.

These organisations know that they can’t beat errors entirely; rather, every error represents a priceless nugget of learning so that the system can adapt in anticipation of the next one. For these companies, they have no other choice but to embrace the inevitability of error as the cost of failure can ultimately impact not only themselves but also in some cases, many thousands of lives in surrounding communities. For the rest of us, we can choose to implement these principles and practices to initiate a ‘step change’ in organisational functioning—a significant leap forward in the quest for optimal quality, productivity and safety.

Sentis specialises in safety culture measurement and transformation. Experts in applied psychology and neuroscience, Sentis helps organisations to enhance and move beyond compliance to empower employees to work safely—not because they have to, but because they want to. Offering training, coaching and consulting, Sentis has helped more than 300 companies and 150,000 people think differently about safety since 2003.

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