intervention assessment. The pre-intervention assessment needs to be multi-method – to discover the organizational values and underlying assumptions (values); the existing organizational structures, policies, procedures, and practices (strategies); employee attitudes and opinions (climate); and employee behaviours (performance). Different elements of the transformation efforts require different assessment techniques, but typically they involve alignment across values, strategies, climate, and performance. The post-intervention assessment needs to be multi-method as well as iterative, and it should be aimed at longitudinal measurement of change to illustrate the evolutionary, and therefore irreversible, nature of cultural change.

This book is aimed at aviation and healthcare professionals as well as organizational development students. We encourage senior managers to think of safety culture transformation as a long-term commitment, invest appropriate resources, specify the performance expectations and be prepared to modify them as necessary, be open to making the structural and procedural changes necessary for the culture to change (remove internal barriers to change), and provide the down-line managers and employees the tools necessary to implement changes. We also wish to encourage middle managers to seek commitment from senior management and participation from the down-line management and employees. We hope that organizational development students will find that the blending of theory and case discussions presented here reinforces their understanding of change management.

Respectfully,

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Chapter 1
The Safety Culture Pyramid

Introduction

Airlines and hospitals need two things to survive: financial strength and public trust. A robust safety culture bolsters both. Typically, airlines operate at a very low profit margin, teetering on the edge of bankruptcy. There are a handful of key sources of financial drain related to the management of risk and the financial consequences of incidents and accidents: direct and indirect costs of accidents, insurance costs, and fines and litigation costs attributable to preventable errors. Likewise, hospitals (many of which are non-profit organizations) operate with a very slight financial margin. Many of the same costs and sources of financial drain associated with the management of risk and consequences of mishap that apply to airlines apply to hospitals. Any efforts to reduce the financial drain contribute toward the overall strength of the organization and thereby extend its longevity. Public trust is fundamental to continued revenue. The flying public needs to trust in the safety of a particular airline just as much as the patients need to trust in the safety of care offered by a particular hospital. A purchased airline ticket is a 'promissory note' to the customer that the airline will get them to their destination safely. Similarly, admission into a hospital is a 'promissory note' that the patient will be cared for without being harmed by the processes of care – that no additional illness or injury will be inflicted that is unrelated to the condition for which the patient is being treated. Management's failure to ensure due diligence in maintaining a safe and reliable aviation/healthcare system could be grounds for accusation of negligence and consequent loss of public trust.

The material presented in this book is based on our original research in aviation and healthcare as well as on a review of pertinent literature authored by colleagues from across the world. While many of our research findings have been presented in technical reports, book chapters, conference papers, and refereed articles, this book offers a unique opportunity to present our collective work in a different, and hopefully, more interesting way. It also enables us to weave in examples of preventable errors in aviation and healthcare in a way that is not possible in traditional academic literature.

A review of safety culture research indicates use of methodologies at two levels: behavioural and attitudinal. Behavioural research in safety culture emphasized causal linkage between specific risk-prone behaviours and their outcomes. This is particularly true in the case of occupational or personal injury studies. Attitudinal research emphasizes the collective psychological state of an organization. Individual attitudes toward safety processes, safety equipment, value

of safety, etc. are measured through surveys and aggregated to report collective norms. While much research has been documented in behavioural and attitudinal aspects of safety culture, little is known about the organizational structures and processes or safety strategies that may have contributed to the individual-level attitudes and behaviours. Similarly, little is known about how the underlying values and unquestioned assumptions in an organization are actualized and about how they influence employee attitudes and opinions toward safety. In order to study safety culture in a more comprehensive manner, multiple research methods are required. A combination of qualitative and quantitative tools, applied over a sufficiently long duration (longitudinal studies), together with some drawn from safety engineering, organizational psychology, and anthropology, will enable us to present a more complete assessment of safety culture. This view of safety culture, known as the *Safety Culture Pyramid*, is used in this book as a shared theoretical context that can be used to assess the existing state of safety culture, develop appropriate interventions, and measure the changes in safety culture.

The Safety Culture Pyramid

Since the appearance of the term *safety culture* in the report on the 1986 Chernobyl nuclear reactor disaster, its popularity 'has led to prolific use of this concept ahead of the science of describing and assessing it' (Patankar and Sabin, 2010). Acknowledging the multi-dimensional and dynamic nature of *safety culture*, Patankar and Sabin (2010) developed a pyramid-style conceptual model that describes it as a state of dynamic balance between four stacked layers (see Figure 1.1). At the tip of the pyramid is safety performance (or safety behaviours), followed by safety climate (or employee attitudes and opinions regarding safety), next are the safety strategies, and finally, safety values form the foundation. We present this model as a pyramid because it provides a unique way of describing the linkages across various theoretical constructs.

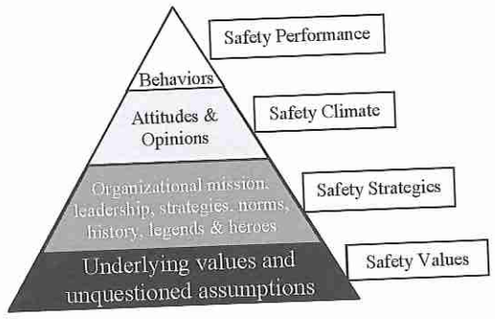

Figure 1.1 The Safety Culture Pyramid

Safety Performance

Historically, investigation of accidents has led to discovery of endemic problems in the organizational safety culture. Examples of such problems include blatant disregard for established procedures, lack of training, routine preference to speed-over-accuracy, and in some cases, rewarding of risk-taking behaviours. Most such investigations focus on the behavioural aspects or factors that are readily observable and directly attributable to the accident under investigation. It is very much a causal-contributory analysis. The 1989 Air Ontario accident in Dryden (Maurino, Reason, Johnston, and Lee, 1997) is perhaps the first case wherein the investigators were specifically instructed to go beyond the traditional causal mapping and uncover the deeper, organizational issues. Subsequently, accident reports have increased emphasis on organizational factors – this is evident in both the Challenger as well as the Columbia investigation reports (Vaughn, 1996; CAIB, 2003). Typically, some form of Root Cause Analysis is used to build a causal chain from the final event to all the actions and in some cases systemic circumstances leading up to the event. Once all the contributing factors are known, appropriate interventions can be developed to minimize the recurrence of a similar accident. From the perspective of the Safety Culture Pyramid, the contributing factors are very important because they may contain information about underlying and commonly present behavioural traits and systemic opportunities that should be managed in order to improve the safety performance of the organization.

Safety Climate

Safety climate, or employee attitudes and opinions regarding safety, has been measured primarily through a plethora of survey instruments. There are over 50 different survey instruments in use to measure employee attitudes and opinions regarding safety. Analyses of survey responses serve as snapshots of the prevailing attitudes and opinions. Since such responses are sensitive to the prevailing organizational conditions and employee perceptions of those conditions, such surveys are called *safety climate* surveys. If a series of safety climate surveys were conducted over multiple years, it would be possible to develop a safety climate trend across the specific factors measured by the instrument. However, most measurements have been episodic and therefore difficult to trend. Johnson (2007) used the Zohar Safety Climate Questionnaire to successfully validate safety climate as a social construct as well as a reliable predictor of safety outcomes (behaviours). Patankar and Sabin (2008) conducted a pre-intervention and post-intervention safety climate study, which demonstrated the influence of a specific intervention on safety climate. So, safety climate surveys could be used to describe longitudinal trends across various factors that are being studied or to determine the effects of specific interventions on the factors that are being studied. Nonetheless, safety climate questionnaires should be statistically validated: they should demonstrate sound validity and reliability.

Safety Strategies

We are using the term *safety strategy* as an umbrella term for organizational structures, policies, procedures, and practices, as well as leadership influence. In many aviation organizations, it is now a standard practice to have a Director of Safety, detached from the operational responsibilities of the organization and reporting directly to the CEO. Similarly, in healthcare organizations, we now have a Patient Safety Officer, who is typically housed under the VP for Quality and Safety. Internal policies and procedures, such as Standard Operating Procedures, help standardize the behavioural expectations across different individuals with similar roles and responsibilities. Industry-adopted protocols such as the Safety Management System or the Aviation/Patient Safety Reporting System serve as both performance management and benchmarking tools. Safety practices, on the other hand, are a measure of what really happens. When a troubleshooting procedure or a drug delivery procedure is particularly cumbersome or actually unsafe, the practitioners tend to develop a workaround. Such workarounds become norms and over a period of time these norms become the behaviours in practice. Vaughn (1996) calls such a trend, 'normalization of deviance'. While such a deviance is a gradual creep of practice away from published procedures, there are some examples where risk-taking behaviours are rewarded as long as they don't result in safety violations. For example, if mechanics can turn around an aircraft faster by not using personal protective equipment or pilots can save time by taxiing the aircraft faster than recommended, there are some inherent business benefits and therefore such behaviours may be either overlooked or rewarded. But when such behaviours result in accidents, the same individuals may be blamed. In a study linking safety leadership, safety climate, and safety behaviour, Wu, Chen, and Li (2008) demonstrate two paths that influence safety behaviour: one path from safety leadership to safety climate and then to safety behaviour; the other path directly from safety climate to safety behaviour. The latter path is a stronger influencer of safety behaviour; however, safety leadership is a stronger influencer of safety climate. The direct influence of safety leadership on safety climate may suggest the significance of leadership in establishing appropriate structures, policies, procedures, and safety performance expectations.

Safety Values

In high-consequence industries, such as aviation and healthcare, safety needs to be an enduring value, meaning it will be consistently practised such that it has sufficient edge over profit motives. However, rarely do we see *safety* in the list of organizational values. Instead, values are typically related to customers, market share, or humanistic elements like integrity, social responsibility, and respect. The values perceived or experienced by the employees are even more important. When an employee group was asked to list their organization's values, the dominant perception was that the organization simply wanted to make money.

In this case, 'to make money' was not explicitly listed as an espoused value of the organization, but it was certainly believed to be an enacted value. If the enacted values don't conflict with the espoused values, there's likely to be less confusion and dissatisfaction among employees, but generally the wider the gap between the espoused and enacted values, the greater the dissatisfaction among the employees. Ostroff, Kinicki, and Tamkins (2003) argue that values are owned and practised by individuals, not organizations; individuals imprint their values on the organization. So, if there's a significant gap between the espoused and enacted values of the organization, the personal values of the leadership of the organization need to be assessed. Of course, an organization may change its values over time, but such changes need to be made explicit. The link between organizational values (or leaders' values) and safety strategies tends to be more explicit in organizations where their original founders are still actively involved. However, DuPont Chemicals has managed to retain safety as its enduring corporate value since 1802. Further, it has helped its partner companies improve their safety culture as well. Clearly, there must be ways to maintain fundamental organizational values through leadership transitions.

Definition of Safety Culture

The *Safety Culture Pyramid* simply asserts that values, strategies, climate, and behaviour are linked. The notion of equilibrium asserts that these four safety culture elements may be linked to denote a variety of different temporal states. Therefore, Patankar and Sabin (2010) define safety culture as follows: 'Safety culture is a dynamically-balanced, adaptable state resulting from the configuration of values, leadership strategies, and attitudes that collectively impact safety performance at the individual, group, and enterprise level'.

Simply stated, safety culture is about 'why we do what we do'.

States of Safety Cultures

Organizational values, leadership strategies, employee attitudes and opinions, and employee behaviours are present in all organizations. They exist in a state of equilibrium: observable behaviours are a result of the dynamic balance that exists between enacted values, strategies in practice, and extant employee attitudes and opinions. Such equilibrium can be described in terms of a variety of different dominant states. Further, these states can be organized along at least two scales: the accountability scale and the learning scale. Four dominant states of safety culture along the accountability scale are as follows: 'Secretive culture, blame culture, reporting culture, and just culture' (Patankar and Sabin, 2010). Similarly, the dominant states along the learning scale are failure to learn, intermittent or isolated learning, continuous learning, and transformational learning. The specific state of safety culture along the accountability and learning scales could be

determined at each level of the Safety Culture Pyramid. For example, based on the review of safety performance and reaction to specific safety-critical events, one could classify the state of safety culture along the accountability scale and/or the learning scale.

The Accountability Scale

Figure 1.2 illustrates the four states of safety culture along the accountability scale: secretive, blame, reporting, and just cultures. Regardless of the specific state of safety culture, it would be very helpful to understand how the four layers of the Safety Culture Pyramid have attained their state of equilibrium and have collectively manifested a secretive, blame, reporting, or a just culture. A deeper analysis of each layer of the Pyramid and the interaction among the four layers will help us understand why a particular state of safety culture exists.

In a Secretive Culture, the organization is highly reactive, operates in a crisis mode for most events, and basic resources are tied to operational metrics with extremely limited accommodation for safety issues. Therefore, when safety issues arise, resources are either cannibalized from existing operational commitments or external sources such as insurance claims or federal aid need to be accessed. Also, several latent failures are known to individuals; in some cases, the errors or failures are masked to prevent punitive action or loss of existing, yet extremely limited resources. As a result of chronic lack of attention to safety issues and regular operation in a crisis mode, the employee-management trust is extremely poor. In such a cultural state, the trust between local management and regional management or the headquarters is also poor.

In a Blame Culture, the organization is highly reactive. Similar to the Secretive Culture, several latent failures may be known, but they tend to remain unaddressed. The organization focuses on identification and punishment of specific individuals in investigating undesirable events; thus employee-management trust is low. Consequently, safety-related performance tends to be poor, i.e. lost-time injuries, equipment damage, avoidable medical errors, etc. tend to be high.

In a Reporting Culture, the employees are regarded as sources of critical information to prevent recurrence of undesirable safety events. Effective mechanisms exist for employees to report latent systemic failures as well as individual errors. These reports are investigated and systemic solutions are

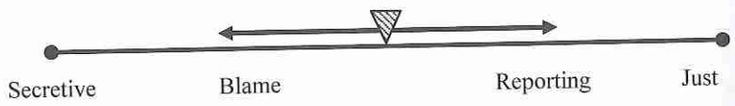

Figure 1.2 The dominant states of safety culture along the accountability scale (Patankar and Sabin, 2010)

implemented. Thus, employee-management trust is high and safety-related performance is strong. Examples of reporting systems include the Aviation Safety Action Program,[1] the Aviation Safety Reporting Program,[2] and the Patient Safety Reporting Program.[3]

In a Just Culture,[4] the people are encouraged, even rewarded, for providing essential safety-related information (Reason, 1997). In normal operations, emphasis is placed on the development of strong safety behaviours – actions, independent of their outcomes, are judged (Marx, 2001). Risk-taking behaviours are penalized, regardless of the actual loss/benefit, and risk-conscious safety behaviours are supported, even if they result in an undesirable event. Emphasis is placed on systemic investigations and solutions. Both management and employees are held accountable for safety improvements and therefore employee-management trust is very high.

The Learning Scale

The dominant state of the prevailing Safety Culture can be classified in terms of organizational learning literature as 'failure to learn, intermittent or isolated learning, continuous learning, and transformational learning' (Patankar and Sabin, 2008). Safety culture in aviation and healthcare can be strategically improved and transformed by engaging in organizational learning processes. Figure 1.3 illustrates the four states of safety culture along the learning scale.

Overall, organizational learning is defined as 'a process of detecting and correcting error' (Argyris, 1977). Organizational learning depends on individuals; however, individual learning alone is not sufficient to produce organizations that learn (Argyris and Schön, 1978). Crossan, Lane, and White (1999) present a useful multilevel framework for understanding the unique contributions that individuals, teams, and systems make to organizational learning. In their model, the generation of new learning begins with individual intuition and interpretation of events. Through dialogue with team members, shared understanding and joint action become possible. Lastly, institutionalization at the organizational level embeds the learning from individuals and teams into new routines, systems, rules and procedures ('strategies' in the Safety Culture Pyramid) to ensure improved performance ('safety performance or behaviours' in the Safety Culture Pyramid) in the future. In effect, such learning techniques can enable replacement of ineffective or unsafe practices with improved and safer practices, eventually changing the organizational culture.

An organization that is in a state of 'failure to learn' is characterized by recurrence of undesirable events with similar causal contributors. For example,

1 <http://www.faa.gov/about/initiatives/asap/>.
2 <http://www.asrs.arc.nasa.gov/>.
3 <http://www.psrs.arc.nasa.gov/flashsite/index.html>.
4 <http://www.justculture.org/default.aspx>.

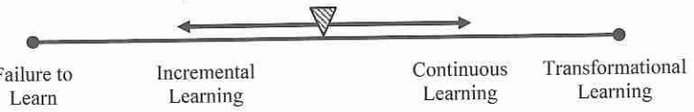

Figure 1.3 The dominant states of safety culture along the learning scale

an organization tends to have repeated heparin dosage errors due to confusing labels or repeated loss of aircraft wheels after take off due to failure to follow proper maintenance procedures. Intermittent or isolated learning typically takes place in response to specific negative experiences, and such learning is limited to preventing those specific negative experiences. For example, as a result of one case of heparin dosage error, the hospital institutes special procedures to prevent heparin dosage errors in the future, but does not address other adverse drug events with similar root cause. Similarly, in the case of aircraft maintenance, the organization conducts special training regarding wheel maintenance, but does not address known errors in other maintenance procedures with similar root cause. In contrast, an organization that is deemed to be a 'continuous learning' organization, creates systems – structures, processes, and people – that not only capture learning opportunities, but also implement solutions that address broad systemic issues. So, if a hospital is in the state of continuous learning, the heparin error would prompt that hospital to build a system that addresses all adverse drug events. Similarly, if an airline is in the state of continuous learning, the procedural error in wheel maintenance would cause the airline to build a system that reviews and improves all maintenance procedures. Finally, in the case of an organization that is in the state of 'transformational learning', the organization would already have a system in place to prevent errors and be proactive in minimizing the probability of errors across the organization. Such an organization would also be recognized among its peers as one that leads in safety innovations and shares safety information freely – an organization that does not compete on safety.

Barriers to Organizational Learning and Potential Solutions

Argyris (1994) describes how individual defensiveness and organizational defensive routines inhibit effective communication, insight, and improved action. Likewise, Mai and McAdams (1995) comment on individual and organizational impediments to learning in the form of limited perspectives (e.g. blind spots) and negative motives (e.g. fear). Senge (1990) discusses seven learning disabilities that afflict organizational settings, including the 'delusion of learning from experience'. He argues that a core learning problem is due to individuals not directly and immediately experiencing the consequences of important decisions since the results take time to become obvious. Husted and Michailova (2002) note problems of learning associated with knowledge-sharing hostility. People are not

comfortable sharing knowledge and therefore may disadvantage the institution. Shaw and Perkins (1992) describe a useful model that organizes causes, symptoms, and solutions associated with barriers to organizational learning.

The Shaw and Perkins Model (Shaw and Perkins, 1992) of barriers to organizational learning is presented in Figure 1.4. The three key barriers to learning from experience are insufficiencies in reflection, action and dissemination. They argue that an individual's decisions and actions are based on a combination of cognitive, perceptual, and attitudinal factors including knowledge, expertise, opinions, strategies, values and assumptions. Events in the world are perceived and interpreted through the individual's prevailing 'belief system' which also provides the basis for action that leads to the outcomes of success or failure. Productive learning can occur when individuals or groups reflect on the consequences of their actions. Reflection that leads to insight about why things went right and turned out as expected allows successes to be sustained. Correspondingly, evaluation of differences between what was intended and what resulted allows one to learn from mistakes, errors, failures, and other unexpected or unintended outcomes. Reflection that leads to insight allows error to be detected and corrected. To be truly effective and produce a sustainable advantage, the insight needs to be disseminated, shared, understood, and integrated into the revised cultural belief system that forms the basis for improved action. For the new knowledge to be effectively applied, organizational members must be empowered to act on the revised belief system.

Shaw and Perkins (1992) suggest that symptoms of insufficient reflection include denial of problems and incomplete or incorrect analysis. This may be caused by performance pressure to produce, competency traps, and an absence of opportunities for reflection and learning. Kramer and Sabin (2003) suggest

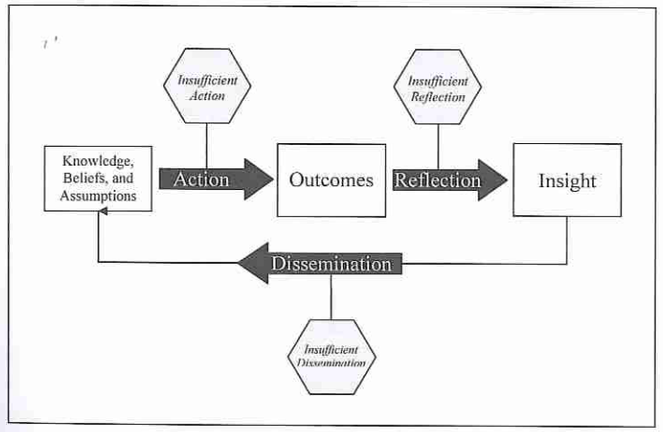

Figure 1.4 Barriers to organizational learning (adapted from Shaw and Perkins, 1992)

that managers and leaders can help overcome insufficient reflection by creating opportunities for shared reflection by implementing events such as debriefings, regular unit meetings, retreats, reflection sessions, strategic planning sessions, and learning conversations. Leaders who recognize, reward, and apply new insights will help engage organizational members in the learning process.

Ironically, Argyris (1986) points out that some of the most highly skilled individuals may in fact be the most resistant to learning and change due to what he calls skilled incompetence: 'Managers who are skilled communicators may also be good at covering up real problems' (p. 74). Argyris (1991) also argues that teaching the smartest people in the room how to learn from mistakes and failure may be the most difficult task since professionals with high levels of expertise have often been shielded from the experience of failure. Consequently, they have not experienced how to learn from failure and when things do go wrong they place blame on others rather than accepting responsibility. To correct this situation, Argyris (1991) suggests that professionals 'need to reflect critically on their own behaviour, identify the ways they often inadvertently contribute to the organization's problems, and then change how they act. In particular, they must learn how the very way they go about defining and solving problems can be a source of problems in its own right' (p. 100).

According to Shaw and Perkins (1992), symptoms of insufficient dissemination of learning include redundancy of effort and ignorance of problems and solutions. Strong inter-group boundaries may block the sharing of learning; organizational units may operate as functional information silos. Husted and Michailova (2002) discuss some of the problems and barriers associated with sharing knowledge. They conclude that reasons for hoarding information involve individual economic concerns or political power games. Recipients may reject knowledge sharing attempts due to professional pride or a desire to maintain the status quo. Cultural attitudes about whether mistakes are viewed as unavoidable or impermissible also have powerful influences on the effectiveness of knowledge dissemination. Husted and Michailova (2002) suggest several strategies for overcoming knowledge sharing hostility such as building trust and cultural expectations of knowledge sharing. Managers can also strengthen sharing and dissemination through both modelling and rewarding knowledge sharing. Shaw and Perkins (1992) suggest promoting collaboration, holding cross-functional conversations, and creating effective systems for knowledge management to promote dissemination of learning.

Knowing is not enough: action is required for organizational improvement. Shaw and Perkins (1992) discuss several reasons for a failure to act on new knowledge, including difficulties of overcoming the inertia of existing procedures, confusion among competing priorities, inadequate resources, and a sense of powerlessness to enact the required change. To encourage effective implementation of new knowledge, leaders need to be willing to challenge extant assumptions and procedures and be willing to support innovation by empowering people to act on new knowledge.

Table 1.1 summarizes the Shaw and Perkins (1992) model in the form of relationships between barriers to learning, symptoms of such barriers, causes for the barriers, and potential solutions.

According to Garvin (1993) a learning organization is 'skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights'. He argues that learning organizations are skilled at five main activities: systematic problem solving, experimentation with new approaches, learning from past experience, learning from the best practices of others, and transferring knowledge quickly and efficiently throughout the organization. In the following section, a set of learning tools are presented that can be used in aviation, healthcare, and other high-consequence industries to improve safety. These tools improve reflection, action, and dissemination of best practices. They act as countermeasures to learning disabilities by developing new learning capabilities to improve safety culture. Table 1.2 contains a summary of selected learning tools that are presented in relationship to the Safety Culture Pyramid.

Table 1.1 Barriers to learning (adapted from Shaw and Perkins, 1992)

Barrier	Symptoms	Causes	Solutions
Insufficient Reflection	• Denial of problems. • Incomplete or incorrect analysis.	• Performance pressure. • Competency traps. • Absence of learning forums.	• Stop and think. • Discuss and inquire. • Examine assumptions and experience. • Seek insight. • Think in new ways.
Insufficient Dissemination	• Problem ignorance. • Solution ignorance. • Redundancy of effort.	• Intergroup boundaries. • Myth of uniqueness. • Narrow information bandwidths.	• Collaborate. • Hold learning conversations across groups and levels. • Promote exchange and adoption of ideas across boundaries. • Build effective systems to share, store, and retrieve knowledge.
Insufficient Action	• Lack of experimentation. • Implementation failures.	• Priority stress. • Bias towards activity versus results. • Perceived powerlessness.	• Invest in experimentation and risk taking. • Empower people to act on new knowledge. • Actively apply lessons learned. • Build a learning culture.

Table 1.2 The Safety Culture Pyramid and basic organizational learning tools

Pyramid Level	Questions for Safety Leaders to Ask	Learning Tools	Purpose	Source Description
Safety Performance (behaviours)	Do we understand why mistakes and failures occur? Are we too busy to take time to reflect?	After Action Review	Improve action by understanding causes of success and failure.	Baird, Holland and Deacon (1999), Kramer and Sabin (2003)
Safety Climate (attitudes and opinions)	What aspects of our culture support or interfere with learning from experience?	Learning Capabilities Survey	Determine learning barriers and enablers.	Marsick and Watkins (2003), Goh (2003), Jerez-Gomez, et al. (2005)
Safety Strategies (mission, leadership strategies, norms, history, legends, heroes)	How do we capture and revisit key moments in our history to prepare for the future?	Learning History	Capture seminal stories that are highly instructive.	Kleiner and Roth (1997)
Safety Values (underlying values and unquestioned assumptions)	Do we practice what we preach? What topics are difficult or not discussable? Do we promote open inquiry?	Dialogue Left Hand Right Hand Column	Examine deeply held beliefs that influence critical decisions and actions.	Senge (1990), Argyris and Schön (1974)
Whole Pyramid Dynamics	Do we connect the dots? Do we see the big picture?	Systems Thinking	Understand the complex causes and structures that influence performance.	Senge (1990), Carroll (1998)

Learning Tools

Each layer of the Safety Culture Pyramid may be examined with a specific learning tool; further, all the layers may be examined in a holistic manner using 'systems thinking'. Table 1.2 illustrates the mapping of each layer with the respective questions that safety leaders must ask, a learning tool that is suited for the specific layer, the purpose of the learning tool, and sources for additional information about the tool and its application.

Many organizations continue to make the same mistakes time after time. After Action Review is a widely used learning tool that provides a powerful yet inexpensive means to examine and improve performance. It provides a systematic way to reflect on experience, determine why successes or failures occurred, and apply the lessons learned to improve future action. The intent is to fix problems

not to affix blame. By determining what went wrong, similar mistakes can be avoided in the future. Likewise, by understanding what went right, effective performance can be sustained and improved. After Action Review has been used extensively by the US Army (Morrison and Meliza, 1999; Wheatley, 1994; US Army Combined Arms Center, 1993). Baird, Holland, and Deacon (1999) describe general applicability of After Action Reviews to a diverse array of organizational settings and time horizons (short-term, e.g. quick behavioural change; mid-term, e.g. policy modification; and long term, e.g. strategy transformation).

After Action Review sessions focus on five key questions: What were our objectives? What were our results – what really happened? What caused things to turn out the way they did? How do we sustain what went right? How do we improve what went wrong? The purpose of answering these questions is to uncover what the group knows following its performance that it did not know previously. Kramer and Sabin (2003) point out that for an After Action Review to be effective it must be rooted in a culture that promotes honest communication and values openness rather than defensiveness. The review should be conducted by a facilitator who frames the questions in terms of genuine dialogue that seeks to understand the causes of performance outcomes, that attempts to address underlying values, and that aims to surface unquestioned assumptions. No topics are to remain guarded from discussion. The point of the review is to capture new knowledge in lessons learned that can be quickly disseminated and acted upon. The review seeks to translate insight into improved action. An After Action Review achieves its greatest effectiveness when it becomes institutionalized as a new habit of mind and develops into a standard operating procedure for individuals, teams, and organizations.

Conducting a learning capabilities survey can determine an organization's learning barriers and enablers. Several normed surveys have been developed for this purpose. Benoit and Mackenzie (1994) describe a diagnostic process and introduce a variety of survey forms that can be used for organizational assessment. They identify 12 main enabling processes for effective learning and change that focus on the following areas: strategic direction, organizational logic, decision-making, position clarity, systematic planning, strategic human resources, innovative problem solving, enterprise-wide problem solving, performance standards, reward systems, interest compatibility, and ethical behaviour.

Goh (2003) developed a 21-item questionnaire that measures five learning capability dimensions: mission/vision clarity, leadership commitment and empowerment, experimentation and rewards, effective transfer of knowledge, and teamwork and group problem solving. The learning capability survey was used longitudinally to assess change programmes to improve learning capability in two organizations over a two to three year period. Significant improvements were documented in several dimensions of learning capability.

Jerez-Gomez, Cespedes-Lorente, and Valle-Cabrera (2005) report the development of a 16-item organizational learning capability measure. Their data were collected from a sample of chemical firms in Spain. Principal components and

confirmatory factor analyses clearly supported four dimensions of organizational learning capability that included the following: managerial commitment, systems perspective, openness and experimentation, and knowledge transfer and integration.

Marsick and Watkins (2003) developed the Dimensions of the Learning Organization Questionnaire (DLOQ). This instrument collects information at the individual, team and organizational level on a total of seven dimensions: continuous learning opportunities, inquiry and dialogue, collaboration and team learning, systems to capture and share learning, collective vision, connection to the environment, and strategic leadership for learning. The scales have proven psychometrically reliable and have been used by a sizeable number of companies. Yang, Watkins, and Marsick (2004) presented a structural equation model of the DLOQ that showed significant effects of the dimensions on measures of knowledge performance and financial performance. The DLOQ is currently the most accessible and widely used measure of organizational learning. It can be used to provide insight into the learning capabilities of aviation and healthcare systems.

An organization that corrects glaring faults after a significant failure and then returns to 'business as usual' in other aspects of its operation, has learning that is intermittent at best. Intermittent learning is crisis-focused. Here results of the learning process are typically isolated to the particular event. Consequently little capacity is developed for sustained reflection on performance and it is unlikely that lessons learned will be shared with other parts of the organization. Additionally there is little interest in further performance improvement until another significant failure occurs.

By contrast, organizations that appreciate the value of continuous learning (e.g. total quality management paradigms) have defined processes in place that seek to consistently improve the quality and reliability of goods and services. Continuous learning is also described as single loop learning by Argyris (1977). Single loop learning attempts to better achieve the given goal by gradual incremental improvement.

Argyris (1977) also introduces the concept of double loop learning to describe situations where the rules themselves are questioned and individuals inquire about the goal itself and the web of assumptions related to it. Double loop learning can lead to a reframing and rethinking of the situation. More recently a newer focus has emerged that is termed triple loop learning (Wang and Ahmed, 2003). Here the focus is on learning to learn, achieving creative insight, innovation, transformation, and knowledge creation.

Learning histories capture seminal stories from the past that can be highly instructive for organizational members. The learning history makes individual experience and insight into it an organizational or systemic learning opportunity. Part of the power of the learning history comes from collective group discussion and reflection on significant events from the story. These events can be communally re-experienced and re-analyzed allowing difficult issues to be exposed for group dialogue. An important outcome is the creation of a shared understanding of the past events and of how lessons learned are relevant to the current organizational

setting. Kleiner and Roth (1997) describe the process for creating the learning history document, which includes a narrative of the key events viewed from the perspective of multiple stakeholders. The document also contains commentary that seeks to uncover underlying assumptions, values, conflicts and reasoning associated with the events; and poses questions that are meant to evoke collective reflection and conversation.

Systems Thinking

Systems Thinking is an important perspective in aviation and healthcare safety because it attempts to understand the dynamics of the 'big picture' and 'connecting the dots' among multiple levels of interacting influences. The history of accident analysis in aviation demonstrates the progression towards systemic analysis. Initial attention was directed to the mechanical reliability of aircraft; however, the safety focus soon included the role and proficiency of the individual pilot. Successive generations of cockpit/crew resource management (CRM) training (e.g. Helmreich, Merritt, and Wilhelm, 1999) focused on individual competencies, group dynamic among the flight crew, interaction with other groups such as dispatchers and maintenance mechanics, integration and institutionalization of procedures into training and normal operations, and an attempt to embrace the entire system by engaging all employees to improve safety. A parallel to CRM's evolution is found in the development of a four-stage accident theory noted by Wiegmann, Zhang, von Thaden, Sharma, and Gibbons (2004). These four stages include the technical period; human error period; socio-technical period; and most recently, the organizational culture period.

The approach of systems thinking was popularized by Senge (1990) as a crucial process in organizational learning. This approach focuses on seeing the interrelationships, patterns, and underlying structures that reveal the dynamic interplay among system components. Systems thinking goes beyond typical linear analysis of cause and effect to include recognition of circular patterns of causality and feedback that play out over time and space. Senge describes a set of underlying generic structures (archetypes) that can be used to diagnose, model, and determine effective points of intervention for change. Carroll (1998) provides an example of how a systems approach can be applied in high-consequence industries.

Attempts to improve healthcare safety have increasingly turned to a systems approach to understand and reduce preventable error (e.g. Carroll and Edmondson, 2002; Larson, 2002; Johnson, Miller, and Horowitz, 2009). Vincent (2004) advocates a systems analysis to investigate clinical incidents and a systems approach to improve surgical quality and safety (e.g. Vincent, Moorthy, Sarker, Chang, and Darzi, 2004). Likewise, Waring (2007a) and argues that researchers and practitioners need to understand how contextual factors can interact in unanticipated ways in complex systems to produce accidents. However, Waring (2007b) reaches a concerning conclusion about how a physician's attribution of

medical error to 'the system' can serve as a rationalization diminishing personal responsibility and allowing accommodation to a flawed system. Waring concludes that 'doctors are neither reaching out to, nor being reached by, the experts from other fields, and that the concept of "systems thinking" as promoted by the patient safety movement is not significantly penetrating the culture of frontline medical staff' (p. 45). The complexities of penetrating culture to institute systemic change can also be seen in the assessment given by Simon and Pronovost (2008), who contend that 'the publication of *To Err is Human* was the vanguard to improve patient safety. Upon nearing the report's 10-year anniversary, little appears to have changed with significant barriers encountered when attempting to track progress' (p. 2913).

Comparative Review of Safety Culture Scales

To summarize the above discussion, the state of safety culture in a given organization may be represented along two scales: the accountability scale and the learning scale. Figure 1.5 presents a conceptual parallelism across these two scales. While there is no empirical research linking the accountability scale and the learning scale, one could hypothesize that the four states across each of the scales are linked. Further, movement of along one scale may be associated with a concurrent movement along the other scale.

Aviation and Healthcare: Two High-consequence Industries Striving for a Stronger Safety Culture

Aviation and healthcare can be considered high-consequence industries because of the potential for loss of human life in the event of an error. In aviation, when the consequence of errors is catastrophic, there is national or international media attention and the entire industry suffers from negative publicity. In contrast, errors in healthcare were mostly unpublicized until the now famous Institute of Medicine report (IOM, 2001), which alarmed the public by estimating that preventable medical errors could be causing between 45,000 and 98,000 deaths per year. Comparatively, that's about five transport airliner accidents per week!

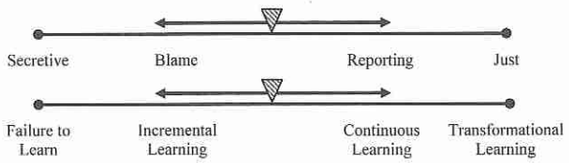

Figure 1.5 The safety culture continuum

In response to the 2001 IOM report, the healthcare community has engaged in numerous efforts to improve its safety culture. Since the aviation industry has been regarded as one of the High Reliability Organizations (HRO, Roberts, 1993), it was seen as an immediate ally in the quest for improved patient safety. Several successful initiatives from aviation were customized for healthcare applications. Examples of such initiatives include Crew Resource Management (CRM), Safety Climate Studies, Just Culture, Checklists, and Socio-Technical Probabilistic Risk Assessment. Saint Louis University has been hosting a series of conferences called 'Safety Across High-Consequence Industries', to provide a forum for researchers and practitioners in aviation, healthcare, nuclear power, chemical manufacturing, etc. to share their best practices, challenges, and success stories. These conferences have developed a network of safety champions who learn from each other and implement practical, effective safety solutions in their respective domains.

Patankar, Brown, Sabin, Bigda-Peyton, and Kelly (2005) reviewed safety culture literature across a variety of domains and reported three zones of safety or reliability (the terms *safety* and *reliability* are used interchangeably):

- Normal: the probability of failure is greater than one in one million operations.
- High Reliability: the probability of failure is between one in one million and one in a billion operations.
- Ultrasafe: the probability of failure is equal to, or less than, one in one billion operations.

Patankar et al. (2005) argue that the typical path from Normal to Ultrasafe is through High Reliability, which is generally achieved by extreme standardization of systems, equipment, procedures, and training. However, they also argue that the very type of standardization that allows a system to transition from Normal to High Reliability, may prevent it from transitioning further to Ultrasafe. Since Ultrasafe is becoming an essential business and societal mandate, in both aviation and healthcare, much attention has been focused on achieving that goal. Systemic improvements made in both industries, under the safety culture improvement initiatives, could help them achieve ultrasafe status.

Similarities and Differences Between Aviation and Healthcare Industries

Aviation and healthcare are similar in the overall nature of their work. Let us consider a heavy maintenance hangar in aviation. This hangar is very similar to a hospital. An airplane comes into the hangar for a 'check-up', mechanics and engineers from a variety of specialties interact with the airplane, perform their respective tasks in a predetermined manner and to pre-established standards, and finally approve the airplane for return to flight. Similarly, for inpatient services, hospitals admit a patient, physicians, nurses, and therapists provide a variety

of medical, nursing, and therapy services in accordance with their respective professional standards and the needs of the patient, and finally approve the patient's discharge. In both industries, work is typically carried out in multiple shifts and over multiple days. Consequently, many of the challenges faced by aviation maintenance personnel and healthcare professionals are similar. Some examples of these challenges are as follows:

- Fatigue due to shift work or extended duty times.
- Interpersonal communication challenges due to shift-turnovers.
- Teambuilding challenges due to dynamic team membership.
- Power distance due to seniority or professional specialties.
- Speed-Accuracy Trade Offs.
- Staffing challenges.
- Professional liability.

While there are many similarities between aviation and healthcare, there are some fundamental differences as well. In the United States, healthcare does not have a single regulatory body to provide comprehensive oversight, whereas in aviation, personnel, facilities and aircraft are all certificated by the Federal Aviation Administration. Due to a lack of a comparable oversight body in healthcare, there are certain inherent challenges across the system. For example, it is difficult to standardize certain routine tasks across medical facilities. Nonetheless, organizations like the Federal Drug Administration, the Agency for Healthcare Research and Quality, as well as the Joint Commission are trying to encourage hospitals as well as medical professionals to adopt certain industry best practices. In fact, state health departments, entrusted with licensing the hospitals to conduct business, are strongly encouraging their hospitals to participate in voluntary adverse event reporting.

The fundamental nature of medical education is 'craft-based': a senior physician works with a junior physician and imparts not just the technical knowledge, but also the diagnostic heuristics. Consequently, there is a noticeable branding of physicians from one intellectual lineage over another. In aviation, the knowledge, skill, and performance expectations are more explicit, resulting in a more regimental repetition of procedures. Furthermore, the recurrent training requirements for pilots are very different from the continuing education requirements for physicians.

Medical simulation – particularly patient simulation – is relatively new. There are no explicit standards for fidelity. Comparatively, the flight simulation technology is very mature and technically advanced to the point that certain airline pilots are trained exclusively on simulators – when they fly the real airplane for the first time, it is often with a full load of passengers. Similarly, there are challenges with standardization of medical diagnostic equipment, infusion pumps, surgical room set-up, etc.

Safety Culture in Aviation

Over the last 100 years, safety culture in aviation has evolved primarily through trial and error. Since pilots are personally committed in each flight, safety of flight has a direct impact on the life of the pilots. In the early years of aviation, most of the accidents were attributed to unreliable technology; hence, research efforts were focused on improving the technology. As the hardware improved, it became more reliable; as the technical reliability improved, the range of operations expanded; as the operating range/envelope expanded, the complexity of challenges increased; and as the business of air travel became more complex, the improvements in technology alone were no longer sufficient to improve safety. Hence, in the last three decades, the emphasis has shifted toward the human element – first in terms of team communication (crew resource management and maintenance resource management) and now in terms of organizational change (safety management systems and safety culture).

Another point to bear in mind about the evolution of safety culture in aviation is the role of regulations. Aviation is arguably one of the most regulated industries. As such, safety is managed through compliance – from design, operation, and maintenance of aircraft, to initial and recurrent training of all pilots, to certification of processes and protocols used in operation and maintenance, to standardization of signage and phraseology, to certification of tools and inspection equipment, to traceability of parts all the way from raw material stock to the finished product and of course their own quality standards! So, it is fair to say that the high reliability (less than one failure in one million operations) has been attained in aviation primarily through standardization or compliance-based safety culture.

The compliance-based safety culture has reached its saturation limit: further addition of regulations is not likely to produce an appreciable increase in safety. On the contrary, addition of regulations could restrict the system's ability to improvise in the face of new threats. In the future, the safety culture needs to be based on safety as a core, enduring value that is practised as a top institutional priority, particularly when in competition with business pressures. Individual professionalism (taking responsibility to improve systemic safety through technical excellence and proactive reporting of errors and hazards) and employee-management trust (employees reporting safety issues without fear of reprisal and management taking appropriate, non-punitive systemic actions in the interest of safety) are both critical to the development of a robust safety culture.

Just Culture is an essential philosophical shift. As long as organizations and legal systems use consequence of an error, rather than the underlying behavioural pattern, as the primary criterion to decide rewards and penalties, an unjust culture will prevail. At-risk behaviours tend to be rewarded when they produce positive business outcomes and penalized when they produce negative business outcomes. In the future, emphasis must be on controlling the underlying at-risk behaviour regardless of the consequence of the behaviour. A non-punitive error reporting system, through improved quality of work and increased productivity, is a

foundational mechanism to not only improve the safety, but also make a significant contribution to the financial health of the organization.

Safety Culture in Healthcare

Management of risk has always been an integral part of medical/clinical procedures. Healthcare professionals are acutely aware of risks involved in various medical procedures or clinical trials of drugs. Such awareness perhaps has also contributed to the acceptance of failures and side effects on a case-by-case basis. However, these failures and side-effects assume that there would be no preventable errors in the system. The degree to which preventable errors, such as medication errors, contribute to deaths or serious injuries was exposed in the seminal report by the Institute of Medicine (IOM), *To Err is Human*, 2001.

Since the release of the IOM report, the healthcare industry has been extensively and aggressively engaged in learning from other industries such as aviation and nuclear power. Several hospital administrators and scores of leading physicians, surgeons, and nurses have taken a proactive role in learning the state of the art regarding safety performance metrics, strategies, and best practices. Some remarkable milestones achieved by the industry in the United States include the following:

- *The National Patient Safety Foundation*[5] was formed in 1997 to 'improve the safety of the healthcare system'.
- *The National Center for Patient Safety* was established in 1999 to 'develop and nurture a culture of patient safety throughout the Veterans Health Administration'.[6]
- *The Institute for Healthcare Improvement*[7] first launched the 100,000 Lives Campaign and later the five Million Lives Campaign to bring national and international awareness as well as to build a ground swell of momentum toward reducing medical errors.
- *The Joint Commission on Accreditation of Healthcare Organizations*[8] sets specific patient safety and quality goals each year that become the goals for its accredited hospitals.
- *MORE-OB (Managing Obstetrical Risk Efficiently)* is a 'comprehensive, three-year, patient safety, professional development, and performance improvement program for caregivers and administrators in hospital obstetrics units'.[9]

5 <http://www.npsf.org/>.
6 <http://www.patientsafety.gov/>.
7 <http://www.ihi.org/IHI/Programs/Campaign/>.
8 <http://www.jointcommission.org/>.
9 <http://www.moreob.com>.

- *Beth Israel Deaconess Medical Center* pledged to 'eliminate all preventable harm by January 1, 2012'.[10]
- *Ascension Healthcare* recommitted itself to 'Healing Without Harm', a quest to build high-reliability healthcare.[11]

As a result of industry-wide efforts, it is now widely acknowledged that patient safety must improve and increasingly, systemic and diverse efforts are being launched across the nation.

Chapter Summary

The *Safety Culture* concept is presented in the form of a two-dimensional pyramid model: vertical and horizontal. The vertical aspect of the model presents a Safety Culture Pyramid with four layers: safety performance, safety climate, safety strategies, and safety values. Available literature suggests that these four layers are linked and that they influence each other. The horizontal aspect of the model presents safety culture in the form of temporal states that can be expressed along a *Safety Culture Continuum*, which can be delineated in terms of an accountability scale and/or a learning scale. A summative illustration of this model is presented in Figure 1.6.

Similarities and differences in aviation and healthcare are presented to lay the foundation for comparative discussion across these two industries throughout the book.

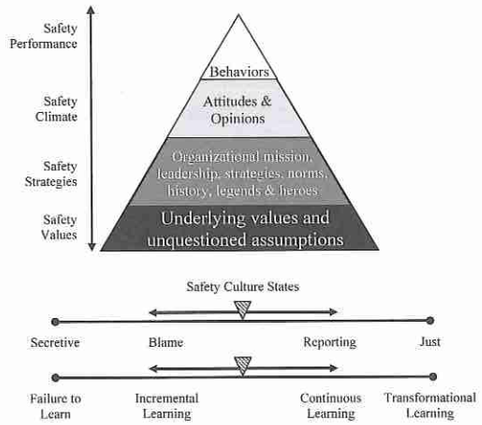

Figure 1.6 Two-dimensional look at the Safety Culture Pyramid

10 <http://www.bidmc.org/QualityandSafety/AspirationsforBIDMC.aspx>.
11 <http://www.ascensionhealth.org>.

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Chapter 2
Safety Culture Assessment

Introduction

In this chapter, we present an overview of various assessment techniques that may be used to build a comprehensive understanding of safety culture in a given organization. Based on the Safety Culture Pyramid Model presented in the previous chapter, we point out a repertoire of qualitative and quantitative assessment tools and techniques that will enable you to fully describe the state of safety culture in your organization.

Analysis of safety behaviours typically starts with a specific event case; hence, case analysis is the dominant technique used to analyze safety performance. In aviation, there are several tools used to analyze and report accidents. Some examples of such tools are: Human Factors Classification System (HFACS); Aviation Safety Human Reliability Analysis Method (ASHRAM); and Maintenance Error Decision Aid (MEDA). In healthcare in the United States, the most commonly recommended tools are provided by the Veterans Health Administration, the Agency for Healthcare Research and Quality, and the Institute of Safe Medication Practices. In both industries, the core methodologies incorporate the key principles of Root Cause Analysis. The causal or contributory factors, which tend to identify technical, systemic, or human factors issues, could then be used for longitudinal trending and tracking. The Heinrich Triangle or the Iceberg Model is used to illustrate how we can shift the focus from infrequently occurring fatal accidents to more frequently occurring incidents and thereby address the common underlying causes or latent systemic failures. This approach assumes that reducing the number of incidents will reduce the probability of major accidents.

As we move from safety performance to safety climate, the dominant technique is survey analysis. There is a plethora of survey instruments in use; some of them have been extensively tested for validity and reliability. We discuss some of the key scales developed through either exploratory or confirmatory factor analysis. Since safety climate is a snapshot of employee attitudes and opinions toward safety, such measurement has limited use in immediate diagnosis; however, data collected from the same organizational unit over multiple years, across different organizational units, or across different organizations in the same industry could be used to benchmark for comparative purposes, and similarities and differences across the subject populations could be studied. Pre- and post-intervention safety climate studies could be used to test the effect of specific interventions. Finally, we present some studies that have been able to demonstrate a link between safety climate and safety behaviours or performance.

Safety strategies need to be studied with a variety of tools and techniques. One of the simplest, yet quite impressive techniques, is artifact analysis. For our purpose, an artifact is physical evidence that could be used to develop a story about specific strategies (mission, values, leadership, structures, processes, policies, practices, etc.) that are used to influence the safety culture in a given organization. Other techniques include field observations like the Line Oriented Safety Audit, specific interviews or dialogues that yield stories about the history of the organization or heroes and legends in the organization, as well as interviews with 'key informants' (people who are either formal or informal leaders in the organization or those who possess deep tribal knowledge). In other words, safety strategies comprise all the things that help institutionalize the culture.

Finally, we discuss the use of artefacts, dialogue and focus group discussion to reveal the gap between espoused values and enacted values. Espoused values are the published values as they appear on corporate websites, annual reports, and general marketing materials. Enacted values are those that people working in the organization seem to experience. Generally, the tighter the alignment of values and strategies, the smaller the gap between espoused values and enacted values; the smaller the gap between espoused and enacted values, the better the safety climate; the better the safety climate, the better the safety performance.

In order to measure the effects of specific interventions on safety culture, a quasi-experimental analysis is recommended. Again, a multidisciplinary approach, borrowing from organizational psychology and anthropology, can be used. A combination of techniques for pre- and post-intervention comparisons is presented. The approach is called 'quasi' experimental because we don't have complete control over the sample population as we implement the intervention; consequently, there are factors other than the intervention itself that may have contributed to the overall change in the culture. So, the intervention and the change may not have 100 per cent cause-effect relationship.

Assessment Methods

Given the multi-faceted, multi-level nature of safety culture, both qualitative as well as quantitative methods are necessary to produce a comprehensive understanding. Figure 2.1 presents four applicable analytical techniques and their corresponding empirical results. These main methodological approaches include the following: case, survey, qualitative, and quasi-experimental analyses. Each of these approaches yields information about various layers of the Safety Culture Pyramid. Together, a multi-method approach (e.g. Di Pofi, 2002) enables triangulating of results from multiple sources (e.g. Paul, 1996) and ultimately yields a comprehensive understanding of the safety culture construct and its different states.

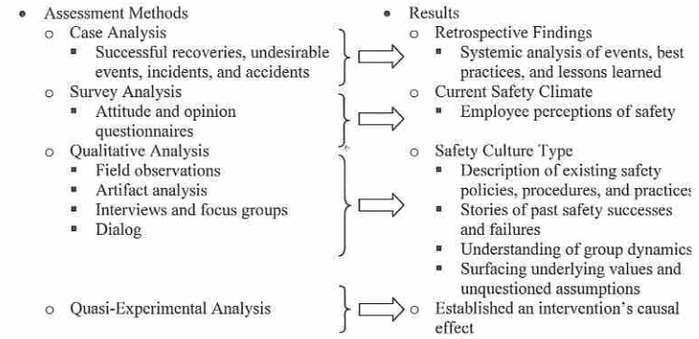


Figure 2.1 Safety culture assessment methods

Case Analysis

Behaviours of individuals and/or groups that are related to the occurrence of undesirable events, incidents or accidents attract attention from investigative and regulatory agencies. A case method is most commonly used in retrospective analysis of undesirable events as well as successful recoveries from an impending disaster (e.g. pilot Sullenberger's successful landing of US Airways flight 1549 in the Hudson river in January 2009 after a disabling bird strike).

In the early years of aviation accident investigation, the causal factors identified in retrospective case analysis were primarily technical and hence interventions were mostly focused on improving the reliability of the technology. As the aviation industry matured and its technology improved, safety attention was expanded to individual human factors and team performance issues (e.g. Crew Resource Management and Maintenance Resource Management) in addition to technical factors. Consequently, accident investigation reports reflected issues concerned with crew coordination, communication, fatigue, and adherence to policies and procedures. More recently, attention has been focused on the additional role of organizational factors in accidents, yielding a corresponding concern with organizational safety culture.

Examples of this retrospective and case-based approach in aviation include investigation techniques used by the National Transportation Safety Board and the National Aeronautics and Space Administration (e.g. NTSB, 2002; NASA, 2006). This retrospective case approach is also found in healthcare and includes Morbidity and Mortality conferences used to review medical error and undesirable patient outcomes (e.g. Gordon, 1994; Pierluissi, Fischer, Campbell, and Landefeld, 2003; and Rosenfeld, 2005) as well as investigations by the respective state-level organization overseeing medical services provided by the local hospitals (e.g. California Department of Public Health or Maine Department of Health and Human Services). Brief cases are presented to illustrate the use of Root Cause

Analysis as a technique to identify multiple causal contributors to undesirable events.

Example 2.1: Wrong-site Tooth Extraction[1]

This example is Case#156 reported on the Web-based Morbidity and Mortality database:

> A 45-year-old healthy man was scheduled to have two teeth extracted for progressive dental caries. The patient underwent the extractions, awoke from the anesthesia, and then realized that his upper left molars had been extracted instead of his right. The error was recognized and acknowledged immediately following the procedure. The patient still required extraction of the diseased teeth, which occurred a few weeks later. He developed no significant complication from either surgical procedure other than enduring two rounds of anesthesia because of the error.

In this example, the undesirable event is that upper left molars were extracted instead of upper right molars – hence, a wrong-site surgery. In a disciplinary or litigious investigation, the focus is on identifying the individual who should be held responsible for the error and punishing that individual. In the case of Root Cause Analysis (RCA), the emphasis is on building a system-wide illustration of various factors that contributed to the final error. The RCA protocol requires the investigator to validate all the facts and to keep drilling down the causal pathway – by asking a series of 'why' questions – until all rational options are exhausted, and all human errors must be preceded by a systemic condition. Why did the surgeon extract the wrong teeth? A possible response might be, 'because markings on the dental diagram were confusing'. One could continue along this pathway and discover several latent systemic issues. Dr. Smith, an expert commenter on this case, lists the following factors: 'Cognitive failure and miscommunication, multiple contiguous carious teeth (rather than one identifiable diseased tooth), partially erupted teeth mimicking third molars, teeth with gross decay that the restorative dentist wants to save, reversed radiographs, and nebulous tooth numbering systems'.

Dental diagrams,[2] such as the one provided by the Agency for Healthcare Research and Quality, may be used to standardize and structure communication between care providers, technicians, and patients to reduce the risk of wrong-site extraction. Similarly, the 'Speak-up' posters, videos, coloring books,[3] etc.

1 <http://www.webmm.ahrq.gov/case.aspx?caseID=156>.

2 A typical dental diagram available at <http://www.webmm.ahrq.gov/media/cases/images/case156_fig1.gif>.

3 'Speak-up' campaign details available at <http://www.jointcommission.org/speakup.aspx>.

created by the Joint Commission, could be used to raise awareness and inspire assertiveness among patients and care providers, as well as patient advocates.

The diagrams, posters, videos, slide presentations, etc. serve as artefacts memorializing and reinforcing the transformation toward an improved safety culture in healthcare. The dental diagram is intended to standardize the communication and documentation protocol and minimize errors; the Speak-up series is designed to raise awareness, inspire assertiveness, and minimize medical errors. Additionally, the dental diagram could serve as a briefing-and-debriefing tool for the dentist to review with the patient both before and after the surgery to confirm with the patient which tooth should be extracted and to review if everything was satisfactory in the procedure after it is finished. Such a practice would serve as a self-imposed tracking of routine procedures to look for trends such as forgetting to do something in preparation for the surgery, discovering some surprises in the patient's dental history, complications caused, or human errors made. Following is an example of an immediate review of a near-miss that reveals that even with guidance to prevent wrong side or wrong site surgery, mistakes may happen:

> We have quarterly safety rounds in surgery where we focus on the good things that have happened and new procedures. We had a 'great catch' session that featured a neurosurgery case. At the time the great catch occurred, the neurosurgeon was so shaken by what happened that he called in the assistant chief for a consultation in the OR.

The case was to treat a young male with an acute head injury from a skiing accident – he had been brought in by a helicopter. The OR team followed all procedures for right side, right patient – all of the 'rights'. Everyone in the room confirmed the surgical site on the patient's head. The surgeon went out to scrub and came back and when he returned he was shocked to discover that he and the nurses and techs had prepped the wrong side. It was a perceptual thing. We sat down and went through what had happened.

The anaesthesiologist looked at the x-ray and said, I am really surprised that he doesn't have more external trauma – must have had a good helmet. He was looking at the x-ray of the side without the injury. It didn't trigger anyone to detect the mistake. We did our usual root cause analysis – we did it in a week and couldn't do the deep dive into the cognitive aspects of this. There were so many opportunities to disengage from their misperception. The nurse and surgeon put the kid's head in the brace and both made the same perceptual mistake. They talked about how to position the brace. We never had time to explore why they shaved the wrong side of head, and why this didn't this get anyone's attention? Or why the anaesthesiologist's comment didn't trigger a re-look? These are intensely interesting questions. This team followed the procedure for preventing wrong site surgery and still didn't get it right.

This is an example of how challenging it can be to conduct a Root Cause Analysis of sufficient depth to understand the cognitive dimensions of a near miss.

Example 2.2: Landing Overrun by Delta Connection Flight 6448[4]

> On February 18, 2007, Delta Connection flight 6448 overran on runway 28 at Cleveland Hopkins International Airport during snow conditions and poor visibility conditions. Three of the seventy-one passengers received minor injuries; the aircraft sustained substantial damage. The NTSB concluded that the probable cause of the accident was 'failure of the flight crew to execute a missed approach when visual cues for the runway were not distinct and identifiable'. Contributing factors were as follows: (1) the crew's decision to descend to the ILS decision height instead of the localizer (glideslope out) minimum descent altitude; (2) the first officer's long landing on a short contaminated runway and the crew's failure to use reverse thrust and braking to their maximum effectiveness; (3) the captain's fatigue, which affected his ability to effectively plan for and monitor the approach and landing; and (4) Shuttle America's failure to administer an attendance policy that permitted flight crewmembers to call in as fatigued without fear of reprisals.

Per the Root Cause Analysis approach, the final outcome is runway overrun. The immediate cause of the overrun is the crew's failure to execute a missed approach – that means failure to elect *not* to land at the intended airport and divert to a different airport or wait for the visibility to improve and try the landing again. Once they committed to land the airplane, the location of wheels touching the runway was about halfway down the runway, which is too far down even without the meteorological challenges. The sloppiness in the decision to land as well as in the execution of the landing is at least partially explained in the third layer of the causal model: why did the airplane overrun? Because the crew failed to execute a missed approach – why did the crew not execute a missed approach? – because they did not think it was a problem – why did they not think it was a problem? – because they made a mistake in their calculations – why did they make a mistake in their calculations? – because the captain was fatigued – why was the captain fatigued? – because he was overworked and was on the tail end of his multi-segment trip. The process could go on a bit further, but once we get into organizational aspects like crew scheduling or corporate fatigue policy, the contributing factors tend to fan out beyond a realistic ability to influence them. The concurrent contributing factor here is the reported deficiencies in co-pilot's flying skills. So, a skill-limited copilot and a fatigued captain tried to land the airplane through poor visibility.

This accident brought to light, again, issues related to pilot proficiency and fatigue. The issue of pilot fatigue is recognized as such a serious challenge that it has made the NTSB's 'Most Wanted' list.

4 NTSB Report Number AAR-8/01, April 15, 2008. Available at <http://www.ntsb.gov/publictn/A_Acc1.htm>.

Since fatigue is a complex phenomenon involving physical and cognitive deterioration and is difficult to objectively diagnose, the most common causal association in fatigue cases is sleep deprivation, which in turn is typically associated with duty time limitations. So, there is a certain level of political pressure[5] for the FAA to develop a fatigue policy or to modify the existing duty-time rule (14C.F.R. § 121.471) and for the airlines to enforce duty-time limitations that consider the number of flight legs flown and duty start times, not just the total duty time.

Figure 2.2 presents a partial list of all the NTSB recommendations[6] regarding human fatigue that has made this issue one of NTSB's top priorities. This list can be regarded as a cultural artifact because it is symbolic of the importance that the aviation industry places on addressing human fatigue challenges. It is also symbolic of the unique relationship between the NTSB and the FAA. The NTSB can only make a recommendation; the FAA has to consider this recommendation, but may not want to, or have capacity to, implement the recommendation. The FAA has to consider not only the opinions of those who will be affected (the aviation community) but also has to consider the costs of implementation (to the FAA and to all the stakeholders).

The issue of pilot fatigue, particularly for those crew members commuting from different cities to their 'base,' came back into the spotlight after the Colgan Air crash[7] in February 2009. Soon after this accident, Colgan Air implemented a 'no questions asked' fatigue policy that allowed their pilots and flight attendants to report if they were fatigued and have someone else take their flights. However, this policy may have been either abused or the fatigue conditions are worse than previously known because a January 2010 report (Zremski, 2010) indicates that the airline is tightening its fatigue policy.

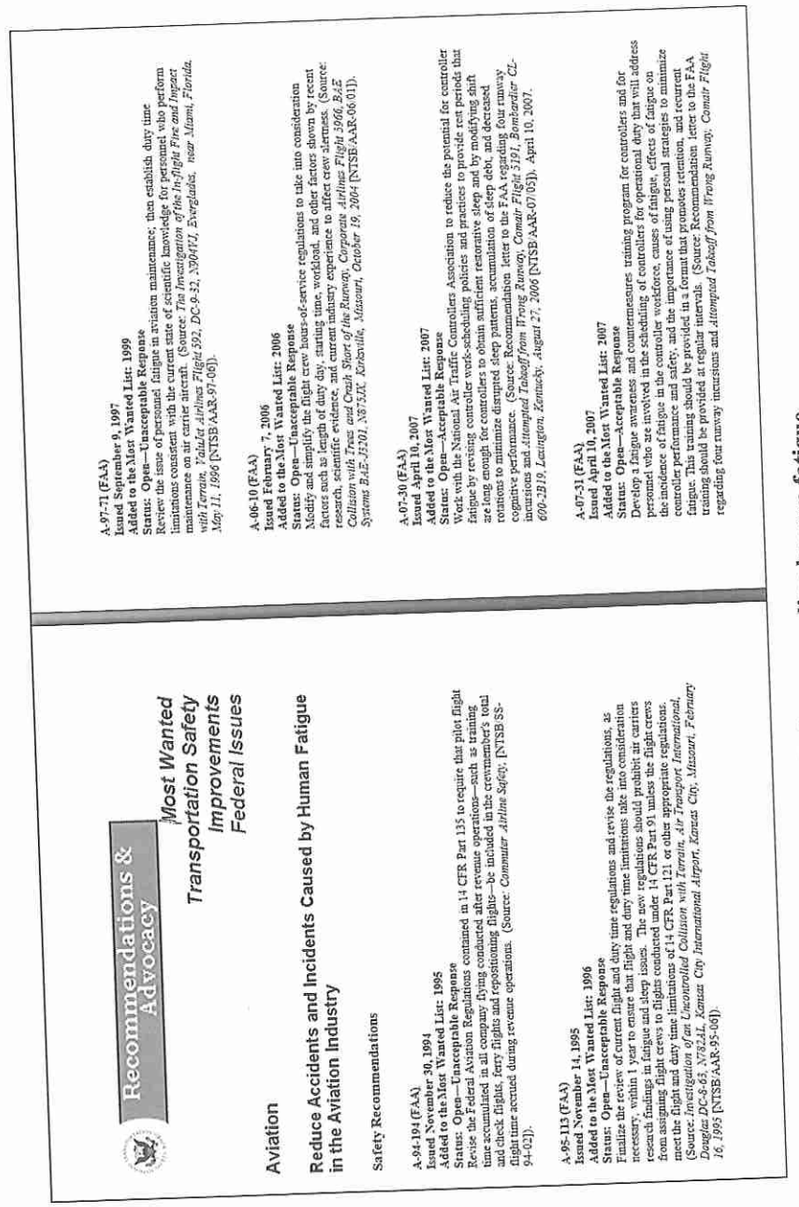
The above two cases illustrate a convergent-divergent effect between incidents and solutions. On the convergence side, multiple contributory factors converge and result in the undesirable event. Case analysis of each event leads to multiple levels of solutions – from individual to organizational to national to global level – hence, the term 'divergence'. In the wrong-site extraction case, the contributory factors that converged to create the event were consistent with contributory factors across wrong-site surgeries in general (not limited to dentistry or to that specific procedure), and hence, the industry-wide or divergent advocacy of the Universal Protocol[8] serves as a critical campaign. Similarly, the fatigue issue raised in the landing overrun incident was consistent with several other airliner accidents and

5 NTSB Safety Recommendation Dated August 7, 2009. Available at <www.ntsb.gov/recs/letters/2009/A09_61_66.pdf>.

6 Available at <http://www.ntsb.gov/Recs/mostwanted/aviation_reduce_acc_inc_humanfatig.htm>.

7 Preliminary Report is available at <http://www.ntsb.gov/>.

8 Universal Protocol poster available at <http://www.jointcommission.org/standards_information/up.aspx>.



Recommendations & Advocacy

Most Wanted
Transportation Safety
Improvements
Federal Issues

Aviation

Reduce Accidents and Incidents Caused by Human Fatigue in the Aviation Industry

Safety Recommendations

A-94-194 (FAA)
Issued November 30, 1994
Added to the Most Wanted List: 1995
Status: Open—Unacceptable Response
Revise the Federal Aviation Regulations contained in 14 CFR Part 135 to require that pilot flight time accumulated in all company repositioning flights—be included in the crewmember's total and check flights, ferry flights and repositioning flights and duty time accrued during revenue operations. (Source: *Commuter Airline Safety*, [NTSB/SS-94-02]).

A-95-113 (FAA)
Issued November 14, 1995
Added to the Most Wanted List: 1996
Status: Open—Unacceptable Response
Finalize the review of current flight and duty time regulations and revise the regulations, as necessary, within 1 year to ensure that flight and duty time limitations take into consideration research findings in fatigue and sleep issues. The new regulations should prohibit air carriers from assigning flight crews to flights conducted under 14 CFR Part 91 unless the regulations meet the flight and duty time limitations of 14 CFR Part 121 or other appropriate regulations. (Source: *Investigation of an Uncontrolled Collision with Terrain, Air Transport International, Douglas DC-8-63, N782AL, Kansas City International Airport, Kansas City, Missouri, February 16, 1995* [NTSB/AAR-95-06]).

A-97-71 (FAA)
Issued September 9, 1997
Added to the Most Wanted List: 1999
Status: Open—Unacceptable Response
Review the issue of personnel fatigue in aviation maintenance; then establish duty time limitations consistent with the current state of scientific knowledge for personnel who perform maintenance on air carrier aircraft. (Source: *The Investigation of the In-flight Fire and Impact with Terrain, ValuJet Airlines Flight 592, DC-9-32, N904VJ, Everglades, near Miami, Florida, May 11, 1996* [NTSB/AAR-97-06]).

A-06-10 (FAA)
Issued February 7, 2006
Added to the Most Wanted List: 2006
Status: Open—Unacceptable Response
Modify and simplify the flight crew hours-of-service regulations to take into consideration factors such as length of duty day, starting time, workload, and other factors shown by recent research, scientific evidence, and current industry experience to affect crew alertness. (Source: *Collision with Trees and Crash Short of the Runway, Corporate Airlines Flight 5966, BAE Systems BAE-J3201, N875XJ, Kirksville, Missouri, October 19, 2004* [NTSB/AAR-06/01]).

A-07-30 (FAA)
Issued April 10, 2007
Added to the Most Wanted List: 2007
Status: Open—Acceptable Response
Work with the National Air Traffic Controllers Association to reduce the potential for controller fatigue by revising controller work-scheduling policies and practices to provide rest periods that are long enough for controllers to obtain sufficient restorative sleep and by modifying shift rotations to minimize disrupted sleep patterns, accumulation of sleep debt, and decreased cognitive performance. (Source: Recommendation letter to the FAA regarding four runway incursions and *Attempted Takeoff from Wrong Runway, Comair Flight 5191, Bombardier CL-600-2B19, Lexington, Kentucky, August 27, 2006* [NTSB/AAR-07/05]). April 10, 2007.

A-07-31 (FAA)
Issued April 10, 2007
Added to the Most Wanted List: 2007
Status: Open—Acceptable Response
Develop a fatigue awareness and countermeasures training program for controllers and for managers who are involved in the scheduling of controllers for operational duty that will address the incidence of fatigue in the controller workforce, causes of fatigue, effects of fatigue on controller performance and safety, and the importance of using personal strategies to minimize fatigue. This training should be provided in a format that promotes retention, and recurrent training should be provided at regular intervals. (Source: Recommendation letter to the FAA regarding four runway incursions and *Attempted Takeoff from Wrong Runway, Comair Flight*

Figure 2.2 Partial list of NTSB recommendations regarding human fatigue

therefore it made the NTSB's Most Wanted list. Again, diverging on the solution side and applying it to multiple organizations.

Additionally, we also want to note the cross-industry effect of divergence. For example, the human fatigue issue raised in the runway overrun example is just as critical in healthcare as it is in aviation. Therefore, we are now starting to see organizations like the American Congress for Obstetricians and Gynecologists (ACOG) release statements that acknowledge the fatigue problem among physicians and recommend ways to minimize fatigue-related errors. We are not suggesting that pilot fatigue issues caused ACOG to acknowledge their own fatigue issues, but the correlation is interesting. ACOG issued the following press release:[9]

> All obstetrician-gynecologists should evaluate the effects that fatigue may have on their ability to care for patients and adjust their workloads, work hours, and time commitments when feasible to avoid fatigue when caring for patients, according to The American College of Obstetricians and Gynecologists (ACOG). In its ongoing commitment to patient safety, ACOG released the new opinion recently in the February issue of Obstetrics and Gynecology. Although there are few published studies on the effects of fatigue on physicians, there is increasing awareness that fatigue, even partial sleep deprivation, impairs performance.

Another aspect of divergence is global impact. For example, the World Health Organization[10] has recognized the importance of preventing medical errors and it is broadening data collection and implementation of interventions to rural and non-hospital settings, which are more common in global healthcare. Again, the link from local to global is not causal, but it is a bit more than coincidental.

Survey Analysis

Survey questionnaires are versatile instruments that could be used to measure key factors across all four levels of the Safety Culture Pyramid as well as to determine the inter-factor influences both within and across the four levels. Further, these characteristics could be used to: (a) compare organizations within the same industry, (b) compare organizations across multiple industries, (c) measure the effects of interventions using pre- and post-intervention comparisons, and (d) conduct regular evaluations over a long period of time to describe longitudinal evolution. However, the survey questionnaires must be carefully designed and their reliability and validity must be tested.

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9 ACOG press release on fatigue effects available at <http://www.acog.org/from_home/publications/press_releases/nr02-01-08-3.cfm>.

10 2009 WHO patient safety information booklet available at <http://www.who.int/patientsafety/en/>.

Safety performance survey Safety behaviours and outcomes can be tracked by a safety performance survey questionnaire. For example, Vogus and Sutcliffe (2007) report their success with the Safety Organizing Scale (SOS), which is a nine-item measure of self-reported behaviours enabling safety culture. This survey instrument was distributed to 13 hospitals across the country, varying in both size and location (urban/rural). The survey instrument was constructed based on the tenets of High Reliability Organizations and tested for validity and reliability. Vogus and Sutcliffe also collected performance metrics such as average patients per Registered Nurse (RN), number of units, average unit size, reported medication errors, and reported patient falls for the six months after the collection of the survey data. A high score on SOS is considered a positive safety culture. The research reported negative correlation between SOS scores and patient-to-RN ratio, medication errors, and patient falls. Therefore, the higher the SOS score, the lower the medication errors and patient falls.

Chang and Yeh (2004) used a different, but still survey-based, approach to develop an airline safety index that measures safety performance relative to other comparison airlines (data are de-identified). A fuzzy multi-attribute decision-making approach was developed to obtain a safety index for each airline. This approach has four dimensions: management, operations, maintenance, and planning. Under management, the following types of data are collected via fuzzy assessment of survey instruments: safety policy and strategy, management attitude/commitment to safety, and employee attitude/commitment to safety. The *safety policy and strategy* parameter aligns very well with the Safety Strategies in the Safety Culture Pyramid and *the management and employee safety attitudes/commitment* connects with Safety Climate and Safety Values (the commitment portion). Under operations, competency status of flight crew and compliance with aviation task procedures are collected via the survey. These two parameters align with the Safety Strategies layer of the Safety Culture Pyramid. According to this method, the larger the safety index, the better the safety of the airline. Again, this example simply goes to illustrate that survey questionnaires could be used to collect safety performance data.

Safety climate survey Survey instruments are most commonly used to assess *safety climate* – the employee attitudes and opinions regarding safety. A typical survey instrument consists of several items that may be scored on a Likert-type scale (e.g. indicate agreement with the statement in the item on a scale of one to five, where one equals strongly disagree, two equals disagree, three equals neutral, four equals agree, and five equals strongly agree). Responses to these items are collected and analyzed using either a confirmatory or an exploratory factor analysis technique. A confirmatory factor analysis pre-groups the questionnaire items in accordance with previously tested survey instruments or theoretical constructs; while an exploratory factor analysis lets the statistical analysis software cluster the items and a unifying label is used to identify that cluster. Once the factors are identified, each of them can be tested for reliability and validity.

Flin, Mearns, O'Connor, and Bryden (2000) reviewed 18 industrial safety climate surveys. Their three most strongly emergent themes were management, safety system, and risk. Management plays a critical role in setting policies, providing resources, enforcing safety-oriented behaviours and encouraging communication of hazardous conditions or errors, as well as enforcing discipline against employees who exhibit poor safety behaviours. Flin et al. (2000) noted that all 18 safety climate surveys contained individual items or factors that attempted to measure management's commitment toward safety programmes. The second theme, safety system, is about creating an organizational infrastructure, such as safety committees, that facilitates continuous improvement of safety performance. The employee opinions tend to reflect the effectiveness of such safety systems in improving safety performance. The third theme seeks to determine whether the employees have appropriate perception of risks, the degree to which employees are involved in managing risks, their personality disposition toward risk. Overall, this study indicates that there is support in the literature for safety strategies to influence safety performance.

Scott, Mannion, Davies, and Marshall (2003) conducted a detailed review of nine survey questionnaires that are used in healthcare and four that are used in other industries but could be used in healthcare. All thirteen instruments examined employee 'perceptions and opinions about their working environment (safety climate), but only a few, such as the Competing Values Framework and the Organizational Culture Inventory, try to examine the values and beliefs that inform those views'. Further, 'none of the instruments examined underlying assumptions that guide the attitudes and behaviours and form the stable substrate of culture'. The Competing Values Framework represents a typological approach, characterizing organizational cultures into four types: clannish, hierarchical, market-oriented, or adhocratic. Each organization usually has characteristics of more than one of these types. The Organizational Culture Inventory represents a dimensional approach and describes culture in terms of thirteen dimensions: orientation to customers, orientation to employees, congruence among stakeholders, impact of mission, managerial depth/maturity, decision-making/autonomy, communication/openness, human scale, incentive/motivation, cooperation versus competition, organizational congruence, performance under pressure, theory S versus theory T (Scott et al. 2003). From our perspective, this study supports the notion that values and beliefs (the foundation of our Safety Culture Pyramid) influence attitudes and opinions (the safety climate).

Colla, Bracken, Kinney, and Weeks (2005) conducted a review of patient safety climate surveys and identified nine surveys. They found that the most common areas addressed by the surveys included: leadership, policies and procedures, staffing, communication and reporting. They concluded that the psychometric properties of the surveys varied considerably. They found five surveys to be comprehensive and sufficiently strong psychometrically to recommend them for further use. These surveys include the following: the Veterans Administration Patient Safety Culture Questionnaire (Burr et al. 2002); the Hospital Transfusion

Service Safety Culture Survey (Sorra and Nieva, 2002); the Hospital Survey on Patient Safety (Sorra and Nieva, 2003); and the Safety Attitudes Questionnaire (Sexton and Helmreich, 2004). The Safety Attitudes Questionnaire had been used to investigate the relationship between safety climate and patient outcomes (safety performance). Colla et al. (2005) concluded that more research is needed to establish the linkage between safety climate surveys and patient outcomes. They recommend that until such findings are available, survey results should be interpreted with caution.

Singla, Kitch, Weissman, and Campbell (2006) also reviewed safety climate surveys used in healthcare. They agreed with Colla et al. (2005) in their general conclusions that the survey instruments would benefit from improved psychometric analysis and demonstration of their ability to predict patient outcomes. Singla et al. (2006) studied 13 patient safety instruments that yielded 23 different dimensions, which they grouped into the following general categories: management/supervision, risk, work pressure, competence, rules, and miscellaneous. They found that the content of the surveys varied considerably. The most common dimensions to be included in the surveys were management and institutional commitment to safety, communication openness, and beliefs about the causes of errors and adverse events. Interestingly they found that risk taking was only included in a single survey. Moreover, while professionalism is regarded by many as critical to patient safety in day-to-day healthcare delivery, it was not addressed directly by any of the surveys studied. Singla et al. (2006) point out that only the Safety Attitudes Questionnaire and the AHRQ Hospital Survey on Patient Safety have substantial data sets available for normative comparisons and benchmarking purposes.

Consistent with the analysis of Colla et al. (2005) and Singla et al. (2006), Pronovost and Sexton (2005) state that in healthcare 'the enthusiasm for measuring culture may be outpacing the science' (p. 231). They offer suggestions for bridging the scientist–practitioner gap in assessing safety culture in healthcare. They discuss the importance of using psychometrically established measures such as the Safety Attitudes Questionnaire. Pronovost and Sexton (2005) also contend that it is important to use multidimensional measures to assess safety culture, thus allowing researchers to track the numerous underlying drivers of patient safety. They recount the situation where units with outstanding levels of collaboration, communication, openness, and excellent safety performance may develop a sense of immunity to error and thus fail to recognize the impact of stressors that may lead to medical mistakes. They also point out the importance of assessing safety culture across all units of an organization since they have found considerable variation of safety culture among units within a single organization. Additionally, these authors discuss the importance of feeding back assessment results to staff as well as to members of senior management so that the results can be collectively understood and lead to informed action that improves patient safety.

Sexton et al. (2006) report on their healthcare research with the Safety Attitudes Questionnaire (SAQ). About 25 per cent of the items in the SAQ trace their lineage to commercial aviation and the Flight Management Attitudes

Questionnaire (Helmreich et al. 1993; Helmreich and Merritt 1998), while the remaining items were developed by consulting conceptual models and subject matter experts. The survey was refined by pilot testing and exploratory factor analyses. The final survey consists of six factors that measure teamwork climate, safety climate, perceptions of management, job satisfaction, working conditions, and stress recognition. The entire survey consists of 60 items (answered on five-point Likert scales), demographic items, and a section for open-ended comments. Versions of the SAQ are available for use in intensive care units, operating rooms, general inpatient areas, and ambulatory care. These versions have minor wording changes to reflect reference to the medical units where the surveys are being administered. The Sexton et al. (2006) results are based on 10,843 surveys representing 203 clinical areas collected from healthcare providers in the United States, United Kingdom, and New Zealand. Hospital safety climates were not monolithic and the authors found it important to assess patient safety at the clinical area level where they found more variability between than within clinical areas. The SAQ, norms, and benchmarking data are available at the following website: <http://www.utpatientsafety.org>.

Development of the AHRQ Hospital Survey on Patient Safety Culture (HSOPSC) is documented by Sorra and Nieva (2003, 2004). The AHRQ survey is available at <http://www.ahrq.gov/qual/patientsafetyculture/hospform.pdf>. It consists of nine safety culture dimensions: supervisor/manager expectations and actions promoting safety, organizational learning, communication openness, feedback and communication about error, non-punitive response to error, staffing, hospital management support for patient safety, teamwork across hospital units, hospital handoffs, and transitions. The survey also contains demographic questions and four safety outcome variables: overall perceptions of safety, frequency of event reporting, safety grade, and number of events reported. A comparative database for the HSOPSC is available at the following website: <http://www.ahrq.gov/qual/patientsafetyculture/hospsurvindex.htm>. In 2009 the AHRQ database included responses from over 600 hospitals and 196,000 individual healthcare providers.

Smits, Christiaans-Dingelhoff, Wagner, van der Wal, and Groenewegen (2008) analyzed results from a Dutch translation of the HSOPSC completed by 583 staff at hospitals in the Netherlands. Based on factor analytic techniques, they found a very similar structure to the original questionnaire. They also reported acceptable reliability and good construct validity. They concluded that HSOPSC is a useful instrument to assess patient safety in Dutch hospitals. They also suggest that HSOPSC appears adaptable for translation into other languages to allow for more cross-country comparisons on patient safety.

Blegen, Gearhart, O'Brien, Sehgal, and Alldredge (2009) also report on recent psychometric analyses of the Hospital Survey on Patient Safety Culture. Their sample included 454 healthcare providers from three hospitals located in the United States. The HSOPSC was administered in a pre-post methodology to assess multidisciplinary interventions aimed at improving safety culture. Their results showed moderate-to-strong validity and reliability for HSOPSC. Subscales

correlated with perceived outcomes: however, they caution that addition research is needed to evaluate predictive validity.

Safety strategies survey Safety strategies consist of factors like organizational mission, leadership, structures, policies, procedures, practices, and training. Survey questionnaires could be used to assess the role of leadership in improving the safety culture, effectiveness of policies and procedures, including those used to change the existing policies and procedures, and training effectiveness. Further, if the change strategies are effective, the structures, policies, procedures, and practices will continue to evolve with the changing needs and new knowledge gained from successes as well as failures. Consequently, the organization will become a learning organization. Again, survey questionnaires could be used to evaluate the organizational learning ability.

While it is widely acknowledged that it is the leaders' responsibility to set the tone for the organization, to guide its strategic development, and to serve as role models for rest of the employees, often leaders are challenged in implementing their strategies. Guth and MacMillan (1986) present results of a qualitative study that builds a simple yet profound model describing why senior management's strategy might fail. Senior management's change strategy might fail if the middle management is not convinced that: (a) a change is necessary and timely, (b) the proposed strategy is the right strategy to achieve the intended goal, and (c) their self-interest is aligned with the corporate goal. Survey instruments may be used to gauge the level of middle-management support in accordance with the above three parameters.

Once the senior managers and middle managers are fully aligned in their goals, strategies, and respective self-interests, successful implementation of the strategy depends on how well management attitudes can translate into behavioural intent and how well the intent manifests into actual behaviour. Again, management attitudes, behavioural intent, and actual behaviours could be assessed with survey questionnaires. Rundmo and Hale (2003) analyzed the relationship between managers' safety attitudes, behavioural intentions, and their self-reported behaviours. They identified ten belief dimensions of management attitude: management safety commitment and involvement; fatalism concerning accident prevention; management attitude toward rule violation; management safety talk and risk communication with the employees; personal worry and emotion about safety issues; powerlessness (fatalism) to do anything about safety problems; priorities of safety in general; mastery of own work situation related to safety; perceived hindrances for safety involvement, and management awareness about potentially-hazardous risks. Behavioural intent was measured across four dimensions: motivation of employees and monitoring of safety practices, time spent on improving procedures and safety regulations, management involvement in design and development of equipment, and involvement in safety instructions and training. To get a sense of the gap between behavioural intent and actual behaviours, managers were asked how much time they actually spent versus the

amount they needed to spend on eight job-related activities during their work hours: operational issues, productivity, product quality, job satisfaction, conflict resolution, safe working environment, and environmental issues. Rundmo and Hale report that their sample of managers spent too little time on operational issues and they should spend less time on all other issues and more on operational issues. The analysis of relationship between attitudes, intentions, and behaviours revealed that 'attitude dimensions exerting the most significant influence were *management commitment and involvement in safety work*, which influenced behavioural intentions with regard to *motivation and monitoring* as well as *procedures and safety regulations*'. Again, there is support in the literature for influence between leadership (safety strategy) and safety performance through safety attitudes (safety climate).

There are a variety of change strategies that could be considered, depending on the safety goals of the organization. While most strategies aim at changing existing organizational structures, policies, procedures, or practices, the choice of a particular strategy should be preceded by assessment of the safety climate and safety performance. These two assessments will form a baseline for pre/post-intervention comparison. If the safety performance assessment leads to the suspicion that latent systemic errors may be present, an error and hazard reporting system could be implemented. Survey instruments could be developed to measure the effectiveness of such a system. A simple tracking of the number of reports submitted per month and the number and type of changes made in response to those reports will help demonstrate how the reporting system, coupled with the subsequent investigation and remediation, is gradually improving the organization, making it a learning organization. Such ability of an organization can be measured along seven dimensions using a Dimensions of Learning Organization Questionnaire (DLOQ): 'Continuous learning, inquiry and dialogue, collaboration and team learning, systems to capture learning, empower people, connect the organization, and provide strategic leadership for learning' (Marsik and Watkins, 2003).

Safety values survey In 1984, Geert Hofstede conducted one of the earliest, and perhaps the largest, cross-cultural research programmes ever in a systematic study of work-related values across more than 50 countries. He found that within a given industry, certain national differences are seen in hierarchical differences and social distance (he called it power distance), in preferences for individualism or collectivism, and in tolerance for uncertainty (he called it uncertainty avoidance). Later, Helmreich and Merritt (1998) showed the effects of differences in national culture among airline pilots and surgeons. Their results act to confirm the theory and prior findings of Hofstede (1984). Taylor and Patankar (1999) found that some of these differences in national culture reported by Hofstede, and confirmed by Helmreich and Merritt, also affect airline mechanics and their managers. Based on these studies, one could say that professionals from Asian countries tend to be more collectivistic than those from Western European countries. When

Patankar and Taylor (2004) measured such differences across the United States, they discovered that maintenance professionals from the East or the West coast of the United States were more individualistic than those from the Mid-western or Central regions. Thus, the notion of 'national differences' could be applied to distinctive geographic locations within the same country. From a professional perspective, it has been demonstrated that certain professionals such as pilots are more individualistic than surgeons (Helmreich and Merritt, 1998) and aircraft mechanics are more individualistic than pilots (Patankar and Taylor, 2004). All these cross-cultural studies focused on deeply held personal values regarding work and demonstrated that differences in work-related values yield discernable patterns of work habits or behaviours. Thus, these studies illustrate the relationship between values and behaviours.

Influence of Safety Values, Safety Strategies, and Safety Climate on Safety Performance

Kouabenan (1998) demonstrates how personal values such as fatalistic beliefs and national cultural norms like mystic practices can influence the perception of accidents and consequently create a tendency 'to take more risks and neglect safety concerns'. A twenty-item survey questionnaire was used to measure responses along two scales: personal belief in fate and risk-taking tendency. Most interestingly, professional drivers were the most fatalistic (and took the greatest risks) and engineers were the least fatalistic. So, there's some support to the notion that personal values and beliefs could impact safety performance – if the personal belief is fatalistic, even placement of legal barriers to prevent over-speeding in one's car may not dampen the individual's risk-taking tendency, and therefore there appears to be a link between safety values and safety behaviours somewhat independent of the mitigating strategies.

Johnson (2007) established that safety climate surveys can provide reliable assessment of the prevailing psychosocial conditions and organizational conditions; further these conditions have been known to impact the safety-oriented behaviours of employees (Neal and Griffin, 2002; Cooper and Phillips, 2004). In addition to the specific psychosocial aspects of the extant safety climate, Arezes and Miguel (2003) note that there are a wide variety of performance factors such as lost time injuries, number of accidents/incidents, and damage events that could be used as indicators of safety. While a decline in such numbers may indicate that the safety of the operation is increasing, there is no guarantee that the trend will continue. Also, there may be an implicit incentive to under-report incidents in order to maintain the positive image of the organization. Nonetheless, performance measures can be correlated with attitudinal changes that are in turn related to specific safety culture change efforts (Patankar and Taylor, 2004) and subsequently used to demonstrate the financial benefits of the change programme. Patankar and Taylor (2004, Ch.8) demonstrate that both positive as well as negative financial returns on investment are possible, depending on how closely the content matches the intent.

Fernández-Muñiz, Montes-Peón, and Vázquez-Ordás (2007) provide a comprehensive example linking most aspects of the Safety Culture Pyramid. They developed a safety culture model consisting of: (a) Safety Management System, (b) Management Commitment, (c) Employee Involvement, and (d) Safety Performance. Their model is very similar to the Safety Culture Pyramid and so elements of this model could be used to demonstrate the application of the Safety Culture Pyramid. For example, the Safety Management System component is essentially Safety Strategies in the Safety Culture Pyramid; parts of the Management Commitment component are more aligned with the Safety Values concept in the Safety Culture Pyramid and some parts are better aligned with Safety Climate and Safety Performance; Employee Involvement is partly a Safety Strategy because it is a way to build buy-in among the employee group and it is partly Safety Performance because the employees will be expected to behave differently as they get involved in the implementation of the Safety Management System; finally, Safety Performance is the same in both models. Fernández-Muñiz et al. tested their model across 62,146 companies (mostly small companies) across Spain, including construction, industrial, and service sectors. The results of their study confirm that management commitment has a direct, positive, and statistically significant influence on both employees' involvement and safety management systems; safety management systems and employee involvement have significant positive influence on safety performance. Again, there is support for the Safety Culture Pyramid Model and the related notion that safety performance is influenced by safety climate, safety strategies, and safety values.

Assessment Across Professional Groups, Organizations, and Industries

Safety Climate surveys can be used across professional groups within the same industry (e.g. Patankar, 2003); across multiple organizations within the same industry (e.g. AHRQ Survey; Safety Attitudes Questionnaire; Helmreich and Merritt, 1998, etc.); across multiple industries (e.g. Safety Attitudes Questionnaire; Harvey, Erdos, Jackson, and Dennison, 2004; Fernández-Muñiz et al. 2007, etc.). However, since the factors that define safety climate have not been completely delineated or systematically agreed among the researchers, we don't quite have industry or national-level benchmarks. Nonetheless, the use of safety climate surveys is stabilizing and the component factors are being tested more rigorously not only for their validity and reliability, but also for their influences on each other.

There are two other ways to use safety climate questionnaires to further test and stabilize the underlying model: longitudinal assessment and pre- and post-intervention assessment. Longitudinal assessment is important because without such assessment, a safety climate survey is limited to one snapshot of the attitudes and opinions at that time for the sample population. Without continued, regular administration of the surveys, it is impossible to determine trends and develop a more complete understanding of the trends.

Karl Weick's message, 'the environment that the organization worries about is put there by the organization' (Weick, 1979, p. 152) is particularly salient. We want to emphasize this quote because we believe the message here is that for a safety *culture* to change, the organization must be equally willing to change its structures, processes, and policies. This is particularly important when employees start using a newly established error-reporting system or a safety management system – they expect that structural or procedural changes will be made in response to their participation, and if the requisite changes are not forthcoming, they will lose interest in the process and therefore in the organization and/or the leadership. With respect to Maintenance Resource Management training, which was intended to raise the awareness regarding human factors issues in aviation maintenance, Taylor and Christensen (1998) note the following observation: 'Frustrated with slow progress in achieving the promise of MRM training, a sizable number of AMTs [aviation maintenance technicians] saw a greater need to speak up – perhaps even in anger or frustration – as the only path for improvement' (p. 161). The MRM training raised the expectations among the employees, but did not deliver the responsive changes promptly enough.

In summary, survey instruments can be used to measure safety performance, to describe the safety climate, to determine the effectiveness of safety strategies or the level of support for certain strategies, and to gauge the alignment of safety values among employees and management. Since surveys tend to engage the employees through solicitation of feedback, the employees tend to expect that something will change in response to the findings from the survey. If nothing changes, the employees will lose faith in the company/management and will be less enthusiastic about organizational changes in the future.

Qualitative Analysis

A comprehensive analysis of safety culture needs qualitative methods such as field observations, artifact analysis, interviews, focus group discussions, and dialogue with key individuals in the organization (e.g. Maxwell, 2004). Typically, a safety culture project may start with interviews, focus group discussions and field observation. In the early stages of the research, interviews are essentially orientation sessions to get to know the industry, the organization, and the facility. Interviews then lead to focus group discussions to elicit key issues or unique interests/characteristics of the organization/location. Concurrent field observations allow the researchers to better understand the work environment of their subjects. Often interviews and/or focus group discussions may transition to a field trip across the organization's various facilities. Also, during these meetings and tours, it would be a good idea to collect cultural artefacts such as newsletters, programme stickers, safety culture brochures or posters, organizational charts, employee evaluation forms, etc. Occasionally, the interviews/focus groups turn into deep dialogue with key informants in the organization. These are precious opportunities to listen and learn all about the history of the organization, the past

stories, legends and heroes from the organization and the overall sense of anxiety or comfort among the employees. This section provides more details about each qualitative data collection technique and provides examples where appropriate.

Field observations Field observation may include naturalistic or participant observation. In naturalistic observation the goal of the research is to observe participants in their natural setting and avoid any intervention or interference with the normal course of events. Participant observation is the primary research approach of cultural anthropology. Here the researcher develops an intensive relationship with the participants by typically interacting over an extended period of time. Ethnography represents a particular approach to field observation by describing human culture from a holistic perspective through direct but non-intrusive observation. This approach is described in the writings of Hammersley and Atkinson (1983), Erickson and Stull (1997), and Spradley (1979).

From a safety culture perspective, Line Oriented Safety Audit (LOSA) is a popular normal operations observation protocol which is used in both aviation and healthcare (cf. Thomas, Sexton, and Helmreich, 2004). Instead of using external observers, as in a traditional ethnographic study, LOSA protocol trains peer observers to observe the flight/maintenance crew or the surgical team in their natural environment under normal operations. This is not an examination/evaluation. The peer observers are specially trained in accordance with the Threat and Error Recognition Model (Helmreich, Klinect, and Wilhelm, 1999) to mark all the threats that the subjects faced, their errors, and their successful recoveries. These data are then used to provide constructive feedback to the teams and improve their safety performance. The teams are always free to decline or end a LOSA-type observation. The theory behind the LOSA-type observations and prompt feedback is that professionals in high-consequence industries routinely manage threats and errors. Some teams develop superior abilities to overcome systemic limitations or deficiencies in one another without compromising their mission, while other teams crumble under comparatively benign threats. The LOSA-type observations enable the teams to learn about their strengths and their weaknesses promptly and, most importantly, without having to wait for an accident. Organization-wide use and documentation of learning through LOSA-type observations would be a mark of a continuously learning organization.

Artifact analysis Cultural anthropologists have developed sophisticated and detailed techniques of describing cultures based on their artefacts. While most of the artefacts are in the form of physical articles that were used by the community or symbols, drawings, and paintings created by the community, some artefacts are also in the form of stories that convey core values and key experiences so that the future generations learn from the past (Bernard and Spencer, 1996). In organizational safety culture, there are similar artefacts.

Artefacts are an important element of the overall cultural assessment because they are created by the people who are part of the organization, and the design

of such artefacts is therefore reflective of the organization's cultural evolution. According to anthropologists, artefacts include physical evidence as well as key stories, legends, and myths that are passed down through generations because deeply held cultural values tend to be passed across generations through stories. Examples of such artefacts, in safety culture, include the following:

- Company publications – mission statement, safety policies, safety performance reports, safety training manuals, accident/incident reporting forms, error-reporting forms, policy or procedure change protocols, accident/incident reports, posters, and warning/caution signs and so on.
- Personal protective safety equipment actually used by the employees – such as goggles, masks, ear protection equipment, fluorescent vests, hard hats, steel-toe shoes.
- Safety markings in the facility – symbols, words, and demarcation lines clearly identifying hazards or hazardous areas as well as required safety equipment (hard hats, goggles, masks, etc.).
- Employee training and certification programmes – including safety awareness training, specific behavioural training to reduce errors and injuries, first-responder type training, incorporation of safe practices in technical training, human performance and team performance issues, system safety programmes (e.g. Crew Resource Management and Maintenance Resource Management).
- Symbols of safety initiatives – logos, stickers, t-shirts, lanyards, awards/medals, certificates.
- Hazard or error reporting programmes – specific non-punitive programmes to encourage all employees to self report their errors and report specific hazards (e.g. Aviation Safety Action Program, Aviation Safety Reporting System, Patient Safety Reporting System, MEDMARX Database).
- Peer observation programmes – programmes designed to raise the awareness of safety threats during normal operation and proactive, non-punitive analysis of ability to mitigate such threats (e.g. Line Operations Safety Audit).
- Stories of past experiences – what makes heroes and legends in the organization? What happened when someone pointed out a serious safety issue – was the individual punished, was the safety issue resolved, is there a general sense of positive achievement or is there a bitterness that signifies distrust? Are safety champions valued or are they viewed as barriers to productivity? How have critical safety challenges been addressed when they threatened to compromise productivity? Are there any well-recognized safety champions – on the employee side (including labour union representatives) as well as the management side? What are the senior employees telling the junior employees?
- Newsletters, methods and tools used to communicate safety practices; report, analyze, and proactively solve safety problems.

Southwest Airlines has published a Safety and Security Commitment[11] statement for its employees and passengers. Johns Hopkins Hospital has a similar statement of commitment, but it emphasizes safety and quality improvement.[12] Both these statements are examples of important cultural artefacts. A comparison of the two statements of commitment indicates that in healthcare, safety and quality are addressed together, while in aviation, they are treated separately. So, strategically, healthcare organizations would be more comfortable applying quality management tools to improve safety, but aviation organizations may be resistive to the use of quality management tools in safety. Further, the aviation industry has made a pledge to not compete on safety. Consequently, industry groups freely share safety data across corporate boundaries. In healthcare, since safety and quality are more tightly coupled, safety, like quality, may be regarded as a competitive advantage. Such subtle, yet critical, distinction between the cultures can be discovered through artifact analysis.

Another example of parallel artefacts in aviation and healthcare is a checklist. Pilots use checklists as part of their routine flying – there's a section for every phase of flight and also for emergencies. Surgeons have started using similar checklists relatively recently. Gawande (2011, pp. 197–200) presents some comparative examples of checklists from aviation and healthcare and argues in strong support of the use of checklists in surgery.

Interviews and focus group discussion Typically, interviews and focus group discussions have been used by safety researchers to develop a basic understanding of the vocabulary, norms, key safety challenges, organizational policies, and procedures. Systematic procedures and best practices can be used to design, facilitate, and analyze information from focus groups and interviews (Krueger and Casey, 2008; Schwarz, 2002; Stewart, Shamdasani, and Rook, 2006).

Such qualitative data are also useful in developing customized survey instruments that can be distributed to a larger audience to collect data on attitudes and opinions. Additionally, stories collected from interviews and group discussions can reveal heroes and legends that symbolize key cultural experiences. These stories tend to reveal deeply rooted meaning and help expose underlying values and assumptions.

Dialogue Dialogue is an intense conversational technique that seeks to address serious topics, underlying values, and unquestioned assumptions. Dialogic communication requires trust, openness, and respect between the participants. Dialogue can offer significant insight into important values and assumptions that are at the foundation of an existing safety culture.

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11 Southwest Airlines' Safety and Security Commitment Statement available at <http://www.southwest.com/about_swa/safety_commitment.html>.

12 John Hopkins' Safety and Quality Improvement Statement available at <http://www.hopkinsmedicine.org/quality/safety/commitment.html>.

Isaacs (1993) defines dialogue as 'a sustained collective inquiry into the processes, assumptions, and certainties that compose everyday experience' (p. 25). Its primary purpose is to help people engage in productive thinking together. Isaacs regards dialogue as a powerful tool for team learning since it focuses attention on aspects of experience that we frequently ignore and examines hidden assumptions behind conventional problems and ways of thinking. Isaacs' *Dialogue and the Art of Thinking Together* (1999), and Senge's *Fifth Discipline* (1990, 2006) and *Fieldbook* (Senge, Kleiner, Roberts, Ross, and Smith 1994) offer useful guidance for building practical dialogue skills to improve team functioning and organizational learning. Levine (1994) contends that selfless collective listening and team dialogue are learnable and replicable skills that can be used in diverse organizational settings to improve insight, innovative thinking, and performance.

Schein (1993) maintains that dialogue 'is a central element of any model of organizational transformation' (p. 27) and is essential to promote understanding of an organization's culture and constituent subcultures. Dialogue is regarded as a basic skill to recognize tacit assumptions, solve problems, resolve conflict, and learn from experience in complex group settings. 'The process of communicating across hierarchical levels … will require further dialogue because … different strata operate with different assumptions' (p. 37). Schein contends that it is necessary to understand ourselves first before we can truly understand others. Recognizing our own limitations can be threatening and cause defensiveness. For dialogue to be effective it must occur in a safe environment where emotional issues can be handled effectively 'without anyone getting burned or burning up' (p. 35). Schein' s 1999 text on the consultation process provides a masterful description of dialogue's use to uncover hidden forces and processes in organizational settings.

Abramovitch and Schwartz (1996) reference the ideas of Martin Buber's (e.g. 1947; 2002) philosophy of personal dialogue to explain the personal (I-Thou) and impersonal (I-It) relationships with patients that can occur in the practice of medicine. The authors argue that the failure of physicians to maintain a genuine dialogue (i.e. I-Thou) with their patients has resulted in a 'humanistic crisis' in medicine. They maintain that treating patients as objects (i.e. I-It) results in numerous undesirable effects, such as patient resentment, dissatisfaction, non-compliance with medical directions, malpractice litigation, and overmedication. These authors argue that these negative outcomes can be minimized through the process of authentic physician-patient dialogue as a basis for shared medical decision-making.

April (1999) asserts the centrality of dialogue to organizational change, which occurs in the context of social interaction. Dialogue builds critical thinking and results in insight and a call to action. Stubbs (1998), like Senge (1990), also regards dialogue as fundamental to bringing about transformative change. Dialogue helps achieve this by going beyond typical discussion to tackle 'undiscussables'. If unquestioned assumptions and other undiscussables are not addressed honest communication is prevented, which then blocks significant change. These authors maintain that transformational leaders require dialogue to be successful.

Gerard and Teurfs (1997) succinctly describe the core elements of effective organizational dialogue. These key dialogue skills include: suspending judgment; identifying assumptions; active listening; and inquiring and reflecting. They contend that by applying these skills, dialogue builds community and changes culture through: behavioural transformation (changing how participants relate to one another), experiential transformation (inducing a feeling of community), and attitudinal transformation (creating attitudes that support collaboration and partnership, which improve decision-making).

Bodily and Allen (1999) explain a six step process in developing strategy that relies on dialogue between decision makers and strategy developers to optimize insight and creativity. The authors maintain that dialogue can be effectively used: 'To identify issues and challenges; to develop creative, doable alternatives; to treat economic value and risk meaningfully; to balance the process of creating strategies and the process of evaluating and choosing alternatives; to reason logically and correctly; and to commit to action' (p. 28).

Keatings, Martin, McCallum, and Lewis (2006) describe the use of dialogue in the process of disclosure about the systemic issues of medical error that led to the death of 11-year-old Claire Lewis in 2001. Initial silence from the hospital regarding the medical error and subsequent editing of information by legal advisors resulted in a report that produced feelings of distrust and anger in the child's family. Greater alienation resulted from a meeting with hospital representatives where the family felt their concerns were met with defensiveness, intimidation, and insincerity. Eventually the hospital acknowledged that the death had been preventable and offered an apology. According to the child's father: 'The disclosure and apology melted horrific feelings away, slowly opening the door to a meaningful dialogue between the family and the hospital staff' (p. 1085). As part of the corrective changes by the hospital a patient advocate role was created and filled by the child's father. He is described as bringing 'unique passion, insight, and empathy' to the position. Dialogue that discloses the facts and takes responsibility has led to trust and healing among families impacted by medical errors.

Mazor et al. (2004), using survey methodology, studied the reactions of health plan members to scenarios about medical error with different disclosure dialogues between physician and patient. They found that full disclosure dialogues by physicians that provided an explanation, accepted responsibility for the error and offered an apology were superior to nondisclosure dialogues, which merely expressed regret for the error without accepting responsibility or providing an apology. These full disclosure dialogues showed higher levels of patient satisfaction, trust, and positive emotions and reduced the intention of changing physicians. In some situations full disclosure also reduced the intent to seek legal advice regarding the medical error, although the authors conclude full disclosure dialogue may not always prevent litigation.

Triola (2006) discussed the role of dialogue and other interpersonal abilities in skilled communication among critical care nurses in order to develop a healthy work environment and improve patient safety. She references research by

Maxfield et al. (2005) and Patterson et al. (2002), who identified seven difficult but critical types of conversation that occurred in healthcare, including: broken rules, mistakes, lack of support, incompetence, poor teamwork, disrespect, and micromanagement. Triola suggest several tools and strategies to address these difficult conversational topics, such as: examining root cause analyses and failure mode effects analyses for communication problems, self assessments to measure confrontation skills, best practices to develop open dialogue that is candid and respectful, and communication coaching.

Quasi experimental analysis Applied field research does not have the same ability to manipulate, randomize and control variables as experimental laboratory research. However, effective quasi-experimental designs (Campbell and Stanley, 1963) are available for use in field settings to study the linkage between variables. Safety culture researchers have called for better empirical evidence to test hypothesized relationships between safety climate, safety culture, safety behaviour, and organizational performance (e.g. Pidgeon, 1998; van den Berg and Wilderom, 2004). Wiegmann et al. (2002) suggest that organizational psychology is particularly attuned to the importance of testing causal relationships due to its interest in implementing change interventions to improve safety culture.

A multi-method, quasi-experimental analysis, as suggested by us, will allow for both qualitative and quantitative methods pre- and post-intervention. The shift in safety cultural state will need to be documented with the appropriate tools and we need to bear in mind that there will be factors other than the interventions that may influence the change in climate or culture.

Safety Culture Transformation

Safety Culture Transformation is 'transformational' because it is about changes in values of organizations and its people. Rochon (1998, Ch. 3) discusses cultural transformation in terms of three levels of change in values: value conversion, value creation, and value connection. If we are working with people and organizations that currently value a blame-oriented culture because they believe in punishment, then the transformation process is about getting them to see the need to change their values and be open to non-punitive ways of improving safety performance. If organizational learning is not a stated value, then we would be striving to create it by demonstrating the importance of organizational learning to the overall success of the organization. Similarly, if flight safety or patient safety is not an explicitly stated value, but service quality is, a connection could be made between service quality and flight/patient safety.

Safety Culture Transformation is about shifting the equilibrium of the Safety Culture Pyramid from its current state to a more desirable state. So, we need to fully understand the current state of the safety culture. This process will enable us to understand the values that are being enacted at this time, the strategies that are in place and in balance with the enacted values, current attitudes and opinions of

the employees and management, and finally the current behavioural trends and patterns. All the safety culture assessment methods discussed earlier in this chapter may be used to develop a thorough description of the existing safety culture. Then a parallel set of behaviours, attitudes, strategies, and values needs to be developed as the desired cultural state. This approach is consistent with our Safety Culture Pyramid Model and with Sloat's (1996) recommendation to first focus on values and unquestioned assumptions and then make changes to artefacts (he includes organizational structures and processes as artefacts), including employee evaluation and recognition systems and performance standards. Gordon, Moylan, and Stastny (2004) and Shackford (2005) focus on behavioural aspects of cultural change, but they too acknowledge that such changes should be consistent with the organizational values.

So, first we have to thoroughly understand our current values and unquestioned assumptions. Next, we need to ask if anything in our desired cultural state is in conflict with the currently enacted values. For example, if we are trying to get an organization from blame culture to reporting culture, we need the employee behaviours to change (they need to start submitting the reports), we need management behaviours to change (they need to stop disciplining every time someone confesses to making a safety mistake and to start correcting systemic failures), and we need the regulator's behaviour to change (they should not fine or otherwise violate the individual's professional certification). In order for people to make such fundamental shifts, they should be ready to accept changes in the corporate values, they should believe that this change is essential, and they should see that they have nothing to lose and much to gain in this process. The actual implementation of the transformation will require several discussions with the key stakeholders, assurances of being understanding and working with individual self-interests, and delivering on the promises made in this process.

Finally, cultural transformation takes time and effort from all. It needs to be an organization-wide commitment. A number of organizational processes and policies – particularly the evaluation and recognition systems – might have to change, it may cost more than originally envisioned or budgeted, and it is not going to be without struggle. In some cases, certain unwilling employees will need to retire or quit before progress can be made. Labour unions, corporate attorneys, and regulators will all need to be committed to making the transformation. Regular measurements through surveys and performance data should be shared broadly to keep everyone informed of the transformation status.

Chapter Summary

In this chapter, we discussed a variety of tools and techniques to assess different aspects of safety culture. In accordance with the Safety Culture Pyramid model, a blend of qualitative and quantitative methods needs to be used to develop a comprehensive understanding of safety culture. There is evidence in the literature

that supports linking safety values, safety strategies, safety climate, and safety performance. Several studies have also demonstrated an influential link between safety values and safety behaviours, safety strategies and safety behaviours, safety climate and safety behaviours as well as from safety values through safety climate to safety performance.

Typically, a study of safety culture starts with qualitative analysis, using interviews, focus group discussions, and dialogue. Then, the study moves on to a review of artefacts such as organizational charts, unique products, awards, safety reports, etc. that signify important developments in the organization's culture. In parallel, we need to start having dialogue with key informants (in anthropological parlance, people who have deep tribal knowledge about the culture) to develop a fuller understanding of culture, and to start collecting specific safety performance cases that illustrate the cultural challenges at the organization. The analysis of such qualitative data will help prepare a survey instrument that could be used to measure safety climate along valid and reliable scales.

The safety climate survey could be used to identify the extant *state* of safety culture in the given organization. A number of different strategies could be used to move the safety culture toward a more desirable state. The literature supports the notion that deep-seated safety values influence safety strategies, which in turn shape safety attitudes; and ultimately, safety climate/attitudes shape behaviours.

In order to transform a given culture, the people in that culture must change. For the people to change, top management must plan the implementation of the new culture very carefully. They must explain to middle management that improving safety culture is the right thing to do; and, that it is in the interest of the organization's survival. Next, they must get the employees to support the initiative by aligning the employee evaluations and reward structure so that the desirable behaviours are rewarded and undesirable behaviours are curbed. Pre- and post-intervention surveys might help illustrate effect of the intervention.

Dialogue is a special technique of engaging individuals in deep, serious discussions aimed at revealing underlying values and unquestioned assumptions. These discussions are not likely to occur unless there is sufficient trust and openness between the interviewer and the participants. Once established, dialogue can be an extremely powerful mechanism to better understand the values and assumptions that are at the foundation of the existing safety culture.

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Chapter 4
Safety Climate

Introduction

Safety Climate is the next layer of the Safety Culture Pyramid. Survey questionnaires are commonly used to measure safety climate, which is a snapshot of the attitudes and opinions of the sample population at the time of the survey. There are over 50 safety culture/climate survey instruments! So, in this chapter, we will discuss how safety climate questionnaires are developed, how they are tested for reliability and validity, and how they are used to assess the current state of safety climate as well as effects of specific interventions such as training on safety climate. Next, we will discuss the Patankar and Sabin Safety Climate Questionnaire (PSSCQ), its psychometric properties, and the evolving influence structures of various factors contained in this questionnaire.

Basics of Safety Climate Measurement

Safety climate measurement typically starts with a combination of interviews, focus group discussions, and ethnographic observations. Collectively, these experiences provide a first-level impression about the safety climate at a particular organization at the time of these experiences.

Interviews and Focus Group Discussions in ATO Technical Operations

Our Air Traffic Organization (ATO) Technical Operations (Tech Ops) Safety Culture Research started with a simple question from the vice president: what is the safety culture like in Tech Ops? At that point, the term *safety culture* was not fully understood, but it was gaining popularity across the ATO. So, we developed a set of questions that would facilitate a conversation with individuals and/or small groups. Since Tech Ops is a national organization, which is divided into three major service areas (western, central, and eastern), we sought permission to interview individuals who represented a sufficiently inclusive sample of job titles and technical specialties across each service area.

Based on our review of safety culture literature (Patankar et al. 2005) and one-on-one interviews with key personnel from Tech Ops, we developed the following list of questions/discussion items for our focus groups. However, the most important aspect of this discussion was to start a conversation and to let the

people talk about their experience and their opinions about safety culture. In total, over 75 individuals participated in these discussions.

- What's the first word/phrase that comes to mind when you hear 'Safety Culture'?
- How would you describe the general work environment in your unit/department at this time?
- What would you consider a 'success story' that illustrates a strong positive safety culture (this could be in your organization or somewhere else)?
- What are some of the key reasons to improve the safety culture?
- What is your experience with getting some systemic improvements accomplished?
- What are some of the necessary steps in improving the safety culture in your department/location?
- What are some of the challenges in accomplishing the above steps?
- What would you suggest to make the above changes last even when some of the key people have moved on to other positions?
- How would you describe the employee-management relationship with regard to mutual trust, interpersonal communication, professionalism, goal sharing?
- What are the key performance parameters on which you are evaluated and your reward/penalties are decided?
- How do you compare/contrast the safety culture in private industry – whether it is in aviation or outside – with that in your organization? Are there any best practices from these external organizations that could be customized and incorporated in your organization?
- How would the employees characterize their managers in this organization? How would the managers characterize their employees in this organization? How would you rate your organizational unit with your peer units – worse than others, about the same as others, better than others?
- Are there any policy changes that need to be implemented in order to improve the safety culture?
- What type of support do you need from your management/headquarters to improve the safety culture?
- What type of support do you need from your labour union to improve the safety culture?
- How long would it take to change the safety culture in your organization?
- How would you know when you have succeeded in accomplishing the cultural change? How would you prevent a relapse?
- Would you like to add any questions?

All focus-group discussions were audio recorded and transcribed. Content analysis was performed to identify key themes and the reliability of the theme extraction was checked by three independent researchers. The following sections present the results of this analysis.

Perceptions regarding 'safety culture' Overall, the term *Safety Culture* was not familiar to most Tech Ops personnel; some related it to personal injury issues, some to the National Airspace System (NAS) safety, and others simply considered it to be just another buzz word. Some examples of work norms revealed that the field personnel routinely engaged in 'workarounds', which are maintenance actions that are not strictly in accordance with the published procedures. In most cases, the personnel developed these workarounds because there were no published procedures for the particular maintenance tasks. Another issue raised, particularly by experienced personnel, was about perceived overemphasis on minimizing cost. In their opinion, the message of efficiency was so strong that the expectation of safety was getting drowned. They questioned whether the long-held goal of ATO – to provide 'safe, orderly, and expeditious flow of air traffic' – was being impacted by increasing priority being placed on minimizing costs and expediting air traffic. This concern was strong enough that those who were familiar with the *Columbia Accident Investigation Board Report* commented that the FAA's safety culture might be headed toward the NASA Culture of 'faster, better, cheaper' (CAIB, 2003) – implying that a certain degree of deterioration in values might be underway. Nonetheless, it was clear in these discussions that Tech Ops is extremely dedicated to keeping the NAS safe. The people had a 'can do' attitude, but the ability to maintain the safety of the system was expected to reach a critical point in the near future with the increasing number of aging 'unreliable' technical systems that continued to be in service. Coupled with the shrinking workforce, the expectation of high reliability was becoming a 'mission impossible'.

State of the current work environment Tech Ops employees took great pride in their work and exhibited 'ownership' of the equipment for which they were responsible; they strongly believed that they played an important role in ensuring safety of the NAS; they often went beyond their call of duty to minimize errors; and they exhibited ingenuity in developing field-level solutions to a variety of problems. There seemed to be a reasonably positive work environment at the local level; the relationship between the local, regional, and headquarters, however, appeared to be increasingly disjointed. Some participants complained about serious communication disconnects between the local, regional, and headquarters levels, which had resulted in local improvisations to systemic problems. There was a marked discontent regarding the decreasing staffing levels and a concern that such cuts in personnel might affect safety; a few examples were provided to illustrate this point. Cases of training deficiencies were common and were linked with staffing shortages and aggressive equipment deployment schedules. Even in some of the 'better' facilities, the employee-management trust was questionable. One of the participants offered the following comment: 'if errors/problems are reported, the system-wide version that is disseminated will often be sanitized

such that critical details are removed for political reasons to protect management'. Managers complained about having limited resources to manage their employees and expressed concern that the message of efficiency was stronger than that of safety.

Success stories In the Tech Ops world, safety of operation is equated with hardware reliability and availability. If the navigation systems, communication systems, radar units, and the environmental systems are operating at or above the target reliability and availability threshold, people regarded the system to be operating at a safe level. Therefore, they regarded each day of safe operation as a 'success story' for the system. When pressed for issues more directly related to safety, the participants described the 'Lessons Learned' database, which is used to document an incident or an accident and the lessons learned from such an event. This database appeared to be a one-way repository of documents that were not used for broader education or development of system-wide solutions. Further, some employees regarded the process of writing a lessons learned report to be punitive in itself. Another database, the Tech Net database, was perceived more positively. It was a database of technical problems and the corresponding solutions. The technical specialists were very comfortable using the Tech Net database to log solutions to problems experienced by others as well as to seek solutions to their own technical challenges.

Key reasons to improve the current safety climate/culture Initially, most participants commented that their current safety culture was very good and needed little improvement. Their reasoning was based on a high equipment availability level: 97–99 per cent. However, as the discussion continued, they acknowledged that the number of highly skilled senior staff is decreasing (due to retirement) while the number of new systems to be maintained and the number of flights are increasing; the system is being stressed. The safety limits of this system are not known, but it seemed to be held together by several individuals who routinely went beyond their call of duty to ensure systemic safety. Clearly, systemic solutions are needed to not only improve the current level of safety, but even to simply maintain the current level of safety.

Experience with getting systemic improvements accomplished There were many examples of local improvements/best practices, but very few that had a national impact. For example, one person rewrote the certification exams for Display System Replacement (DSR) and had them published nationwide – he was very satisfied with the outcome. Another example is when a security planning group worked with First Responders, FBI, and Secret Service to develop a plan to handle terrorism and national emergencies. Overall, many employees had participated in planning for improvements, but their recommendations were not implemented; hence, they are now reluctant to participate in similar efforts. It is generally difficult

to make systemic improvements due to organizational bureaucracy; information exchange is typically not effective.

Challenges to accomplishing improvements Since Tech Ops is a national organization, it is often difficult to contact people across time zones. Tension between management and employees seemed to be high in some locations, generally due to mistrust resulting from performance and budget issues. The decline in staffing levels was believed to be reducing redundancies and impacting safety of individuals as well as the NAS. The following examples were shared to illustrate that the risk tolerance is on the rise:

- One person is responsible for maintaining two geographically separated systems. If both these systems fail at the same time, one person will not be able to restore both systems simultaneously; he will have to choose one system over the other and the one that remains out of service will pose a continued risk to the system.
- Instead of two, only one person is sent out on a job at remote sites. If that person gets electrocuted, there is nobody to call for assistance; also, if that person makes a mistake, there is nobody to double-check.
- Many-a-times, there is only one person on the watch for critical systems at night. Sometimes, that person does not have the training or the experience to address the wide range of calls that he/she might receive. There is no back-up.

From a management perspective, tension between production and safety is real and better training is needed to manage this tension. Poor communication between local, regional, and headquarters levels inhibits field problems from reaching appropriate people higher in the management for timely attention. Infrequent personal contact between the three levels breeds misunderstandings and sends mixed messages.

Employee-management relationship Most people were satisfied with the employee-management relationship at the local level. However, some sites appeared to have very low employee-management trust. Across the board, many employees seem to be threatened with the increasing emphasis on job reductions. Some managers seem to be unprepared to handle declining staffing and increasing workloads, particularly with existing communication challenges between local, regional and national levels, as well as the ineffective employee and management evaluation systems. Managers with prior Tech Ops field experience or better communication with the workforce were more respected by their employees. Several people criticized the headquarters due to a lack of personal contact and believed that the problems they faced in fielding new systems could have been averted by headquarters. A common theme expressed was that words speak of safety and actions speak of efficiency: 'HQ does not practice what it preaches'.

Parameters for performance evaluation Both managers and employees were dissatisfied with their respective evaluation systems because they were not always based on merit, there were no clear and efficient means to handle substandard performance, and different managers handled evaluations differently. From a safety perspective, it was interesting to note that nobody was evaluated on safety. Different locations/sites were being held to different performance standards. Many expressed the belief that the annual evaluation was a joke, a perfunctory five-minute interaction. Further, there was no clear career progression ladder in the system or no incentive to move from a less complex facility to a more complex facility or to the headquarters.

Comparison with external organizations or private industry Some locations rated themselves better than private industry; others rated themselves worse than private industry. Many individuals indicated that the US military had better performance standards regarding safety.

Necessary policy-level changes Generally, people believed that policies would not change until an accident occurred. Employees believed that Tech Ops was very reactive: once people are killed, more staff would be hired. According to them, in order to change the safety culture, Tech Ops needs to be more proactive. For example, the new maintenance philosophy, which is a shift toward reliability-centered maintenance, relies on system service data that may not be accurate. In the past, technical specialists often performed maintenance actions even if they were not scheduled to perform the maintenance because they were either in the vicinity of the equipment or noticed some anomaly that required attention. Many technical specialists believed that such spontaneous maintenance actions tend to provide a false sense of reliability in aging equipment. As the organization moves toward condition monitoring and extended maintenance intervals, the safety risk may increase. A real risk-assessment and associated guidance material is needed to assist in performance vs. safety decisions at the operational level.

Need for management support Field personnel felt that the headquarters was getting increasingly out of touch with the local issues. Some managers were accused of changing outage reports to make their facility look better. For example, 'An unscheduled outage may be changed to a scheduled outage to make the facility look better; however, the result is that equipment appears not to need preventative maintenance because it did not fail. If equipment is not prone to periodic failure, then less manpower is needed to maintain it and new hires are not made. This creates a culture based on lies.' For the culture to change, problem managers and supervisors must be changed. Managers need to better understand the technical needs rather than focus on manipulating the maintenance intervals to match the staffing/budget limitations.

Need for labour union support Some managers report that they would like to see the union focus more on organizational (FAA) goals rather than on individual member's needs. Some employees think that the union (PASS – Professional Aviation Safety Specialists) is too weak – not like NATCA (the National Air Traffic Controllers Association). Some employees joined the union to protect their jobs; others were active in influencing local changes and improving work conditions. Some employees were satisfied with the local union representatives, but not with the national representatives. PASS was believed to be frequently reactive to management instead of being proactive and a strong, equal partner in key decisions.

Comments from open discussion Aggressive technology/system implementation schedule undermines quality/safety. FAA does not want to hear grass roots problems. People who maintain the systems have little opportunity to provide input to the design and acquisition of such systems. Great performers are not recognized; poor performers are not penalized. Concern regarding the overall shift in who the customer is: from the flying public to the airlines. While senior staff loved their job in the past, they are now looking forward to retirement – it's no longer worth the effort.

Important issues across the system The focus group discussions can be further distilled into seven key themes: (a) identity crisis, (b) interpersonal communication, (c) labour-management relationships, (d) interpersonal trust, (e) goal sharing/attainment, (f) performance standards and evaluation, and (g) employee involvement in shaping the collective future. Essentially, the Tech Ops employees are talented professionals committed to their mission of ensuring NAS safety. At the time of the focus group discussions, they indicated some confusion about their organizational priorities and hence there is some question regarding their identity – is safety an organizational priority over efficiency? Are they working toward a safer system for the flying public or are they working toward a more efficient system for the airlines? The issues with interpersonal communication, labour-management relationships, and interpersonal trust are rather typical of a large and distributed organization like Tech Ops; however, a unifying safety philosophy coupled with appropriate training materials would go a long way in improving communication and interpersonal relationships. Changes to performance evaluation systems and opportunities for employee involvement are critical in changing the organizational culture in the future. These two items are the classic artefacts of the old culture that will keep resisting adoption of the new culture.

Development of the Patankar and Sabin Safety Climate Questionnaire

The focus group discussions presented earlier and the literature review discussed in this section led to the development of the Patankar and Sabin Safety Climate

Questionnaire (Patankar and Sabin, 2008). This questionnaire has three sets of factors: organizational factors, team factors, and outcome factors. The specific items that relate to each of the factors are presented.

Organizational Factors

Knowles (2002) claims institutional identity, information flow, and relationships as the three key aspects for managing organizational success. He demonstrated through several case examples how he was able to improve both safety as well as business performance at DuPont chemical plants using his Process Enneagram. Based on additional literature in safety (cf. Westrum, 1995; Reason, 1997; Patankar and Taylor, 2004) and organizational change management (cf. Collins and Porras, 1997; Wheatley, 1999; Collins, 2001), Patankar et al. (2005) added leadership and evaluation (cf. Roughton and Mercurio, 2002) as two other core elements necessary for a successful safety management system.

Institutional identity Understanding institutional identity is critical to sustaining new programmes – whether they are safety programmes or business initiatives. Collins and Porras (1997) studied several companies and deduced that successful companies were better able to 'preserve the core and stimulate progress'. In reviewing the progress of Maintenance Resource Management Programs, Patankar and Taylor (1999) note that the absence of an umbrella document that connected these programmes with the institutional goals may have at least contributed to the deterioration of such programmes. When a programme is tied with the core corporate identity and goals, it receives attention from the highest level of the corporate management (Knowles, 2002). Consequently, everyone down the chain of command is more likely to be held accountable for the success of such programmes. For example, when DuPont Chemicals realized that their business success was fundamentally dependent upon their safety programmes, a culture of high reliability (and high safety) emerged. Similarly, when the DuPont management recognized that it was essential to collaborate with their stakeholders, the community in which DuPont's plants were located and their regulators, they acknowledged that everyone's survival was interdependent, and they developed comprehensive safety programmes (Knowles, 2002). There are many such similarities in the nuclear power sector (cf. Schulman, 1993) as well as in other high-reliability sectors (cf. Roberts, 1993). The basic fact is that in organizations with a strong safety culture, safety is integral to the organization's survival/success.

Sloat (1996) claims, 'an organization is most effective when artefacts, values, and assumptions are lined up and mutually supportive' (p. 66). If such alignment is not orchestrated, the safety programme (or change programme in general) tends to be launched at the artifact level alone – new stickers, logos, uniforms, etc. Eventually, the new initiative 'will be overwhelmed by the practices that are supported by the values and assumptions of the organization' (p. 68). and it

will die. Therefore, in order to have a sustainable safety programme, it has to be aligned with the fundamental identity, values, and assumptions of the organization. The espoused safety values may be accessible through corporate promotional materials, but the enacted safety values are usually discoverable through periodic safety climate surveys.

The following questionnaire items are aimed at institutional identity:

- NAS [National Airspace System] safety is consistently communicated as the core value/goal of the ATO-Tech Ops.
- There is high consistency between words and actions throughout ATO-Tech Ops.

Information flow Westrum (1993) views information flow as such a critical element of an organization that he classifies organizations based on this key parameter: pathological, bureaucratic, or generative. Clearly, the ability of an organization to receive good information and act on it in appropriate manner is dependent on the mechanisms that are set up for such information flow. There are many similarities between Westrum's classification and the one by Senge (1990) on learning organizations. Senge views information as key for organizational learning. Based on the growing literature on reporting cultures (Marx, 1997; Reason, 1997; Taylor, 2004; Patankar and Gomez, 2005), it is clear that an organization could transition from a blame-ridden culture to the one that has a 'Just Culture' (Marx, 1997; 2001), if it is successful in implementing an effective reporting culture. The effectiveness of a reporting culture depends on the employees' confidence in the system or the leadership – they need to feel that their feedback/input will be taken seriously (Harper and Helmreich, 2003). The quality of information flow vertically across the organizational ranks, and more importantly the effects of such information (e.g. does anyone really act on this information?) impacts interpersonal trust. Patankar, Taylor, and Goglia (2002) studied interpersonal trust among aircraft mechanics and their supervisors; they report that up to 30 per cent of the mechanics do not trust their supervisors to act in the interest of safety. Later, Patankar, and Driscoll (2004) noted that organizations with error reporting programmes such as the Aviation Safety Action Program had a higher level of interpersonal trust than those without. Therefore, it is not only important to open information flow vertically as well as laterally throughout the organization, but it is also important to act on the information that is received as a result of such open communication.

In an example from the Technical Operations domain of the FAA's Air Traffic Organization, Ahlstrom and Hartman (2001) discovered that according to some specialists (technicians), the equipment status information and information in other databases are not always maintained and up-to-date. This discrepancy can cause errors such as calling a field technician who is unavailable to fix a problem and thus increasing outage durations. The specialists also indicated that weather played a critical factor in Airway Facilities (now Technical Operations) decision-

making. However, Ahlstrom and Hartman's observations and structured interviews revealed that specialists often do not have current weather information for their area.

Another source of errors among the specialists was procedural ambiguity or noncompliance. This may be due to lack of training on the part of the specialist or memory overload. These errors occur in the present Maintenance Control Centers (about 40 are strategically placed throughout the United States), but there is also the potential for increased human error of this type with the introduction of new procedures and business practices associated with the Operations Control Centers (OCC) – three centrally located regional centres responsible for monitoring and controlling the facilities in their region, assigning personnel and resources, and coordinating Airway Facilities (now Technical Operations) and Air Traffic Information (Ahlstrom and Hartman, 2001).

The following questionnaire items are aimed at information flow:

- Tech Ops managers will act on NAS safety concerns voiced by their employees.
- Very good communication about NAS safety exists up and down the Tech Ops chain of command.
- Very good dialog and communication exists between Tech Ops and their Enroute and Terminal Air Traffic partners to ensure NAS safety.

Relationships Fundamentally, people make the organization. Hence, it is important to build strong, positive, professional relationships between the people who work together. Knowles (2002) has illustrated in several examples how people come together in crises, forget their individual differences, and work toward the larger problem at hand. If such collaboration and cooperation could be retained after the crisis is over, the organization would function under the 'self-organizing' or 'living system' paradigm. Relationships within the organization are shaped by the level of shared purpose, open communication between the people, and their interdependence. As Knowles experienced, once the information was openly shared and the goals were clearly communicated, the health of the professional relationships among the people within his organization, as well as throughout the larger community in which the organization was located, improved dramatically. From a living systems perspective, positive information flow is bound to result in healthier professional relationships because organizations are living systems and information is the lifeblood of such systems (Wheatley, 1999). It is up to the leadership to take advantage of such natural forces and align them in a positive direction. There is additional literature on the quality of professional relationships, their effect on job satisfaction, and the overall organizational success (cf. Freiberg and Freiberg, 1996; Herzberg, 1966). Therefore, it is important to invest in building strong, professional relationships in an organization.

The following questionnaire items are aimed at relationships:

- There is excellent cooperation between different Tech Ops specialties/ disciplines.
- Working in Tech Ops is like being part of a large family.

Leadership Effective leadership appears as a key contributor to successful safety programmes in a variety of domains. Fleming and Lardner (1999) studied the impact of supervisors' attitudes, management style, and behaviour on their subordinates' safety behaviour in the offshore oil industry. This study identified a number of supervisor attributes that were associated with positive subordinate safety behaviour, and less risk-taking behaviour indicated that their supervisor possessed attitudes, skills, and behaviours that can be summarized as follows:

- Valuing their subordinates.
- Visiting the work-site frequently.
- Facilitating work group participation in decision-making.
- Effective safety communication.

Fleming and Lardner's research suggests that a supervisor safety management development programme could be an effective mechanism for safety culture improvement. The factors to be considered when developing a supervisor safety development programme are as follows:

- Supervisor training should include a focus on the interpersonal aspects of safety management.
- Training should be skill-based (the how) as opposed to purely knowledge-based (the what).
- Subordinates should be involved in decision-making.
- A role model should be provided to motivate supervisors and keep the process moving.
- Support should be given from senior and middle management.

In a survey of train drivers in the United Kingdom, Clarke (1998) found that very few drivers (3 per cent) reported other drivers' rule breaking behaviours where a third of the drivers felt that rule breaking by another driver was not worth reporting. Clarke also found that train drivers in the United Kingdom were less likely to report incidents if they considered managers would not be concerned with such reports. High levels of non-reporting were most evident when workers felt that incidents were just 'part of the day's work' and that 'nothing would get done'. These findings indicate that incidents are not reported because they are accepted as the norm; this was further reinforced when drivers perceived that reporting an incident would not result in any action being taken, indicating a lack of commitment by management. However, the results also indicate that drivers would be more likely to report an incident if they thought something would be done to remedy the situation.

The influence of leadership on the success or longevity of a safety programme was also reported by Taylor and Christensen (1998) and Patankar and Taylor (2004). In both of these studies, it was reported that: (a) most maintenance resource management programmes stalled due to a 'lack of management follow-up', and (b) the awareness of safety issues raised by training programmes tends to erode or even turn into a negative attitude, if such awareness is not reinforced by supporting structural or procedural changes. Management must clearly demonstrate that it is willing to make the changes necessary to sustain the attitudes and behaviours espoused by the training programmes and bridge the gap between 'espoused theory' and 'theory in use' (Argyris and Schön, 1974). The Australian Occupational Health and Safety Commission cites, 'Recurring findings across the studies were the critical role played by senior managers in successful health and safety management systems, and the importance of effective communication, employee involvement and consultation' (Gallagher, Underhill, and Rimmer, 2001, p. 12).

In studies of aircraft mechanics and health care professionals, Patankar, Brown and Treadwell (2005) note that the priorities of frontline workers and supervisors or management personnel are different: frontline personnel tend to be focused on technical aspects of their jobs and managers tend to focus on the fiscal and operational aspects of their jobs. If we apply Wheatley's (1999) 'living systems' model, each person in an organization can be motivated to change by linking his/her individual survival (in the job) to that of his/her organizational unit. Patankar, Brown, and Treadwell's studies suggest that frontline personnel are motivated by their respective duty ethics; therefore, if they are mature enough in their ethical decision-making, they will be more concerned with fulfilling their professional duty (their professional survival is tied to the validity of their professional licensure, which, in turn, is tied to adherence to standard professional practices) than in saving money for their company. Since these studies note that managers tend to be more focused on fiscal or operational aspects (their survival as managers is tied to the fiscal performance/efficacy of their organizational unit), one could deduce that the managers could be more motivated to support the safety programme when such a programme demonstrates a specific fiscal impact.

The following questionnaire items are aimed at leadership:

- Tech Ops managers encourage their employees to report safety discrepancies and human errors without fear of negative repercussions.
- I trust the risk assessments made by Tech Ops leaders regarding NAS safety.

Evaluation/accountability Strebel (1998) noted that employees make three levels of compacts in the workplace: first, the formal compact based on their appointment/employment contract – what do they need to do to retain their job; second, based on psychological aspects – how hard do they really have to work, what reward/recognition will they receive, and will it be worth the effort; and third, based on the social aspects – what is the level of consistency between the company's mission statement and experienced practices or what are the real rules that determine who gets what in this company. The tighter the alignment of the change programme with these three compacts, the better the likelihood of its success. Therefore, if safety performance is important to the organization, it must be measured, all employees and their managers must be held accountable for their actions or inactions, they must receive equitable recognition for their efforts, and the policies and practices must be consistent (cf. Roughton and Mercurio, 2002). In organizations with strong safety cultures, the safety goals of the organization are fully understood by each employee (including the CEO) and each person is held accountable for doing their part in achieving the organizational goal (Grubbe, 2003). Therefore, employee evaluation is a critical part of organizational performance: it is the glue that makes change initiatives 'stick'.

The following questionnaire items are aimed at evaluation or accountability:

- For specialists [technicians], employee performance appraisals are closely linked to the Tech Ops goals of maintaining NAS safety.
- For specialists, good work performance related to NAS safety is rewarded.
- For specialists, poor work performance related to NAS safety is promptly addressed and corrected.

Team Factors

Patankar, Bigda-Peyton, Sabin, Brown, and Kelly (2005) placed Professionalism, Interpersonal Trust, Goal Sharing, Adaptability/Resilience, and Institutional Support in the Team Factors category because these scales are dependent on collaboration among coworkers, employee-management relationship, the level of connection an individual feels with the general direction of the organization, etc. Ultimately, these factors seem to cluster around the notion of teamwork.

Professionalism In multiple longitudinal survey research projects, involving several thousand aviation maintenance personnel, researchers have reported that individual professionalism, which is composed of professional competence as well as self-awareness of vulnerability to human performance limitations, is critical to the development of a safer maintenance environment (or culture) (Taylor, 1995; Taylor and Christensen, 1998; Taylor and Patankar, 2001). Later, Patankar, Brown, and Treadwell (2005) added 'the ability to make sound ethical decisions' to the definition of individual professionalism.

In this chapter we present professionalism as a team factor because the notion of individual technical competence seems to be dependent on the perceived identity of the organization (do we hire only the best technicians? Are we renowned for the best in-house training programmes?), as well as the evaluation systems in place (how do we handle lapses in technical performance/skill?). While one's ability to make ethical decisions may be independent of the organization in which

they are employed, the gap between individual ethical standards and those of the organization is likely to be influenced by the quality of information flow, leadership, and the evaluation system. Thus, we believe that the organizational factors that were presented earlier have some influence on individual professionalism.

The following questionnaire items are aimed at professionalism:

- Tech Ops employees use adequate redundancy and backup systems to minimize the probability of systemic failure.
- My work group consistently learns from its successes and failures.
- I am proud to work for Tech Ops.
- My work group is the 'best in business' when it comes to supporting NAS safety.

Interpersonal trust Organizations with a positive safety culture are characterized by 'communications founded on mutual trust, by shared perceptions of the importance of safety, and by the efficacy of preventive measures' (ACSNI, 1993). Further, the importance of interpersonal trust in building a strong safety culture has been noted in several studies (cf. Helmreich, 1999; Patankar, Taylor, and Goglia, 2002; Roughton and Mercurio, 2002; GAIN, 2004; Patankar and Taylor, 2004).

The process of clearly establishing acceptable versus unacceptable behaviour, if done properly in a collaborative environment, brings together different members of an organization that might often have infrequent contact in policy decision-making. This contact, as well as the resulting common understanding of where the lines are drawn for punitive actions, enhances the trust that is at the core of developing Just Culture. In order to combat human errors, we need to change the conditions under which humans work. The effectiveness of countermeasures depends on the willingness of individuals to report their errors, which requires an atmosphere of trust in which people are encouraged to provide essential safety-related information. (GAIN, 2004).

The following questionnaire items are aimed at interpersonal trust:

- My supervisor can be trusted to act in the interest of safety.
- My suggestions about safety would be acted on if I expressed them to my supervisor.
- I feel comfortable going to my supervisor's office to discuss safety problems.
- My supervisor listens to me and cares about my concerns.
- My supervisor trusts me.

Goal sharing La Porte and Consolini (1991) studied High Reliability Organizations (HROs) and reported that such organizations have very clearly identified operational goals and the consensus among the employee groups is unequivocal. Considering that much of the HRO research was concentrated on Naval aircraft carrier operations and nuclear power plants, one could visualize a battery of personnel trained to perform specific tasks to perfection on a routine

basis. While one might argue that many other systems depend on goal sharing, three other features distinguish the HROs from the rest: (a) extensive system of internal crosschecks to ensure fail-safe performance, (b) constant training and monitoring to encourage a culture of responsibility and accountability, and (c) a high level of social control by limiting influences from environments external to the organization (Clarke and Short, 1993).

In organizations that are less isolated from their environmental influences or the ones that are more open than HROs, the value of goal sharing becomes even more pronounced. Pierce (2005), himself a manager at Massachusetts General Hospital, acknowledges that, 'culture drives quality and safety', and claims that their articulation of the hospital's vision into a simple, straightforward language has provided them with a 'clear measuring stick for evaluating and directing all that goes on'.

There are many ways to measure corporate performance, such as the Balanced Scorecard (Kaplan and Norton, 1998), but the key is to ensure that what's measured is consistent with the desired goals (Zahlis and Hansen, 2005). It is particularly important to address this issue when safety and performance goals may compete against each other. Drury and Gramopadhye (1991) have reported 'Speed-or-Accuracy Trade-off – SATO' as a key challenge for managers in aviation and other high-consequence industries; typically, safety is encouraged as long as it does not interfere with performance targets; when performance targets are endangered, workarounds and violations of safety practices tend to emerge and they tend to be overlooked by management. Patankar and Taylor (1999) observed a decision-making protocol called Concept Alignment Process (CAP) that was used by a corporate flight department to make decisions related to operations, flight safety, and maintenance safety. This process was effective in aligning the daily tasks with the overall goals of the organization as well as with the safety standards. In order for this process to succeed, managers had to commit to backing off on the performance targets if the risk (safety) was elevated beyond the preset acceptable level. Such active risk mitigation is not likely when clear goals are not established and communicated, processes to enforce adherence to preset performance parameters are not clear, or managers are not empowered to scale back on their performance targets when risk is beyond the acceptable level.

The following questionnaire items are aimed at goal sharing:

- The primary objectives of my work group are highly aligned with key Tech Ops goals.
- I strongly agree with ATO's mission and goals.
- I understand my specific responsibilities to support my work group's goals.

Adaptability/resilience Functional and component redundancies are key aspects of reliability in HROs. It is this level of redundancy that allows the system to collapse its hierarchy under crisis and still maintain the performance reliability (Clarke and Short, 1993). Considering that HROs are typically more protected

from external environmental influences, they tend to have financial and human resources to maximize their reliability (safety). Since the survival of the organization (nuclear power plant, chemical plant, aircraft carrier, offshore oil platform, etc.) as a whole depends on safe execution of every mission and timely and safe recovery from minor lapses, tremendous emphasis is placed on systemic as well as task-level safety. When such organizations are plagued with economic pressures and redundancy is compromised, their vulnerability tends to increase; fewer people are loaded with more tasks; the 'coupling' of already complex systems increases; and the 'task loading' tends to render individual personnel incapable of responding to the additional workload imposed by a crisis (VanDrie, 2005).

Declining human resources may be compensated by increased automation, but such technology must be matched with the human operators and maintainers – sociotechnical systems must take into account human and machine reliability issues and strive to develop a joint optimization of their individual strengths (Taylor and Fenton, 1993).

The following questionnaire items are aimed at adaptability or resilience:

- I frequently do more than is expected to protect NAS safety.
- For Tech Ops, NAS safety is heavily dependent on the specialist's work ethic.
- I readily adapt to the challenges of getting my job done.

Institutional support systems Regardless of whether cultural design or change efforts start from the top leadership and permeate down the organizational hierarchy or grow from grass-roots efforts and bubble to the top, institutional support systems are vital for such efforts to flourish. For top-down efforts, the typical challenge is in converting the corporate 'propaganda' into reality – bridging the gap between the 'espoused theory' and the 'theory in use' (Argyris and Schön, 1974). Some organizations have used a participative approach that involves key user groups to influence the espoused culture and develop structures and performance parameters to measure goal attainment. Again, while the traditional HROs may have the luxury of limiting the influences of external environments, most other organizations do not; yet, they must raise their safety performance to the level of HROs and beyond. In order to achieve this goal, purposeful structures and processes developed by dedicated leaders throughout the organization are essential.

Depending on how distant a particular organization is from achieving safety at the HRO level or higher, more or less dramatic changes in the norms, policies, procedures, and practices may be necessary. In order to orchestrate such changes, it may be necessary to provide a variety of new services like employee counselling, safety awareness training, on-the-job training, and management/leadership training; new programmes like an error/hazard reporting programme, process improvement programme, event investigation programme, and risk management; and new ways of recognizing employee contributions. Overall, the people must feel that their organization is willing and able to change in order to meet the

established safety goals and that everyone, regardless of position or seniority, is held accountable for their actions (or inactions).

The following questionnaire items are aimed at institutional support systems:

- I have resources to do my job the way it should be done.
- My work group has the necessary number of staff to do the job right.
- Specialists receive adequate technical training to perform their work effectively and maintain NAS safety.

The title of this scale was changed to 'Adequate Resources' to better match the Tech Ops domain.

Outcome Factors

Outcome factors are hypothesized to be the effects of organizational factors and team factors. Also, outcome factors are the most visible or most frequently measured. The specific areas covered under these factors are described below.

Employee satisfaction Typically, employee satisfaction surveys give valuable information about the morale and motivation among the employees, their perceptions of their workplace, their self-worth in their jobs, and the employee-management relationship. These surveys may also indicate specific problem areas such as communication effectiveness, response to specific policies that were implemented or are planned, or more general change efforts underway (cf. Hackworth, et al., 2004).

Herzberg (1966) has identified several workplace satisfiers and dis-satisfiers. Most employee satisfaction surveys tend to build upon Herzberg's early work. One key finding from Herzberg's research is that it may not be possible to increase satisfaction by simply reducing the dissatisfaction; moreover, people will find means to overcome their dissatisfaction if they are particularly satisfied about a particular aspect of their job. For Herzberg, reducing dissatisfaction would not create genuine satisfaction, but growth and engagement in the nature of work itself could potentially lead to increased satisfaction.

Lately, employee satisfaction surveys are being used to rank companies as 'best companies to work for'. Such ranking draws the attention of top management and could be used effectively to institute deep, meaningful changes in the organization. One danger in using employee surveys, like any other survey, is that employees expect that the management will act on their findings; they expect that something will change as a result of the survey. If nothing changes, the employee-management relationship tends to suffer (cf. Patankar and Taylor, 2004). Also, while such surveys may be helpful in knowing the status of employee morale, they can also be very useful in diagnosing specific problems.

The following questionnaire items are aimed at employee satisfaction:

- Tech Ops employees have a high level of job satisfaction.
- I am proud to work for Tech Ops.

Customer satisfaction Customer satisfaction is more commonly used as a diagnostic tool as well as a benchmarking tool. Organizations that excel at customer service/satisfaction are often quoted as the ones that are fanatic about customer satisfaction and frontline employees are rewarded/corrected based on the quality of their interaction with their customers (Collins and Porras, 1997, Ch.6). Standardized customer satisfaction measurement tools can be used to identify customer-service problems throughout the organization. Such standardized measurement tools are also effective in communicating the customer satisfaction goals in a clear and consistent manner throughout the organization, especially when the organization is dispersed across the country and has many different technical/functional units.

The following questionnaire item is aimed at institutional identity customer satisfaction:

- En Route and Terminal Air Traffic partners are highly satisfied with Tech Ops work to maintain the reliability and technical safety of the NAS.

Public image/perception Airlines are typically ranked based on criteria such as customer satisfaction, lost/damaged baggage statistics, on-time arrivals and departures, and in-flight service quality (Bowen and Headley, 2002). Similarly, other companies may be ranked or recognized based on certain industry-accepted performance criteria: ISO certification, Malcolm Baldrige National Quality Award, J.D. Power, and Associates Award, etc. While these awards are symbols of recognition by peer organizations, accident/incident reports or large-scale environmental damage reports can severely harm the organization's reputation in the business as well as in the social community in which it operates. It would be valuable to scientifically determine whether or not any of the organizational factors or team factors presented in this report influence any of the public image criteria.

The following questionnaire items are aimed at public image/perception:

- My work group is the 'best in the business' when it comes to supporting NAS safety.
- Safety of NAS has never been better.

The title of this scale was changed to 'Safety Performance' to better match the Tech Ops domain.

Regulatory compliance Aviation, being one of the most highly regulated industries, is most vulnerable to regulatory violations. Federally certificated job functions such as pilot, mechanic, and dispatcher are highly procedural and these

procedures are incorporated into specific regulatory requirements. Therefore, violation of any of the prescribed procedures tends to translate into regulatory violation. Since the procedures are intended to provide for a safe execution of the corresponding task, violation of the associated procedure might be an indication of increased risk or reduced safety – most maintenance errors are attributed to procedural violations (Patankar, 2002). Therefore, the number of regulatory violations assessed against a particular aviation company could be regarded as an inverse measure of its safety record.

Errors/violations, whether regulatory or not, tend to be reportable events in most safety-conscious industries. Therefore, these events get investigated; the focus of such investigations is now shifting from the traditional 'blame game' to a more systemic solution. The frequency of errors and more importantly the comprehensive solutions resulting from the investigations could serve as valuable measures of safety culture.

The following questionnaire items are aimed at regulatory compliance:

- Specialists often need to do 'workarounds' to compensate for lack of component compatibility.
- Specialists often receive equipment to be installed and maintained before it is adequately tested.
- Often there are inadequate specifications for compatibility standards between various types of equipment.
- Specialists often need to do 'workarounds' to compensate for inadequate or out of date procedures.

The title of this scale was changed to 'Technical Standards' to better match the Tech Ops domain.

Stakeholder value From a business perspective, many progressive organizations now believe that employees are the primary stakeholders and customers are secondary; take care of the employees and the employees will take care of the customers. Employee satisfaction also impacts staff turnover and the expenses related to re-training. It is important to balance the needs of the internal employees with those of the external business partners and customers. Chemical companies like DuPont have demonstrated outstanding community partnerships that strengthen not only the company's image as a safety-conscious organization, but also the community's trust in the organization as a positive work environment and as a positive influence on the local economy. Similarly, the airline industry has formed a Commercial Aviation Safety Team (CAST) to evaluate and recommend specific safety enhancements. These recommendations are better received by the regulators and the flying public because they are industry-driven and developed in a spirit of partnership. Ultimately, the success of the organization is reflected in the success of its stakeholders: if the airline succeeds/survives, all the associated support businesses thrive/survive; the same is true for other large companies.

The following questionnaire items are aimed at stakeholder value:

- Tech Ops employees have a high level of job satisfaction.
- I am proud to work for Tech Ops.
- En Route and Terminal Air Traffic partners are highly satisfied with Tech Ops work to maintain the reliability and technical safety of the NAS.
- Safety of the NAS has never been better.

The Patankar and Sabin Safety Climate Questionnaire

In the preceding section, we showed you how items for a survey questionnaire could be developed. This approach was used to develop the Patankar and Sabin Safety Climate Questionnaire, which now consists of 58 items. All items are to be scored on a five-point Likert-type scale where one equals strongly disagree, two equals disagree, three equals neutral, four equals agree, and five equals strongly agree. This questionnaire was prepared for the Technical Operations group of the Air Traffic Organization (ATO), FAA.

As you will note, many of the questionnaire items are customized to the Tech Ops domain. However, most of them can be adapted to the language of other industries. For example, the following item could be restated to match the respective industry:

Original:

- NAS safety is consistently communicated as a core value/goal of the ATO-Tech Ops.

Restated for patient safety:

- Patient safety is consistently communicated as a core value of our hospital.

Restated for employee safety:

- Employee safety is consistently communicated as a core value of our company.

Survey Items and Scales

A confirmatory factory analysis was conducted using conceptual assignment of the survey items to the corresponding scale. Based on the reliability analysis of each scale, the item composition was modified. Table 4.1 lists the scales, their corresponding Cronbach's Alpha, a measure of reliability of the scale, account of variance percentage, and Kaiser-Meyer-Olkin (KMO) scores. A minimum Alpha

of .500, a minimum per cent variance of 50, and a minimum KMO of .500 were used to accept the scale as reliable and the factor as appropriately loaded.

Each item within each scale had a factor loading of at least 0.500. Following the confirmatory factor analysis, an exploratory factor analysis was conducted. Two new scales emerged: (a) Learning from Errors, and (b) Error Reporting. The original Support Systems scale was renamed Adequate Resources, the Public image/Perception scale was renamed Safety Performance, and the Regulatory Compliance scale was renamed to Technical Standards to better match the domain of this research. All the 'R' items in Table 4.1 are reverse-scored items.

In order to further test, validate, and revise the scales, the questionnaire needs to be administered multiple times – to additional populations (even across multiple professions in the aviation industry as well as across other industries) and to the same population (repeated studies over a period of time to see how the scale holds its reliability).

Table 4.1 Scale composition and reliability

Scale	Items	Cronbach's Alpha	Accounts for Variance (per cent)	KMO
1. Organizational Factors				
1.1 Institutional Identity	1,2	0.775	82	.642
1.2 Information Flow	5,7,8	0.710	64	.638
1.3 Relationships	9,10	0.699	77	.500
1.4 Leadership	11,12	0.777	82	.500
1.5 Evaluation	13,14,15	0.723	65	.668
1.6 Learning from Errors	19–21,24	0.817	65	.801
2. Team Factors				
2.1 Professionalism	33,36,53,56	0.683	51	.687
2.2 Supervisor Trust	25–29	0.948	83	.902
2.3 Goal Sharing	30–32	0.702	63	.658
2.4 Adaptability/Resilience	34,35,37	0.671	61	.664
2.5 Adequate Resources	41–43	0.675	61	.651
2.6 Error Reporting	16R,22,23	0.545	55	.629
3. Outcomes Factors				
3.1 Employee Satisfaction	52,53	0.675	76	.500
3.2 Customer Satisfaction	54	NA	NA	NA
3.3 Safety Performance	56,58	0.661	75	.500
3.4 Technical Standards	48–51R	0.848	70	.755
3.5 Stakeholder Value	52–54,58	0.787	62	.775

Structural Tests

The three-factor structure (organizational factors, team factors, and outcome factors) outlined in the Patankar and Sabin Safety Climate Questionnaire can be tested to determine the influence of one factor over the other(s). Patankar, Bigda-Peyton, Sabin, Brown, and Kelly (2005) presented a conceptual model called the Purpose-Alignment-Control (PAC) Model, which used the above mentioned three-factor structure to illustrate the potential influence of organizational factors on team factors and that of organizational and team factors on the outcome factors. Subsequently, Block (2008) used Structural Equation Modelling (SEM) to test the PAC Model. Block used three fit indices: goodness of fit (GFI), root mean square error of approximation (RMSEA), and comparative fit index (CFI). Using these three fit indices, researchers test a variety of combinations of relationships among factors to ultimately determine the best model fit. Typically, GFI and CFI values above 0.90 and RMSEA value below 0.08 are considered good model fit. Additionally, path coefficients are used to indicate the strength of the relationship between two constructs; the closer the value to 1.0, the stronger the relationship. Overall, the CFI, GFI, and the RMSEA indicate whether the relative relationship of the various factors can be validated with empirical data. The path coefficients indicate the strength of the relationship, indicating how likely it is that one factor might influence the other.

Figure 4.1 illustrates the conceptual PAC Model. Block (2008) supported the general structure of the PAC model, but modified the factor structure to be more consistent with the MRM/TOQ attitude areas (c.f. Taylor, 2000). The GFI for this modified structure was .92, the RMSEA was 0.047 and the CFI was 0.99.

These results suggest that the PAC model could be used to continue to test the relationship between organizational factors, team factors and outcome factors. Also, influence of specific factors on other factors could be studied and appropriate interventions could be developed.

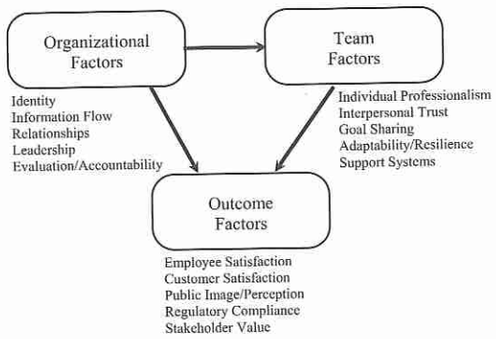

Figure 4.1 Conceptual illustration of factor influences in the PAC model

Chapter Summary

Since there are over 50 different safety climate survey questionnaires, it is not practical to present a comparative review. Instead, this chapter presented a detailed look at development and testing of one safety climate survey questionnaire. The process and the outcomes originated in a study conducted for the Technical Operations domain of the Air Traffic Organization.

Generally, a safety climate survey design starts with a series of focus-group discussions or interviews with key stakeholder groups. Based on the outcome of these discussions as well as the relevant literature, a survey questionnaire can be developed. If the items used in the questionnaire have been validated by other studies, they have a better chance of demonstrating validity and reliability. New and/or unique items could be tested for validity and reliability using accepted statistical methods. Ultimately, a structural equation modeling approach may be used to describe the influence of one group of factors over others.

In the example used in this chapter, a three-factor structural model emerged. Organizational factors are believed to influence team factors, and organizational factors and team factors are believed to influence outcome factors.

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