A COMPARATIVE REVIEW OF SAFETY CULTURES

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Executive Summary

Based on our analysis of the thirteen definitions of *safety culture* and incorporation of the concept of adaptable living system, we offer the following working definition of safety culture: *safety culture represents environmental and psychosocial factors that promote certain behaviors or attitudes and inhibit others*. The overall sustainability of a change program to mature into a *cultural* change will depend on three key factors:

- The level of organizational readiness for change and ability to remain focused on the goal
- The ability of top executives, their teams, and champions of change to clearly define the goal or purpose, align resources toward the accomplishment of that purpose, and empower its employees as well as managers to make the necessary changes in established organizational structures, processes, and policies
- A robust intervention and measurement to demonstrate improvement

It is possible for an organization to transition from normal to high reliability to ultrasafe, if it is able to purposefully ratchet its safety performance to the next higher level and demonstrate its ability to promptly adapt its structures, processes, and policies to be consistent with the established safety goals. In other words, it must achieve a dynamic balance between reliability (=safety) and resilience (=ability to reorganize or adapt).

The case examples from five different industries (nuclear power, aviation, chemical/ pharmaceutical, construction, and health care) illustrate that the attention provided to the inculcation of a strong positive safety culture depends on the degree of coupling between safety and operational/business survival—the tighter the coupling, the greater the integration of safety as a core organizational value.

- The Diablo Valley Nuclear Power Plant example illustrates how a strong safety culture is designed through extreme procedural control, redundancy, and regulatory oversight.
- ASAP, FOQA, VASIP, and CAST are some of the emerging examples in the aviation industry to illustrate collaborative efforts that are underway. These efforts are pushing safety performance toward the ultrasafe level through concerted efforts to improve safety performance beyond high reliability.
- The DuPont example illustrates how one could engage the organization in a collaborative relationship with the community and the regulators to achieve a phenomenal change in the quality of life of the entire community and public image of the company.
- Examples from Pfizer, Birse Rail, Octel, Woodrow Construction, Transco, and the US construction industry demonstrate the respective organization's efforts to improve workplace health and safety. The collaborative/participative processes used, the emphasis on management accountability for safety, and clear communication of safety goals are indicators of the improvement in their overall safety culture.
- The health care example illustrates how individual practitioners are customizing established practices from the aviation industry to improve patient safety and to comply with the hospital's accreditation requirements.

Finally, the authors present a new conceptual approach, the Purpose-Alignment-Control Model, to assist in building actionable safety culture change programs. This model integrates organizational, team, and outcome factors to foster sustainable, transferable, and lasting changes.

1.0 INTRODUCTION

Culture has been defined from two broad perspectives: environmental (structures, processes, and policies) and psychosocial (attitudes, behaviors, values, norms, and beliefs). For example, Wood (1993) defines culture as the "environment in which things grow;" whereas, Pidgeon and O'Leary (1995) define culture as the shared values, beliefs, attitudes, and behaviors of a particular population. In trying to understand the relationship between environmental conditions and individual or team-level attributes, it is valuable to bear in mind Karl Weick's observation that "the environment that the organization worries about is put there by the organization" (1979, p.152). There is a plethora of literature on safety culture—mostly focused on describing culture and analyzing cultural factors that may have led to certain mishaps. In this report, we present a review of the key theories that describe safety culture, some commonly used tools and techniques to measure safety culture, an example of an organization where a strong positive safety culture was built by design, and an example of an organization where a strong positive safety culture was built through an extensive change program. Finally, we present a synthesis of the safety culture literature in the form of a conceptual model that would allow safety champions and leaders to actively manage key factors that contribute toward the overall safety culture. At this time, we present this model as a concept, which is based on secondary data; it needs to be tested further with empirical data.

Some questions that were considered in this study include the following: (1) Are there any organizations that had a good safety culture from the start? (2) Are there any that successfully transformed their existing culture to one that was more desirable? (3) How did they know that changes took place? (4) What were the metrics they used? (5) What were the attributes that changed? (6) How did they go about doing it? (7) How long did they take? (8) What did it cost? (9) What were the obstacles they had to overcome? (10) What were the benefits? (11) What kind of organization was this?

Generally, there are very few organizations that have been documented as ones having a strong safety culture from the start. These organizations are engaged in high-risk activities on a routine basis and their success at those activities have earned them the recognition as High Reliability Organizations (HROs)—typically with failure or accident rate less than six sigma (less than one failure/accident per one million events/opportunities).

The metrics used to measure the success of change programs vary, depending on the triggers for the change. For example, if the change program was initiated to control accidents or worker injuries, the measurement is focused on those statistics. On the other hand, if the program was initiated to raise the overall awareness level, the measurement is focused on pre- and post-training awareness. So, the measurement tools and techniques are either related to specific performance factors or general safety climate/culture. There are many examples to illustrate that both performance as well as the overall safety climate ("climate" is short-term; whereas, "culture" is long-term) can be influenced by an appropriately designed safety program—some focus on behavioral aspects while others focus on attitudinal aspects, but both are achievable. The time required to change varies according to the scale at which these programs are implemented. For example, there are cases in the aviation maintenance industry that illustrate changes within the first year of implementation. These changes should not be considered cultural changes because for a change to be considered cultural, it has to be sustainable. For a change to

be sustainable, it has to last long enough that it is not likely to relapse. However, the change programs do illustrate the positive effects of the intervention.

Typically, case examples in many industries tend to support a loose categorization based on a three-phase perspective of sustainability: first phase being 3-5 years, second phase being 6-12 years, and the third phase being 13-20 years. In our study, most change programs seemed to stall in the first phase. These programs offer several positive benefits, but don't tend to last beyond the first phase because of either internal or external turbulence in the organization/industry. The second phase changes are able to outlast the turbulence and sustain the momentum—they mature in scale (more people are affected by this change) as well as in transferability (additional organizational units are involved). Typically, these programs are less susceptible to internal organizational turbulence, but are still vulnerable to external turbulence. As the change programs move into the third phase, they reinforce themselves through sufficient positive changes in the internal and external stakeholders and are less likely to relapse. Most local innovations and safety programs like logbook error management (cf. Taylor & Christensen, 1998) tend not to progress beyond the first phase. The Maintenance Resource Management program is an excellent example of a program that was not able to progress beyond the second phase (cf. Taylor & Patankar, 2001). The Crew Resource Management program, on the other hand, is an excellent example of a program that has reached the third phase (cf. Wiener, Kanki, & Helmreich 1993). Further, success of the CRM program has inspired many in the health care community to adopt certain key CRM techniques and improve the safety performance in their profession. Thus, there are some examples of successful transfer of innovation/best practices. Regardless of whether or not a particular change program reaches the third phase, it is important to note that there are financial as well as non-financial benefits from most well-designed and implemented safety programs. However, if the third-phase maturity is desired, we suggest purposeful study and implementation.

Upon studying literature on organizational or safety cultures, the following key shifts need to occur:

1. Measurement techniques need to move from a "snapshot" approach to a more mature, empirically-validated models that illustrate the effects of certain organizational and individual factors ultimately influencing the safety culture. Thus, appropriate intervention strategies could be developed and scientific advances could be made in developing/changing safety culture.
2. Change programs need to be developed and managed from the perspective of living systems rather than mechanistic systems. Under the living systems paradigm, emphasis needs to be on two key elements: core identity and adaptability. If operational safety is an integral part of the core identity, then the system will find innovative ways to maintain, or even enhance, safety as it adapts to its changing environment. On the other hand, if operational safety is not a part of the core identity, the adaptation may tend to be dominated by other factors. Therefore, the desirable adaptive living system needs to continuously improve safety performance within the operational context and in spite of the challenges.
3. Transferability of successful programs from one domain to another, with appropriate levels of customization, needs to be studied.

2.0 SAFETY AND SAFETY CULTURE THEORIES

A large body of literature regarding safety and safety culture exists. This section presents an overview of the key perspectives that various researchers have presented on these topics. Since safety is an interdisciplinary concept, multiple perspectives on safety have evolved over time. For example, regulatory bodies and insurance companies tend to refer to safety in terms of "acceptable level of risk;" engineers tend to refer to safety in terms of "failure modes and effects;" psychologists tend to refer to safety in terms of individual and organizational causal factors that contribute to errors or failures; and systems theorists tend to view safety as a product of multiple subsystems or micro-systems that contribute toward a safe or successful outcome of the macro-system. Just as there are diverse perspectives on the concept of safety, there are equally diverse interventions: regulators and insurance companies tend to bound the operating range of a system within acceptable limits; engineers tend to design systems that have very low probability of failure (high reliability) and if these systems do fail, they fail in a relatively safe mode; psychologists tend to focus on individual attitudes and behaviors as well as organizational cultures that could be influenced so as to ensure that people behave in a safer manner; and systems theorists tend to acknowledge the fallibility of humans as well as technology in complex sociotechnical systems and drive toward the design of corresponding levels of redundancies, robust defense mechanisms, and recovery strategies. These concepts are neither conflicting nor mutually exclusive. This section presents an overview of the key theories related to safety and safety cultures.

2.1 Normal Accident Theory, High Reliability Theory, and the Ultrasafe Theory

Scott Sagan (1993) presents an excellent comparison between the Normal Accident Theory and the High Reliability Theory. Charles Perrow (1984) developed the Normal Accident Theory, which, in its simplest form, states that in complex, tightly-coupled systems, accidents are inevitable. Perrow argues that over the lifetime of a complex, tightly-coupled system, the defense mechanisms deteriorate due to a variety of factors. New risks are introduced as a result of such deterioration and when localized changes don't consider the systemic implications, the ultimate result is an accident. High Reliability theorists like La Porte, Consolini, and Roberts argue that it is possible to build a highly reliable system (reliability = safety) from less reliable parts (La Porte & Consolini, 1991; Roberts, 1993). One fundamental tenet in this theory is that system-level reliability can be improved by increasing the functional redundancy (same person trained to perform multiple functions) and component redundancy (multiple people trained to perform the same function). Perrow, however, argues that simply adding redundancy is not sufficient to prevent accidents because redundancy can lead to complacency.

If high reliability is considered six sigma (probability of failure is less than one in a million operations), ultrasafe is considered nine sigma (probability of failure is less than one in a billion operations). Amalberti, Auroy, Berwick, and Barach (2005) present five successive systemic barriers that prevent health care from becoming an ultrasafe industrial system: "the need to limit discretion of workers, the need to reduce worker autonomy, the need to make the transition from a craftsmanship mindset to that of equivalent actors, the need for system-level (senior leadership) arbitration to optimize safety strategies, and the need for simplification." Based on the arguments presented regarding ultrasafe systems, it seems for a system to achieve safety greater than six

sigma, it will need to be adaptive both at the individual component level as well as at the systemic level and be collectively focused on maximizing safety.

Normal accident theorists argue that accidents are inevitable because systemic safety tends to degrade over time, high reliability theorists argue that safety can be managed through systemic reliability in spite of the component unreliability, and ultrasafe theorist argue that improvements beyond high reliability are not possible unless both the individual components as well as the system are highly adaptive to the conditions and are able to dynamically learn and update their respective reliabilities (called “deutero-learning” by Bateson, 1972). In other words, the transition from normal system to high-reliability system depends on the system transitioning from a less bounded system to a more bounded system. Next, for a system to be considered ultrasafe, it needs to sustain and improve its safety performance in a less bounded environment. Therefore, safety appears to be a dynamically unstable state that must be actively managed in order to maintain it at the desired level.

Table 1 presents a comparison between the Normal Accident Theory, the High Reliability Theory, and the Ultrasafe Theory

Table 1: Sagan's Comparison between the Normal Accident Theory and the High Reliability Theory (Sagan, 1993, p. 46) and the Ultrasafe Theory (Amalberti, Auroy, Berwick, & Barach, 2005)

Normal Accident Theory	**High Reliability Theory**	**Ultrasafe Theory**
Root metaphor: Mechanistic/Newtonian System	Root metaphor: Controlled/bounded living system	Root metaphor: Open/unbounded living system
Accidents are inevitable in complex and tightly coupled systems	Accidents can be prevented through good organizational design and management	Accidents tend to increase on both sides of the regulatory constraints. If the constraint is too low, it encourages risk taking because mission accomplishment is valued the most, regardless of the risk. If the constraint is too high, it denies even experts absolute discretion.
Safety is one of a number of competing objectives	Safety is the priority organizational objective	Safety is achieved by team-level balance between autonomy and structure.
Redundancy often causes accidents: it increases interactive complexity and opaqueness and encourages risk-taking. Redundancy evolves over time to intercept error trajectories.	Redundancy enhances safety: duplication and overlap make "a reliable system out of unreliable parts." Redundancy is designed to improve safety/reliability.	Redundancy enhances safety, but ability to anticipate the risks and compensate proactively, takes safety to the next higher level. Redundancy is on a "principle" basis to proactively cover variations to core processes.
Organizational contradiction: decentralization is needed for complexity, but centralization is needed for tightly coupled systems.	Decentralized decision-making is needed to permit prompt and flexible field-level responses to surprises.	Separation of skill from individual to professional position and standardized expectation of skill level, regardless of the specific person assigned to the position
A military model of intense discipline, socialization, and isolation is incompatible with democratic values.	A "culture of reliability" will enhance safety by encouraging uniform and appropriate responses by field-level operators.	A culture of open communication and protection from self-incrimination promotes timely resolution of systemic hazards.
Organizations cannot train for unimagined, highly dangerous, or politically unpalatable operations.	Continuous operations, training, and simulations can create and maintain high reliability operations.	Organizations and systems need to be adaptive and not overly burdened by out-dated regulatory requirements.
Denial of responsibility, faulty reporting, and reconstruction of history cripples learning efforts.	Trial and error learning from accidents can be effective, and can be supplemented by anticipation and simulations	Organizational learning is a key component that drives the changes in structures, policies, procedures, and practices.

2.2 Culture: National, Organizational, and Professional Perspectives

In 1984, Geert Hofstede conducted one of the earliest, and perhaps the largest, cross-cultural research programs 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 midwestern or central regions. Thus, "national" culture does not necessarily have to be limited to foreign countries.

With regard to organizational cultures, Westrum (1995) claims that, "the critical feature of organizational culture for safety is information flow." Therefore, he classifies organizational cultures in terms of "pathological," "bureaucratic", and "generative" behavior patterns. A pathological organization discourages information flow and penalizes people for raising safety-related issues. A bureaucratic organization tends to be effective in handling routine challenges and handles problems mostly at the surface level; thus, "latent factors" (Reason, 1997) may continue to remain unresolved. A generative organization, on the other hand, encourages information flow and rewards behaviors that foster "conscious inquiry" to solve problems at their root.

From a professional perspective, it has been demonstrated that certain professions such as pilots are more individualistic than surgeons (Helmreich & Merritt, 1998) and aircraft mechanics are more individualistic than pilots (Patankar & Taylor, 2004).

Thus, differences in work-related values, attitudes, and behaviors exist across at least three dimensions: national, organizational, and professional.

2.3 Safety Culture

In discussing *safety culture*, the context is generally limited to safety values, attitudes, and behaviors among the people in a particular organization. In that sense, one could regard safety culture as a subset of organizational culture, but since individuals from different national origins as well as professional groups are likely to constitute the organization, the differences associated with the corresponding cultures are also likely to influence the overall safety culture within that organization. The term "safety culture," however, appears to have arisen out of the report on the 1986 Chernobyl disaster, where the errors and violations of the operating procedures that contributed to the accident were seen by some as being evidence of a poor safety culture at the plant (Fleming & Lardner, 1999). Since then, it has been applied in the analyses of several well-known accidents like the Piper Alpha oil platform explosion in the North Sea, the Clampham

Junction rail disaster in London (Cox & Flin, 1998), the Canadian airline accident in Dryden (Maurino, Reason, Johnston, & Lee, 1999), and the more recent NASA tragedies—Challenger (Vaughn, 1996) and Columbia (CAIB, 2003). Now, almost everyone involved in safety program management or operations in high-consequence industries is interested in safety culture—what is it and how do we get it?

Wiegmann, et al., (2004) report thirteen different, yet complementary definitions of safety culture. The commonalities across these definitions include the following:

- Safety culture is a concept defined at the group level or higher, which refers to the shared values among all the group or organization members
- Safety culture is concerned with formal safety issues in an organization, and closely related to, but not restricted to, the management and supervisory systems
- Safety culture emphasizes the contribution from everyone at every level of an organization
- The safety culture of an organization has an impact on its members' behavior at work
- Safety culture is usually reflected in the contingency between reward systems and safety performance
- Safety culture is reflected in an organization's willingness to develop and learn from errors, incidents, and accidents
- Safety culture is relatively enduring, stable and resistant to change.

While one could argue that all organizations have a safety culture, Wiegmann, et al., (2003) identify five global components or indicators of a positive safety culture

- Organizational commitment
- Management involvement
- Employee empowerment
- Reward systems
- Reporting systems

Based on our analysis of the thirteen definitions presented by Wiegmann et al. (2004) and incorporation of the concept of adaptable "living system" (Wheatly, 1999; Knowles, 2002), we asked the question, "What is the culture that you want to grow?" In response, we offer the following working definition of safety culture: *safety culture represents environmental and psychosocial factors that promote certain behaviors or attitudes and inhibit others*. If safety is indeed an important value in a given organization, not only is it highly likely that the above five global indicators of positive safety culture will be clearly visible, but also, there will be formal/informal organizational mechanisms to inhibit attitudes and behaviors that tend to dilute any of the five global indicators. We believe that both encouraging factors as well as inhibiting factors are equally responsible for building a specific safety culture in a given organization; hence, both need to be considered.

Safety culture is typically measured and described in terms of psychosocial attributes of the people in the sample population rather than the preconditions that tend to encourage certain attributes and inhibit others. Whether the description is from the perspective of the message and the behavior communicated from the top management to the frontline employees (Gaba, Singer, Bowen, and Ciavarelli, 2003) or in terms of the collective scores on values, attitudes,

competencies, and patterns of behavior (Helmreich, Fouchee, Benson, & Russini, 1986; Taylor, 1995; Ciavarelli, 1998; IOMA, 2003; Patankar, 2003; Gibbons, von Thaden, & Wiegmann, 2004), the measurement techniques, and therefore the descriptions, tend to emphasize the sample population's aggregate psychosocial composition. Perhaps, this emphasis could be shifted a little more toward the capturing of past experiences or legends that might predispose the individuals toward an undesirable attitude or behavior; measurement of the existence and effectiveness of structures and processes that encourage the desirable individual or group-level attitudes and behaviors; and processes by which success stories are communicated and heroes are recognized.

An individual's contribution to the safety culture is largely based on his/her understanding of the necessity and effectiveness of the prevailing safety efforts. An individual that understands the rationale behind a given strategy is better able to tactically implement those elements of strategic safety programs and processes. Taylor and Christensen (1998) measured an individual's sense of the connection with organizational safety priorities in terms of "goal sharing." Another important dimension of individual-level perception is interpersonal trust. Patankar and Taylor (2004) measured this parameter and noted that organizations with better safety performance have higher trust between mechanics and managers. Also, Patankar and Driscoll (2004) discovered that organizations with an active reporting culture also have higher levels of mechanic-to-management trust. Therefore, if one were to study the effectiveness of reporting mechanisms, in addition to the attitudes toward error-reporting systems, a more balanced understanding of the prevailing safety culture could be developed.

Karl Weick's message quoted in the Introduction, "the environment that the organization worries about is put there by the organization" (1979, p.152) is particularly salient. We want to reinforce 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 reporting system—they expect that changes will be made and if the requisite changes are not forthcoming, they will lose interest in the process and therefore in the organization or the leadership. With respect to MRM training, 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).

2.4 Blame Culture, Reporting Culture, and Just Culture

One of the key obstacles to building a safety culture is the prevalent "blame culture" in high-consequence industries such as aviation. Historically, the common understanding has been that with high professional responsibility, comes high probability of blame. When a mishap occurs, the general tendency in many national and organizational cultures has been to blame the individual responsible for the last action prior to the mishap. In some countries, as described by Patankar and Taylor (2004), this practice is so prevalent that the licensed aircraft maintenance professionals have accepted the blame culture as a professional risk—they get significantly higher wages for holding the license and so they are expected to take the blame if one needs to be assigned. Clearly, such blame culture does not encourage communication of systemic problems or latent failures. Many commercial aviation organizations, as well as the Federal Aviation Administration, have recognized this reality and are striving toward building a "Just

Culture" (Marx, 2001). A Just Culture differentiates between *carte blanche* forgiveness of the guilty party and the blame culture. It is based on the premise that as responsible professionals, aircraft mechanic/engineers or medical professionals or air traffic controllers are expected to perform to certain basic professional and ethical standards. If they perform within those standards and commit an error, the error is forgivable. On the other hand if the performance is in violation of those standards, the error is classified as reckless; hence, it is unforgivable and is subject to a disciplinary action. Reason (1997) describes a Just Culture as an atmosphere of trust in which people are encouraged, even rewarded, for providing essential safety-related information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behavior. In a recent study published in the *Flight Safety Digest*, Stastny et al. (2004) observe the following:

> Different departments or work teams within an organization may be associated with distinct subcultures and different safety climates that can influence reporting rates (Fleming et al., 1998; Mearns et al.,, 1998). In particular, work environments in which accident reporting is discouraged often involve "macho" role models, for example in the construction industry (Leather, 1988); offshore oil industry (Flin & Slaven, 1996; Mearns et al., 1997) and the aviation industry (O'Leary, 1995).

Gordon, Moylan, and Stastny (2004) report an example of how Danish Air Traffic Controllers attempted to create a Just Reporting Culture. According to a recently enacted Danish law, air traffic controllers are required to report events and it is "punishable *not* to report an incident in aviation." This law and the supporting infrastructure resulted in a dramatic increase in the number of reports by controllers—980 reports compared to 15 reports prior to the law. Such dramatic enforcement of a reporting system is bound to identify an interesting array of hazards and is also likely to place a very strong accountability on the government to actually implement systemic changes to minimize the hazards. Stastny et al. (2004) report that extensive preparations have been made to receive and analyze the incident reports and the results of such analyses need to be published twice a year.

In the American aviation industry, the Aviation Safety Action Programs (ASAP) in flight and maintenance are excellent examples of initiatives that are designed to take the organizations that support such programs to the ultrasafe level. Although there are more ASAP programs in flight operations than in maintenance, evidence is beginning to indicate that significant progress is being made in maintenance—the number of reports are increasing, the organization as well as the industry is becoming more proactive in resolving systemic or latent failures, and the mechanic-to-management trust is higher in organizations with ASAP programs (Patankar & Gomez, 2005). Thus, there is some evidence that a blame culture can be changed to a just culture via successful implementation of a reporting culture. Further, the greater the ability of the system to change its internal structures and processes and consequently the attitudes and behaviors of its people (the overall adaptability), the greater its ability to take safety to the ultrasafe level.

2.5 Cultural Change: Transfer of Innovation

Differences in national, organizational, and professional cultures in aviation and health care have been reported (Helmreich & Merritt, 1998; Taylor & Patankar, 1999). Similarly, the role of organizational cultures in safety-critical industries has also been studied extensively (Reason,

1997; Westrum & Adamski, 1999). Largely, these studies have focused on describing the *concept* of culture or safety culture. Concurrently, many organizations have elected to implement system-wide changes; however, because the current state of knowledge mainly addresses the definition of culture, it is not clear when such organizational changes should be declared successful or when exactly one could declare that there has been a cultural *change*. "Exactly how to create a safety culture is not clear, although many agree that it will include continuous organizational learning from 'near miss' incidents as well as accidents" (Ringstad & Szameitat, 2000).

Jackson, (2005) suggest that throughout the change process the following should be evaluated to determine continuous improvement and alterations to the change plan:

- Does management demonstrate a visible commitment to health and safety?
- Is there a sufficient level of communication and education in health and safety?
- Is there a sufficient level of involvement by employees?
- Are the levels of awareness communicated adequately?
- Do the employees accept responsibility for their own health and safety, and do they encourage others to follow suit?
- What is the organizations current attitude towards health and safety?

Patankar, Bigda-Peyton, and Brown (2005) presented a means to express the state of the organizational change accomplished by the specific change program by measuring the state of that program along three interrelated dimensions—scalability (S), transferability (T), and longevity (L). Based on a variety of definitions of safety culture and safety climate, Wiegmann et al. (2004) conclude that safety climate is temporary and safety culture is long-term. Extending that conclusion, evidence of a cultural change would most likely include a change in organizational structures, processes, and policies. Such a change eventually becomes independent of the initiating champion. Therefore, by all measures, a cultural change is not likely to relapse. If the state of a particular change program could be described in terms of scalability (the number of individuals using it), transferability (the number of organizational units using it), and longevity (the total years that it has been in existence)—collectively referred by Patankar, Bigda-Peyton, and Brown (2005) as the STL Model—one may be able to define a three-dimensional threshold beyond which the change could be considered long-term enough to be commonly accepted as a cultural change.

Among the three dimensions in the STL Model, the transferability dimension appears to be most critical in pushing a given change program past the cultural-change threshold. However, the voluminous literature on the adoption and dissemination of innovation focuses on one-way transfer. Rogers' (1983) introduced the idea that there are different audiences for innovation, and that these audiences form a bell curve. This work framed the typical pattern of the diffusion of innovation and was followed by Moore (1991) who applied it to the world of technology innovation as understood by pioneers, early adopters, pragmatists, skeptics, and critics of particular innovations. Moore's key insight was that of the "chasm," which he suggests is characteristic at several points along the adoption curve but especially at the transition between "early adopters" and "pragmatists." Gladwell (2002) used the lens of social networks to explain why some innovations catch on and others do not. He described typical roles played by individuals in fostering innovation, such as "connectors" (those who bring people together) and

"mavens" (those who like to spread information to others who might need or want it). Finally, he noted that "small things can make a big difference—in other words, they can produce a "tipping point." Gladwell's work is interesting to understand why certain innovations may have reached their respective tipping points, but there are no examples of how a particular organization may have orchestrated a desired tipping point by purposeful actions.

From an individual perspective, Goldsmith (2002) describes a set of enabling beliefs that differentiate more successful people from their peers and contribute to successful change efforts (self-efficacy, self-determination, optimism, and positive perception of past performance). While these individual-level characteristics are important and almost self-selecting of champions of change programs, the enabling conditions for transfer of innovation or for driving of change programs are not clearly evident in the literature. Cases that illustrate a strong, positive safety culture exist in the nuclear industry and in U.S. naval air carriers, and cases that illustrate a purposeful change program tend to be scattered in aviation and chemical industries. Literature that chronicles successful and not so successful programs aimed at changing safety culture is limited. Nonetheless, Mitroussi (2003) argues that when the survival of the organization is at stake, its people will be more willing to give up old values and practices and take up new ones; however, an incremental change with appropriate allocation of resources is required. We would add that for people to be willing to change, they should also believe that such a change will help—they need to have some sense of control over the situation (cf. Harper & Helmreich, 2003)

The question of how long it would take to change a given culture is common among managers, but the response depends on the scale (how many people need to change their behavior) at which such a change is desired—based on Moore's (1991) classification, it will depend on the relative proportion of early adopters, skeptics and critics of the change program. Also, there is a notion of "organizational readiness" for change—described in terms of preconditions such as the levels of compliance with standard operating procedures, collective commitment to safety, individual sense of responsibility toward safety, and employee-management relationship (Patankar, 2003). However, it is important to note that culture change takes place in small groups as well—this is where Gladwell's (2002) concept of small actions making a big difference comes to play. Again, the question arises as to how one could orchestrate a tipping point rather than simply wait passively and see if the small changes do matter. Literature on fostering cultural change suggests that focused and deliberate efforts are essential to craft such a change (Sabin, 2005). Additionally, there are leverage factors such as level of awareness in the greater community, regulatory requirements/pressures, business survival factors, industry standards, etc. When local change efforts transition toward organization-wide changes and then toward a policy/regulatory change, the change program tends to achieve a much higher degree of stability. For example, if we trace the evolution of the Crew Resource Management (CRM) Program (Wiener, Kanki, & Helmreich, 1993) and the Maintenance Resource Management (MRM) Program (Taylor and Patankar, 2001), one glaring difference as to why the CRM program has been institutionalized and not the MRM program is that CRM training is a regulatory requirement. Also, the global awareness and acceptance of the CRM program was greatly enhanced by practitioner heroes such as Captain Al Haynes, multiple airline pilot unions, and the operational leaders of many airlines who are pilots. The pilots had their own share of challenges in overcoming the deep-rooted culture of command and control, but through large-scale efforts leveraged by the above

mentioned factors have led to a time when most novice pilots are familiar with the key concepts of CRM and expect their future airline jobs to demand refined practice of CRM techniques.
In contrast, the maintenance community suffered significantly from not having the MRM training as a regulatory requirement, especially as the airlines started to deteriorate their financial strength. MRM programs were disbanded at many of the airlines and champions of such programs lost their jobs. Well-recognized spokespersons like past National Transportation Safety Board Member John Goglia continue to promote MRM programs, and with the new group of maintenance personnel in charge of safety, many of the companies have turned their attention to the maintenance version of the Aviation Safety Action Program (ASAP). This is an FAA-endorsed program and has shown great promise in its ability to effect specific changes at both organization- as well as industry-level. Therefore, it seems like the maintenance industry is set to "leapfrog" and build the ASAP programs and incorporate the MRM concepts in the comprehensive solutions that are generated in the ASAP recommendations.

2.5.1 Organizational Effectiveness and Culture Change

Since the 1960s, this area has seen several waves of improvement efforts, including Organizational Development, Work Redesign, Total Quality Management, Reengineering, and Learning Organization/ Systems Thinking. None of these has apparently had a lasting effect, at least in solving the problems identified with the safety improvement movement. Here, too, we find pockets of improvement, but not sustainable, system-wide cultures of high performance and learning.

For instance, when organizations are highlighted as "successes" (Peters & Waterman, 1982; Senge, 1990; Collins & Porras, 1997), they are often seen as laggards within a matter of years. Senge's examples were exciting but, as in the case of safety improvement, a closer look revealed pockets of success that were not well-connected or transferable.

What can we, or should we, make of this?
There are common patterns and themes between these two bodies of knowledge and experience, suggesting that the next set of problems to solve are how to transfer, maintain, sustain, and scale local innovations to a system-wide level. This is a systems safety challenge that must draw on the best knowledge and practice available in both the safety world and the organizational change world.

Conversely, the organizational change world must go beyond its current paradigms to address the same generic issues. One way of doing so is to link efforts with a specific content domain such as safety, a domain seen as compelling and more tangible to most people than the themes of sustainability and transferability. Another way, and one to which the organizational field should contribute, is how to scale local innovations more broadly, to the system level. This is a challenge of transferability and scalability; it goes beyond safety but needs to be addressed in that domain.

Why would both bodies of knowledge and experience fall short in similar ways? We suggest three basic hypotheses, or reasons:

I. The use of methods and approaches which are applicable rather than actionable;

II. The lack of methods for improving culture and performance (in safety and other domains) which can deal comfortably and effectively with conditions of turbulence; in other words, the lack of a methodology for reflective learning; and
III. A set of assumptions about the nature of the systems we have, and the conditions we face, which must be reframed in order for us to address the problems of creating sustainable, system-level changes in safety.

Regarding hypothesis I:
Literature on organizational learning (Argyris & Schön, 1974, 1978) suggests that most of the knowledge produced in consulting, research, and educational interventions is "applicable"—that is, it might apply to the conditions faced by the practitioners. In contrast, "actionable" knowledge is produced, and presented, in the following categories: in Situation A, in order to achieve to B, I need to make the following assumptions and take the following actions. If I do so, I will probably achieve the outcome(s) I intend.

Argyris, Putnam, and Smith (1985) and Argyris (1993) developed a methodology (which they called Action Science) for producing actionable knowledge reliably and consistently. Our experience with this methodology in the field suggests that it produces a 50% increase in effectiveness and promotes transferability and sustainability of changes.

Regarding hypothesis II:
We are at the end of one era and the start of another. Since the 1960's, change agents have made a linked set of assumptions:

- We are in an environment of (relative) abundance
- The root cause of organizational inefficiency, ineffectiveness, low productivity, and low growth is scatter, fragmentation, and incoherence
- Our job is to promote standardization, coherence, and alignment
- Processes carry higher leverage than events (for changing people)
- Therefore, our job is to reduce variation in workflows and processes

This approach was made popular by Deming (1986) and Shewhart (1980) under the banner of quality improvement (first popularized as Statistical Process Control, then as Total Quality Management). Its variants live on today, in the basic paradigm that lies underneath virtually all schools of practice in improving safety and quality.

An alternative approach was made known by Peter Senge, starting with *The Learning Organization* (1990). Senge said the task was learning and innovation, and that the inhibitors had more to do with our thinking than with variance in workflows. The remedy, among other things, was the "fifth discipline": mastering systems thinking. Unfortunately, Senge's idea was disconnected to a practice model for making it come alive; thus it was interpreted, and taken on, as an unworkable "fad" or bolted on to the existing paradigm.

We believe the time has come to take seriously an alternative paradigm, which we call reflective practice. For one thing, the operating assumptions have changed; most "change agents" today would say that:

- We are in an environment of (relative) scarcity.

- We may still agree that the root cause of organizational inefficiency, ineffectiveness, low productivity, and low growth is scatter, fragmentation, and incoherence.
- But our job is to promote growth and innovation; we can no longer afford to focus only on standardization, coherence, and alignment.
- Processes carry higher leverage than events (or changing people).
- Therefore, our job is to *increase* variation in workflows and processes.

Once we enter a world of *increasing* variation, we need new methods to manage the variation within a range that optimizes the use of organizational energy. In addition, as we increase variation, we take more risk and court the hazards of having things "slip between the cracks", go unnoticed, or otherwise put the enterprise in danger.

The paradigm shift needed here is from "learning" to reflective practice. First coined by Donald Schön in *The Reflective Practitioner* (1983), this term refers to a dynamic, evolving, yet structured process that enables variation within a range. Both art and science, Schön's method is little known outside the world of formal education, especially teachers and teacher education in primary and secondary schools. It has also been used, to an extent, in architecture, design, and urban planning. For the most part, though, this methodology does not appear in the literature on change or safety. We think that situation should change.

Schön's formative work in this line of inquiry began in the early 1970s with *Beyond the Stable State* (Schön, 1971). He argued that we were entering a time of instability and dynamic change, and that models and practices designed for stability would not fulfill our needs. Soon after that, Schön began working with Argyris and developing the methods and approaches he later called "reflective practice."

Reflective practice is iterative and evolving, dynamic and static. It has been prototyped and used in a variety of settings, including those to be mentioned in the case review section of this report. We hypothesize that the combination of action science and reflective practice methods, put into practice, can help to deal with the problems of transferability, scalability, and sustainability of change under conditions of turbulence.

Regarding hypothesis III:
We contend that there is a need to reframe our assumptions about the nature of the systems we have, and the conditions we face, in order to solve the problems outlined in this memo. In both the systems safety and organizational change worlds, there is active, ongoing dialogue about the need for transformation, including transferability, scalability, and sustainability. Yet the practice model that is typically recommended remains within the governing assumptions, and paradigm, we have been using since the 1960s.

For instance, Amalberti, et al. (2005) outline a case for transformation. Saying that the goal should go beyond "High Reliability" to "Ultrasafe" organizations, they identify five systemic barriers to achieving that goal. Ultimately, they contend, ultrasafe can only be achieved under relatively stable conditions, *thus we must reduce variation.* In addition, they suggest that under conditions of turbulence the best we can do is achieve high reliability performance levels.

But what if the problem lies with the paradigm itself, and with the methods we are accustomed to using within that paradigm? We contend that ultrasafe organizations are possible, *and necessary*, under conditions of turbulence. However, this axiom (and its associated paradigm) must be tested; and the methods associated with action science and reflective practice can be deployed to provide that test.

What kind of turbulence is necessary, normal, and even desirable in aviation? Or for that matter, in other high-consequence industries, such as health care? We think this question can be addressed through hypothesis generation and testing.

Finally, these arguments bring us back to the paradigm shift from the mechanistic organizational model to the living systems model. In the living systems model (Wheatley, 1999), endless achievable possibilities exist, but for them to evolve into a sustainable reality, the following conditions need to be satisfied:

- The core purpose of the organization needs to be thoroughly understood and maintained
- Every individual must remain open to adapting to the environment, as long as the core's integrity is maintained
- Employees must believe that they can control the outcome and their change efforts must be consistent with the core purpose and need to be supported indefinitely

2.6 Intermediate Summary: The Safety Culture Continuum

A culture, in general, and safety culture, in particular, exists in every organization, industry, and nation. This safety culture could be represented along a continuum (see Figure 1). From the perspective of how safety-related errors are handled, one could place an organization somewhere along the blame-reporting-just culture continuum. In order to transition from a blame culture to a just culture, one needs to implement a reporting culture. Similarly, from the perspective of how safety-related information is handled, one might find that a particular organization is aligned with the characteristics of a pathological, bureaucratic, or a generative organization. Depending on how errors, incidents, or accidents are investigated, an organization may choose an approach that is crisis-focused, symptomatic, or root-level. From a learning organization paradigm, the organization could either be one that experiences incremental learning, continuous learning, or transformational learning. Ideally, it seems like we should be driving organizations toward a just culture, generative use of information, root-level resolution of mishaps, and transformational learning. It is important to note that these attributes are complementary and dynamic—specific and deliberate efforts must be made to maintain the desired state and the attributes of this desired state may themselves change over time.

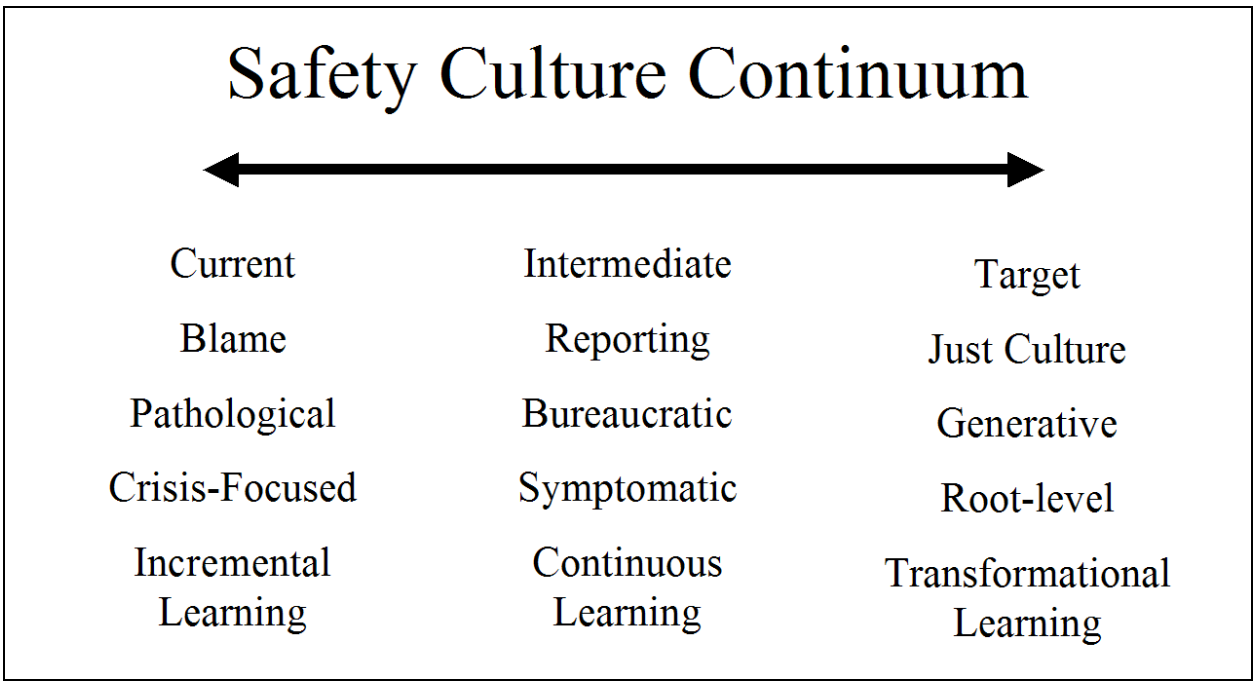

Figure 1: The Safety Continuum

3.0 SAFETY CULTURE MEASUREMENT

Safety culture measurement tools could be classified as either proactive or reactive, depending on whether the tool is used to measure or sample certain characteristics of the extant culture in response to an adverse event (reactive) or to sample/assess current state to predict/influence future performance (proactive). Most of these techniques tend to start with a qualitative approach wherein specific accident cases are used to describe the events leading up to the accidents and the underlying causal factors of those events are investigated. Some times, researchers are able to build real-time case studies through ethnographic observations of normal activities. When sufficient cases have been collected, the method can transition to quantitative techniques via a survey questionnaire. Such questionnaires are typically focused on measuring psychosocial factors. Examples of such measurement and classification tools/techniques include the following: Westrum's (1993) pathological organization, bureaucratic organization, and generative organization; Reason's (1997) assessment of latent failures to manage the risk of organizational accidents; Helmreich and Merritt's (1998) safety culture measurement based on national, organizational, and professional cultures; Ciaverelli's (1998) measurement of organizational risk; Patankar and Taylor's (2004) parameters of interpersonal trust and professionalism to manage individual attitudes and behaviors that shape the organizational culture; Patankar's (2003) measurement of organizational readiness for safety culture interventions; and Wiegmann et al.'s (2003) airline safety culture questionnaire. Similarly, special tools and taxonomies have been developed to classify data from accident/incident investigations.

In addition to survey instruments, Patankar and Taylor (2004) used field interviews and ethnographic observations to assess the more active changes in culture as a direct result of a training program, such as the Maintenance Resource Management program, and have also quantified the financial benefits of such programs. They have collected cultural artifacts such as stickers, memory-aid cards, checklists, and policies and procedures that were developed to introduce the respective cultural changes in various companies. These artifacts are an important element of the overall cultural assessment because they are created by the people who are actually involved in the change process and the design of such artifacts is reflective of the organization's image.

Eisenlohr, Render, & Patterson (2003) identified organizational attitudes and characteristics that may indicate what might be characterized as a less then desirable safety culture for a healthcare organization. Generalizing these dysfunctional attributes we identify the following:

- Focusing on the experience, motivation, or actions of an individual in an incident or accident (Placing blame on a single individual)
- Emphasizing the features that differentiate the specific workplace of an incident or accident ("That could never happen here because we…)
- Demonizing sub-populations in the system ("This group is always making mistakes…")
- Defending why change is not possible ("Management never listens to us; they are the ones who need change").

Helmreich (1999) identifies conditions the organization must assume in order to promote the transformation of the existing safety culture in to a culture that values and promotes safety as a priority within an operational system.

- Trust
- A non-punitive policy toward error
- Commitment to taking action to reduce error-inducing conditions
- Diagnostic data that show the nature threats and the types of errors occurring
- Training in threat recognition and error avoidance and management strategies
- Training in evaluating and reinforcing threat recognition and error management for instructors and evaluators

Although a plethora of cultural assessment tools are in use today, "There appears to be agreement among researchers that both qualitative and quantitative methods have unique potential for assessment and theory testing and that there is a benefit to combining methods to gain a comprehensive understanding of safety culture" (Wiegmann, et al. 2002).

In addition to the specific psychosocial aspects of the extant safety culture, Arezes and Miguel (2003) note that there are a wide variety of performance indicators such as lost time injuries, number of accidents/incidents, damage events, etc. 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 attributable to specific safety culture change efforts (Patankar & Taylor, 2004) and subsequently used to demonstrate the financial benefits of the change program. Patankar and Taylor (2004, Ch.8) demonstrate that both positive as well as negative return on investment is possible, depending on how the change program is managed.

3.1 Factors Used to Assess Safety Culture

Our review of the literature found a number of psychometrically validated questionnaires designed to assess specific aspects of safety, safety climate/culture, high reliability organizations, and ultrasafe organizations. Of particular relevance are items from questionnaires designed by the following researchers: Hofstede (1984); Helmreich, Fouchee, Benson, and Russini (1986); Westrum (1993); Taylor, (1995); Helmreich and Merritt (1998); Ciaverelli (1998); Gaba, Singer, Bowen, and Ciavarelli (2003); IOMA (2003); Patankar and Taylor (2004); Patankar (2003); Wiegman, von Thaden, and Wiegmann (2003); and Gibbons, von Thaden, and Wiegmann (2004). Items from these questionnaires have been through a number of iterations and customizations as different researchers have tested their validity and relevance in specific domains such as flight, maintenance, medicine, and general organizational safety climate.

Next, upon reviewing the Hackworth et al. (2004) study of employee attitudes in the Air Traffic Operations of the Federal Aviation Administration, some complementary items were identified that can be further evaluated to determine their relevance for assessing safety culture. Finally, elements of living systems, as described by Wheatly (1999) and implemented by Knowles (2002), as well as key characteristics of top-performing companies, as described by Collins and Porras (1997) and Collins (2001), have been added as well. Collectively, this diverse array of questionnaire items provides a unique opportunity to test the statistical relationships between organizational, team, and outcome factors. Further, these items can be used to measure the

prevailing state of safety culture at a particular organization. Once the inter-relationships between the various factors are better understood, interventions can be more effectively designed and implemented to help organizations move toward the ultrasafe state.

The entire set of items composed from the above mentioned research is presented in Appendix A (Factors To Assess Multiple Dimensions of Safety Culture). Table 2 identifies the main factors, their related dimensions and provides an example of individual items.

Table 2: Assessing Multiple Dimensions of Safety Culture

Factors	**Dimensions** (Example Items in Parentheses)
Organizational Factors	**Identity** (e.g., Safety is a core value in this organization)
	Information Flow (e.g., Effective mechanisms exist to report safety hazards/discrepancies)
	Relationships (e.g., There is a spirit of cooperation between various departments/ organizational units)
	Leadership (e.g., Supervisors do not permit cutting corners to get the job done)
	Evaluation/Accountability (e.g., Employee selection processes gives due consideration to technical qualifications as well as attitude toward safety and teamwork)
Team Factors	**Professionalism** (e.g., Internal crosschecks on decisions, even at the micro level, and fail-safe redundancy to determine when critical decisions are timely and correct)
	Interpersonal Trust (e.g., My supervisor can be trusted to act in the interest of safety)
	Goal Sharing (e.g., Operational goals are very clear and consensus is unequivocal)
	Adaptability/Resilience (e.g., There is sufficient degree of resource availability, human redundancy, and a highly functional, highly flexible division of labor)
	Support Systems (e.g., Training and monitoring encourage a culture of responsibility and accountability)
Outcome Factors	**Employee Satisfaction** (e.g., Morale and motivation in this organization are high)
	Customer Satisfaction (e.g., Customer satisfaction is high and consistent across multiple organizational units)
	Public Image/Perception (e.g., The organization is highly regarded by the public-at-large as a safe/reliable organization)
	Regulatory Compliance (e.g., Compliance with local, national, and international regulations is high and consistent with the reputation of the organization)
	Stakeholder Value (e.g., Employees are primary stakeholders; customers are secondary stakeholders)

3.2 Intermediate Summary: Transitioning Along the Safety Culture Continuum

The key factors listed above emerge from extensive review of literature on safety theories and safety culture. The inter-relationship between these factors and their group/cumulative influence on the overall safety culture have not been tested. It is likely that such tests will reveal a more actionable model for sustainable change.

The key factors are expected to provide information and points of leverage to enable safety managers as well as operational managers to actively and efficiently manage their resources so that they may build their respective organizations as adaptive living systems. The safety goal of such an adaptive living system must be to purposefully ratchet its safety performance to the next higher level. As this system transitions toward that goal, it must adopt new structures, processes, and policies that would achieve the next higher level of safety and once that level is achieved, it must be equally prepared to reorganize itself—develop new structures, new processes, and new policies—that will take the system to the next higher level of safety. It must achieve a dynamic balance between reliability (=safety) and resilience (=ability to reorganize or adapt).

In this journey, the system will transition from a less bounded system with high failure rate to a more bounded system and significantly reduced failure rate. However, in order for this system to achieve the next higher order of safety, it must be able to adapt—to enable appropriate and timely changes in its organizational structures, processes, and policies. Figure 2 illustrates this concept.

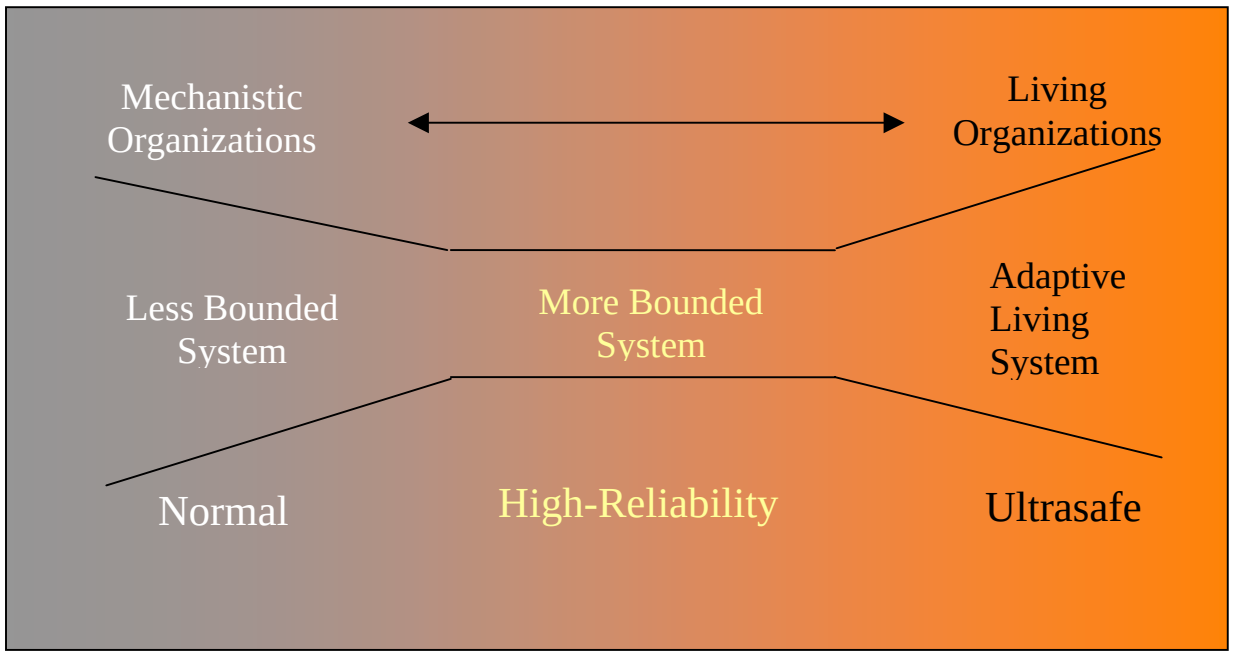

Figure 2: Typical transition from normal to ultrasafe system

4.0 CASE EXAMPLES OF POSITIVE SAFETY CULTURE

In our review of case examples that illustrate positive safety culture, we discovered that there seem to be three broad categories of change programs—local, national, and international. One could use the STL Model (Patankar, Bigda-Peyton, & Brown, 2005) to say that these three categories represent the Scale at which a particular change program is implemented. There also seems to be connection between the scale of implementation and the longevity of the program. For example, local programs tend to have a gestation period of about three to five years, national programs tend to require ten to twelve years, multi-national programs tend to take even longer to come to full fruition. Further, in order for change programs to grow in scale and/or last longer, there appears to be a need for a certain level of transfer of best practices from one organizational unit to another. The greater the transferability, the greater is the probability of the program reaching international acceptance.

The cases presented in this section provide examples of strong, positive safety culture by design as well as through the implementation of specific change programs. Realistically, a true "safety culture by design" can only be found in the nuclear power industry because that is among the select few industries, if not the only industry, where even a single failure could be catastrophic to a large community—city, state, or country. Other industries have had experience with accidents and depending on how closely these accidents were tied to their business/operational survival, they learned sooner or later to integrate operational safety into their business model.

Cases from five different industry segments are presented: Nuclear Power, Aviation, Chemical/Pharmaceutical, Construction, and Health Care. As we review these cases, it is important to note the socio-economic significance of safety in the respective industry segment. As the risk (combination of probability of error and exposure due to the resultant accident) increases, so does the significance of the specific safety initiative. Also, such a cross-industry review offers opportunities for unique, synergistic learning.

- In the nuclear power industry, accidents could destroy a very large community; hence, the acceptable risk in such operations is extremely low. Therefore, the nuclear industry is highly regulated/controlled and there is an overwhelming emphasis on safety throughout the organizations.
- For aviation to be accepted as a viable mode of transportation, the risk had to be reduced to a level that was acceptable by the flying public—the customer. The Federal Aviation Administration, and its predecessor regulatory organizations, established not only the criteria for the design, operation, and maintenance of the aircraft (the machinery), but also certification criteria for the operational personnel and the organizations. Again, a higher level of safety was achieved by increasing control of both the environment as well as the various agents interacting with the system. Emerging practices such as the Aviation Safety Action Program, Flight Operations Quality Audit, and other data sharing initiatives indicate that the industry is poised to move toward a more adaptive system as the new controls are mostly voluntary rather than regulatory requirements of the preceding generation.
- The chemical industry has made significant progress in improving its image as a "socially responsible" industry. Many such organizations have focused on improving worker health, reducing damage to the surrounding environment, and raising the overall safety

awareness/standards. One could argue that significantly strengthened and enforceable regulations via the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) have created the necessary financial motivation to raise the safety performance in this sector.

- In the construction industry, we note that in addition to OSHA-compliance issues, the industry has been developing innovative business contract models that incorporate safety performance as one of the parameters for establishing eligibility of vendors and service providers. Since this industry is essentially a network of several specialized service providers working on a specific project, such integration of safety and business practices seems to make sense.
- The health care industry is rapidly adopting best practices from a variety of high-consequence industries in order to improve its safety performance. The widely quoted *Institute of Medicine* report (IOM, 2003) has garnered attention from entities internal and external to the system. The key thrust areas in this industry seem to be as follows: transition from a blame culture to a just culture via a reporting culture; improvement in cross-disciplinary collaboration; and improvement of the overall safety culture.

4.1 Safety Culture By Design

4.1.1 Case 1: The Diablo Canyon Nuclear Power Plant

Under High Reliability Organizations, Schulman (1993), further classifies the HROs as a decomposable or a holistic HRO. Such distinction is based on the organization's ability to decouple "dependencies and inter-activeness among administrative and technical systems" (p. 38). He classifies Air Traffic Control System as a decomposable HRO because "the network of air routings can be closed off sector by sector in the case of equipment failure" and the controllers can actually "buy" time to localize or isolate the problem (limit complexity) and then focus on the solution. In holistic HROs, however, "safety in the face of failure requires maintaining the highest level of organizational integration—both in analysis and in action" (p.42). Schulman describes the Diablo Canyon Nuclear Power Plant as a model of a holistic HRO—here, a strong safety culture exists by design.

> The Diablo Canyon plant has two separate units, each of which is capable of generating approximately 1100 MW of electricity for a combined total at full out put of 2,190 MW. There are 1250 employees on site and over 1,100 outside consultants, staff augmentation, and service contact workers employed during scheduled maintenance overhauls or "outages." (p.42).
>
> Diablo Canyon is organized into Operations, Maintenance, and Engineering departments. Operations has senior control operator, control operators and assistant and auxiliary operators. Maintenance personnel are divided into Mechanical, Electrical, and Instrument and Control departments. (p.42).
>
> In addition, the plant has a Nuclear Power Generation support group in the General Office of Pacific Gas and Electric in San Francisco (NPG/GO). Despite its location 300 miles to the north, this group is actively involved in the plant's operations. Its director is a senior vice –president of the company. NPG/GO has approximately 711

> employees, 387 alone in Nuclear Engineering and Construction Services (NECS), which does construction work at Diablo Canyon on an assignment basis. It also has a wide variety of nuclear engineers, systems analysts, regulatory compliance specialist, and emergency planners. (p.42).
>
> For nuclear power plants there is really no passive-mode safety. Complexity cannot be decomposed readily to achieve stability through simplification. Anytime there is a nuclear fuel in a reactor, a variety of systems must operate to monitor and control its reactivity, dissipate its heat, control water pressures and flows, as well as maintain a variety of backup systems that safeguard these primary functions. Even when fuel has been removed from the reactor, highly radioactive components must still be monitored, shielded, and contained. (p.42).
>
> The responsibility for action, if too localized, can be dangerous. Remedial actions need to reflect a system-wide perspective of the consequences of what is being done. Actions taken too soon, in too narrow a context, can jeopardize other parts of the system. The closure of one valve, for example, may increase pressure on others. Even actions taken in separate generating units might affect one another. In one case at Diablo Canyon, a test requiring the brief shut down of an instrument air pressure system on one reactor during its scheduled maintenance overhaul was postponed due to worry that perhaps the instrument might somehow be connected to the air pressure system of the other operating unit. Even the engineering drawings of the units were not taken as definitive evidence of the independence of the air systems. Only after a personal inspection or "walk-down" of the entire system by a supervising engineer were maintenance workers authorized to act to initiate the air shut down on the non-operating unit. (p.43).

What makes this case a unique example of a strong safety culture by design is that safety is on everyone's mind all the time. Everyone clearly understands that a lapse in one critical step could endanger not only themselves but also a substantial portion of their community. They have developed numerous structural and operational safeguards to detect problems and resolve them before they mature into incidents or accidents. The one notion of risk at work here is that the individual workers endanger their own lives when they take risks. While this may seem comparable to industrial safety, the big difference is that when workers compromise safety in a nuclear power plant, the entire power plant, as well as the community in which it resides, is at risk. Therefore, the entire organization's survival—personal as well as communal—depends on each individual person's adherence to the highest standards of safety.

4.2 Examples of *Change* in Safety Culture

4.2.1 Case 2: The US Aviation Industry: ASAP, FOQA, VASIP, and CAST Programs

Instead of focusing on one specific change effort, in this case we highlight some industry-wide initiatives that are helping the aviation industry further improve its safety record.

In aviation, majority of the early efforts to improve safety were focused on design improvements; over the past 50+ years, these improvements have yielded an accident rate lower than one in a million—six sigma or high-reliability level. Hempe (2005) illustrated the decline in

accident rates, superimposed with concurrent technological advances (see Figure 3). It is essential for the aviation industry to drive this accident rate to the one in a billion—nine sigma or ultrasafe level. The National Civil Aviation Review Commission Report states that, "A flat accident rate coupled with the anticipated healthy growth in aviation will lead to a significant increase in the absolute number of accidents. If there is no change in the accident rate, and the anticipated growth occurs, there will be a large airliner accident somewhere in the world every 7-10 days by the year 2010" (NCARC, 1997). Figure 4, from the Commercial Aviation Safety Team (CAST) illustrates the projected growth in air traffic.

Tracing back to the evolution of the aviation industry, clearly, the preferred means of increasing safety was to tighten the regulations, increase standardization, and increase surveillance. This is how the industry transitioned from the open system era of barnstorming to the current high-reliability era. Now, in order to move to the next level, both the industry and the FAA are making deliberate efforts toward industry-wide voluntary partnerships that identify hazards and enable systemic resolution of hazard-producing conditions. Once these partnerships are well established and the partnering organizations are able to proactively make the necessary internal changes, the system will have evolved to the ultrasafe level.

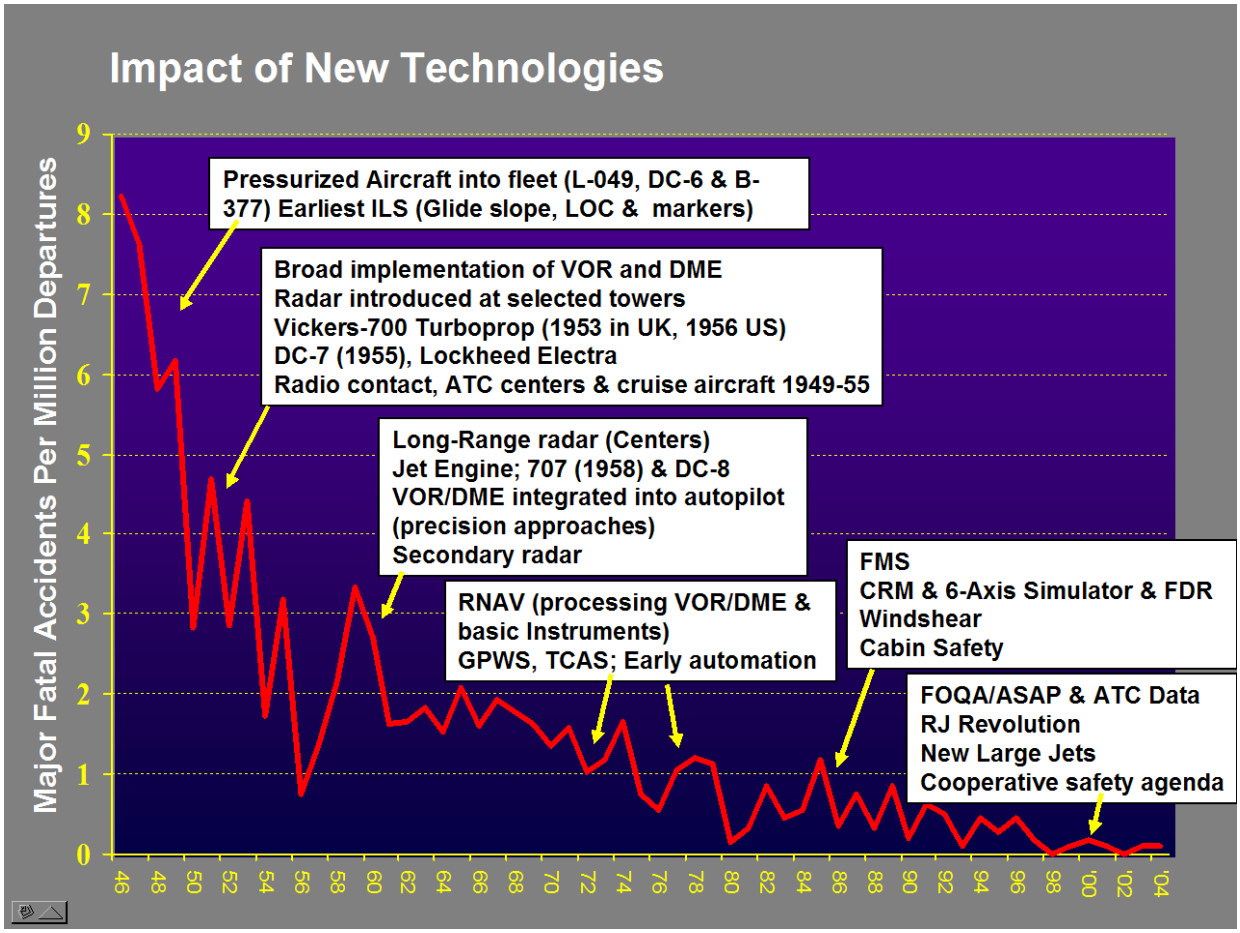

Figure 3: Impact of technology on aircraft accident rate (Hempe, 2005)

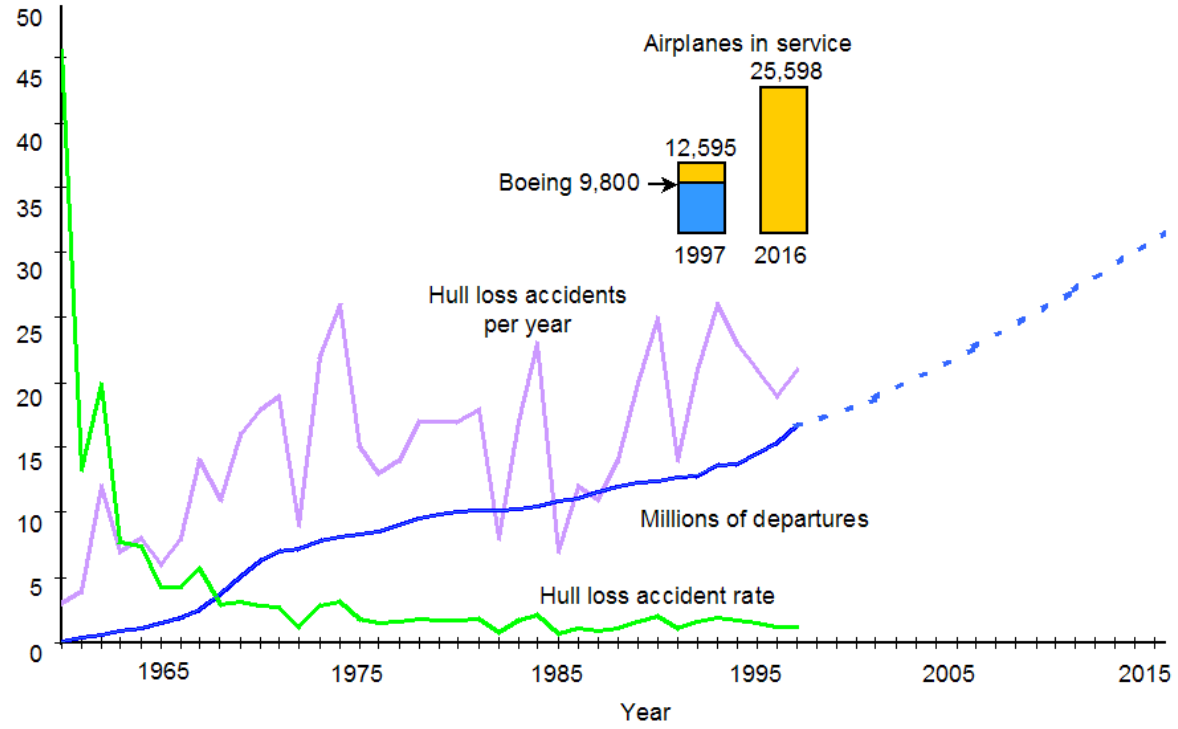

Figure 4: Projected growth in number of departures (CAST, 1998)

Aviation Safety Action Program (ASAP) is a voluntary error-reporting program available to pilots, mechanics, dispatchers, and flight attendants. This program is based on the premise that the person who committed the error holds vital information about the preconditions leading up to the error and, if appropriately involved, could help institute systemic solutions that ultimately minimize the probability of a similar error by another person (cf. FAA, 2002). The ASAP program is different from other types of reporting programs (For example, the ASRS program or an internal hazard reporting program or the FAA's Safety Hotline) because in this program, there is an explicit commitment from the FAA, the company, and the employee group (whether unionized or not) that they will collectively ensure that (a) the reporting individual is provided protection in accordance with the applicable policies and procedures and (b) systemic improvements are implemented. By formalizing such a commitment, airlines and aviation maintenance organizations are moving toward the ultrasafe culture.

The Flight Operations Quality Assurance (FOQA) program allows airlines to acquire data on a wide variety of parameters depending on the level of sophistication/maturity of the data acquisition units and the vintage of the aircraft on which this technology is installed. The FOQA program is another voluntary program that allows airlines to identify operational hazards and provide reliable quantitative evidence regarding the hazard. Many airlines claim that they have been able to address such safety hazards proactively and effectively, and the FAA claims that the net savings derived from a FOQA program for a fleet of 50 aircraft could be as high as $892,000 per year (FSF, 1998).

One key hurdle in a more widespread implementation of both ASAP as well as FOQA program has been the issue of confidentiality of the data provided to the FAA. Recently, the FAA has been successful in obtaining protection of such voluntarily submitted data from the Freedom of Information Act (Patankar & Gomez, 2005). This is a significant milestone, not just for ASAP and FOQA programs, but also for the overall quest to change the people's attitude regarding error reporting.

The Voluntary Aviation Safety Information-sharing Process (VASIP) is a system that would allow sharing of ASAP and FOQA results across organizations. While the original data may be protected by the embedded security system, the partnering organizations will be able to view the aggregate results across the industry. This will allow all partners to get a better sense of the industry-wide benchmark, without compromising the confidentiality of the participating organization.

The VASIP program takes the safety infrastructure to the next higher level and ratchets the organizational learning opportunities from a specific company level to the industry level—one does not have to wait to identify a particular hazard in their own organization in order to initiate the corrective/preventive action.

Again, ASAP, FOQA, and VASIP collectively signify a level of maturity in the aviation industry that (a) makes it acceptable for a highly skilled professional to make a mistake and (b) holds the three key parts of the aviation system—the FAA, the company, and the employee group—accountable to address the latent issues that tend to lead to errors.

Another way of improving safety is through an industry collaborative such as the Commercial Aviation Safety Team (CAST). The CAST group consists of two teams: the Joint Safety Analysis Team (JSAT) and the Joint Safety Implementation Team (JSIT). As the names imply, the JSAT is tasked with detailed analysis of aircraft accidents and recommendation of appropriate interventions. The JSIT is then tasked with studying the feasibility of those interventions and with developing a strategic plan of action for both government representatives as well as the industry representatives. Together, the JSAT and the JSIT, provide a report to the overall CAST regarding the final recommendations. Since CAST recruits top management personnel from industry and government sectors, the recommendations developed by this group receive high visibility. Therefore, CAST is another great example of collaborative efforts to improve the overall safety of air travel. (Additional information is available at http://www.aia-aerospace.org/departments/civil/cast/background.html).

With all the data collection efforts underway (through ASAP, FOQA, CAST, etc.) some industry experts argue that the aviation industry is "data rich and analysis poor." This sentiment tends to reflect that the industry needs to focus its future efforts on intelligent data mining so that timely, meaningful, and cost-effective interventions can be developed. Again, as a system matures from high-reliability to ultrasafe, the volume of available data will increase and innovative analytical techniques will need to be developed so that not only best solutions could be developed, but also their effectiveness could be monitored.

4.2.2 Case 3: DuPont Chemicals

This case illustrates how the safety culture at one particular chemical plant was changed. We present a story told by Richard Knowles (2002) regarding his experience with the Niagara Falls Plant of DuPont Chemicals. Besides the safety-related issues, this story illustrates a process that Knowles has used repeatedly and successfully to improve the safety record, improve business performance, and to improve community relations. Thus proving that his process, called Process Enneagram, works and more importantly, it is possible to have "the togetherness, trust, well-being, and community all the time *if this is what we choose* [original emphasis]" (p.26).

DuPont has been in business for over 200 years and has always regarded safety as the top organizational priority—mainly because they started as a manufacturer of black powder for the U.S. Government in 1802—a lapse in safety procedures was very likely to eliminate the company—therefore, operational safety was quickly recognized as an integral part of business success. Over the years, the company has honed its safety audit programs as well as the overall communication and process improvement programs. In 1994, they established a "Goal of Zero" injuries and incidents, and in the year 2000, decided to adopt a "Goal of Zero" for soft tissue injuries like carpal tunnel syndrome and back injuries. In 2002, over 80 percent of its 367 global sites completed the year with zero lost time injuries. (Grubbe, 2003).

While DuPont's safety record is legendary in industrial safety circles, the company or its plants are not without their challenges. Dr. Richard Knowles took over as the Plant Manager of the Niagara Falls Plant in 1983. The following is his story about the status of the Plant and how he led the cultural change efforts.

> The Niagara Plant was a tough assignment. It had the worst labor relations history in the Company. There were two strikes in its history, one of which lasted for 6 months in 1970-71. The Plant's safety performance was not good…On my first day, I was informed that we'd had a lost workday injury because a man had cut off his finger in the Sodium Shop…The operating area [of the Sodium Shop] had been in use for 85+ years and showed the wear and tear. The attitude of Plant Management towards the injury seemed pretty casual. It was clear we were in a pretty deep safety hole. (p.xvi).
>
> About a year before I'd moved to the Plant, there had been an environmental release in which a small chlorine cloud had come down to the ground…in the middle of a Niagara University/Siena College football game…The enrollment of new students at Niagara University had fallen off, and they felt that DuPont had contributed to the problem. (p. xvi).

Knowles attended a public hearing on the status of the Love Canal tragedy, which had caused severe environmental damage and widespread fear and sickness among the residents of Love Canal, NY a couple of years prior. At this meeting, Knowles observed that the emphasis was on technical topics and not on the effect of the tragedy on the people in the community or on what was being done to help the community—he learned that it was important to connect with the people involved in such a tragedy.

> Shortly after this episode [the Love Canal hearing], I learned that our Plant had serious environmental problems stemming from production operations that had been

> discontinued 15 years earlier. I had my first press conference. I had to tell the community and our Canadian neighbors that chlorocarbons like chloroform and methylene chloride were leaching from the soil under the Plant, and about 50 pounds a day were going into the Niagara River. Our news of the material leaching from under the Plant was not well received…I tried to be as open and honest about the problem…I learned that sharing the information openly, talking honestly about it, and sharing the plans to do something about it were really important. Taking on an issue like this by openly sharing the information and plans was not normally done in the chemical industry in 1983, so I felt that I was way out on a limb. (xvii).

By opening up to the community and by his willingness to empathize with the people involved, Knowles was able to build strong personal relationships with key people in the community. These relationships helped him as well as the key constituencies build mutual trust. Concurrent with his community-relations efforts, Knowles also addressed over 200 grievances filed by his employees by working openly with the Union. In spite of the many heated arguments regarding the grievances, the employees saw that he was "trying to find the truth" the best that he could and "was trying to listen" (p. xviii).

As Knowles continued to improve the safety performance as well as production, he noticed the following:

- When there was a crisis, people put all the problems down and worked together in quite astonishing ways; yet after the crisis, they went back to behaving badly.
- In order to make good decisions, he needed good information; and in order to get good information, he had to be out in the Plant and get to know the people very well. Information flowing up and down the hierarchical chain was not as reliable as he had thought.

Knowles reports multiple issues related to worker safety concerns, environmental damage, or quality and production issues. He resolved these issues by using a technique called Process Enneagram, which is based on the "Living Systems" paradigm. This process uses Identity, Relationships, and Information as the central elements of Self-Organization.

> We shared all the Information at least weekly and, as we worked together, listened, and talked, trust and interdependence built. Our Relationships became healthier and stronger. Anyone could go to whomever they wanted to get the Information they needed. This was a very deep process. Working in this way improve everything we did, both during the conversion and afterwards. Used consciously together, these are the patterns and processes for developing self-organization. (p.34).

> To have our work processes go well we need to begin with a clear, compelling question that relates to the specific work that we wish to do. This question is developed by the people involved and must be compelling in order for us to have the interest and energy to take on the work effectively…The scope of the beginning question can vary enormously. It can be very narrow, like "How do I type a report?" or broader like "How do we improve the customer service in our business? Or very broad like "How do we change the entire nature of our business?" (p.34).

> If I discover that I need to join two boards (Identity) and I decide to use a nail to joint them (My Intention), I must hold the hammer and nail properly (Principles and

> Standards). I must decide where to put it, and how to hold the work (Issues and Tensions). Then I have to decide how to set up the work place (Structure) and actually drive the nail (Work). Hopefully, I get better at driving nails and building thins (Learning). If I write a few notes, I'll have some Information that will help me as I go forward. I'm in a process of Learning and growth. (p.34).
>
> The questions that the people in the organization address as they consider the nine attributes all relate to the opening question, and to this opening question must be important and compelling to them. (p.34-35).

While understanding the many organizational changes that Knowles was able to implement and sustain, it is critical to note that he was also undergoing a radical personal transformation. He moved from being a "command and control" type leader to one with a much higher "emotional intelligence" (cf. Goleman, 2001a). Goleman (2001b) has described six leadership styles: authoritative, democratic, affiliative, coaching, coercive, and pacesetting. Out of these, he claims, "leaders who have mastered four or more—especially the authoritative, democratic, affiliative, and coaching styles—have the best climate and business performance" (p. 74). Clearly, Knowles was able to apply at least four key leadership styles quite effectively.

4.2.3 Case 4: The US Navy's SUBSAFE Program

According to Iwanowicz and McBride (2005), the USS Thresher, the first submarine in its class, was launched to sea in 1960. It was a nuclear powered submarine with the modern hull design and best available technology. On April 10, 1963, the Thresher was lost at sea about 200 miles off the northeastern cost of United States and all 129 people aboard the submarine died. A rigorous investigation followed, and several findings were reported: deficient initial specification, poor ship-building and maintenance practices, incomplete or non-existent records of work performed, and deficient operational procedures. In response to these findings, the "December 23, 1963 Letter" was issued outlining the criteria for Submarine Safety Certification. The certification program that was developed in response to these criteria established the foundation for initial and recurrent certification of submarine safety for the US Navy. Its purpose was to provide "maximum reasonable assurance" of safety through hull integrity that precludes flooding and operability and controllability of critical systems to recover from flooding. Iwanowicz reports that while sixteen submarines were lost in non-combat situations between 1915 and 1963, only one submarine has been lost in non-combat situations since 1963—this submarine was not SUBSAFE certified. No SUBSAFE certified vessel has been lost.

The overall SUBSAFE program appears similar to aircraft airworthiness certification and maintenance programs. There are many checks and balances in place in civil aviation that have resulted in high reliability operations. Since the civil aviation industry is an open system that is vulnerable to socio-economic factors not present in military operations, it will not be fair to compare the SUBSAFE program's record with civil aviation or any other commercial operations; however, it is valuable to note that systemic quality control mechanisms have been used successfully to instill a strong, positive safety culture in the aviation industry.

4.2.4 Case 5: The Capsugel Accident Prevention Process at Pfizer

Pfizer reports that their gelatin capsule manufacturing business—Capsugel—is using a behavioral approach to instill an awareness of workplace health and safety in every employee's daily activities. (http://www.pfizer.com/ehs/case_studies/greenwood.html).

The Capsugel Accident Prevention Process—CAPP—emphasizes personal responsibility for behaving safely in the workplace. To help create this safety culture, employees receive CAPP training on, among other things, observation techniques and feedback. They apply these diagnostic skills on their own job and to their colleague's work behavior through 20-minute, on-the-job observation exercises. At the end of a typical observation session, a colleague will provide feedback to the co-worker about any safe or unsafe work practices and, together, discuss ways to enhance their safe work practices. This technique is very similar to typical Crew Resource Management techniques of briefing and debriefing. However, the enhancement here is that Pfizer employees entered their observations into a database to track trends and provide comments on their work environment and equipment. To promote open discussion and disclosure of safety observations, their observations are entered into the database without reference to specific individuals. Capsugel's safety management reviews and follows up on all observations recorded and uses this information to target areas for shared learning and improvement within the facility. This active database makes the knowledge obtained through debriefings actionable.

Capsugel first piloted this program on a small scale at its Greenwood, SC, USA facility in 1997, and rolled it out nationwide in 1998. Though instilling a strong safety culture takes time, Capsugel has seen positive results already. Since kicking-off the program at Greenwood in 1997, lost-time accidents—on-the-job injuries involving one or more days away from work—have been reduced by 80%, and injuries tracked according to the U.S. Occupational Safety and Health Safety Act—commonly referred to as OSHA recordable injuries—have fallen by over 65%. Given this demonstrated impact, Capsugel rolled out the CAPP program to its facilities in Bornem, Belgium; Colmar, France; and Puebla, Mexico in 2002.

4.2.5 Case 6: Pfizer's Latin American Safety Culture

Pfizer's Latin American and Canadian manufacturing facilities have established a good formula for building a robust safety culture among colleagues. Through a combination of teamwork, knowledge sharing and communication, they have advanced employee awareness of their respective role in creating and maintaining a safe and healthy workplace. (http://www.pfizer.com/ehs/case_studies/latin_america.html).

Process-based teams are at the heart of this regional program. On a process-based team, each member understands all of the responsibilities and tasks required of the entire team. Each team takes ownership of its health and safety performance by putting many day-to-day health and safety responsibilities directly in the hands of unit leaders and colleagues. For example, facilities in Brazil and Mexico have implemented a weekly, 5-minute chat initiative, during which manufacturing operators gather to enhance colleague awareness of workplace health and

safety issues and how their actions affect the safety of themselves and their colleagues. This is a good example of goal sharing and flattened hierarchies for enhanced performance.

Additionally, facility environment, health and safety (EHS) staff partners with the process teams to develop and implement good health and safety management practices and provide training. EHS site leaders also work closely with the medical department at each site to track injuries and near misses to identify and address their root causes. This is a great example of teamwork or relationship building across the traditional organizational boundaries.

Finally, communication among teams in the region has been and will continue to be critical to the success of this initiative. EHS staff from the 11 facilities in the Latin America/Canada region meet face-to-face twice a year to discuss projects, enhance networking and share information on the initiatives being implemented by facilities in the region. These efforts have delivered measurable results. Manufacturing facilities in the Latin America/Canada region have experienced reduced accident and injury rates and medical treatment cases. In fact, 5 out of the 11 facilities in the region had no lost-time accidents in 2003. Delivering safe and healthy workplaces is among the Company's highest priorities. Creating a culture of safety among all colleagues is how they plan to meet this commitment. Their manufacturing facilities in Latin America/Canada have demonstrated that teamwork, sharing best practices, and open communication collectively represent one way to effectively assure health and safety becomes everyone's responsibility at Pfizer.

4.2.6 Case 7: Birse Rail

Birse Rail is a part of Birse Construction and provides specialized railway engineering services throughout the United Kingdom. It employs 800 people including workers, contractors, and managers. In 2001, they had a reportable accident frequency rate of 0.64 per 200,000 hours worked (the UK construction industry has since moved to incident frequency reporting—see http://www.constructingexcellence.org.uk for details). In order to address this problem, the company launched a widespread culture change initiative that started with the top management and involved employees, contractors, as well as key business partners. Their central theme was "zero tolerance" of accidents. In just one year, the company was able to bring down their accident frequency rate to 0.2 per 200,000 hours worked. The cost of induction and training of the direct labor force is estimated to be about £15,000 per year (approximately US $26,000) and the cost of management time spent on health and safety matters is about £120,000 per year (direct and indirect costs—about US $211,000). The company claims that the "Safety First" program has more than recovered its cost. Besides this obvious safety improvement, the company cites the following achievements of the program:

- Reduction in down time
- Increase in contract pre-qualification scores
- Increase in client confidence, contributing to repeat contracts
- Improved relationship with supply chain
- Reduced management time spent on accident investigations
- Highly commended by the Royal Society for the Prevention of Accidents

Additional information about the above case is available at
http://www.hse.gov.uk/businessbenefits/casestudy/birserail.pdf

4.2.7 Case 8: The Associated Octel

In 1996, following a series of major incidents at Ellesmere Port (including a major fire and fatality), and a decline in the company's core business, there was a change in Associated Octel's senior management. The new management emphasized the need to increase accountability as the central focus in order to improve the safety performance as well as save the business.

According to Stewart Burley, the site director, "Changing the culture at a site like this does not happen overnight. It is a 3-5 year journey. Leadership and a consistent intolerance of unacceptable behavior are key."

Some of the key characteristics of the new safety culture are as follows:

- Managers and supervisors report in person to the Manufacturing Director on injuries and incidents
- Remedial actions following accidents are closely monitored
- The health and safety management system has been changed to support the culture changes
- Shop floor employees are positively encouraged to report issues and refuse to carry out tasks if they feel unsafe
- Direct channels of communication to senior managers to increase trust and openness on
- safety issues

The following benefits of the new safety culture were reported:

- Effective 40% reduction in production unit costs and improvements in equipment reliability during a period of staff reductions (60% of workforce)
- Reduction in lost time incidents from 35 in 1996 to zero in 2002 and 2003
- Improved trust and reputation in local community
- Reduction in insurance claims, from over 50 in 1997 to zero in 2002
- Improved staff morale – absenteeism down from 10% to 2.5% of staff
- 50% reduction in injuries compared to hours worked
- Improved housekeeping procedures
- Greater accountability in internal projects, particularly in capital investments made to the site
- Improved trust and reputation in local community
- Reduction in lost time incidents from 35 in 1996 to zero in 2002 and 2003

Additional information about this case is available at
http://www.hse.gov.uk/businessbenefits/casestudy/octel.pdf

4.2.8 Case 9: Woodrow Construction

Woodrow Construction is a home-builder with over 7,000 employees worldwide. The company places great importance on safety and health of its employees as well as the future home owners—its customers. They want to promote the image of "Woodrow Home is a Safe Home." Therefore, they have developed a safety culture development program that actively measures the safety performance of each site against the national standards in the industry and also tracks it against their business performance.

Some of the key elements of their safety culture are as follows:

- Motivating our staff through a measurement and reward scheme, based on commercial and health and safety performance. Bonuses are linked to the achievement of safety targets
- Enabling our staff by making sure they have the relevant training and by providing guidance and information
- Ensuring our strategy is met through a team of professional health and safety advisors and a management system that reports performance and innovation in detail
- Continuously improving by setting benchmarks above legal compliance. Site innovations feed through to the boardroom so that best practice from sites is adopted as standard practice

The following benefits of their safety culture were reported:

- By being seen as the company of choice for safety and productivity with our workforce and sub-contractors
- Costs relating to claims, injuries and delays are minimized
- Being seen as a responsible business helps us sell our product, recruit and retain people and benefit stakeholders

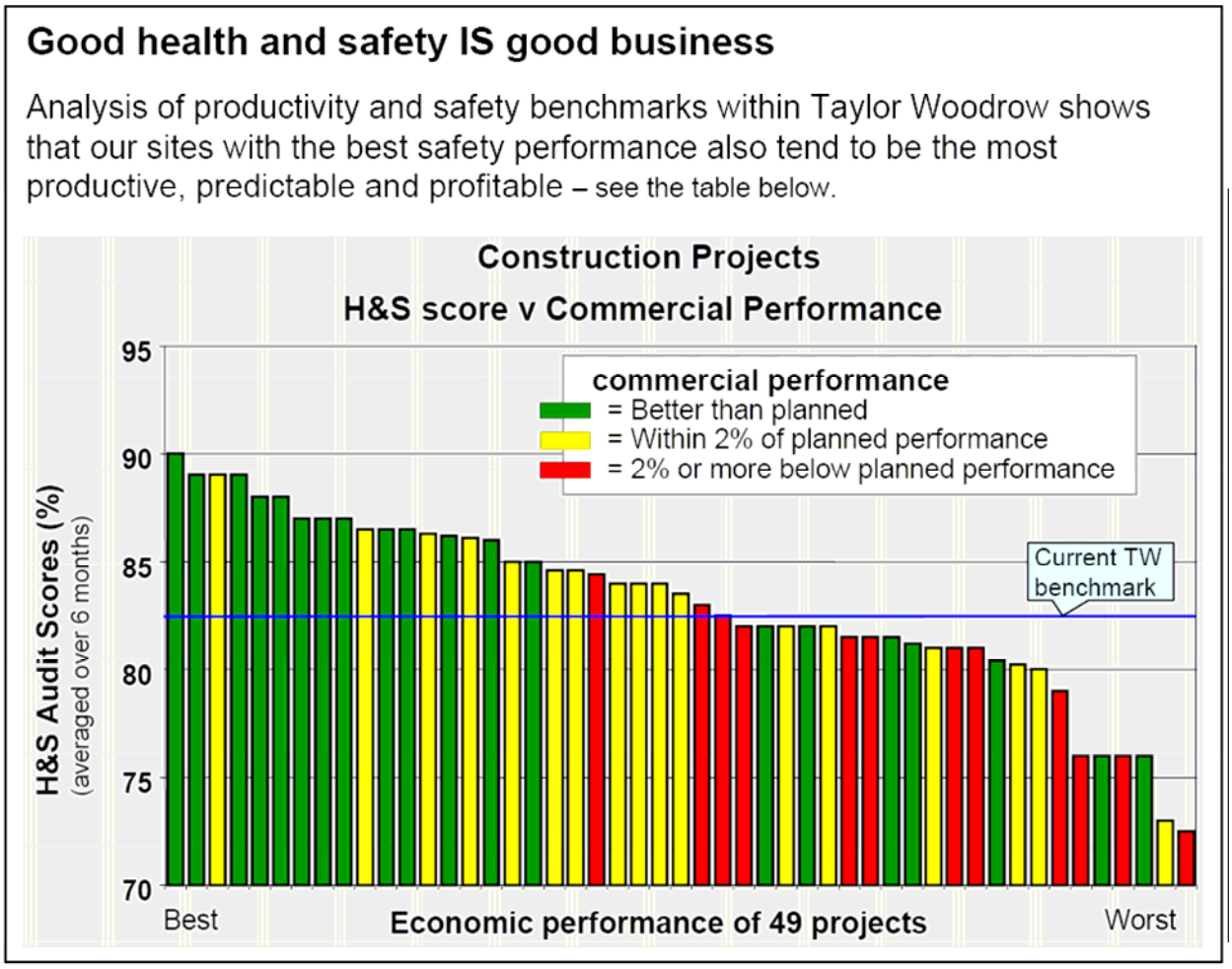

Figure 5: Benchmarking economic and safety performance

Additional information about this case is available at (http://www.hse.gov.uk/businessbenefits/casestudy/taylorwoodrow.pdf)

4.2.9 Case 10: Transco—Working Together for Safety and the Safety Charity Challenge

Transco is a part of National Grid Transco Pvt. Limited Company. It transports natural gas, maintains the supply infrastructure, and operates the national gas emergency service. Through its integration of health and safety into overall business management, and a partnership approach with employees and safety representatives, injuries have been substantially reduced.

In 1998 there were 543 Lost Time Injuries (LTIs) to Transco's 15,300 employees. This level of pain and suffering to its workforce was unacceptable to the company, which believes safety is paramount. In addition, it was a significant cost to the business.

Transco reports the following business benefits of their "Working Together for Safety" program:

- Health and safety leadership skills transferable to other areas of business performance
- Over 80% reduction in lost time injuries from 35.5 per 1000 staff in 1998 to 6.6 in 2003

- Approximately £4.5 million savings through improved injury rate
- Acknowledgement of improved performance, enhancing staff morale and pride
- Improved reputation with key stakeholders

Transco reports the following health and safety benefits of their "Working Together for Safety" program:

- Over 80% reduction in the number of accidents, incidents and injuries
- Improved incident investigations, with prompt sharing of lessons learnt to prevent recurrence
- Improved safety culture – ownership at all levels with the commitment and competence to improve
- Significant increase in the reporting and resolution of hazards and near misses

National Grid Transco (NGT) believes that safety is paramount and that all work-related injuries and illnesses are preventable. Although the company had robust safety management systems in place they still found that incidents at work, which resulted in employees taking time off work remained unacceptably high. In 1999, Transco calculated the cost of each Lost Time Injury (LTI) to be £6000. This included costs for non-availability of employees including, lost production, investigation costs and civil claims. The reduction in LTIs has saved about £4.5m over 4 years. There are also savings from reductions in non-lost time injuries and incidents, and from a reduction in civil claims.

Working alongside the existing safety management systems, NGT launched the Safety Charity Challenge, which has radically reduced incidents and consequently, lost time injuries, providing considerable savings to the company and at the same time, benefiting selected charities. The key focus areas were as follows:

- Active Support from Top Management: The Directors have supported the process from the start through regular communications, time at management meetings and, most importantly, getting out to meet employees. Health and safety is on the agenda of all management meetings plus there are frequent specific meetings between managers, safety representatives and safety advisors.
- Clear Communication and Employee Involvement: Working with employees has been fundamental to the initiative's success, with GMB and Unison Safety Representatives involved throughout. This includes joint meetings, communications, training, investigations and inspections. Monthly briefings for staff on issues and improvements use photos and videos.
- Accountability: Clear allocation of responsibility to line managers, management is held accountable through staff performance process, and management and employees are supported by safety management training.
- Effective Hazard/Safety Reporting System: Hotlines are established with one telephone number for staff to ensure hazards and incidents are reported and resolved.
- Prompt Accident Investigation: A manager and a safety representative investigate Lost Time Injuries on the day they occur, and lessons learned are promptly shared with staff.

Employees were challenged to identify, report and remove hazards that could lead to lost time injuries, for each one identified and removed, the company makes a donation to Mencap or

Enable its equivalent in Scotland. Key to its success was the fact that everyone involved in the company could contribute and that follow-up actions – the removal of the hazard – could be demonstrated.

In 2001, the scope of the challenge was broadened to include road safety, the aim being to reduce traffic accidents involving Transco vehicles by 40%. The allocation of the donations was also changed to enable staff to decide which good causes should benefit from the Challenge resulting in 50% going to local charities and the remaining half continuing to go to Mencap/Enable.

The merger with National Grid provided the opportunity to spread this best practice initiative into the rest of the merged business and is now implemented across all UK regulated businesses.

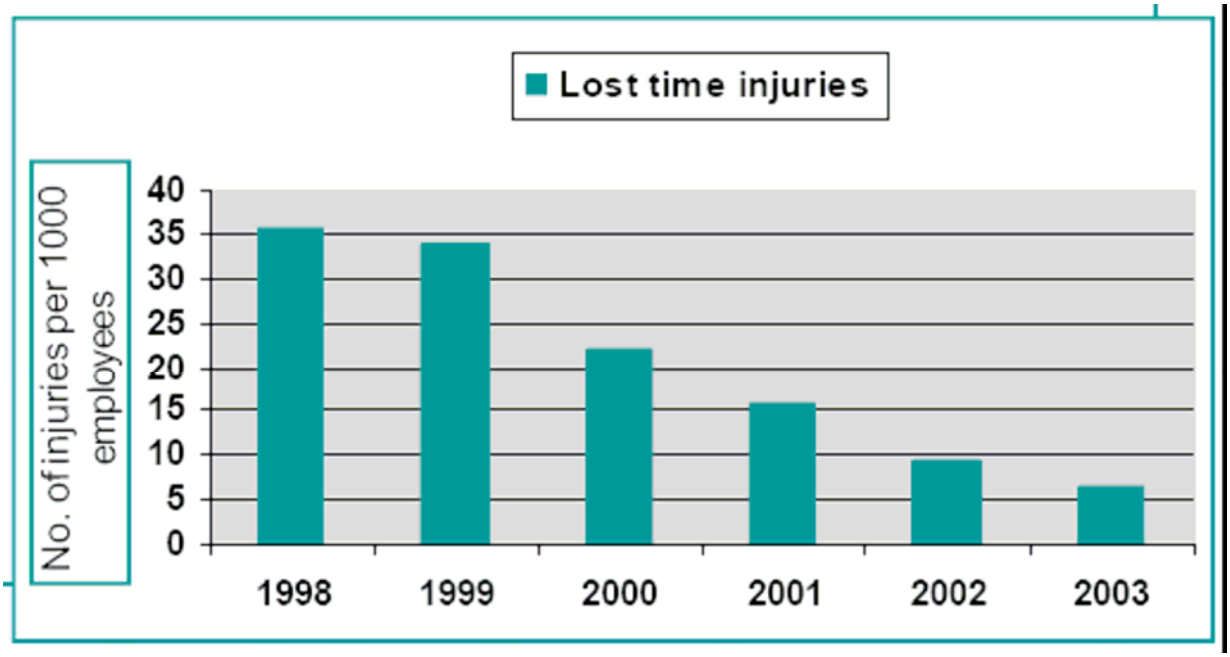

Figure 9: Change in lost time injuries as a result of the safety initiatives at Transco

Additional information about this case is available at
http://www.hse.gov.uk/businessbenefits/casestudy/transco.pdf

4.2.10 Case 11: Stadium Construction

The US Occupational Safety and Health Administration (OSHA) has three comparative cases available on their website at http://www.osha.gov/dcsp/alliances/abbott/stadium_construction.html. These three cases illustrate financial benefits of participating in a voluntary, collaborative program called MASTER: Mobilized Alliance for Safety, Teamwork, Education, and Results. This program, much like the ASAP program in aviation, was designed to bring the labor, management, and regulatory groups together to improve safety. Although the emphasis of the MASTER program is on worker safety, it has demonstrated benefits to the business as well as the overall safety culture in the construction industry. Some comparative benefits of MASTER that were illustrated in the OSHA cases are as follows:

The Paul Brown Stadium

- A $453M project that lasted about 2.5 years
- 3.35 million man-hours
    - Job lost time rate of 0.95 (national average for the construction industry is 4.0)
    - OSHA recordable rate of 5.48 (national average for the construction industry is 10.4)
- Actual losses due to accidents were $42% of the original estimated losses
- Net program savings estimated to be $4.6M

The Great American Ballpark

- 1.2 million man-hours
    - Job lost time rate of 0.8
- Estimated workers' compensation savings
    - $160,000 through Owner Controlled Insurance Program
- Net program savings estimated to be $3.1M

The MASTER project

The goal of the MASTER project is self-compliance through the cooperative efforts of labor, management, and OSHA in the construction industry. According to the 1999 BLS, construction had a fatality rate of 14.0 per 100,000 employees compared with general industry's 3.6 per 100,000, and on average OSHA has traditionally devoted roughly 40-50% of its compliance resources to enforcement activities within the construction industry.

The MASTER project was developed in 1993 to not only address the hazards within the construction industry but also to promote and recognize those jobsites controlled by a contractor that had a demonstrated and effective safety and health program in place.

Important program criteria include:

- To be selected as a MASTER project, the contractor must meet the following criteria:
- An established and implemented comprehensive safety program with a written safety and health program submitted to the OSHA Area Office
- The authority to require and enforce the use of conventional fall protection when their employees or sub-contractor employees are performing work that is in excess of six feet above a lower level
- All supervisory personnel complete the OSHA 30-hour course for the construction industry
- All non-supervisory personnel engaged in construction activities complete the OSHA 10-hour course for the construction industry
- All employees on the project receive at a minimum a 2-hour safety orientation covering general job site safety and health rules when hired and before accessing the job site. Records of training certification will be maintained and made available for review upon request
- Signs posted near the main entrance of the site of at least 3 feet by 5 feet that recognize the site as a MASTER project

- Submitted Experience Modification Rates and OSHA 200 logs for the three previous years
- No OSHA citations in the past three years
- No fatalities or catastrophes which resulted in accident-related serious violations within the past three years

In order to retain a "MASTER" project designation, the incidence rate for the project for the total number of recordable injuries must remain below the construction industry average, and they must agree to provide OSHA with access to the work site.

1. High visibility of safety personnel on the job site
   Safety personnel will include three levels of safety supervision on the job-site with every contractor having a responsible person in a safety role reporting to the prime contractor, and weekly meetings between all site safety personnel keeping open the lines of communication.

   The job site must have a safety manager with at least three years experience overseeing safety and health programs on construction sites. The safety manager is responsible for conducting frequent and regular job site inspections and holding job site safety meetings at least weekly with safety representatives for labor and the contractor.

   The job site will also have a labor representative as a liaison to the safety manager. The representative must have completed a construction apprenticeship program that included safety and health issues as part of the curriculum, and will accompany the safety manager on job site inspections and attend safety meetings and will be involved in all accident investigations.

   Also, each prime or subcontractor will appoint an on-site safety representative to be the contractor liaison to the safety manager. The representative will accompany the safety manager and labor representative on job-site inspections in their respective area, and will attend the regular job-site safety meetings.

2. An above average rate of training that focused on highest risk areas
   The program requires a minimum of 2-hour safety orientation covering general job-site safety and health rules when hired, plus weekly tool box talks covering areas related to planned work activity and significant risk areas. Significant risk areas include: falls, being stuck by equipment or machinery, electrocution, and caught-in between equipment, buildings, and/or materials

3. Management commitment with incentives to employees[3]
   Incentive program for construction crews to work safely on the Paul Brown stadium project were implemented by offering monthly prizes such as pizza lunches, polo shirts, baseball caps, tools, and Bengals tickets. The construction management team was paying for the program without any additional charge to Hamilton County.

4. On-site medical personnel and facilities
   The goal of an on-site medical facility is to decrease the chance of a minor injury becoming more serious and thus resulting in lost-time. However, having the on-site facility on the Paul Brown stadium project meant that many minor injuries that in the past would have gone unreported were now seen by the nurse. This lead to a rise in

overall injuries reported. But a decrease of lost-time accidents is attributed to a pro-active environment where workers were encouraged to seek medical attention even for would-be minor injuries, and the employees are generally able to return to work without delay.

5. Pre-employment drug testing plus drug testing after all accidents involving personnel or equipment or any observed suspicious behavior

6. Thorough accident investigations
   OSHA will be given access to the job site to review records, attend job-site safety meetings, and conduct limited site audits. OSHA will conduct enforcement investigations on major accidents and fatalities. All non-formal complaints received by OSHA will be referred to the safety manager and the labor/building trade representatives who will conduct an investigation and report their findings and corrective actions to OSHA within two working days. Formal complaints will be handled in this manner if agreed upon by the complainant otherwise OSHA will conduct an enforcement investigation. If the job-site appears on OSHA's current programmed construction cycle, the inspection will be limited to a review of compliance with this directive, except where high-gravity serious or imminent danger conditions exist. OSHA may participate in job-site safety activities, and as needed, OSHA may provide on-site training to workers and their representatives.

   The MASTER project must submit every six months and upon completion of the project the following measurements:
   1. Number of recordable injuries compared to the industry average incident rate
   2. The Days Away, Restricted, Transferred rates compared to the industry average
   3. Survey of labor and management to determine their personal views of how the program worked.

4.2.11 Case 12: BP's Time out For Safety

Time Out For Safety (TOFS) is a British Petroleum (BP) effort initially developed for use at BP Amoco's Andrew platform in the North Sea (http://www.rydermarsh.co.uk/hseresearch3.html).

TOFS was an effort undertaken by labor with buy-in from management to mitigate accidents on oilrigs that resulted in physical injury to employees and the loss of valuable equipment. The program has shown significant success and is now being adopted by other BP Amoco platforms across the North Sea.

The focus of TOFS is to change the manner in which labor responds to perceived hazards in the workplace while at the same time encouraging management to recognize and reward activities that while resulting in rig down-time results in safer cost effective operation. TOFS empowers all employees to evaluate any and all situations and gives them authority to stop a job action if they feel a stoppage is necessary to maintain safety.

The program does not seek to identify particular situations that should results in a work stoppage, although a range of situations is identified as being appropriate for a work stoppage. These include the following:

- A change of plan
- An unscheduled event
- Incomplete understanding
- An observation with a safety impact
- A need to pass on information critical to the job
- Emergence of a previously unidentified risk or hazard
- The need to ask for help.

If an employee calls for a TOFS, the job at hand is suspended. Opportunity is provided for the individual calling the TOFS to address his or her concerns with their workgroup. The workgroup itself works collectively to develop mediation to assure continued safety.

Management is encouraged to support the TOFS by providing positive feedback to the employee calling the TOFS. Additionally management encourages workers that a TOFS is not acknowledged as a down-time with its accompanying stigma.

4.2.12 Case 13: Collaborative Communication Cycle as a Means for "G.L.I.T.C.H." Harvesting

Structured communication, similar to a pre-flight briefing and a post-flight debriefing in aviation, is now being used in some hospitals. The "Collaborative Communication Cycle" Model is one such example. The following story of how this structured communication model evolved, how it was applied, and what it was able to accomplish is from Jeffrey Brown's chapter, "Key Themes in Healthcare Safety Dilemmas" (Patankar, Brown, & Treadwell, 2005, pp. 114-122).

> In 1999, care providers at a mid-sized community hospital began re-thinking care processes for open-heart surgery patients. Caring for open-heart surgery patients is socially and technically complex; surgeons, therapists, nurses, pharmacists, social workers, and many other disciplines must carefully coordinate their assessments and actions with one another, and with patients and families. The traditional approach to communicating and coordinating is characterized by independent interactions with the patient by members of each discipline. Nurses, therapists, social workers, and other clinical professionals each gather information from the patient, develop their own care plans, and then enter these plans into the patient's medical chart, a written record. The written record is an imperfect means of coordinating activity; informational gaps, ambiguous data entry, changes in patient situation, and other issues routinely compel care providers to seek or provide clarifying information in order to fit together the patient's total care plan. This is accomplished through phone calls, paging, and other interactions on the clinical floor and elsewhere. The end result of this approach to decision-making, communication and coordination is that much of the patient information gathered by each discipline is redundant, and patient care processes are often fragmented. Clinical care provided in this traditional manner is vulnerable to oversights and conflicting actions based on misunderstandings of patient situation and uncertainty about the overall plan of care. Care providers exert a great deal of effort to close gaps in communication, correct flawed concepts and ensure that patients' needs are met. Many of the practitioners report that they

routinely went home worried about gaps in care management they might have missed.

These care providers, eventually known as the 'cardiac surgery team', decided that altering patterns of interaction and communication might improve the care of their patients. Rather than conducting rounds on their patients independently, they decided to collaborate, starting by bringing all disciplines together at the same time on rounds. This decision alone was problematic, because of the complexity of schedules and other obligations in existing practice patterns. Moreover, the concept of true collaborative practice is countercultural in health care. Although team-based practice is the norm for professionals in industries like aviation, what is called teamwork in health care is actually a collection of individual practitioners who loosely coordinate their actions. Especially from the point of view of physicians, the idea of collaborative decision-making challenges deep traditions of autonomous decision-making and action. Seen from this perspective, allowing other disciplines a significant say in care decisions could be viewed as abdicating control and professional responsibility for the patient. From the point of view of administrators, who might chance by the unit and see the team gathered around a patient, it could seem like people were wasting valuable time when they should be working.[1]

Further deviating from tradition, the cardiac surgery team invited families to join the rounds process, and be considered as part of the team. The traditional approach to providing care often left families and patients with a high degree of uncertainty and anxiety about what would happen next, both during the hospitalization and following release from the hospital. A frequently heard comment was "Don't you people talk to each other?" It was common to receive many post-discharge phone calls from patients and family members attempting to clarify the plan for recuperation. The cardiac surgery team hoped to preclude this uncertainty and anxiety by including patients and families in planning, beginning on the first day of post-surgical experience in the hospital.

Despite various obstacles, the cardiac surgery team launched their collaborative rounding process in the fall of 1999. They chose to organize the team by bringing together the roles that work interdependently to care for open-heart surgery patients. Hence the full team included the patient and her or his family, plus a variety of disciplines. For any given patient, dependent on care needs, the full team could include the unit nurse, physician assistant, nurse practitioner, social worker, surgeon, spiritual care counselor, home care/visiting nurse coordinator, pharmacist, physical and occupational therapists, respiratory care therapist, dietitian, diabetic educator, office manager, cardiac rehabilitation specialist, and utilization review coordinator. To guide collaboration and decision-making the team developed their own approach to structured communication called the 'Collaborative Communication Cycle'.

An integral element of the communication process is a debriefing that enables a review of any variation between intended care and actual care received by the patient. Deviations from intention are recorded, to enable proactive analysis of human,

[1] In reality, although not occurring at the same time, each discipline engaged in traditional rounds would see the same patient independently for a similar period of time, then spend significant time chasing down information from other caregivers in an effort to test understandings, correct misunderstandings, and sort out the whole plan of care.

technical or organizational factors—either to intervene in potentially unsafe conditions, or to evaluate and disseminate a serendipitous discovery of practice improvements. Given the cultural expectation in traditional health care of error-free performance, generally the word 'error' is stress provoking. To emphasize that most errors are actually context and system events, team members, including patients and families, were asked to identify any 'G.L.I.T.C.H.es' in care since the last briefing. G.L.I.T.C.H. is an acronym for Gathering Little Insights That Can Help. Building sufficient trust to share G.L.I.T.C.H.es was a fragile process that took time, and was attended by initial ups and downs in the willingness of providers to discuss such deviations openly.[2] The leadership of the surgeon was instrumental in building this trust. A willingness to disclose and discuss his glitches and to discuss the glitches of others in a non-punitive manner, focused on learning, set the climate and tone of the process and proved essential to the practice being normalized. This simple debriefing mechanism catalyzed a robust reporting process, eliciting important information daily with respect to the functioning of the clinical unit, and of deleterious or beneficial side effects of 'upstream' organizational decision-making. Through this mechanism, the Cardiac Care Team became a learning sub-system, capable of driving organizational learning.[3]

During the patient's first experience of collaborative care, post-surgery, the briefing leader advises the patient and her or his family that each team member will introduce himself or herself. They are also advised that they should interrupt anytime they need clarification, or additional information. The concept of a glitch is also introduced. Patients and family members quickly adapt to the process. During the first day following surgery they may listen more than participate, but by the second day they are more involved, and by day three they are actively engaged and have questions or concerns to be addressed.

Fundamentally, the cardiac care team altered the context of care, from one that revolved around the tasks and the independent actions of physicians and other clinicians, to one where the focus was on development of a collective understanding of patient needs and a strategy of care that harnessed the knowledge and skill resources of the entire interdisciplinary team. The following are some of the context-changing purposes and functions at the core of the Collaborative Communication Cycle:

1. Achieve alignment among care providers, patients, and patients' families regarding the patient's situation and plan of care. All care providers, including family, and patients were included as team members in this alignment process, with a clear voice in decision-making. Rather than the traditional approach to 'reporting', wherein a subset of professional disciplines will communicate with each other, literally and figuratively 'over the head' of the patient, each discipline would address his/her thoughts and recommendations to the patient, using accessible language. Medical jargon would be translated into lay language;

[2] An example glitch (Uhlig, et al., 2002): 'A single, one-time dose of furosemide (Lasix; Aventis Pharmaceuticals, Bridgewater, NJ) was ordered following surgery. The order was misinterpreted and recorded as a daily dose. During the collaborative rounds process on the following day, this glitch was identified and corrected before an additional dose was administered'.

[3] Learning, for the purposes of this chapter, is defined as a change in behavior based on experience.

conversation was directed toward the patient instead of toward other practitioners.

2. Establish a philosophical foundation for communicating and collaborating characterized by respect, relationship, inclusion and self-care. Rather than a narrow diagnostic and treatment discourse, focused on the patient's disease, the patient would be affirmed as a whole person and their progress in healing and adjusting to their altered health status would be noted and acknowledged.[4] The team recognized that while they may view open heart surgery as routine, for patients the experience is a frightening and difficult life adjustment. They would do their best to provide a healing and caring relationship that would help alleviate the anxiety of patients as they recovered from the extraordinary experience of open heart surgery and began to adapt to this significant interruption in their life routine.

3. Create a psychologically safe communication environment. To serve the foregoing purposes, the team needed to establish an environment in which patients, patients' family members, and all clinical disciplines would feel free to voice information and share alternative perspectives—even if the information or perspective conflicted with the views of the traditional authority, i.e., physician. By developing an environment in which information flows freely, the intellectual resources of the entire team may be harnessed to achieve the best possible understanding of the patient's situation and the best possible care strategy. As trust in the emotional safety of the communication process grew so did a sense of joint accountability for the entire process of care to which each individual contributed.

4. By establishing trust in the structured communication process, team members also established an information-rich decision-making environment. This strengthened the team's chances of avoiding errors due to informational deficiencies that were rife in the traditional approach to rounds. Further, a sense of joint accountability for the entire process of care empowered team members to speak up in order to identify and trap an error before it could cause harm to the patient. The team was also more likely to detect and mitigate an error that had already affected the patient before the consequences became critical.

5. By deliberately and routinely harvesting information about deviation from intentions in the fulfillment of care processes (a.k.a., glitches or errors) the team became a source of continual intelligence on error-provoking conditions and hazards. They also identified practice improvements associated with such deviations. If coupled with a robust analysis and intervention process, the team had the potential to act as an engine for continual learning and improvement—at unit and organizational levels.

The cardiac surgery program at this hospital participated in a collaborative database called the Northern New England Cardiovascular Disease Study Group (NNE). This is a voluntary consortium that includes all open-heart surgery programs in northern

[4] In other words, while the patient's disease or diseases would continue to be treated in a manner consistent with the best medical technology and techniques available, the psychological focus of patient and provider interaction was on the patient's wellness and productive adaptation rather than a narrow discourse centered on the status of a diseased organ.

New England, USA. The NNE tracks the clinical outcomes of its members, using risk models and observed mortality for all open heart surgery patients in the region. Prior to implementation of collaborative rounding, operative mortality for the Cardiac Care Team's patients was consistent with that predicted by NNE data. Following implementation of the collaborative rounds process, operative mortality of the Cardiac Care Team's patients began to decline significantly from expected rates, relative to the NNE (Uhlig, et al., 2002). **Within two years of beginning the process, operative mortality for the Cardiac Care Team's patients was less than half of that expected based on NNE prediction** [Emphasis added].

Patient satisfaction was tracked using a survey managed by Press Ganey Associates. Following implementation of the collaborative rounds process, the cardiac surgery program consistently achieved ratings that were in the 97th-99th percentile, relative to national figures, across the USA. Patients and families expressed how important it was to have the team convene each day, and to listen and interact over questions and concerns. They were less anxious because they were not chasing after caregivers to find out what was happening with their loved ones. One family member stated (Uhlig, et al., 2002):

> We were comforted as we watched this team gathered around my husband's bed, discussing his care together. We were empowered as we realized that our personal [patient] knowledge, our observations, and our questions were important to all those making the care decisions. We felt positive because we were involved and had no doubt that this medical team was informed, involved, and working together to provide my husband with the very best care possible.

Staff also expressed increased satisfaction with the collaborative rounds process, relative to traditional rounds (Uhlig, et al., 2002). In recognition of the safety and quality improvements brought about by the Collaborative Communication Cycle, the Joint Commission for the Accreditation of Healthcare Organizations and the National Quality Forum awarded the team one of the first John M. Eisenberg Patient Safety Awards for System Innovation in 2002. This national recognition is given to a handful of individuals and organizations each year.

Of particular interest with respect to patient safety is the fact that operative mortality decreased significantly following implementation of the Collaborative Communication Cycle in post-surgical care. Consistent with the Joint Commission data on the role of communication in patient death and serious injuries, this decline in operative mortality suggests that a significant number of deaths attributed to surgical processes may in fact be linked to processes of post-surgical care management. And, many of these deaths might be prevented through the use of structured communication to guide interdisciplinary teaming. Although the glitch harvesting process captured rich information for the improvement of system functionality, these data were not meaningfully incorporated in the organization's process improvement program. Changes and improvements were made if within the purview of team members, or if team members were successful in efforts to resolve problems with members of other units of the hospital. Fundamentally, the GLITCH harvesting process was never properly assessed as a tool for identification, analysis and intervention in latent failure conditions. Further study is needed to tease out both a fuller understanding of GLITCH causation and the role of structured communication in the reduction of operative mortality.

The Collaborative Communication Cycle (a) desensitized rank; (b) evaluated all of the concepts being presented by team members in the analysis, minimizing the probability of personal bias influencing the outcome; (c) it requires the users to continuously evaluate their chosen path of action in the light of any new information that may become available over time; and (d) it requires the users to actively attempt to identify the root causes that may have led to the presentation of multiple concepts or presentation of invalid concepts so that systemic errors may be eliminated prior to further compromises to safety.

In addition to establishing a shared concept of each patient's situation, structured communication methodologies guide decision-makers in blending rule-based and risk-based responses to patient care situations. This assists providers in adapting formal and tacit clinical protocols based on unique patient needs. Further, under conditions of high uncertainty, structured communication guides knowledge-based problem solving, to help care providers arrive at the best possible risk-based assessment and response when no protocol/rule is known to apply.

4.3 Intermediate Summary: A Change in Safety Culture is Possible

In this section, we have provided case examples from a variety of domains to illustrate that a change in safety culture is possible. Different examples illustrate the use of different metrics to measure their success—in some cases, they have used industry norms as benchmarks to measure their local performance; in other cases, they have developed unique community or industry-government partnerships to set higher standards for their own industry as well as for others. It is also important to note that the scope or scale at which a particular cultural change is implemented depends on the sphere of influence of the leadership driving this change—in the case of the Collaborative Communication Cycle, the emphasis was on a particular surgical team; whereas, in the case of the Commercial Aviation Safety Team, the emphasis was on the entire aviation industry. In the ASAP program, leadership came from a team of aircraft mechanics/technicians, company managers, and FAA inspectors. Thus leadership can come from different levels- the sector, the executive suite, operations teams, or champions of change. The key leadership issue appears to be the ability to mobilize resources, including energy and attention, toward the achievement of safety objectives.

A precondition for sustained safety improvement efforts appears to be the belief that safety is critical to a sector or organization. When that condition is met, safety culture can be linked to a core sense of identity and purpose. Still, for the desired safety culture to grow, this purpose or goal must be clearly understood and communicated consistently and repeatedly, until it has become second-nature to everyone involved in the process. Next, the organization must demonstrate its willingness to change established structures, processes, and policies if any of them are discovered to hinder the accomplishment of the core purpose. Different levels and units of the organization must be aligned and must demonstrate this willingness. Finally, all the participants must feel that they have real ability to control, or at least influence, the outcome.

5.0 THE "PURPOSE-ALIGNMENT-CONTROL" MODEL: KEY PARAMETERS FOR SAFETY CULTURE

5.1 Introduction

Based on the literature review presented in the previous section, we have developed a conceptual model illustrating the inter-relationship of various factors that ultimately and collectively build a specific safety culture. We call this approach, "Purpose-Alignment-Control" or "PAC" Model. This model is based on fundamental and consistent findings across several safety-critical cases. For example, in High-Reliability systems, organizational units or teams are able to focus on one central purpose—the mission—and collapse the hierarchical structures to the extent necessary, align their individual efforts to maximize the probability of accomplishing the collective goal, and all the individuals strongly believe in their ability to control the outcome. In observing how teams behave in crises, many researchers (for example, Knowles, 2002) have pointed out the unique ability of certain teams to collapse constraints, self-organize and sharply focus on the goal—we call this ability to focus, "purpose." Active alignment of organizational resources and individual human resources would be possible if the purpose is clearly defined and focus is maintained. Further, we believe that such teams are willing and able to "align" their individual efforts toward the resolution of the problem because they believe that they can "control" the outcome—pilots try to prevent an impending accident because they believe that it is preventable.

In the PAC Model, there are three sets of inter-related factors—organizational factors, team factors, and outcome factors. Our hypotheses are (a) the organizational factors influence the team factors and (b) the organizational and the team factors together influence the outcome factors. The radial arrows emanating from the concentric circles in Figure 10 represent the potential influence that each group of factors might have on the next group. The circular arrows represent a sense of control and the need for purposeful alignment of efforts and resources. When we look at the bulls-eye illustration in Figure 10, it is important to focus on the handful of priority factors that must be purposefully aligned first, in order to enable other factors to align subsequently.

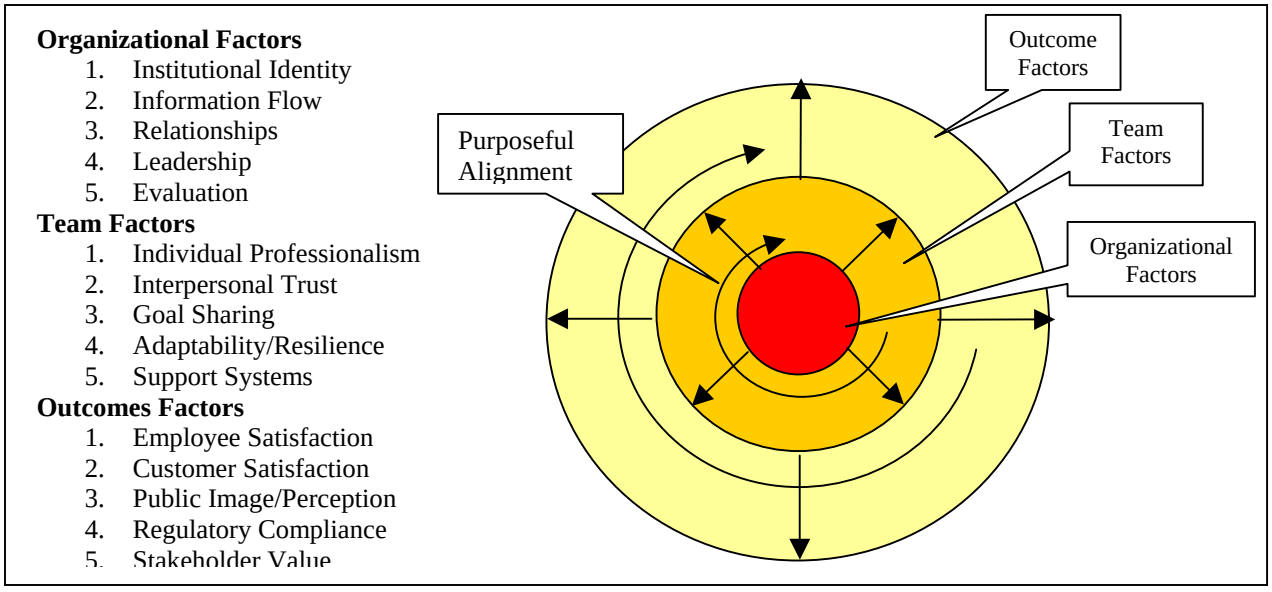

Figure 10: The "PAC: Purpose-Alignment-Control" Model

Cox and Flin (1998) comment on the proliferation of the literature on safety culture and the need for scientific evidence that clearly demonstrates the link between various attributes of safety culture. Forgarty (2004) supports the claims of other researchers who point to the influence that social and organizational factors have on human error (e.g., Patankar, 2002; Reason, 1990; Sutcliffe & Rugg, 1998). His study was able to demonstrate that "these linkages are primarily indirect, mediated by individual differences in psychological health and morale." The conceptual model presented in this section seeks to expand on Fogarty's work and further test the data with the help of case studies and survey questionnaires.

5.2 Organizational Factors

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

5.2.1 Institutional Identity

Understanding institutional identity is key to sustaining new programs—whether they are safety programs 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 programs with the institutional goals may have led to at least the deterioration of such programs. When a program 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 programs. For example, when DuPont Chemicals realized that their business success was fundamentally dependent upon their safety programs, a culture of high reliability (and high safety) emerged. Similarly, when the company management recognized that it was essential to collaborate with their stakeholders, the community in which these plants were located, and regulators, they were able to develop more comprehensive safety programs—everyone's survival was interdependent (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 that, "an organization is most effective when artifacts, values, and assumptions are lined up and mutually supportive" (p. 66). If such alignment is not orchestrated, the safety program (or change program 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).

Therefore, in order to have a sustainable safety program, it has to be aligned with the fundamental identity, values, and assumptions of the organization.

5.2.2 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 setup 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 & 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 & 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 percent of the mechanics do not trust that their supervisors will act in the interest of safety. Later, Patankar and Driscoll (2004) noted that organizations with error reporting programs 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 & Hartman (2001) discovered that according to some specialist (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 strategically placed throughout the US), 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 OCC (Operation Control Centers—three centrally located regional centers 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).

5.2.3 Relationships

Fundamentally, it's the people who 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 of 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 be functioning 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, information flow and resultant relationships are inevitable 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 (Freiberg & Freiberg, 1996; Herzberg, 1966). Therefore, it is important to invest in building strong, professional relationships in an organization.

5.2.4 Leadership

Effective leadership appears as a key contributor to successful safety programs in a variety of domains. Fleming and Lardner (1999) studied the impact of supervisors' attitudes, management style, and behavior on their subordinates' safety behavior in the offshore oil industry. His study identified a number of supervisor attributes that were associated with positive subordinate safety behavior, and less risk-taking behavior indicated that their supervisor possessed attitudes, skills, and behaviors 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's research suggests that a supervisor safety management development program could be an effective mechanism for safety culture improvement. The factors to be considered when developing a supervisor safety development program 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 UK, Clarke (1998) found that very few drivers reported other drivers' rule breaking behaviors (3%) 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 U.K. 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, which 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 program 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 programs stalled due to a "lack of management follow-up" and (b) the awareness of safety issues raised by training programs tends to erode and even turn into a negative attitude if such awareness is not reinforced by supporting structural or procedural changes—a clear demonstration that the management is willing to make the changes necessary to sustain the attitudes and behaviors espoused by the training programs and bridge the gap between "espoused theory" and "theory in use" (Argyris & Schön, 1974). The Australian Occupational Health and Safety Commission cites that, "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: the frontline personnel tend to be focused on technical aspects of their jobs and the 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 (of his 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 a manager 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 program when such a program demonstrates a specific fiscal impact.

5.2.5 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 program with these three compacts, the better the likelihood of success of the change program. 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 & 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, 2001). Therefore, employee evaluation is a critical part of organizational performance: it is the glue that makes change initiatives "stick."

5.3 Team Factors

It is our hypothesis that the above-mentioned organizational factors influence the following team factors: Professionalism, Trust, Goal Sharing, Adaptability/Resilience, and Institutional Support

5.3.1 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 & Christensen, 1998; Taylor & Patankar, 2001). Later, Patankar, Brown, and Treadwell (2005) added the ability to make sound ethical decisions to the definition of individual professionalism.

In this report we present professionalism as a team factor because the notions of individual technical competence seem 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 programs?), 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 their 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.

5.3.2 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, & Goglia, 2002; Roughton & Mercurio, 2002; GAIN, 2004, Ch. 3; Patankar & Taylor, 2004).

> The process of clearly establishing acceptable versus unacceptable behavior, 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).

5.3.3 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 air 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 HRO 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 & 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 & Norton, 1998), but the key is to ensure that what's measured is consistent with the desired goals (Zahlis & 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 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.

5.3.4 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 & 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 & Fenton, 1991).

5.3.5 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-root 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 & 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 to limit 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 process developed by dedicated leaders throughout the organization are essential.

Depending on how far 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 counseling, safety awareness training, on-the-job training, and management/leadership training; new programs like an error/hazard reporting program, process improvement program, event investigation program, 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 everyone, regardless of position or seniority, is held accountable for their actions (or inactions).

5.4 Outcome Factors

It is our hypothesis that the organizational factors and the team factors, presented above, collectively influence the outcome factors. If this hypothesis can be supported with empirical data, the outcome factors could be regarded as the symptoms resulting from the strengths or weaknesses in the organizational and/or team factors. Structural Equation Modeling will need to be employed on the empirical data to determine the strength of these influences.

5.4.1 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 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 dissatisfiers. 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, this would not create genuine satisfaction—only possibility for growth, engagement, and nature of work itself.

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 the employee expects 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 & Taylor, 2004). Also, while such surveys may be helpful in knowing the status of employee morale, they can be very helpful in diagnosing specific problems.

5.4.2 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 & 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.

5.4.3 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 & 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 damage 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.

5.4.4 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.

Similarly, in the chemical industry or in the offshore oil industry, the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) play the role of a watchdog. While the EPA is mostly concerned with the greater environmental aspects, OSHA is focused on worker safety. Together, they provide a regulatory framework for the protection of the community and the individual. Since their fines for violations are extremely high, especially the EPA violations, business survival is severely threatened.

In the healthcare sector, although the physicians and nurses operate under the craft model rather than a mechanistic procedural model, errors in medical procedures increase the industry-wide risk of such procedures and thereby increase the liability/malpractice insurance for the physicians and hospitals. Therefore, errors or violations of accepted practices/standards tend to degrade the 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.

5.4.5 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 the 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.

In today's financially competitive market, it is critical that all safety efforts are tied with measurable financial benefits. Return-on-investment (ROI) calculations enable safety program managers to take the case for their programs from "necessary" (based on the intrinsic value of such programs to the organization) to "necessary and sufficient" (based on the intrinsic value of such programs to the organization that is supported by sound financial justification). The overall impacts of safety programs include the following:

- Reductions
    - Physical health issues: Lost time injuries, hospital stays, deaths/accidents
    - Liability issues: insurance premiums, malpractice or intentional disregard suits
    - Rework: warranty claims or out-of-compliance issues
    - Environmental pollution: public health and safety or regulatory compliance issues
- Enhancements
    - Employee morale: reduced turnover equals reduced training cost and improvement in human capital of the organization
    - Improved quality: improved public image and improved customer satisfaction
    - Improved financial solvency: increased interception of error trajectories translate into better chance of avoiding a high-profile accident; therefore, there is a greater chance of continued corporate solvency
    - Parallel improvements in productivity and business performance

5.5 Intermediate Summary: The PAC Model

The three sets of inter-related factors—organizational, team, and outcome—presented in this section are supported by several research studies in a wide range of domains. However, the scientific relationship among these factors has not been established. If a proven technique such as Structural Equation Modeling (SEM) could demonstrate the level of influence a particular factor has on another factor in this model, it would be a significant contribution to the safety culture as well as organizational behavior research.

The Purpose-Alignment-Control Model offers a way to move toward an organization that is able to raise the safety standard beyond high reliability. If the safety purpose/goal is clearly defined and consistently communicated, the field personnel believe that they have control over the outcome, and the organization is committed to aligning its structures, processes, and policies such that the probability of accomplishing the stated purpose is maximized, it may be possible to build an adaptive living organization that is capable of continually ratcheting the safety standard beyond high reliability.

6.0 CONCLUSIONS

1. There are some organizations that have a very mature, positive safety culture. All these organizations depend heavily on a strong, positive safety culture for their overall survival—even a minor lapse would seriously endanger their existence. Therefore, very early in their evolution, extreme emphasis was placed on safety-focused attitudes and behaviors throughout the organization. Today, such organizations are recognized as High Reliability Organizations (HROs).
2. There are many examples of organizations that have transformed their safety culture from a less desirable to a more desirable state. In addition to the HROs mentioned earlier, there are a select few that have maintained their success. There are numerous other examples, from a variety of industries, where changes were made, but they did not translate into an enduring, *cultural* change because those changes lasted for less than five years and then dissolved.
3. There are three key issues regarding research and measurement of safety culture: (a) Survey instruments take a "snapshot" measurement of safety *climate*. When such measurements are repeated across multiple organizational units and conducted repeatedly over a reasonably long time (over five years), a *cultural* assessment can be developed. (b) A rigorous analysis of the various factors that influence safety climate/culture needs to be conducted so as to better understand the inter-relationship among these factors and their individual, group, and cumulative influence on the overall safety climate/culture. Structural Equation Modeling is proposed as one means to investigate such scientifically defensible relationships. (c) Results from measurements need to be distributed consistently throughout the organization so that everyone is fully aware of their contributions to the goals and are able to make timely actions/changes that are consistent with the organizational goals.
4. The Purpose-Alignment-Control or PAC Model could be used to implement, monitor, and measure the effectiveness of safety change programs. According to this model, three categories of factors—organizational, team, and outcomes—should be aligned with the express purpose of accomplishing a clearly defined set of goals and the employees should be empowered to self-organize and control other structural and operational variables in order to maximize the probability of achieving the identified goals. As the organization becomes more adept at calibrating and retooling to achieve new goals, it is plausible that the organization will transition from a mechanistic organization to an adaptive living organization and achieve a safety performance beyond high-reliability.
5. There are many examples that illustrate safety improvements and overall cultural change. Specific means of calculating financial benefits/value of such programs are available and can be used to demonstrate the value of individual-level injury reduction programs as well as organization-level cultural change programs. When safety becomes an integral part of the organization, expressed as a core value, there will be visible reduction in worker injuries, regulatory penalties, accidents, and community-level disasters. Consequently, there is a higher probability for the business to thrive, not just survive. Ultimately, a successful cultural transformation is possible through purposeful, dedicated, and consistent efforts from all levels of the organization. Leverage factors such as level of awareness in the greater community, regulatory requirements/pressures, business survival factors, political pressures, industry standards, etc. could play a significant role in accelerating and/or sustaining the momentum for such a change.

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APPENDIX A: FACTORS TO ASSESS MULTIPLE DIMENSIONS OF SAFETY CULTURE

This appendix contains a list of factors and related items selected from past research to assess safety climate/culture and organizational change. Items have been derived from: Hofstede (1984); Helmreich, Fouchee, Benson, and Russini (1986); Westrum (1993); Taylor (1995); Helmreich and Merritt (1998); Ciaverelli (1998); Gaba, Singer, Bowen, and Ciavarelli (2003); IOMA (2003); Patankar and Taylor (2004); Patankar (2003); Wiegman, von Thaden, and Wiegmann (2003); Gibbons, von Thaden, and Wiegmann (2004); Hackworth et al. (2004); Wheatly (1999); Knowles (2002); and Collins and Porras (1997). Items are grouped into the following categories: organizational factors, team factors, and outcome factors.

Organizational Factors

Identity

1. Safety is a core value in this organization
2. This organization has a reputation for high-quality performance
3. Safety is an integral part of all operations
4. This organization does not compromise safety to get the work done or to accomplish the mission
5. There is a high degree of consistency between words and actions throughout this organization
6. This organization must adapt to internal and external influences without compromising the core purpose or value.

Information Flow

1. Effective mechanisms exist to report safety hazards/discrepancies
2. Safety goals of the organization are communicated consistently throughout the organization
3. Good communication flow exists up and down the organization chain of command
4. People report safety hazards/discrepancies
5. People believe that their safety-related suggestions will be considered seriously
6. Best practices are communicated regularly to all employees
7. Safety successes are celebrated
8. Mechanisms for field employees to communicate directly with top executives exist and are effective
9. Top executives visit with the field employees adequately
10. Gaps between corporate propaganda and employee/management behavior are addressed promptly and effectively

Relationships

1. There is a spirit of cooperation between various departments/organizational units
2. This organization is like a small family
3. People talk about safety or operational issues regardless of their position in the organizational hierarchy

4. The employee-management relationship is cordial and mutually respectful
5. The organization and its employees make positive contributions to their civic communities

Leadership

1. Supervisors do not permit cutting corners to get the job done
2. Risk decisions are made at the proper level, by most qualified people
3. Organization's leaders consider safety issues during the formation and execution of operational and training plans
4. Organizational leadership encourages reporting safety discrepancies without the fear of negative repercussions
5. Leaders encourage everyone to be safety conscious and follow the rules
6. Leaders model strong, positive safety behaviors—sets the example for compliance with operating standards
7. The Safety Officer/Director position is a desirable job in my organization
8. The senior company management is seriously interested in reviewing the effectiveness of our safety program.
9. Leaders support their subordinates in handling unique situations based on their skill and knowledge.
10. Leaders are well-trained to handle technical, business, as well as human issues throughout the organization and its stakeholders

Evaluation/Accountability

1. Employee selection process gives due consideration to technical qualifications as well as attitude toward safety and teamwork
2. Employees as well as supervisors are evaluated on their safety performance
3. Good safety performance is rewarded
4. Poor safety performance is corrected
5. Performance and safety behaviors are integrated in annual evaluations
6. Evaluations are meaningful and connected with the organizational mission/goals
7. Personnel in the organization conduct continuous technical proficiency training
8. Performance standards are clearly communicated and uniformly applied
9. Employee/Management evaluations are closely linked with organizational vision and goals
10. Reward/penalty system is fair, applied consistently, and well understood.

Team Factors

Professionalism

1. Internal crosschecks on decisions, even at the micro level, and fail-safe redundancy to determine when critical decisions are timely and correct
2. It is acceptable for employees to refuse high-risk procedures when they are personally stressed or fatigued
3. Employees are not expected to perform jobs for which they have not been trained

4. When employees perform new or unique jobs, adequate redundancy and backup systems are in place in order to minimize the probability of failure
5. Individuals are held accountable for high ethical standards

Interpersonal Trust

1. My supervisor can be trusted to act in the interest of safety
2. Management has a reputation for high integrity
3. My safety ideas would be acted on if reported to supervisor
4. My supervisor protects confidential or sensitive information
5. Managers trust that their subordinates will execute the delegated task in the most professional manner.

Goal Sharing

1. Operational goals are very clear and consensus is unequivocal
2. Every team member understands the team's goals, performance standards, and his/her specific role on the team.
3. Adequate support systems including training, equipment, and information are provided to make the goals achievable.
4. There is a high degree of consistency between organizational goals/vision, unit goals, and individual goals.
5. Incentives are tightly coupled with goal attainment

Adaptability/Resilience

1. There is sufficient degree of resource availability, human redundancy, and a highly functional, highly flexible division of labor
2. Skill and knowledge rather than bureaucratic authority drive decision making
3. Management reacts well and readily adapts to unexpected changes
4. Dynamic and reliable data are available and adequate latitude is provided for field personnel to make timely decisions
5. Technological innovations/solutions are effectively matched with human performance capabilities without compromising safety

Support Systems

1. Training and monitoring encourage a culture of responsibility and accountability
2. High level of social control by limiting influences from environments external to the organization
3. Employees are provided with adequate resources (time, staffing, budget, and equipment) to accomplish their job safely
4. Adequate support systems such as counseling services and training exist to improve safety performance
5. Employees who report their weaknesses in technical knowledge/skill, safety issues or organizational mission are provided with timely and appropriate support
6. Norms, policies, and procedures that hinder safe operations are actively changed
7. Mechanisms to change established norms, policies, and procedures are effective and efficient

8. Undesirable events are viewed as learning opportunities and systemic improvements are implemented promptly
9. Standardization of low-level tasks is enforced; autonomy in high-level tasks is granted; and appropriate mechanisms exist to actively reduce the risk in rare or ground-breaking procedures.
10. Non-punitive error and hazard reporting systems are highly effective in addressing systemic issues within the organization as well as in the industry.

Outcome Factors

Employee Satisfaction

1. Morale and motivation in this organization are high
2. People believe that their organization is making satisfactory progress
3. People take pride in their job in this organization
4. People feel that their contributions are valued and their role is important for the overall success of the organization
5. Fair, non-punitive, consistent, and effective mechanisms exist to address dissatisfaction

Customer Satisfaction

1. Customer satisfaction is high and consistent across multiple organizational units
2. Customer retention is high
3. Frontline employees are given the latitude to make appropriate changes in the protocol in order to satisfy the customer
4. Employees are encouraged not to sacrifice personal integrity and loyalty in the interest of customer satisfaction
5. Standards of customer satisfaction are clearly communicated throughout the organization

Public Image/Perception

1. The organization is highly regarded by the public-at-large as a safe/reliable organization
2. The organization has received top awards for safety performance
3. The organization is considered as a role model for top safety performance among the peer organizations in the industry
4. The organization is actively involved in raising the industry standards for safety performance
5. The organization is actively involved in raising public awareness about safety issues and in holding their top management accountable for raising the safety standards for the industry

Regulatory Compliance

1. Compliance with local, national, and international regulations is high and consistent with the reputation of the organization
2. The organization is actively involved in shaping the future regulations through appropriate industry-civic-regulatory advisory groups
3. Effective auditing and monitoring/reporting mechanisms exist to detect regulatory violations
4. The organization practices voluntary disclosure of regulatory violations when appropriate

5. Compliance with regulatory requirements is viewed as the baseline standard of performance.

Stakeholder Value

1. Employees are primary stakeholders; customers are secondary stakeholders
2. The organization demonstrates a social or civic responsibility toward the welfare of the larger community/environment within which the organization functions
3. The organization is practices continuous learning and improvement within the organization
4. The success of the organization is reflected in the success of its stakeholders
5. All stakeholders are treated with respect and compassion