Safety Culture and its measurement in aviation

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In this paper I describe the concept of 'Safety Culture' and its measurement, with particular regard to aviation. The impetus for the paper stems from a proposed intervention into a segment of the aviation market and a desire to measure the effectiveness of the intervention. The paper commences with a discussion on the term 'safe(ty)' to place some boundaries on the term and to frame the proceeding discussion. Closely linked to the concept of 'Safety Culture' is 'Safety Climate' which is also discussed in some detail. Whilst the paper considers the divergence of views on the definitions of 'Safety Culture' it also draws out significant similarities and ties different perspectives to a framework espoused by Cooper (1999). As the paper demonstrates, measurement of 'Safety Culture' can be a significant task however acceptable levels of measurement can be obtained by the administration and evaluation of surveys or questionnaires.

The task

The Civil Aviation Safety Authority (CASA) is embarking on a project to articulate the benefits of Safety Management to a specific group within the aviation community of Australia. The group is Low Capacity Regular Public Transport (LCRPT) operators and was chosen after being identified as a group more at risk of having an accident than other groups. The project, which can be seen as an intervention, proposes to brief

senior management of LCRPT organizations on Systems Safety and the current CASA 'system safety method' of surveillance. The brief will be followed by a scheduled audit some months hence.

The proposal

The proposal is to measure the effect of the intervention. One mooted outcome of the intervention is 'an awareness of Systems Safety'. Measurement prior to the intervention and post the audit appears to satisfy the 'when to measure' conundrum. The 'how and what to measure' needs scrutiny and is the focus of the literature review and subsequent position paper. As a starting point, measurement of 'Safety Culture' appears to be reasonable. The following review focuses on defining 'Safety Culture' and has broadly been sub divided into:

- Safety definition
- What to measure (culture, culture sub components, and Safety Climate)
- How to measure (observation, audit and survey/questionnaire).

Safety definition

The definition of safety needs to be explored in order to put a Safety Culture into some context within the aviation environment. Safe appears to be one of those terms that everyone has a sense of but no one can quite define. Most definitions appear to fail to take into account future states e.g. by measuring what has happened; the supposition being that because you had no accidents or incidents you must be have been safe. This supposes that Safety is the absence of accident or incident. It would however, be ludicrous to advocate that Valuejet operations were safe before the accident into the everglades and then unsafe afterwards. The colloquial term often used to describe this phenomenon is 'an accident waiting to happen'. After discussing several dimensions of 'Safety' the term will be framed for the purposes of this position paper.

The Macquarie Dictionary defines safe as:

safe

–**safely**, *adverb* –**safeness**, *noun*

/sayf/

adjective, **safer**, **safest**, *noun, adverb*

adjective

1. secure from liability to harm, injury, danger, or risk: *a safe place.*

2. free from hurt, injury, danger, or risk: *to arrive safe and sound.*

3. involving no risk of mishap, error, etc.: *a safe estimate.*

4. dependable or trustworthy: *a safe guide.*

5. cautious in avoiding danger: *a safe player.*

6. placed beyond the power of doing harm; in secure custody: *a criminal safe in gaol.*

be on the safe side, *Colloquial* to take every precaution.

It is easy to see that the dictionary definition is too simplistic for a complex environment such as aviation. It does however have significance as the way the public perceives Safety. That is, they expect to arrive safe and sound, free from risk.

Hudson (2001, p. 1) espouses a simple definition, 'Just make sure people don't get hurt'. This definition whilst simple has merit as it contains the element of a system (Just make sure) and the element of injury free (don't get hurt).

Wood (1996, p. 28) notes that a workable aviation definition of Safety is based on the acceptability of risk, stating that, "if a particular risk is acceptable then we consider that thing or operation acceptable. Conversely when we say something is unsafe, we are really saying that its risks are unacceptable". As Thomas (2001, p. 5) noted:

> *"A low accident rate, even over a period of years, is no guarantee that risks are being effectively controlled….This is particularly true in organizations where there is a low probability of accidents but where major hazards are present. Here the historical record can be an unreliable or even deceptive indicator of safety performance".*

Risk management therefore appears to be an inherent characteristic of being safe. Zohar's (1980) work is not in accord with this notion in that the validation of his climate survey was accident rates and his goal to define organisational characteristics that differentiate between high and low accident rate companies. The presence or absence of an unsafe act, then, does not appear to be a robust measure to describe an organisation as safe or unsafe. It does however appear appropriate (logical) to believe that the presence or absence of observed unsafe acts is a factor in the safety measurement of an organisation (the weight of which is unknown).

System Safety Engineering and Management states that Safety may be defined as a quality of a system that allows the system to function under pre-determined conditions with an acceptable minimum of accidental loss. In this way Safety should be thought of as a characteristic of a system. Interestingly Airservices Australia (2001, AA-Safe-001, p. 1) defines Safety as "Being in a situation where the risks of an aircraft accident or air safety incident are reduced to a level as low as reasonably practicable" reinforcing the proposition that the working definition of Safety includes risk management.

Safety can then be framed for the purposes of this paper as a characteristic of a system that does not permit unacceptable risks to be undertaken with the goal of injury free operations.

What to Measure

CULTURE.

In order to measure something we must first determine what it is and then gain an understanding of it. In an attempt to understand culture we should define it and then look at its sub components. This in turn may give a clue to measurement of Safety Culture.

Culture has been defined as *the values, beliefs, rituals, symbols and behaviours that we share with others that help define us a group, especially in relation to other groups* (Merrit and Helmreich, 1996, p. 1) and organisational culture as *a system of shared values, assumptions, belief and norms that join organisational members* (Smircich 1988: Kilmann, Saxton & Serpa 1986 as cited in Bartol et al (1995, p. 101)). Hayward (1997, p. 1) quotes Hofstede (1980) where he indicates culture *is the collective programming of the mind which distinguishes the members of one group from another*. UK Health and Safety Commission (1993, as cited in Cooper 1999, p. 2) define Safety Culture as "*the product of individual and group values, attitudes, competencies, and patterns of behaviour that determine the commitment to, and the style and efficiency of, an organizations Health and Safety programs. Organisations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy measures*". Cooper (1999, p. 2) notes that the UK Health and Safety

Commission's definition is given prominence by researchers. Hudson (2001, p. 13) states that an organisation's Safety Culture *is an evolutionary process from unsafe to safe and as such only after a certain point in development can an organization be said to take safety sufficiently seriously to have a safety culture*. Hudson (2001, p. 1) broadly defines Safety Culture as "*Who and what we are, what we find important, and how we go about doing things around here*"; additionally Hudson (2001) links the organisation's culture and therefore its Safety Culture to its development evolution. Hudson (2001, p. 10) notes that organisations go through stages from pathological states to generative states. This notion appears to be a concept adapted from Westrum's 1995 work on information flow in organizations. Hudson's (2001) evolution of a Safety Culture accords with the work of ShamRao (1999, p. 2) where he notes that there are 3 main cultural developments, the first of which is ensuring that training programs, work conditions, procedures and processes comply with regulations (passive compliance), the second is involving workers in the task of regulatory compliance and encouraging them to take personal responsibility (active compliance) and the third teaching individuals to scan for hazards, to focus on the potential injuries and the safe behaviour(s) that can prevent them and to act safely (behavioural). The combinations of the views of Hudson (2001), ShamRao (1999) and Westrum (1995) have been incorporated in Figure 1.

Organisations often espouse their requirement for appropriate Safety Cultures in their Policy Manuals. An appropriate aviation example is from Airservices Australia (2001 AA: Safe-001, p. 1) that states,

> "*Airservices Australia will develop a culture among all managers and staff which fosters an increasing understanding of the importance of Safety in all of our activities and the resultant responsibility of each individual. Airservices Australia will provide the environment, support and training necessary to achieve this goal"*.

Distilling elements from the discussions above it appears that culture can be divided into two major components of intrinsic (values, beliefs, assumptions, 'who and what we are', what we find important') and extrinsic elements (behaviour, norms, rituals, symbols, 'how we go about things around here'). The intrinsic element is a psychological element and the extrinsic element behavioural, both of which accord

with a 3-element model by espoused by Cooper (1999) discussed later in the paper. These elements also appear to have an individual and a collective aspect, the classification of which is on a continuum from some negative position to a positive position. The Safety Culture is therefore made up of a collection of individual cultures and other sub cultures within the environmental constraints and promotions of the organisation. It seems intuitively responsible to conclude that organisations will have a 'Safety Culture', however it's classification as good/bad, safe/unsafe, or acceptable/unacceptable is an unknown position without some measurement or a comparison to similar organizations.

The traditional concept of culture is represented in Figure 2 and incorporates many of the features discussed above.

The concept of Safety Culture is further dissected in the following discussion on culture sub components.

Figure 1

Organisational evolution tied to its safety cluture
adapted from Hudson 2001, ShamRao 1999 and Westrum 1995

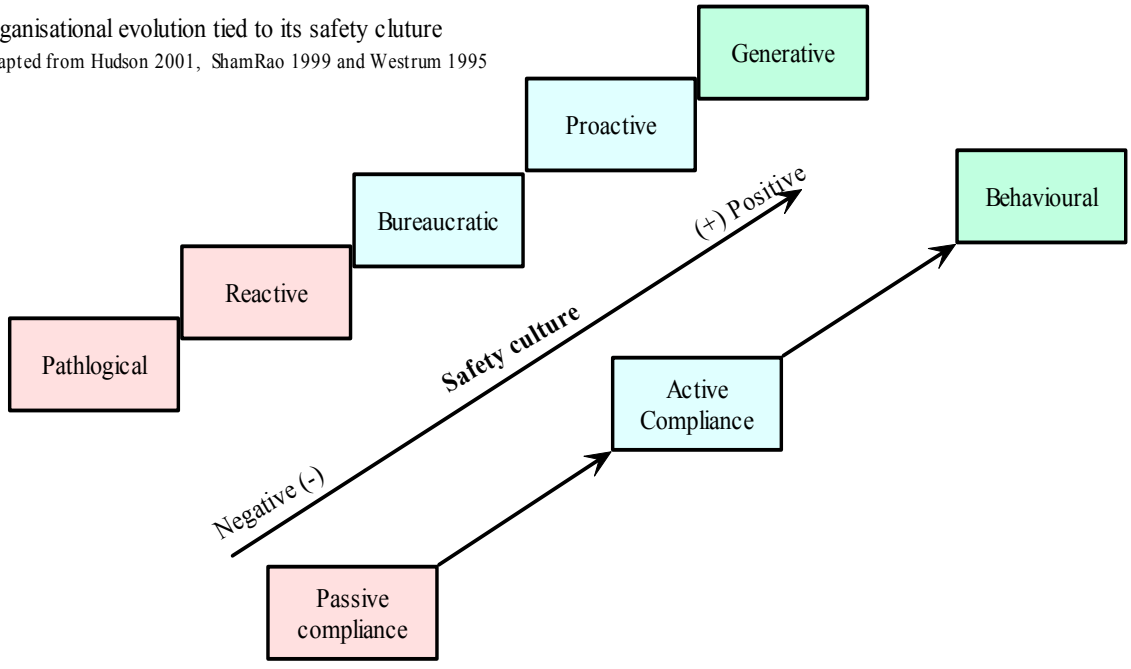
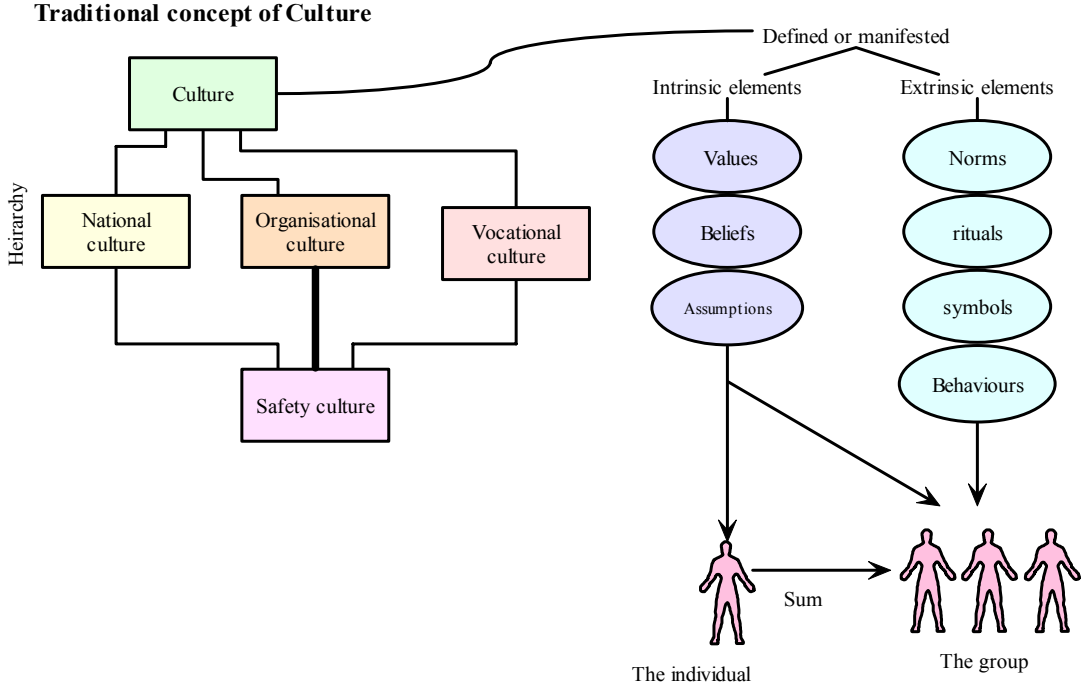


Figure 2
Traditional concept of Culture



CULTURE SUB COMPONENTS

Whilst there are differing perspectives within the broad definition of Safety Culture there appears to be general agreement, however when it comes to decomposing culture to its sub components there appears to be a moderate divergence of opinion. Different perspectives on sub components are noted below followed by a detailed discussion.

Idaho National Engineering and Environmental Laboratory (INEEL, 2001, p. 11) notes that 8 core components of a total Safety Culture are:

- Management commitment to Safety
- Job satisfaction
- Training, equipment, Physical environment
- Organisational commitment
- Worker Involvement
- Co-worker support
- Performance management
- Personal accountability

Fleming (2000, p. 3) notes that 10 elements of the Safety Culture Maturity Model are:

- Management commitment and visibility
- Communication
- Productivity versus Safety

- Learning organisation
- Safety resources
- Participation
- Shared perceptions about Safety
- Trust
- Industrial relations and job satisfaction
- Training

Zohar (1980, p. 97) doesn't specifically define Safety Culture but espouses that the dimensions that make up a Safety Climate are:

- Strong management commitment to Safety
- Emphasis on Safety training
- The existence of open communication links and frequent contacts between workers and management
- General environment control and good housekeeping
- A stable workforce and older workers
- Distinctive ways of promoting Safety

Hudson (2001, p. 10) disagrees with the term climate used by Zohar (1980) indicating the appropriate term would have been culture. Confusingly Hudson (2001, p. 10-footnote 2) also notes that "the notion of Safety Culture is somewhat different from that of Safety Climate originally espoused by Zohar". Despite differences in terminology there is much similarity between the two papers in terms of their stance on management commitment and organisational beliefs however Hudson (2000, p. 11) has preferred to use Reason's (1997) dimensions of:

- An informed culture
- A reporting culture
- A flexible culture
- A learning culture, none of which are discussed in this paper

Importantly in the context of this paper the International Civil Aviation Organisation (1992) notes that a good safety culture is made up of the following attributes:

- Senior management placing a strong emphasis on safety
- Staff having an understanding of hazards within the workplace
- Senior management's willingness to accept criticism and an openness to opposing views
- Senior managements fostering a climate that encourages feedback

- Emphasising the importance of communicating relevant safety information
- The promotion of realistic and workable safety rules
- Ensuring staff are well educated and trained so that they understand the consequences of unsafe acts

Cooper (1999, p. 3) believes, with the authors above and in line with goal setting theory, that Safety Culture is a super-ordinate goal that is achieved by dividing the task into a series of sub-goals that are intended to direct people's attention towards the management of Safety. Cooper (1999, pp. 4-5) then notes that there are three major components of Safety Culture in line with Bandura's 1977 and 1986 work on reciprocal determinism. Reciprocal determinism identifying that people are neither deterministically controlled by their environments nor entirely self-determining. These 3 major components are the person, situation and behaviour; of which 'person' and 'behaviour' featured in the discussion on the definition of culture above where the psychological and behaviour elements were aligned with the intrinsic and extrinsic elements. Further expansion of Cooper's (1999) work leads to his proposed model which has been replicated at Appendix A. Cooper (1999) has combined the research of many people to develop the model as shown and as can be seen in Appendix A, the model is multi layered with the person, job and organization being replicated for the three main dimensions of Safety Management Systems, Safety Climate and Behaviour. The Cooper model seems to have significant credibility as it follows the UK Health and Safety Guide 48 (see Appendix B) and elements of the Cooper model are being taught in aviation safety courses (Mullins 2001). Cooper's (1999) model has some attractive features in that it combines Zohar's Safety Climate dimension in addition to commonly used Safety Management Systems and Behavioural Dimensions, all of which can be measured to various degrees. Mearns (1998, p. 1) articulates the distinction drawn by Cooper (1999) between the 3 dimensions when discussing offshore installations and suggests that senior management within individual companies try to create a particular 'culture' with respect to health and safety, but that the context of the operating environment and the particular activities which the installation is engaged in, determines the prevailing 'Safety Climate' which is of far more relevance to the offshore worker. Importantly Mearns (1998, p. 2) also argues that organizations should pay more attention to how their 'Safety Culture', in the form of norms, values, assumptions and philosophies map into their rules, policies, procedures and how these, in turn, are perceived and enacted by the

workforce in a particular environmental context. Mearns (1998) appears to be noting that culture is homogenous but captured within context. Using this notion it appears reasonable to conclude that a change in context will lead to a change in culture Additionally, Mearns' statement accords with Coopers (1999) model in that 'norms values, assumptions and philosophies' equate to the psychological elements, enacted by the workforce equates to the behavioural element and the environment context' equates to the Safety Management Systems element.

The climate within a context appears to be a major determinant of culture. This notion appears to accord with Zohar's (1980) work. Cooper (1999, p. 2) whilst noting reciprocal determinism also notes on that the effect of one element on its reciprocal is not necessarily equal to the reciprocated effect. This then accords with the proposition that Safety Climate can be a **major** determinant of culture. Hudson (2001, p. 10) in contrast, espouses that "the culture defines the setting within which the climate operates". Hudson's view does not align with others such as Mearns (1998) and Zohar (1980, 2000). The wider view appears to be that climate affects culture significantly more than the reciprocal.

The similarities between Zohar's (2000) work and Cooper's (1999) model (Appendix A) can easily be identified and have been tabled below (Table 1) for easy reference. It is worthy of note that certain authors have a position regarding Safety Cultures dependent on their particular focus. By way of example, Krispin and Hantula (2001) focus solely on behavioural safety interventions as does McSween and Matthews (2001), however, Cooper's (1999) model appears to broadly consider all positions including behavioural, perceptual (climate) and situational (Safety Management Systems) dimensions perhaps not to the depth of the single focus but with the whole in mind.

Table 1

Comparison of Cooper (1999) and Zohar (2000) regarding the 3 major components of Safety Culture.

Cooper (1999)		Zohar (2000)
Safety Climate	⟺	Safety Climate
Behaviours	⟺	Assumption that perceptions translate into behaviours
Safety Management Systems	⟺	Acknowledged in the paper noting the work by James and Jones (1994) but not the focus of the paper

To reinforce the usefulness of the Cooper (1999) model the UK Health and Safety Executive Safety Climate Measurement User Guide and Tool kit (p. 8) via their Multiple Perspective Assessment Model as shown in Appendix 3 also indicates the major components of Safety Culture, which align with Coopers (1999) dimensions as shown in Table 2 below.

Table 2

Comparison of Cooper (1999) and UK HSE Safety Climate Measurement User Guide and Toolkit regarding the 3 major dimensions of Safety Culture.

Cooper (1999)		Safety Climate Measurement User Guide and Toolkit
Safety Climate	⟺	*Manifestation:* Employee, Contractor and External perceptions.
Behaviours	⟺	*Manifestation:* Employee commitment, attitudes, responsibility, behaviour etc.
Safety Management Systems	⟺	*Manifestation:* Safety Policy, Systems and Processes, Structures, Reports.

What appears to be in no doubt is that Safety Culture, by whatever name, has sub components and interactions between these components. Management commitment, training, communication and job satisfaction appear as common threads in the comparison in Table 3. Support for the significance of management commitment was identified by Dedobbeleer and Beland (1991) when they identified only two factors in their safety culture instruments; that of management commitment to safety and employee involvement in safety. All authors cited, prima facie, agree that some manifestation of the individual's cultures has a significant impact on the collective or group culture. It is also clear that the terms of Climate and Culture are often used interchangeably and confusingly when it seems that whilst interlinked, climate is a sub component of culture.

The sub components of culture are manifested in ways that can be measured. It seems intuitive that to conclude by way of example that management commitment to Safety can manifest itself, say, in the allotment of budget funds to Safety measures, which may be measured by an audit of the Safety Management System.

Table 3

Comparison of culture/climate sub components identifying the similarity between components.

Fleming (2000)	Zohar (1980)	INEEL (2001)	ICAO (1992)
Management commitment and visibility	Strong management commitment to Safety	Management commitment to Safety	Senior management placing a strong emphasis on safety
Communication	The existence of open communication links and frequent contacts between workers and management		Senior management's willingness to accept criticism and an openness to opposing views
			Emphasising the importance of communicating relevant safety information
Industrial relations and job satisfaction	A stable workforce and older workers	Job satisfaction	
Training	Emphasis on Safety training	Training, equipment, Physical environment	Ensuring staff are well educated and trained so that they understand the consequences of unsafe acts
	General environment control and good housekeeping		Staff having an understanding of hazards within the workplace.
Learning organisation	Distinctive ways of promoting Safety	Organisational commitment	Senior managements fostering a climate that encourages feedback.
Participation		Worker Involvement	
Shared perceptions about Safety		Co-worker support	
Safety resources		Performance management	
Trust		Personal accountability	
Productivity versus Safety			The promotion of realistic and workable safety rules.

In synopsis, Safety Climates have sub components that manifest themselves in measurable ways in the dimensions of Safety Climate, Behaviours and Safety

Management Systems. The particular term used (climate/culture) to describe many of these components needs further clarification and is discussed next.

SAFETY CLIMATE

Safety Climate as previously discussed is a term that requires additional discussion to clarify where it is positioned with regard to Safety Culture.

The Macquarie Dictionary defines climate as " **3.** the general attitude and prevailing opinions of a group of people." This of course does not adequately capture the essence of climate but does give an indication of the perception of the term. Many organizations use Safety Climate as a key indicator of the Safety health of an organization. This, in conjunction with the prevalence of Safety Climate surveys and the work of Zohar (1980, 2000), make Safety Climate an issue worthy of separate consideration. Particularly significant in any discussion on the issue is Zohar's (1980 p. 96) observations that "Obviously, then, any given organization creates a number of different climates…" and that James and Jones (1994) distinguished between measures of organisational climate that are based on (a) structural properties such as size, structure, systems complexity, leadership style and goal directions and (b) perceptions held by employees about aspects of their organisational environment summarized over individual employees. The term Safety Climate used by Zohar focuses only on employee perceptions. The structure and systems as part of climate (James & Jones 1994, (a)) fit into the dimension of Safety Management Systems in the Cooper (1999) model. Additionally Zohar (1980) makes the assumption that perceptions translate into behaviours which is one of the three dimensions of Coopers (1999) work. Zohar (1980, p. 96) states, "it is assumed that these perceptions have a psychological utility in serving as a frame of reference for guiding appropriate and adaptive task behaviours. Based on a variety of cues present in their work environment, employees develop coherent sets of perceptions and expectations regarding behaviour-outcome contingencies and *behave accordingly*…". So it appears that Zohar's (1980) concept of Safety Climate can be easily subsumed into the Cooper (1999) model. Notwithstanding the subsuming, Zohar's work requires further discussion. Support for the importance of perceptions in Safety Cultures is also noted by Williamson, Feyer, Cairns, & Biancotti (1997, p. 16) where they state. "In

understanding the safety climate or culture of a workplace, the perceptions and attitudes of the workforce are important factors in assessing safety needs"

Zohar (1980, p. 96) defines climate as "a summary of molar perceptions that employees share about their work environments" also noting that the development of his work followed Schnieders (1975) proposal that "the term organizational climate should describe an area of research rather than a specific organizational measure". Despite following Schniders proposal Zohar did develop general (not organizational) measures and these measures (via administered surveys) appear to form the basis of many other climate surveys such as NASA's Safety Performance Survey, John Hopkins University Safety-Climate Questionnaire and the USA Nuclear Regulatory Commission Safety Culture and Climate Survey.

The Safety Climate espoused by Zohar (1980) can be viewed as the discrete element of Safety Climate in Cooper's (1999) model and is confirmed by Cooper's acknowledgement and reference to his work. Similarly Zohar (1980) appears to share Cooper's (1999) assertion of reciprocal determinism when he indicates perceptions and therefore behaviours are based on work environmental cues. Even though comprising only one third of the Cooper (1999) model, Safety Climate appears to be the most discussed, recognized and measured dimension. Pizzi, Goldfarb and Nash (2001, p. 1) appear to concur with the importance of Safety Climate measurement when they state, "The aspect of organizational Safety Culture that may be visible or measurable is sometimes referred to as the safety 'climate', which includes management systems, safety systems, and individual attitudes and perceptions". Interestingly this statement uses both parts of the James and Jones (1994) climate definition; structure/systems and perception. Also in agreement with the measurement of climate was the Ladbroke Grove Rail Inquiry (2000, p. 2), which concluded, " A distinction can be drawn between culture and climate. Climate is the observable, tangible part of culture. Culture is the understanding of people's fundamental values with respect to say, risk and Safety".

In light of the preceding discussions it appears reasonable to conclude that Safety Climate is a distinct dimension of Safety Culture that lends itself to measurement of safety perceptions within the organisation.

How to Measure

It is worth noting that psychological and behavioural measurement is generally collected from the individual perspective and then requires some amalgam of the measurement to gauge the collective culture.

The techniques of observation, audit and survey are discussed below. A fourth technique of interview is not discussed in this paper.

OBSERVATION

Observation is a technique to measure behaviours. Behaviour is one of the 3 major dimensions of the Cooper (1999) model. It is also worth recalling that Zohar (1980) believes that it is not necessary to measure behaviours as he assumes that attitudes measured through survey are enacted as behaviours. Zohar's (1980) work appears to support his assumption as his measurements were positively validated against measures such as accident rates and lost time incident frequency rates.

The UK Health and Safety Executive Safety Climate Measurement User Guide and Tool kit notes that observation can be direct or indirect. Indirect being used to collect data via reports and organisational records and direct usually using behavioural checklists tailored to the operation. An example of such a checklist is shown below at Table 4. Cooper (1999, p. 10) notes that the behavioural aspects of Safety Culture can be examined via peer observation, self-report measures and/or outcome measures. He also notes that analysing an organisations accident history for the previous two years often reveals a relatively small number of safety behaviours that have been implicated in the vast majority of organisational accidents. It seems reasonable to postulate this analysis to determine safety-implicated behaviours can significantly narrow the focus of the observation. Cooper (1999, p. 10) also notes other sources "to glean safe behaviours includes risk assessment documentation, standard operating procedures, permits to work, group discussions etc" and further that "the behaviours identified from these checklists are then placed on observational checklists and trained observers regularly monitor personnel against them." Cooper's (1999) considerations on measuring behaviours and the UK Health and Safety Executive Safety Climate

Measurement User Guide and Tool kit considerations are both consistent in their approach which could be attributable, in part, to their collective reference to the UK Health and Safety Guides 48 (Human Factors in Industrial Safety) and 65 (Successful Health and Safety Management).

Helmreich (in press, p. 2) espouses the use of Line Operations Safety Audits (LOSA) in the operational domain of aviation. LOSA are programmes that use expert observers to collect data about crew behaviour and situational factors on normal flights. Helmreich (in press) in accord with Cooper (1999) also indicates that specific behaviours have been associated with accidents and incidents and that data is collected via checklists. From the discussion above there appears to be general agreement that a review of organisational documentation precedes the observation so as to focus the observation on specific behaviours. The documentation review is also used to compose organisational and functional specific checklists. It seems reasonable to postulate that the confirmation of, or absence of, specific behaviours can be collected and extrapolated to form a picture of Safety behaviours within an organisation, however, significant research must be conducted before a useable audit can be conducted. This makes observing behaviours a time and resource consuming process.

Table 4
Behavioural Checklist adapted from the UK Health and Safety Executive Safety Climate Measurement User Guide and Tool kit

Tasks	Behaviour	Safe	Unsafe	Not seen
Daily Inspection	Used checklist			
	Completed checklist			
	Avoided propeller arc			
	Used PPE for fuel drain and oil check			
	Steady pace			
	Avoided interruptions			
	Checked hatch/doors/caps for security			
	Certified appropriately			

AUDIT

The audit centers on the systems an organizations has in place to manage the Safety of its operations. The term Safety Management Systems (SMS) is widely used to describe these systems. Airservices Australia in their Safety Management Manual (AA:Safe-002, p. 5) defines their SMS as "the policies, requirements, elements, procedures and activities by which means Safety Management is undertaken in an organization". Cooper (1999, p. 10) notes that,

> *"the situational aspects of safety culture tend to be reflected in organizational policies, operating procedures, management systems, control systems communication flows and workflow systems as well as factors such as noise, heat, light, and physical proximity associated with the immediate working environment. As such, this wide range of cultural influences should be measured via audits of safety management systems".*

Many organizations have safety systems, which should be self-auditing. For example Airservices Australia (Air Services Australia Safety Management Manual, AA:Safe-002, p. 5) espouses the objective of its Safety Management System thus:

> "*To ensure that there is a system in place to assess the safety implications and safety hazards in Airservices' operations, and to determine the action necessary to minimize those hazards, and to monitor the implementation of that action on a periodic basis".*

Auditing of SMS can also be carried out externally via audit of the organisation's safety case, as is the case with the Civil Aviation Safety Authority auditing Airservices Australia. Airservices Australia (2001, AA:Safe-002, p. 5) defines safety case as "A document which provides substantial evidence and argument of whether the airways system to which it pertains meets its safety objectives" . This paper however focuses on internal organizational audits.

A Safety Audit focuses on the management and systems in place to ensure risk is managed. By way of example I have listed below (Table 5) the major headings and sample questions from each heading of the audit checklist noted in Appendix D of the Operators Flight Safety Handbook. (GAIN, 2000)

Table 5. Sample audit checklist (GAIN, 2000)

Safety Audit
Management Structure
☞ *Does the company have a formal, written statement of corporate safety policies and objectives?*
☞ *Does the company have a confidential, non-punitive incident-reporting program?*
Management and Corporate Stability
☞ *Have any managers of operational divisions resigned from the company because of disputes about safety matters, operational procedures or practices?*
Financial Stability of the Company
☞ *Are safety-related technological advances implemented before they are dictated by regulatory requirement, i.e. is the company proactive in using technology to meet safety objectives?*
Management Selection and Training
☞ *Is there a formal management selection process?*
☞ *Do new management personnel receive formal safety indoctrination or training?*
Work Force
☞ *Have there been recent layoffs in the company?*
☞ *Is there a high rate of personnel turnover in operations and management?*
☞ *Are the safety implementations of deteriorating morale considered during the planning and implementation of reduction in work force or other destabilising actions?*
Fleet Stability and Standardisation
☞ *Is there a company policy concerning cockpit standardization within the company's fleet?*
☞ *Do pilots/flight-operations personnel participate in fleet-acquisition decisions?*
Relationship with Regulatory Authority
☞ *Are Company safety standards set primarily by the company or by the appropriate regulatory authority?*
☞ *Does the Company set higher safety standards than those required by the regulatory authority?*
Operations Specifications
☞ *Does the Company have formal flight-operations control, e.g. dispatch or flight following?*
Operations and Maintenance Training – Training and Checking Standards
☞ *Does the Company have written standards for satisfactory performance?*
☞ *Is there a periodic review of training and checking records for quality control?*

Operations Training
☞ *Does the Company have a formal program for training and checking instructors?* ☞ *Is initial operating experience (IOE) mandated?*
Training Deices
☞ *Are approved simulators available and used for all required training?*
Flight Attendant Training
☞ *Do flight attendants receive comprehensive initial and recurrent safety training?*
Maintenance Procedures, Policies and Training
☞ *Is formal maintenance training provided by the company for all maintenance personnel? Is such training done on a recurrent basis? How is new equipment introduced?* ☞ *If contracted maintenance is used, is it included in the quality assurance program?*
Scheduling Practices
☞ *Does the company train flight crew members to understand fatigue, circadian rhythms and other factors that affect crew performance?* ☞ *Are there flight and duty time limits for pilots?*
Crew Qualifications
☞ *Does the Company have a system to record and monitor flight crew currency?* ☞ *Are the Company's simulator instructors line-qualified pilots?*
Publications, Manuals and Procedures
☞ *Are all flight crewmembers issued personal copies of their type operations manuals/FCOM and any other controlled publications?* ☞ *Is the airline operations manual periodically updated?*
Dispatch, Flight Following and Flight Control
☞ *Does initial/recurrent dispatcher training meet or exceed FAR's/JAR's requirements?* ☞ *Are computer generated flight plans used?*

The UK Civil Aviation Authority also uses an audit system noted in CAP 712 'Guidance for Auditing a Formal Safety Management System' and The Flight Safety Foundation (FSF) November 1996 Flight Safety Digest published an Airline Management Self-audit. Both of these audits are along the same lines as the example above. Interestingly the ICARUS committee that developed the FSF Airline Management Self-audit noted on page 2, "Honest and critical self-assessment is one of the most powerful tools that management can employ to measure flight safety margins".

Auditing appears to be a very powerful tool if tailored to the organization or domain. However the weighting and meaning of the audit questions is of some question. The FSF self audit foreword notes that there are no right or wrong answers but they should stimulate thought however inability to provide a rationale for the answer should serve as a warning flag with more review required.

With the aforementioned in mind it appears safe to conclude that the interpretation of the results of the audit for safety benchmarking is an arduous task.

SURVEY-QUESTIONNAIRES

Zohar (1980, 2000) measures the Safety Climate by surveying the employee's perceptions with regard the organisations Safety Climate. Zohar's (1980, 2000) work in measuring using surveys against traditional safety measurements of accident rates and lost time incident frequency rates appears to withstand analytical scrutiny. As noted previously there is a logical premise that just because you haven't had an accident doesn't mean an organisation is safe. Following Reason's (2001) 'Swiss Cheese' model the better the layers of defence the safer the system. This does not invalidate Zohar's climate measurements however it does make the validity of the measurement problematic when adapting it to alternate domains. Regardless of the validity of the measurement, movement in the measurement can still be ascertained over time or, as in the proposed case, pre and post intervention. The attraction of this methodology is evident in its widespread use.

A very brief list of climate surveys is below:

- UK Health and Safety Executive Safety Climate Measurement User Guide and Tool kit
- NASA's Safety Performance Survey (management and employee)
- John Hopkins University Safety-Climate Questionnaire
- USA Nuclear Regulatory Commission Safety Culture and Climate Survey.
- Operators Flight Safety Handbook Safety Surveys.
- National Safety Council of Australia Safety Climate survey
- Airline Safety Culture Index (Edkins, 1999)

The utility of Zohar's (1980) work as a basis to move forward appears to come from the validity of its measurements. Zohar (1980, pp. 97-98) identified 5 key

characteristics of low accident companies. He then developed a questionnaire and administered an initial version for analysis. Zohar then carried out principal-component factor analysis and a discriminant analysis of the Safety Climate Questionnaire and identified 8 measurable factors. The validity of the questionnaire appears sound and as noted by Edkins (1999) "Since Zohar's initial work, a number of researchers (Glenon, 1982; Brown & Holmes, 1986; Dedobbeleer & Beland, 1991; Seppala, 1992; Glendon, Stanton & Harrison, 1994; Cooper, 1995; DeJoy, Murphy & Gershon, 1995) have developed additional safety culture instruments." Edkins (1999) went on to develop an Airline Safety Culture Index (ASCI) and apply it in a major international Asia Pacific airline which was validated using principal component factor analysis. Further support for Safety Climate questionnaires has been provided by Williamson et. al. (1997) where they noted:

> "*The most striking finding in the development of this questionnaire was that there was little variation between respondents on a very large proportion of the questions originally selected. Clearly there are well-known beliefs about safety in the working community which need to be understood in order to progress the concept of safety culture*."

The questionnaires noted above, appear similar in format as the five point Likert scale is predominately used, however the content, as would be expected, varies according to the domain and the occupation being measured in addition to the authors interpretation of the key dimensions of a Safety Culture. It is also worthy of note that the Australian Transport Safety Bureau proposes to develop a Safety Climate Survey adapted for the Australian aviation industry (as indicated to the author).

Interestingly, Zohar (1980, p. 99) noted that different categories of industrial organisation had different characteristics and therefore different Safety Climate scores. For instance, chemical factories had the highest scores due to the technology and the risk whereas food-processing plants have the lowest scores. The value of this observation could be tested in the Australian aviation market to see if there are different Safety Climate scores between segments. Nonetheless, it appears that a Safety Climate questionnaire is an appropriate tool for the measurement of the proposed intervention. The measurements of the Safety Climate can be plotted on a radar graph as indicated in the UK Safety Climate Measurement User Guide and Toolkit, p. 18 as reproduced at Appendix D.

Safety Culture and Measurement in context

A majority of the discussion above focuses on general Safety issues within an organization including occupational health and safety issues. The focus of aviation Safety issues in this case is not directly aimed at the individual employee or the collective manifestation in its entirety but more at the Safety of those who fly. This is not to diminish the value or need of OH&S issues but to contextualise the Safety aim.

As discussed, defining Safety is a difficult process with many perspectives to take into account, however Safety was viewed as a characteristic of a system that does not permit unacceptable risks to be undertaken with the goal of injury free operations.

Safety Culture was determined in line with Coopers (1999) model with 3 key dimensions - a behavioural dimension, a psychological dimension and a structural or system dimension. Each of these dimensions then had a person, organization and job element. The Cooper (1999) model encompassed and accorded with the work of many others. Following the Cooper (1999) model into measurement, the 3 key methods of observation, audit and survey also aligned well with the behavioural dimension using observation, the psychological dimension using perception surveys and the structural or system dimension using Safety Management Systems audits. The work of Zohar (1980) in validating his Safety Climate survey makes it the basis of a very attractive tool. This is evidenced by the widespread use of Safety Climate surveys. The relative ease of administration and the validity of the Safety Climate survey tool make it an excellent choice for the measurement of the intervention proposed, particularly as the outcome mooted was ‘an awareness of System Safety’.

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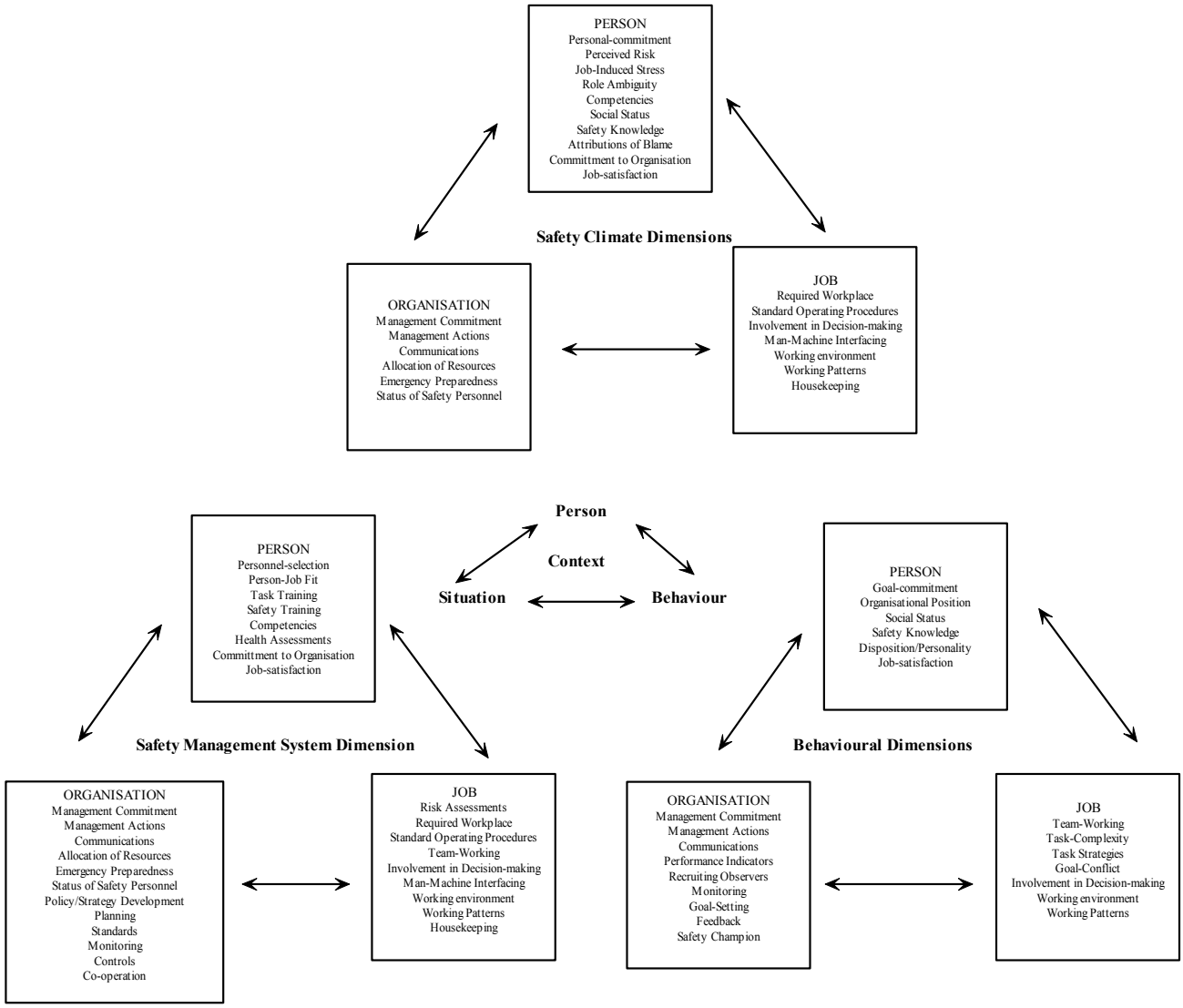
Appendix A: Reciprocal Model of Safety Culture (Cooper, 1999).



Reciprocal Model of Safety Culture (Cooper 1999)

Appendix B: A Performance Shaping Factors Listing based on HS(G)48 (Whally-Lloyd 2001)

The Organization

1. Safety Climate
2. Standards Setting
3. Monitoring Activities
4. Supervision
5. Learning from Past Accidents

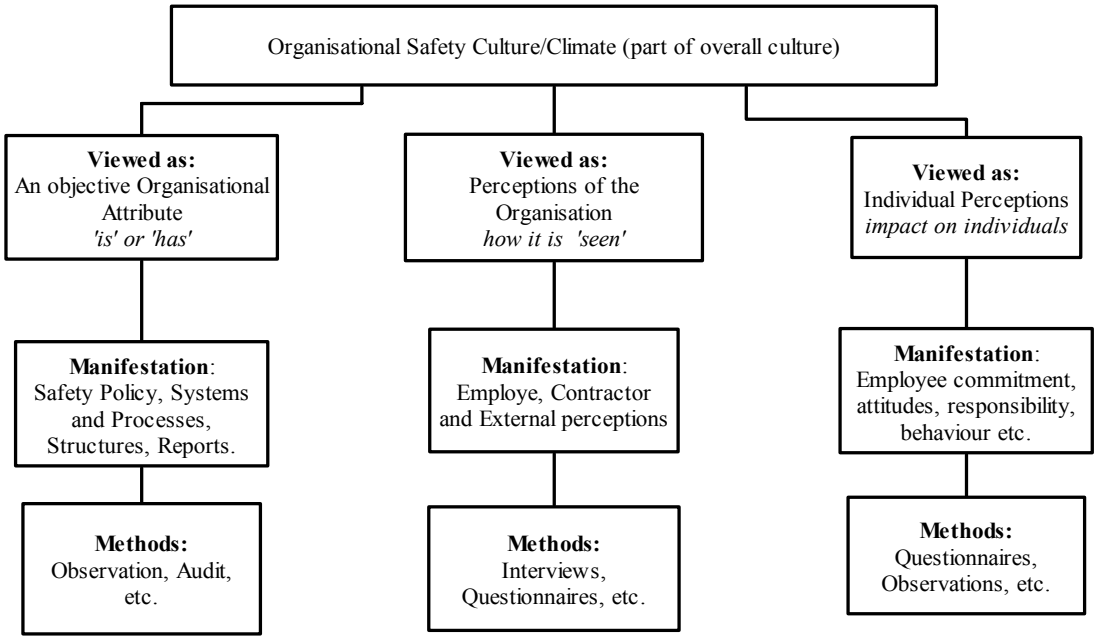
The Job

6. Identifying and analyzing Critical Tasks
7. Decision making and Risk Perception
8. Human-Machine Interface
9. Procedures and Operating Instructions
10. Working Environment
11. Tools and Equipment
12. Work Pattern
13. Communication

Personal Factors

14. Personnel Selection
15. Training/Experience
16. Health Assessment and Monitoring

Appendix C: Multiple Perspective Assessment Model (Safety Climate Measurement User Guide and Tool kit, p. 8)



Multiple Perspective Assessment Model
Safety Climate Measurement User Guide and Toolkit

Appendix D: Adaptation of Comparative radar plot Safety Climate Measurement User Guide and Toolkit (p. 18).