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EXECUTIVE SUMMARY

The term safety culture has been in use over the past few years in Air Traffic Management (ATM), but it is not always clear what is meant by this term, or how exactly it relates to ATM industry. This report seeks to explain the concept of safety culture, first as it was developed in other industries since the mid ‘80s until now, and second in terms of how it specifically relates to ATM. It also seeks to explain the relationship between safety culture and Safety Management Systems (SMS), and show why safety culture is important even if a good SMS is in place.

The objectives of this report are to:

- Develop an understanding of safety culture in ATM, by identifying the safety culture elements through building on other industries’ understanding of safety culture and tailoring this understanding to ATM’s nature and needs
- Determine how safety culture develops and changes
- Determine the role and significance of safety culture in ATM
- Relate this understanding to current Safety Management System approaches as are being adopted by European ANSPs
- Develop a basis for safety culture measurement and guidance.

A semi-structured interview tool was developed, structured under the main SMS elements (including safety reporting, safety assessment, working practices and safety issues, safety resources etc.) and further safety culture prompt questions were developed to understand the mechanics of safety culture, that is, why it is working and how it can fail.

The survey was undertaken with 52 staff (controllers, managers, supervisors, technicians) in four European ANSPs in 2005. The analysis process highlighted five similar themes, under which there were 18 key elements.

Using the responses, ‘stories’ provided evidence of the symbols, behaviours, assumptions and values (espoused and actual), and these were related to how safety culture might be undermining or supporting safety management. This enabled the identification of measures to improve safety culture where it was being ‘disabled’. Examples of safety culture ‘enablers’ could also be identified, constituting good practice.

The results are in four main sections:

1. Safety Management Commitment (Priority of safety; Responsibility for safety; Resources for safety)
2. Trust in Organisational Safety Competence (Trust in safety process; Regulatory effectiveness)
3. Involvement in Safety (Communication about changes; Communicating problems (speaking up); Involvement of ATCOs in safety; Management involvement in safety; Working with contractors)
4. ATCO Safety Competence (ATCO Competence; Team effectiveness; Training for safety in ATM; Procedures and working practices)
5. A Just Reporting and Learning Culture (Error tolerance, blame and punishment; Rewards and incentives, and Performance appraisal; Reporting (and investigating) incidents; Learning from incidents)

The surveys found evidence that safety culture is important in ATM - even in cases where an SMS is in place, things may not be working properly due to safety culture impacts (in particular what this study has called ‘safety culture disabled’). The results suggest that whilst a good SMS is necessary, it may not be sufficient. Efforts must therefore be made to measure safety culture as well, and identify and rectify short-comings. The scientific literature and the survey and analysis embodied in this report have laid the groundwork for a safety culture measurement tool, as well as providing the areas for development of guidance and best practical guidance on safety culture for air traffic control centres. The simplified dynamic model of safety culture, together with its enablers and disablers, offers a usable framework with which to explore safety culture deficiencies or vulnerabilities, and a means to identify how best to tackle them. This latter aspect therefore has the dual use of developing safety culture guidance and serving as a safety culture investigation or intervention tool.

A roadmap for developing a way to manage safety culture can be seen as follows:

1. Raise awareness and interest in ANSPs in the concept and role of safety culture
2. Verify the results of this study, and where possible enlarge the ‘database’ by involving more ANSPs
3. Further analysis of the mediating role of the supervisor (and technical support) in developing the safety culture
4. Develop initial guidance based on the work in the survey, structured according to the safety culture elements, and enrich such guidance via ANSP participation
5. Develop a safety culture measurement system that can assess an ANSP’s safety culture, identify vulnerabilities and pinpoint areas for improvement
6. Develop a safety culture intervention tool that ANSPs can utilise themselves (with external support) to explore and improve their safety culture
7. Develop a Safety Culture Learning Forum that will enable industry-led advancement in this area.
**BACKGROUND**

Air Traffic Management (ATM) is a very safe industry - both in terms of quantitatively measured outcomes such as accident rates and also qualitative measures such as the perceptions of the travelling public. That said, however, it is not often clear to those within the industry, let alone the outside observer, as to why the safety performance of the industry has been so good for so many years.

The industry is currently expanding to cope with increased levels of traffic and this is coupled with fundamental changes to how ATM services are provided.

- **Will the ATM system be able to cope safely with these changes?**
- **If so, how will it cope?**
- **What fundamental factors will keep the industry safe?**

All the above questions remain unresolved and so in this era of expansion and change, one of the biggest challenges that the European ATM industry currently faces is identifying and classifying the crucial ingredients of effective safety management and the measures the industry should adopt to maintain its exceptional safety performance.

The development and implementation of Safety Management Systems (SMS) are seen by many in the industry as being the ‘safety holy grail’ as they formalise the safety of the ATM system in terms of tangible and abstract concepts which are all around Europe, which are focussed upon the objective of developing SMS applicable to Air Traffic Management Services.

The intense activity to develop these SMS is not merely a compliancy response to the introduction of EUROCONTROL Safety Regulation Requirements (ESARRs) (e.g. see EUROCONTROL, 2000) but it is also an attempt to ensure that ATM retains its hard fought status of being an extremely reliable and safe industry.

Although it has been recognised that the existence of an appropriate and comprehensive SMS is necessary for maintaining and improving the safety of ATM operations, it is not an end in itself. A Safety Management System will not assure safety if it is not used properly and thus all the staff involved in the provision of ATM services need to be properly aware of its existence, understand its basis, and be motivated to use the Safety Management Systems that are currently being developed.

Employee awareness, understanding and motivation and similarly ‘soft’ phenomena such as their attitudes, perceptions and beliefs are all wrapped-up within the concept of ‘organisational culture’. The influence of culture is something that is often taken for granted by those working in the organisation but it has an implicit and very strong influence on the safe behaviour of employees (Cox and Flin, 1998).

**Safety Culture,** a sub-dimension of organisational culture, is therefore a fairly recent attempt in ATM to advance the area of understanding the different organisational and managerial influences on safety. Research to link safety management with cultural factors is still to be fully embraced by the ANSP community and current research efforts are still mainly focussed upon safety management.

Recently in ATM, the term safety culture has come into the fore, as well as related terms such as Just Culture and Learning Culture. Whilst such terms have been in use for some time in other industries, they are relatively new to ATM. Whilst a Safety Management System can be explained very explicitly, and written down as a formal document system and associated processes, safety culture is harder to expound. Yet other industries have found it necessary to invest both in SMS and safety culture.

Safety culture has been shown to be a key predictor of safety performance in a number of industries (including nuclear, chemical, offshore and rail). It is essentially the attitudes of personnel about the company’s approach to safety, their perceptions about the magnitude of the risks that they face and their beliefs in the necessity, practicality and effectiveness of measures to control risks. There are strong indications that the safety culture concept would work when applied to the ATM industry and so the concept merits further development for ANSPs.

In theory, therefore, explicit indicators of ATM safety culture can be derived. It should then be possible to develop a safety assessment and improvement approach which will focus on safety management systems whilst also providing explicit links to the safety culture features and characteristics that influence the effectiveness of safety management activities. The strength of treating safety culture and safety management in tandem is that the approach can focus upon both assessing and improving safety culture. Through safety culture assessments being related to tangible safety management processes, ANSPs can more readily understand the safety culture concept and thus target improvements to both their safety culture and safety management systems.

The remainder of this report therefore seeks to explain the concept of safety culture, show where it has come from, and how it relates specifically to ATM. However, this is not merely a theoretical piece of work. The project that led to this report has involved four ANSPs to determine how safety culture can support safety, and how lack of it can degrade safety, and examples of both of these aspects are presented in Section: Developing a Safety Culture for ATM as evidence of the importance of safety culture for ATM.

**PROJECT OBJECTIVES**

- Develop an understanding of safety culture in ATM
- Identify the safety culture elements by building on other industries’ understanding of safety culture and tailoring this understanding to ATM’s nature and needs
- Ensure this understanding is not merely theoretical, but is also grounded in ANSP practice experience
- Determine how safety culture develops and changes
- Determine the role and significance of safety culture in ATM
- Relate this understanding to current Safety Management System approaches as are being adopted by European ANSPs
- Develop a basis for safety culture measurement and guidance
The work in this project was undertaken in three main phases:

1. Survey of four ANSPs, using semi-structured interviews of personnel at multiple levels representing management, supervisory and ‘workforce layers’ in the organisation (the latter including controllers, maintenance staff and technicians), with the aim to:
   (I) Understand the key factors that make up safety culture in ATM;
   (II) Identify the safety culture factors that are working effectively and those that are not and relate these to safety culture ‘enablers’ and ‘disablers’;
   (III) Document episodic indicators (stories / examples about safety culture) from the four ANSPs.

2. Develop an ATM safety culture ‘framework’ - essentially a ‘roadmap’ for developing the means to manage safety culture in ATM. This way forward is described in Section: Summary and Conclusions: The Way Forward.

3. A bibliography of references is presented in Section: Literature Review.

Approach

A Review of Safety Culture

This section considers the origins of safety culture in other industries, its relationship with other concepts such as safety climate, just culture, and the safety management system approach, and its relevance to ATM.

Organisational Culture

To understand safety culture’s origins, it is first necessary to consider organisational culture. Most of us spend a significant amount of time at work, and different companies and organisations can each be seen to have their own unique culture, which defines the way that company or organisation works or operates. To the people who have been in a company or organisation for some time, the way things work is simply accepted as ‘how it is’, whereas to outsiders or newcomers it may sometimes seem unusual. A key point, which will be returned to later, is that it can be difficult for people outside this culture to understand it or truly see how it works (and why it is done a particular way), and this can apply to safety behaviour as well as other ‘products’ from an organisation.

The concept of safety culture therefore has its origin in the social and behavioural psychology of the 1950s and 1960s that came to the fore in the organisational psychology, organisational behaviour, and management literature of the 1980s. The literature on organisational culture offers a number of definitions which encapsulate shared beliefs and values. For example, Uttal (1983) defines corporate (i.e. organisational) culture as ‘a system of shared values (what is important) and beliefs (how things work) that interact with a company’s people, organisational structures, and control systems to produce behavioural norms (the way we do things around here)” (p. 66). This definition appears to be so relevant to the current topic that Reason (1998) wrongly cited this as a definition of safety culture rather than organisational culture. Additionally, Schneider (1987) describes organisational culture as underlying assumptions about the world and about human nature, and Schein (1990) argues that these are ‘basic assumptions which are invented, discovered or developed by a given group (and) ...taught to new members” (p.110). The key point here is that these ‘ways of doing things around here’ are often taught or picked up during training, such as the On Job Training Instruction (OJT) that most controllers experience prior to being validated as controllers. Training is therefore a critical key to the development of safe operating practices and safety culture.

Safety Culture

The term safety culture gained its first official use in an initial report into the Chernobyl nuclear power accident in the Ukraine (IAEA, 1986). The accident was a large shock for the industry as a whole, and was greeted by puzzlement as to how it could have happened. The IAEA (International Atomic Energy Agency) report introduced the concept to explain the organisational errors and operator violations that laid the conditions for disaster. Public Inquiry reports have since implicated poor safety culture within operating companies as a determinant of several high-profile accidents, such as the fire at King’s Cross underground station (Fennell, 1998), the sinking of the Herald of Free Enterprise passenger ferry (Sheen, 1987), the passenger train crash at Clapham Junction (Hobden, 1989), and Überlingen (Rutenber, 2005). In the Überlingen accident there were several examples which potentially reflected poor safety culture such as lack of training and lack of manpower which resulted in a compromise of safety of operations. The relevance of safety cul-
came from a realisation that unless the
ish or at least continue. This shift in focus
allowed pressures to build on safe opera-
functioning that
case) back to organisational
power plant operator - who was usually
accident (eg train driver, pilot, nuclear
from the person at the 'sharp end' of the
not foreseeable, and moved attention
because it explained accidents that were
noted above. It caught on particularly
rospectively), and marine transport as
Theoretical development of safety culture
ature to safe operation is not disputed (Cox
Thaden, Sharma, & Mitchell, 2002) despite
Reason's (1998) argument that it is a con-
cept as positive safety cultures by defining the
ber of characteristics that are expected in
endorse this position and provide a num-
attitudes in organisations and individuals
uring culture has '...the definitional preci-
sion of a cloud' (p. 192). Two of the domi-
nant definitions are as follows. With refer-
ence to the Chernobyl disaster, the
International Atomic Energy Agency
(IAEA) defined safety culture as ‘...that
assembly of characteristics and atti-
tudes in organisations and individuals
which established that, as an overriding
priority, nuclear plant safety issues
receive the attention warranted by their
significance’ (IAEA, 1991: p. 1). The UK
Health and Safety Commission (HSC)
endorse this position and provide a num-
ber of characteristics that are expected in
positive safety cultures by defining the
concept as ‘...the product of individual
and group values, attitudes, percep-
tions, competencies, and patterns of
behaviour that determine the commit-
ten to, and the style and proficiency of,
an organisation's health and safety
management. Organisations with a pos-
itive safety culture are characterised by
communications founded on mutual
trust, by shared perceptions of the
importance of safety, and by confidence
in the efficacy of preventive meas-
ures.’ (HSC, 1993: p. 23). These definitions
of safety culture clearly resonate with the
definitions of organisational culture stat-
ed earlier.

Building on the organisational culture lit-
erature, Reason (1997) identified five
important components of safety culture as follows:
(I) informed culture
(II) reporting culture
(III) just culture
(IV) flexible culture
(V) learning culture

An informed culture is a safety system that
collates data from accidents and near
misses and combines them with informa-
tion from proactive measures such as
safety audits and climate surveys. In turn,
this safety system requires the active and
honest participation from the workforce
to report near misses, complete attitude
surveys and become involved in how
safety is managed in their organisation.
This is called a reporting culture, charac-
terised by an organisational climate in
which workers feel free to contribute to
the informed culture. However, workers
will not feel free to contribute unless a
just culture, characterised by an atmos-
phere of trust, is in evidence. This must be
distinguished from a no-blame culture, as
a just culture does not turn a blind eye to
criminal or negligent acts. In some
instances, rewards may be offered for
reporting near misses in much the same
way as they are for safe behaviour
although there are potential problems
with this such as over-reporting.

A flexible culture is one that successfully
manages safety during change due to
external demands, such as, for example,
increasing technological complexity of an
operating system, or increasing general
or peak capacity in the ATM network, or
major organisational changes (e.g. privati-
sation). Collecting this information is
futile unless it is used to enhance the safe-
ty performance of the organisation.

A learning culture is needed to draw
appropriate conclusions from the infor-
mation collected along with the will
to implement changes to procedures and
equipment as deemed necessary.

These components are similar to those
cited by Weick (1987) whose criteria for
high reliability in an organisation is a cul-
ture that encourages interpretation,
improvisation, unique action, and a cli-
mate of trust and openness between
management and workers. Together,
these components of safety culture will
result in a set of social norms, which are
unspoken rules of behaviour that will
result in sanctions if not followed
(Ostram, Wilhelmsen, & Kaplan, 1993).
Behaviours that support safety and avoid
sanctions could be reporting near misses
and errors.

Although there has been much written
on the topic, there has been little advance
in its theoretical basis since the late '90s
(Wiegmann et al., 2002). There is still a
lack of instruments to measure it and a
degree of ambiguity over definitions and
thus subsequent measurement. Nevertheless, a review of the literature
published in 2002 established several
commonalities among safety culture def-
initions (Wiegmann et al., 2002).

Safety culture:
- operates at the group level or higher
- is related to management and super-
visory systems
- emphasises a contribution from
everyone at every level of the work-
force
- has a relationship with members'
behaviour at work
- is reflected in the relation between
reward systems and safety perform-
ance
- is reflected in an organisation’s will-
ingness to develop and learn from
errors, incidents and accidents
- is relatively enduring, stable and
resistant to change

Based on these extracted common
themes a global definition of safety cul-
ture was proposed: “Safety culture is the enduring value and
priority placed on worker and public
safety by everyone in every group at
every level of an organisation. It refers
to the extent to which individuals and
groups will commit to personal respon-
sibility for safety; act to preserve,
enhance and communicate safety con-
cerns; strive to actively learn, adapt and
modify (both individual and organisa-
tional) behavior based on lessons
learned from mistakes; and be rewarded
in a manner consistent with these val-
es” (Wiegmann et al., 2002).
The literature highlights two particular attributes of safety culture, namely workforce involvement and management commitment. These are described below.

**WORKFORCE INVOLVEMENT**

The International Nuclear Safety Advisory Group (INSAG) states that two outcomes indicative of high safety culture are a just reporting culture where the workforce feel comfortable reporting incidents and near misses, and a culture where individuals are willing to challenge unsafe acts and conditions (INSAG, 2002).

It is likely that the only way to achieve this level of cultural maturity is to have a workforce involved in health and safety. Workforce involvement is essentially about workers’ control over their own safety.

Workforce involvement in safety takes several formal and informal forms including participating in risk assessments, safety audits and accident investigation, and discussing health and safety in meetings and ‘toolbox talks’.

 Provision of activities that increase involvement and the willingness of the workforce to become involved in safety initiatives can be influenced by supervisors and managers (Yule, 2005). For example, Simard & Marchand (1995) found that participative supervision and decentralised use of power by middle managers to be the best predictor of workers’ propensity to become involved in safety initiatives.

The outcomes of an involved workforce appear to be employ-ees who are more willing to take on personal responsibility for safety (Cheyne et al., 2003), engage in and are more aware of safety issues, and are more willing to rectify them.

**MANAGEMENT COMMITMENT (SAFETY LEADERSHIP)**

Management commitment to safety has been established as the main influence on workforce safety climate perceptions (Clarke, 2005, Finl et al., 2000). Published research on leadership per se currently favours the trans-formational approach which pos-poses that leaders build on rela-tionships with followers in order to achieve higher levels of perfor-mance than expected. The meaning of transformational leadership here is aiming to increase a team’s awareness of the safety aspects of the task and their importance, and getting them to focus on organisational goals rather than individual ones. The aim is also to be ‘visionary’ and set motivating and intellec-tually stimulating goals, and to be ‘inspirational’. Generally, transfor-mational leadership is correlated with ‘charismatic’ leadership, but this need not be the case.

Effective leaders are therefore vigilant and monitor perform-ance and stay in good communi-cation with their subordinates. They are able to identify mistakes, deviations from performance, and conditions that may endan-ger safety before they manifest as accidents. They also provide posi-tive verbal feedback for good per-formance (i.e. for capturing errors, reporting near-misses, speaking up). Transformational leaders pay strong attention to communica-tion and also articulate an appealing vision of the future. By doing so, they encourage employees to set aside personal gain in favour of longer-term suc-cess for the organisation. A grow-ing literature shows that transfor-mational leadership is significant-ly related to workers’ rule compli-ance and safety motivation (e.g. Batling et al., 2002; O’Dea, 2000), and has been shown to signifi-cantly reduce industrial injury rates (Zohar, 2002a; 2002b).

**SAFETY CULTURE AND SAFETY CLIMATE**

The terms safety culture and safety cli-mate have been used interchangeably in the literature (Cox & Flin, 1998). Denison (1996) states that the methods used by researchers can aid distinction between studies that have measured culture from those that have measured climate. He states that measuring culture requires qualitative methods whereas climate can be measured by quantitative methods and goes on to argue that quantitative measures such as questionnaire surveys cannot fully represent the underlying safety culture. These safety climate sur-veys offer a snapshot of the prevailing state of safety and are useful in deter-mining employee perceptions about safety in their organisation at a particular moment in time. In concurrence, Schneider (1990) argues that climate can only give a flavour and indication of the underlying culture, and cannot capture the ‘full richness’ of the organisational cul-ture. Cox and Cox (1996) also demon-strate this point by likening culture to personality and climate to mood. Some responses may be indicative of the indi-vidual’s stable underlying beliefs, values and personality but overall, the survey will reflect how the individual feels at that point in time. The comparison between culture and personality seems attractive because personality is relatively stable over time whereas climate and mood can be susceptible to short-term fluctuations (Pervin, 2003).

For this reason the focus in this report is on safety culture, not safety climate. However, when it comes to developing a robust measure of safety culture, as will be discussed at the end of the report, it is necessary to take heed of the experiences from the domain of safety climate. Nevertheless, before leaving safety cli-mate, there are several important insights for this report.

Much safety climate research has focused on perceptions of management commit-ment to safety (this mirrors safety cul-ture’s own focus on safety leadership, mentioned above). This is seen as an ever-riding or primary factor. Perceptions of management commitment to safety are moderated by supervisor actions which would imply that safety climate should be relatively similar within work groups therefore indicating that safety climate should be operationalised at the group level (Zohar, 2000). A ‘group’ for ATM could represent a particular shift of controllers. More recently Zohar & Luria (2005) have argued that safety cli-mate also exists at the organisational level whereby workers across an organi-sation should have relatively homoge-nous (effectively the same) perceptions of top management’s commitment to safety if the organisation has good safety cli-mate. This would suggest that different controller shift teams at the same Air Traffic Control Centre for example would have the same perceptions about commit-ment to safety from top management.

Other researchers have also found that the level of an organisation’s safety cul-ture influences an individual’s risk judg-ments (Adie et al., 2005), and that safety culture perceptions are different at differ-ent levels of an organisation and person-nel categories (Ek & Arvidsson, 2002; Ek, Arvidsson, Akselsson, Johansson, &Josefsson, 2003). Also, there is some evi-dence that training significantly predicts safety culture (Arboleda, Morrow, Crum, & Shelley, 2003).

The key insight here is that for investiga-tion and measurement of safety culture the group becomes the reference point, and ‘group’ can mean a group of con-trollers, technicians, or can refer to the supervisory layer or middle management, or top management. This suggests that to understand safety culture in an organi-sation it will be necessary to sample from groups or personnel at different ‘levels’ in the organisation.

The further implications from Zohar’s work concern how values and attitudes about safety are learned by people in an organisation. Employees are informed about the possible consequences of safe or unsafe behaviours by paying attention to overt statements and actions by man-
As has been presented earlier, safety climate measures have used questionnaires. However, within other disciplines of psychology, such as the personality literature, there have been attempts made to move away from self-report questionnaires, which can be heavily influenced by impression management (trying to make a good impression of oneself) and social desirability (wanting to be liked/accepted by one’s peers/others). These two influences could play a role in industry when trying to measure safety culture as often individuals are aware of the correct answer and adjust their position accordingly or portray an image of the person they would like to be as opposed to what they actually are. Furthermore, how accurately can an individual appraise themselves? Can they make an informed judgement of their behaviour? For this reason reliance on questionnaires alone is not recommended for safety culture investigation or measurement.

As has been presented earlier, safety climate can be regarded as the indicator of the organisation’s safety culture as perceived by employees at a point in time (Cox and Flin 1998). However, in reality the terms are not so clear cut, with many writers using the terms safety culture and safety climate interchangeably. To avoid further confusion between the two concepts, only safety culture will be referred to for the remainder of the Report.

SALFETY CULTURE AND SAFETY MANAGEMENT

’Safety Management’ has also emerged as a concept and safety discipline in its own right in recent years. In general, research has often failed to distinguish between Safety Management and Safety Climate/Culture. Kennedy and Kirwan (1998) suggest that Safety Management should be regarded as “a documented and formalised system of controlling against risk or harm.” Arguably Safety Management has always existed in ATM, because it cannot have been so safe for so long by pure chance or will alone. However, Safety Management in the past may have been a more implicit process or set of procedures. More recently though, and in line with ATM itself becoming more complex and interactive, Safety Management now refers to more explicit procedures and processes to achieve safe operation and output.

ANSF organisations are therefore now required to have a Safety Management System (SMS) implemented in the organisation compliant with ESARRs (ESARR 3). The requirements are designed to act as the basis for safety management focus and control as well as enabling outside audit of the SMS implementation. Safety Management, however, is ‘normative’ in approach – it refers to how things should work, but as we all know, procedures are not always followed, for good or poor reasons. Therefore, however good the safety management system of an organisation is, the way it exists on paper does not necessarily reflect the way it is carried out in practice. It is the safety culture of the organisation which will influence the deployment and effectiveness of the safety management resources, policies, practices and procedures” (Kennedy and Kirwan, 1998). Put simply, it is the relationship between Safety Management Systems and Safety Culture, since the former are already in use in ATM, and any model of safety culture and its resultant elements should ideally be ‘concordant’ with elements used by SMS approaches.

CORE ELEMENTS TO BE CONSIDERED IN A MODEL

When considering ‘soft’ concepts such as culture, understanding must work from visible behaviour shown by groups of individuals right through to basic assumptions held by these groups as portrayed in Figure 1 (based upon Schein, 1992). This understanding is particularly relevant when attempting to develop means by which safety culture can be identified and measured.

UNCONFRING HOW SAFETY CULTURE WORKS USING MODELS

When trying to understand something, it is often useful to develop a model that explains how something works, and what its main elements or features appear to be. Such a model (in this case safety culture in ATM) then clarifies what exactly is being studied (so there is no confusion between e.g. safety culture and other related concepts such as Safety Climate or Safety Management Systems), and can facilitate the development of measures, intervention approaches and guidance material. This section therefore explores a potential model of safety culture in ATM.

First, however, it is necessary to discuss the relationship between Safety Management Systems and Safety Culture, since the former are already in use in ATM, and any model of safety culture and its resultant elements should ideally be ‘concordant’ with elements used by SMS approaches.

Safetv Managers are mainly interested in safety behaviour: what people will do in certain situations that may come to pass. Safety culture theory, however, tells us that the behaviour of individuals is influenced by the values of their superiors (particularly management) and, peers, and the basic assumptions they have about how safety works in their organisation. Values may be those ‘espoused’ by management (the ‘talk’), or actual acts (e.g. praising someone for raising a safety issue) which can also be seen as ‘symbols’ because they are visible (the ‘walk’).

Hence the phrase ‘walking the talk’ (meaning management don’t just talk about safety, they do visible things about it).

There are several areas of Schein’s (1992) model that are worthy of note:

- Culture is about shared assumptions and can only be understood in a group setting
- Outsiders notice characteristic ‘symbols’ and can question underlying reasons, but only insiders can understand the full context. But since ‘insiders’ don’t tend to notice these as symbols, because they may have become routine, both perspectives are needed to decipher culture.

When trying to investigate safety culture in an organisation, there are therefore several ways forward based on this model:

- Start with symbols which are characteristic for the issue in the culture
- Search for espoused values by asking “Why do you do it like that?”
- Dig for basic assumptions by asking if values explain all symbols. Are there conflicts or anomalies?
- Sort cultural assumptions into those supporting and constraining the desired performance or objective. Is there group consensus on that?
- If basic assumptions must change to achieve the desired result, expect great investment in time and effort.

As an example, the model developed by Oshri et al. (2006) is an adaptation of the model presented by Kirwan and Kennedy (1997). This model is developed based on empirical data and is used to study the relationship between safety culture and safety climate in ATM. The model consists of four levels:

1. Visible Expressions (e.g. Management Actions)
2. Espoused Values (What is Said)
3. Basic Assumptions (What is Believed)
4. Core Elements (What is Done)

The model is illustrated in Figure 1. The relationship between Safety Management Systems and Safety Culture, since the former are already in use in ATM, and any model of safety culture and its resultant elements should ideally be ‘concordant’ with elements used by SMS approaches.

In this model, Safety Management Systems are not only the basis for the development of Safety Culture, but also the means for the deployment and effectiveness of the SMS implementation. The model suggests that Safety Management Systems are not only the basis for the deployment and effectiveness of the SMS implementation, but also the means for the deployment and effectiveness of the SMS implementation. The model suggests that Safety Managers are mainly interested in safety behaviour: what people will do in certain situations that may come to pass. Safety culture theory, however, tells us that the behaviour of individuals is influenced by the values of their superiors (particularly management) and, peers, and the basic assumptions they have about how safety works in their organisation. Values may be those ‘espoused’ by management (the ‘talk’), or actual acts (e.g. praising someone for raising a safety issue) which can also be seen as ‘symbols’ because they are visible (the ‘walk’).
The above model of culture is a descriptive model, and it gives us the major core elements, but it is ‘static’. What is needed is a more ‘dynamic’ model that will help to see how safety culture can be improved, leading to improved safety behaviour.

Therefore, as well as the components, knowledge of the ‘dynamics’ of the safety culture is crucial in order to monitor, measure, control and improve the safety culture. A tailored “Dynamic Safety Culture Model” was developed based on Mary Joe Hatch’s (1993) dynamic culture model as presented in Figure 2. The specific aim of a dynamic culture model is to present an example of the dynamics of culture allowing for an understanding of the potential for change.

Safety communication is introduced as an underlying prerequisite for all dynamic culture changes. The ability to communicate assumptions and values is an important enabler for achieving shared perceptions, assumptions and values. Sources for safety culture are integrated into the model to demonstrate that there will be basic prevalent assumptions and values independent from the organisational assumptions and values. Safety climate is encompassed in this model representing the process of behaviour reflecting commitment to safety, but perceived by the employees based on their cultural background.

ORIGINATORS OF SAFETY CULTURE

An important assumption in the model is that safety culture has one or more originators. The safety culture originators will often be education, training, professional background, national identity, group identity etc. An important task is to analyse the clash between the original safety culture and the safety culture created by the organisation (if any).

Furthermore, an attempted safety culture change will have an initiator focusing most often on the behaviour; the symbolic elements or the original culture originators. However, dynamics in safety culture can also be initiated by shifts in assumptions and values among members of groups.

VISIBLE AND INVISIBLE LAYERS

The model works with a visible and an invisible layer. Behaviour and symbols represent the visible layer and assumptions and values represent the invisible layer. Thus in order to assess a specific safety culture, it is important to observe the behaviour and symbols while trying to learn about the assumptions and values. The process of assessing the underlying values and assumptions represents an interpretation phase. The result is therefore subjective and highly dependent on the values and assumptions of the person doing the interpretation.

EXAMPLE OF THE MODEL: THE NAVIAIR REPORTING SYSTEM

“In 2001, a new law was passed by the Danish Parliament, mandating the establishment of a compulsory, strictly non-punitive, and strictly confidential system for the reporting of aviation incidents. A particular and perhaps unusual feature of this reporting system is that not only are employees (typically ATCOs and pilots) encouraged to report all incidents because of fear of sanctions and a very aggressive press related to the number of official incident reports which indicated “failure reports” by employees. This fear was substantiated by benchmarking results with Sweden (LFV) which showed that the number of official safety incidents reported (approx. factor 3).”

NAVIAR - Peter Majgård Nørbjerg, 2002.

The implementation of the reporting system in NAVIAIR that embraced the new legal framework is well documented and provided a good example for the purpose of testing the model presented above.

Figure 3 depicts the example in the context of the dynamic safety culture model.

RESULTS

The safety culture is improved by strengthening a just, reporting, informed, and learning culture. The reporting system becomes a formal focal point for shared assumptions and values enacted into consistent behaviour. The enactment provides basis for better incident analyses, trend assessments and potential for improvement which ultimately improves safety.

Figure 2. Dynamic Safety Culture Model adopted from Hatch, 1993

Figure 3. NAVIAIR Reporting System (in the context of the Dynamic Model for Safety Culture)
DEVELOPING A SAFETY CULTURE SURVEY FOR ATM

The previous chapters have considered safety culture from a research perspective. This section now attempts to link the theory to practice and experience in four European ANSPs. The model (based on Hatch, 1993) was used to define questions that could be asked at different levels in four different ANSPs to ascertain how safety culture worked in individual ACCs.

As will be seen, this led to insights on safety culture and its importance, and laid the foundation for a safety culture measurement system, safety culture guidance, and improvement approach. It also led to a simplification of the cultural models discussed above.

SURVEY SCOPE

It was decided to survey four ANSPs that were geographically disparate, which would also tend to give them different cultural traits according to geographical diversity on the European map. Figure 3 shows that there are many facets to culture, from the level of the operational element (the Team), to the regional and national level influences and nuances that will affect culture.

Within this study, people inside an ACC organisation were interviewed so, at most, this covered the first three inner rings in Figure 4. Regional and national differences were therefore not under investigation in this phase of the investigation of safety culture. However, the fact that four disparate ANSPs were investigated means that the results as a whole will tend to be more generic than if focusing on a single ANSP or culturally homogeneous part of Europe (e.g. focusing only on Scandinavia, or North-West Europe, or the Latin countries, etc.). Nevertheless regional and national cultural aspects can be important (Guldentum, 2000) and so it is planned in a later phase to expand the number of participating countries.

EXPERT INPUTS TO SURVEY DESIGN

If the development of safety culture surveys in ATM and other industries is used as a reference point, it can be seen that the generation of the survey items can often take many months in itself. When starting to develop a survey from scratch, the methodology that is usually adopted in the running of ‘focus groups’. Focus groups are an approach where the workshop participants hold different organisational functions or job roles. This interaction of different roles allows a wide perspective to be adopted in the identification of the items for the survey.

However, there was not the availability of time and resources in the project to support such an approach. Therefore, in order to supplement the information derived from the literature review, the project team combined their experience in safety culture surveys with their experience of ATM operations, in order to arrive at the initial set of items for the survey. The mechanism to achieve this was a brainstorming session between the specialists in the project team in order to generate the safety culture survey items.

IDENTIFYING SAFETY MANAGEMENT SURVEY ITEMS

A crucial part of the design of the survey was to determine the means by which safety culture and safety management factors could be related to one another. If this was not done, it would be likely to lead to confusion between the two approaches, and it would also be hard to show where safety culture could underpin or support Safety Management Systems. The way in which this can be achieved ‘theoretically’ was described in Section: A Review of Safety Culture for ATM through the development of the Safety Culture Model. However, this relationship needed to be established at a ‘practical’ level in terms of how the items on the survey were related to SMS aspects. In effect there were three inputs to this process: i) ESARR 3 elements - the ‘official’ SMS elements; ii) DNV `River Diagram’ Approach - a multi-industrial set of SMS elements; iii) EEC Safety Climate Survey (Gordon et al, 2004) - a set of safety climate elements strongly aligned to safety management.

From these three sets, the following twelve main SMS elements were derived to structure the questionnaire. Examples of the survey questions structured according to these SMS elements are found in Annex A.

• Policy
• Planning
• Safety Organisation
• Regulation and Standards
• Safety Assessment
• Safety Surveys
• Training and Competence
• Infrastructure and External Services
• Safety Documents
• Operations and Work Controls
• Safety Occurrence Reports
• Reward / Incentive Systems

DETERMINING SAFETY CULTURE QUESTIONS AND PROMPTS

Safety culture theory suggests that to understand the mechanics of safety culture, that is, why it is working and how it can fail, it is necessary to see how organisational practices project their safety image (through what they say and do behaviours and symbols, and how that image is perceived via assumptions and values). However, when talking to controllers and managers at ACCs, such psychological terms may not be clearly understood, and indeed there can be confusion between these terms even amongst psychologists. Therefore questions must be asked about concrete issues as may appear as SMS elements, such as safety reporting, safety assessment, working practices and safety issues, safety resources etc. The answers to questions on these aspects can then be interpreted by safety culture analysts to identify underlying assumptions, values, etc., and to show where safety is working and where it is not, and how it is failing. It is this latter point that is key: it is often very easy to see a poor safety culture, but quite another matter to discern how to put it right. This is because the problems are often at the ‘invisible’ or cultural layer (e.g. differing assumptions between controllers and management). This section therefore explains what was done in the survey, what was found, and how it can help us to understand ‘the’ safety culture problems. As will also be seen at the end of the section, the basic psychological aspects of safety culture in any case can be reduced to a more understandable, communicable and therefore ultimately a more usable approach.

In the surveys described in the next section, a link needed to be made between an SMS area and indicator based survey, and the Dynamic Safety Culture Model. When asking questions based on the SMS indicators in ANSPs, the answers described examples of how the organisation worked with and committed to safety (as perceived by the respondent). The survey questions featured a series of follow-up questions formulated in ‘SMS language’. An example of the question approach for part of an SMS area is as follows.

Many questions were asked, based around SMS areas as identified earlier. Note that it is up to the respondents to provide the context in the answer. The analysts were searching for examples (stories) or evidence of safety culture in action, whether functional or dysfunctional. Follow-up questions and later analysis would then focus on interpreting the answers in terms of the symbols or symbolic behaviour and the analysis of the respondents’ interpretation of such symbols/behaviour to show their assumptions and values (detailed examples are given later).

These were developed to help elicit the safety culture information. Essentially the questions and prompts attempt to achieve elicitation of the following items:

 Verify safety culture dimensions relevant to the ANSP
 Identify factors working effectively or not
 Relate safety culture factors to Safety Management Systems
 Document episodic indicators from ANSPs (i.e. stories about safety culture)
 Identify ways to improve safety culture.

Figure 4. Organisational Layers Considered in Survey Content

DEVELOPMENT OF THE SAFETY CULTURE SURVEY TOOL

LITERATURE INPUTS TO SURVEY DESIGN

Key references for the development of the survey approach appropriate to ATM included EUROCONTROL (Gordon et al, 2004), and Swedish studies on safety climate (Erik et al, 2002; 2003). Outside of aviation and ATM there are various studies that were consulted including those performed in the oil and gas industry (see Meaburn et al, 2003 and 2004) and a number of landmark nuclear power studies (see Lee, 1993; ACSNL, 1993; IAEA, 1994).

Figure 4. Regional and National Organisational Layers Considered in Survey Content
SAFETY CULTURE SURVEY ADMINISTERING THE SURVEY

The survey items acted as prompts in order to explore safety culture issues in the semi-structured interview format. This was usually two interviewees to one respondent, allowing one interviewer to ask the questions, the other to take notes and seek clarification. This format also helped with analysis later. Some group interviews also occurred, e.g. a small group of supervisors or controllers interviewed together. The interviews at each ANSP were spread over two to three days. People were selected from operational levels (i.e. controllers, technical support and maintenance), supervision and line management, and upper management levels (e.g. director level). Table 1 shows the number and type of personnel interviewed at the four ANSPs.

ANALYSING, INTERPRETING AND SUMMARISING THE DATA

The transcripts (undertaken online) from the interviews were initially documented in a word document in free-format. The analysis process was as follows:

Documenting and Sorting - the analyst identified and highlighted phrases in the interview scripts that helped to explain how the safety culture worked in the ANSP. For each ANSP, the analyst combined the highlighted phases and categorized them according to similar themes.

Interpretation - using the responses and the inherent ‘stories’ or evidence to determine symbols, behaviours, assumptions, and values (espoused and actual), and relate these to how safety culture might be undermining or supporting safety management.

Re-structuring of Data - using the model, the information was re-constructed to show how safety culture was working, and how it was failing. This also enabled the identification of measures to improve safety culture where it was being ‘disabled’. Examples of safety culture ‘enablers’ could also be identified, constituting good practice.

Re-evaluation of the Model - The analysis was useful in identifying the enablers and disabled and re-constructing the issues, leading to suggestions for safety culture improvement. However, the allocation of responses into symbols and behaviours, and into assumptions and values, was not so clear-cut. In terms of a method it has two problems: I) classification was not robust enough, and II) the terms used (e.g. symbol, value, assumption etc) were not felt to be clear and concrete enough. The method was more a psychologist’s tool rather than a tool that could be used by people inside an ANSP. Therefore the model has been simplified as described in Section: Refinement of the Safety Culture Model: Safety Culture Enablers and Disablers.

The results are in four main sections:

‘Disablers’ are those factors that prevent development of a positive safety culture, while ‘Enablers’ facilitate the process.

SAFETY CULTURE ELEMENTS

The various interview results were pooled to generate a large list of issues. Several of the analysts were involved in clustering these in to a set of comprehensive safety culture elements. These are defined in Tables 2.1-2.5, and are exemplified by extracted statements from the interviews.

RESULTS OF SAFETY CULTURE SURVEY

The results are in four main sections:

- the first showing a set of safety culture elements that can be the basis for a safety culture measurement tool
- the second showing the principal links between the safety culture and safety management elements
- the third showing the refinement and simplification of the safety culture model
- and the fourth developing evidence of safety culture enablers and disablers.

<table>
<thead>
<tr>
<th>Level</th>
<th>ANSP1</th>
<th>ANSP2</th>
<th>ANSP3</th>
<th>ANSP4</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Supervisor</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Operational</td>
<td>8</td>
<td>7</td>
<td>10</td>
<td>7</td>
<td>32</td>
</tr>
<tr>
<td>Technical/support</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>11</td>
<td>14</td>
<td>16</td>
<td>53</td>
</tr>
<tr>
<td>Individual Interviews</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Group Interviews</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 1 - Interviewee type at each ANSP

Finally, in order for interviewees to feel comfortable and free to respond openly in their interviews, there needed to be an emphatic and clear approach defined to address confidentiality of participant’s responses and any associated data issues. Interviewees were assured that their responses would be treated in confidence, where both individuals and organizations have been made anonymous in the report write-up.

The required budget for doing the job is always available

Table 2.1-2.5 - Safety Culture Elements, Sub Elements and Examples of Phrases from Interviews

1. SAFETY MANAGEMENT COMMITMENT

<table>
<thead>
<tr>
<th>DISABLER EXAMPLES</th>
<th>ENABLER EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority of safety</td>
<td>Responsibility for safety</td>
</tr>
<tr>
<td>Sometimes the goal is to handle heavy traffic</td>
<td>It is the responsibility of staff to read the new procedures in their own time</td>
</tr>
<tr>
<td>People are pulled between safety and delivering a service</td>
<td>There is no official safety department</td>
</tr>
<tr>
<td>There is no separate safety department</td>
<td>People feel they are responsible</td>
</tr>
<tr>
<td>Responsibility is a proactive participation by staff, it cannot be dictated by management</td>
<td>The SMS has brought the focus on personal responsibility</td>
</tr>
<tr>
<td>Personal goal of zero losses of separation is realistic</td>
<td>Responsibility is a proactive participation by staff, it cannot be dictated by management</td>
</tr>
</tbody>
</table>

Resources for safety

- The financial situation does not allow for the role of a safety manager
- There are insufficient resources to carry out safety cases, despite a formal SMS being in place
- The previous manager’s focus was on no delays. The focus now is to maintain safety levels
- The Manager writes a monthly intranet letter and finishes with “better safe than sorry”
### 2. TRUST IN ORGANISATIONAL SAFETY COMPETENCE

<table>
<thead>
<tr>
<th>DISABLER EXAMPLES</th>
<th>ENABLER EXAMPLES</th>
</tr>
</thead>
</table>
| Trust in safety process | • We’re producing safety cases but we’re not doing local housekeeping  
| | • The SMS is developed but not yet implemented  
| | • The SMS structure is not supporting us  
| | • There are not enough simulations to test the new procedures  
| | • I did not trust the simulator people. They told us it would be easy, but it did not make sense. They did not listen to us |
| | • The right people (experienced and current controllers) are involved in safety assessments  
| | • Periodical system check in maintenance are carried out where a preventative culture is encouraged among maintenance staff  
| | • A report highlighting system problems is given to the manufacturer. These are loaded onto the simulator to check they have been rectified |
| Regulatory effectiveness | • Separation of regulator and ANSP would allow more formal auditing  
| | • There is a lack of communication between the ANSP and the regulator |

### 3. INVOLVEMENT IN SAFETY

<table>
<thead>
<tr>
<th>DISABLER EXAMPLES</th>
<th>ENABLER EXAMPLES</th>
</tr>
</thead>
</table>
| Communication about changes | • New procedures are issued by staff notice  
| | • Office notices are not an effective way to communicate, as there is only one accessible computer with the information and no verification that controllers understand  
| | • People sometimes forget to do the computer-based briefing before shift |
| | • A safety briefing from the station manager to the team outlines new staff notices, new activities, restrictions etc  
| | • For big changes, controllers are given training in simulations  
| | • Maintenance engineers communicate with controllers before touching a system |
| Communicating problems (speaking up) | • We have no-one to complain to. The ‘open door’ policy does not exist  
| | • Some people can be difficult to talk to about their mistakes  
| | • Controllers are less willing to speak up (about improvements to systems) as they are not listened to  
| | • I feel able to discuss with colleagues if they do something wrong  
| | • There are clear reporting lines when there is a failure  
| | • We discuss working methods during “team meetings” to collect ideas for improvement  
| | • Debriefing and report from the team meetings are given to management |
| Involvement of ATCOs in safety | • Controllers’ involvement in safety assessments is for show  
| | • Designers do not listen to controllers opinions  
| | • I do not feel responsible or involved in new changes  
| | • Controllers’ proposals are taken into consideration  
| | • There is controller input into the design of the system, which ensures user requirements are addressed |
| Management involvement in safety | • Controller briefing by management is there to cover management’s backs - controllers are just told to read the notices  
| | • Briefing by station manager is not very complete  
| | • Management ask about incident trends, and they communicate the message that we need to improve safety |
| Working with contractors | • The external services/supplier did not want to help. Their focus was on selling  
| | • The relationship with the ATM system manufacturer improved when operations worked directly with them |
| | • Informal relationships with contractors helps the work |
### 4. ATCO SAFETY COMPETENCE

<table>
<thead>
<tr>
<th>ATCO competence</th>
<th>DISABLER EXAMPLES</th>
<th>ENABLER EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Competency is only called into question when there is an incident.</td>
<td>We have annual theoretical and practical tests yearly.</td>
</tr>
<tr>
<td></td>
<td>Controllers still make errors, even good controllers might not know everything they should.</td>
<td>You have to pass stringent tests to become a controller.</td>
</tr>
<tr>
<td>Team effectiveness</td>
<td>You have to learn a new way of working when you change teams (which can be difficult if the team is not relaxed).</td>
<td>We ask for help when it’s busy.</td>
</tr>
<tr>
<td></td>
<td>Some controllers are easier to work with than others (with regard to working style).</td>
<td>We don’t leave a position vacant if someone might need a break.</td>
</tr>
<tr>
<td></td>
<td>There is a lack of fallback training and emergency training.</td>
<td>Supervisor puts those people together who work well.</td>
</tr>
<tr>
<td></td>
<td>Computer-based training was not enough to train controllers in using the new system.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Need to improve training using results from incident reports.</td>
<td></td>
</tr>
<tr>
<td>Training for safety in ATC</td>
<td>There is a lack of proactive safety analysis.</td>
<td>Training strongly enforces safety.</td>
</tr>
<tr>
<td></td>
<td>Having to feed the system all the time means that we can lose the picture.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Controllers sometimes have to go around the edge of procedures to do their job.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATC performance in approach and departures is close to minima.</td>
<td></td>
</tr>
</tbody>
</table>

### 5. A JUST REPORTING AND LEARNING CULTURE

<table>
<thead>
<tr>
<th>Error tolerance, blame &amp; punishment</th>
<th>DISABLER EXAMPLES</th>
<th>ENABLER EXAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>People make mistakes, but here you’re not supposed to.</td>
<td>Management believe that it is human to make errors.</td>
<td></td>
</tr>
<tr>
<td>Some people don’t report because they believe they might get blamed.</td>
<td>We have a no-blame culture where staff are encouraged to report all incidents.</td>
<td></td>
</tr>
<tr>
<td>There is a lack of consistency across the organisation with regard to discipline and re-training.</td>
<td>We learn from incidents - controllers do not feel punished.</td>
<td></td>
</tr>
<tr>
<td>Rewards &amp; incentives &amp; Performance appraisal</td>
<td>We never get praise for doing the job without incidents.</td>
<td>Controllers reward each other for difficult performances.</td>
</tr>
<tr>
<td>People resent the financial bonus as it is based on a self-performance appraisal.</td>
<td>Maintenance is appreciated for no loss of control.</td>
<td></td>
</tr>
<tr>
<td>Our performance appraisals are not relevant to our job.</td>
<td>Engineering has safety goals as personal performance goals.</td>
<td></td>
</tr>
<tr>
<td>Reporting (and investigating) incidents</td>
<td>It is not in our character to report incidents.</td>
<td>Controllers are encouraged to report in order to see trends and make changes.</td>
</tr>
<tr>
<td>We’re not supposed to report minor incidents, things that cannot be noticed.</td>
<td>We have trust in the confidentiality of the incident reporting process.</td>
<td></td>
</tr>
<tr>
<td>We don’t have formal incident reporting forms (only the ICAO minimum requirements).</td>
<td>Supervisors receive training in discussing incidents with controllers.</td>
<td></td>
</tr>
<tr>
<td>We need to have proactive safety analysis (to point out what could go wrong).</td>
<td>Traffic replay is used (supervisor prepares themselves by replaying it alone first).</td>
<td></td>
</tr>
<tr>
<td>Learning from incidents</td>
<td>Follow-up can be very slow.</td>
<td>Supervisors take on the remedial actions.</td>
</tr>
<tr>
<td>There is a lack of organisational learning from feedback on system problems reported - feedback is only given to the shift or individual.</td>
<td>They have case examples of incidents to show other controllers (with the controllers permission).</td>
<td></td>
</tr>
<tr>
<td>There is no feedback from incident analysis; neither on information dissemination nor actions taken.</td>
<td>We complete the reporting form ourselves and tell our colleagues what happened and what should be done.</td>
<td></td>
</tr>
<tr>
<td>Safety issues are generally discussed, but no forms are completed.</td>
<td>Quick feedback on incidents is provided to controllers.</td>
<td></td>
</tr>
<tr>
<td>Training and feedback on incidents would make our job less stressful.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
These elements therefore capture the safety-related safety culture aspects from the interviews at the four ANSPs, and could act as the basis for a safety culture measurement tool for European ATM. As discussed earlier though, it is useful to understand links between such elements and SMS elements. Otherwise there is a risk of confusion between the two areas, which would inevitably lead to disagreement over what matters (e.g. the significance of safety culture problems) and how best to tackle it (strengthening of SMS or safety culture improvement measures).

RELATING SAFETY CULTURE AND SAFETY MANAGEMENT ELEMENTS

Although in the development of the survey method a 12-element SMS model was utilised, in this section a 16-element SMS system (an adapted ‘River Diagram’ approach, mentioned earlier) is used because this more elucidated set of SMS elements enables a more precise matching between safety culture and SMS. A matrix showing the principal links between safety culture elements and SMS elements is shown in Table 3.

<table>
<thead>
<tr>
<th>Safety Culture Elements (identified during ANSP survey)</th>
<th>SMS Elements (from the River Diagram)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Safety Management Commitment</td>
<td>Priority of safety</td>
</tr>
<tr>
<td></td>
<td>Responsibility for safety</td>
</tr>
<tr>
<td></td>
<td>Resources for safety</td>
</tr>
<tr>
<td>2. Trust in Organisational Safety Competence</td>
<td>Trust in safety process</td>
</tr>
<tr>
<td></td>
<td>Regulatory effectiveness</td>
</tr>
<tr>
<td>3. Involvement in Safety</td>
<td>Communication about changes</td>
</tr>
<tr>
<td></td>
<td>Communicating problems (speaking up)</td>
</tr>
<tr>
<td></td>
<td>Involvement of ATCOs in safety</td>
</tr>
<tr>
<td></td>
<td>Management involvement in safety</td>
</tr>
<tr>
<td></td>
<td>Working with contractors</td>
</tr>
<tr>
<td>4. ATCO Safety Competence</td>
<td>ATCO competence</td>
</tr>
<tr>
<td></td>
<td>Team effectiveness</td>
</tr>
<tr>
<td></td>
<td>Training for safety in ATC</td>
</tr>
<tr>
<td></td>
<td>Procedures &amp; working practices</td>
</tr>
<tr>
<td>5. A just Reporting &amp; Learning Culture</td>
<td>Error tolerance, blame &amp; punishment</td>
</tr>
<tr>
<td></td>
<td>Rewards &amp; incentives &amp; performance appraisal</td>
</tr>
<tr>
<td></td>
<td>Reporting (and investigating) incidents</td>
</tr>
<tr>
<td></td>
<td>Learning from incidents</td>
</tr>
</tbody>
</table>

Table 3. Matrix of Safety Culture elements that can affect SMS Elements
REFINEMENT OF THE SAFETY CULTURE MODEL

As described in Section: Safety Culture Survey Analysing, Interpreting and Summarising the Data, classifying the data using the terms in the Hatch (1993) model, such as symbols, behaviours, assumptions and values, was not robust enough and it was thought the method was more a psychologist’s tool, rather than a tool that could be used by people inside an ANSP. Therefore a simplified safety culture model has been developed. The essential elements have been identified as the following:

- What is BELIEVED
- What is SAID
- What is DONE
- The OUTCOME

These simpler categories are less confusing and easier to communicate to stakeholders. Nevertheless, they do encapsulate the key ingredients of a dynamic model of safety culture: what is believed includes assumptions and values; what is said includes symbols and behaviour; what is done is behaviour; and the outcome includes behaviours, values and assumptions. The resulting ‘model’ is shown in Figure 5.

This model can therefore still search for stories and evidence of safety culture, but it is easier to focus on what is said, typically by management (the espoused values), and then determine whether the perception (or reality) is that the management ‘walk the talk’ or not. With respect to what is done and what is believed, this is often where the digression begins, for example between one group and another. This may be represented by one group (e.g. management) believing one thing and another group (e.g. ATCOs) believing another. The outcome shows whether it matters or not.

RELATING SAFETY CULTURE TO SAFETY MANAGEMENT ASPECTS

In this example we see that several SMS aspects are affected. Incident reporting is likely to be affected, and so is the chance for organisational learning. The management in contrast will see low incident reporting as positive, because they believe performance can be error free. Safety assessment is also likely to be separated organisationally from incident analysis, and even if it is not, it will be able to deduce little, because most likely there will not be detailed incident investigation nor searching for root and systemic causes (because the controller ‘just got it wrong, so re-train him’). Policy, note, is not overtly affected, because the policy may well state what the top management say - but of course then it is a misrepresentation of the safety reality in the organisation.

Yet the impact on trust, on belief that safety is taken seriously and belief in the SMS, will be greatly undermined. This impact is harder to gauge but it is clearly an undesirable impact and is non-benign in terms of safety culture.

This example shows an example of one safety culture disabler, using the refined model (in the previous model the key aspect is a difference between management and controller assumptions: the former believe error-free performance is possible, the latter do not). The utility comes however from pin-pointing where the root of the problem lies, in this case at the belief level and the action level. Management need to be persuaded that even very good controllers may have incidents, particularly when they are trying to finely balance safety and management goals of efficiency and productivity, in sometimes complex air traffic situations. They need to understand that having no incidents and in-depth analysis means that you do not know what may be around the corner.

Having shown an example of the approach, the following section gives more re-constructed examples of the enablers and disablers that were found, and the types of safety culture issues that arose during the safety surveys.
SAFETY CULTURE ENABLERS AND DISABILERS

The idea of these examples is to show how safety culture actually works, or can fail, within an ANSP. The examples focus mainly on two groups, management and workforce, the latter usually referring to the ATCO level. Arguably there is at least a third intermediate level for supervisors (when discussing an ACC), but their mediating role in safety culture is not yet clear, nor was it clarified by the surveys. In general, if the management and controllers share the same beliefs about safety and behave accordingly, this pattern usually reflects positive safety culture although it could also reflect negative safety culture if the issue being considered is something such as shared amongst both management and operations. Where management and controllers do not share the same beliefs about safety or their behaviours are in opposition, this pattern reflects negative safety culture and its associated dis-enablers. The following examples are used to illustrate the above propositions in greater detail.

Examples of Safety Culture Enablers

1. SAFETY OCCURRENCE REPORTS: DEVELOPING A CULTURE OF TRUST

Management and controllers believe in incident reporting and trust each other in order to learn from incidents.

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>MANAGEMENT</th>
<th>OPERATIONAL STAFF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>● Both controllers and management believe they should submit reports of all occurrences.</td>
<td>● Not known.</td>
</tr>
<tr>
<td></td>
<td>● Both controllers and management believe human errors exist and reports are an important basis for learning and improving safety.</td>
<td>● The senior instructors’ activities are accepted by the controllers as a professional approach to safety.</td>
</tr>
<tr>
<td></td>
<td>● Controllers and management trust each other and a just culture where occurrences are reported exists.</td>
<td>● Based on best and worst practice it is possible to develop new and better procedures.</td>
</tr>
<tr>
<td>What was DONE</td>
<td>● Management do not punish those who report, instead that are supported and the report is addressed.</td>
<td>● To share best and worst practice among ATCOs.</td>
</tr>
<tr>
<td></td>
<td>● The ATCO reports the incident to the supervisor and they discuss the incident.</td>
<td>● Shared beliefs strengthening the subculture identity and improving safety.</td>
</tr>
</tbody>
</table>

2. SAFETY GOALS AS PERSONAL PERFORMANCE GOALS

Engineers are given individual performance goals that relate to the system level performance goals with the aim of increasing the safety of the ATM service.

<table>
<thead>
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<tbody>
<tr>
<td></td>
<td>● The organisation views safety as being as important as any other goals for the ATM service. To achieve high capacity is not sufficient alone; adequate levels of safety also need to be achieved.</td>
<td>● To prioritise safety as the key parameter.</td>
</tr>
<tr>
<td></td>
<td>● Safety is seen to be treated by management as an important determinant of performance among staff. Through the formal evaluation and appraisal system, the organisation recognises that safety goals are at least as important as capacity goals (e.g. engineers are required to check radar information regularly in order to estimate position errors).</td>
<td>● If an ANSP does not ensure safety as a primary goal, it will face serious problems.</td>
</tr>
<tr>
<td>What was BELIEVED</td>
<td>● To share best and worst practice among ATCOs.</td>
<td>● Controllers remember the motto and take it seriously.</td>
</tr>
<tr>
<td>What was DONE</td>
<td>● The organisation views safety as being as important as any other goals for the ATM service. To achieve high capacity is not sufficient alone; adequate levels of safety also need to be achieved.</td>
<td>● The chief of centre consistently ends newsletters and communiqué with the sentence “Better safe than sorry”. In addition, his daily enactment supports the statement.</td>
</tr>
<tr>
<td>OUTCOME</td>
<td>● The common culture and cooperative identity is strengthened around the common goal/value. ATCO feels supported by management when they prioritise safety over other goals.</td>
<td>● Controllers remember the motto and take it seriously.</td>
</tr>
</tbody>
</table>

3. LESSON DISSEMINATION OF SAFETY OCCURRENCE REPORTS

There is an initiative from operations to share information about incidents with each other, without encouragement from management. In this situation, to improve the organisational learning, management would need to take a more active role in lesson dissemination.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>● Not known.</td>
<td>● Not known.</td>
</tr>
<tr>
<td>What was BELIEVED</td>
<td>● The senior instructors’ activities are accepted by the controllers as a professional approach to safety.</td>
<td>● A senior instructor from the training department develops presentations of occurred incidents, discusses them with the ATCOs and provides suggestions for new procedures. The initiative is informal, personal and not formally supported by the organisation.</td>
</tr>
<tr>
<td>What was DONE</td>
<td>● Based on best and worst practice it is possible to develop new and better procedures.</td>
<td>● To share best and worst practice among ATCOs.</td>
</tr>
</tbody>
</table>

4. SAFETY POLICY: DEVELOPING A MEANINGFUL STATEMENT

Chief of the centre regularly demonstrates his commitment to safety.

<table>
<thead>
<tr>
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</thead>
<tbody>
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<td>● To share best and worst practice among ATCOs.</td>
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</tr>
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### 1. SAFETY OCCURRENCE REPORTS - NO BLAME AND PUNISHMENT

Management and controllers have different views on human error, leading to a lack of trust between them, and reduced reporting.

<table>
<thead>
<tr>
<th>What was BELIEVED</th>
<th>MANAGEMENT</th>
<th>OPERATIONAL STAFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human errors can be avoided by strong enforcement. “You should not make mistakes.”</td>
<td>● We cope with the situation as best we can but are only human “human errors exist.”</td>
<td>● We have a no-blame culture.</td>
</tr>
<tr>
<td>● If the ATCO is culpable they could be suspended, retrained, or another appropriate measure.</td>
<td>● The ATCO will be blamed and punished if mistakes are noticed.</td>
<td>● We have a no-blame culture.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● We have a no-blame culture.</td>
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<tr>
<td></td>
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<tr>
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<td></td>
<td>● We have a no-blame culture.</td>
</tr>
</tbody>
</table>

**OUTCOME**
- Separation in shared understanding leading to lack of trust between two parties and reduced incident reporting and learning.

### 2. OPERATIONS & WORK CONTROLS: INFORMALLY MODIFYING PROCEDURES

Introduction of an environmental law led to management and controllers having different perspectives on following the environmentally-related procedures.

<table>
<thead>
<tr>
<th>What was BELIEVED</th>
<th>MANAGEMENT</th>
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</tr>
</thead>
<tbody>
<tr>
<td>● Management accept environmental legislation.</td>
<td>● “The environmentally related procedures are jeopardising safety levels”. “Legislation” is perceived as jeopardising safety levels by employees.</td>
<td>● To produce a safe service is more important than producing an environmentally friendly service (shared by management and employees).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>● The ATCO is expected to ensure safety.</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>● The ATCO is expected to ensure safety.</td>
</tr>
</tbody>
</table>

**OUTCOME**
- ATCOs specialise themselves in a sector which they know well, feel comfortable controlling and where they feel they can deal completely with any situation likely to occur. They will therefore not feel motivated to operate a more challenging sector or airspace that is known to be more problematic.

### 3. TRAINING AND COMPETENCE: LACK OF PREPARATION FOR UNUSUAL INCIDENTS

ATCO experiences a non-routine or emergency situation, but are not prepared for dealing with such events.

<table>
<thead>
<tr>
<th>MANAGEMENT</th>
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<tbody>
<tr>
<td>● We don’t have the resources to carry out additional training.</td>
<td>● The ATCO may be left on their own to deal with non-normal operations, because the organization does not want to prepare them properly for dealing with these types of events.</td>
</tr>
<tr>
<td></td>
<td>● Request from ATCOs for training to deal with emergencies.</td>
</tr>
<tr>
<td></td>
<td>● ATCOs specialise themselves in a sector which they know well, feel comfortable controlling and where they feel they can deal completely with any situation likely to occur. They will therefore not feel motivated to operate a more challenging sector or airspace that is known to be more problematic.</td>
</tr>
</tbody>
</table>

**OUTCOME**
- There is no training for situations that fall outside of normal operations. There is resistance to update training programs and modules to deal with such types of events.
- Request from ATCOs for training to deal with emergencies.

### 4. SAFETY ORGANISATION: OPEN DOOR POLICY

Management and controllers have different views on discussing issues with the Operations Manager.

<table>
<thead>
<tr>
<th>MANAGEMENT</th>
<th>OPERATIONAL STAFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>● I have an open door policy but not the means to support it.</td>
<td>● The door is not really “open”. Management do not have the time to respond to their request.</td>
</tr>
<tr>
<td></td>
<td>● There are more important things to do that are of higher priority.</td>
</tr>
<tr>
<td></td>
<td>● Employees see the open door policy as a token gesture and don’t use it.</td>
</tr>
</tbody>
</table>

**OUTCOME**
- Employees see the open door policy as a token gesture and don’t use it.
- The door is not really “open”. Management do not have the time to respond to their request.
SUMMARY AND CONCLUSIONS

SAFETY CULTURE IN ATM

Safety culture has been in existence as a fixed concept since shortly after the Chernobyl nuclear power plant accident approximately twenty years ago. It is recognised in other industries as the culture underlying safety - how safety works in an organisation. It is distinct from SMS which is the formal system for managing safety, and is different from safety climate, which is a snapshot of safety attitudes, whereas safety culture is more enduring and stable. Poor safety culture can undermine or even negate SMS efforts.

The surveys found evidence that safety culture is important in ATM - even in cases where an SMS is in place things may not be working properly due to safety culture impacts (in particular what this study has called safety culture disablers). The results suggest that whilst a good SMS is necessary, it may not be sufficient. Efforts must therefore be made to measure safety culture as well, and identify and rectify short-comings. The scientific literature and the survey and analysis embodied in this report have laid the groundwork for a safety culture measurement and management framework. In particular, the surveys and collaboration with four ANSPs has helped immensely with the transition from scientific theory to practical aspects that controllers and their managers will be able to relate to and work with.

There now exists a preliminary set of safety culture elements adapted to ATM, and their links to ATM SMS elements have been identified. This result should become the basis for a safety culture measurement tool, as well as providing the areas for development of guidance and best practical guidance on safety culture for air traffic control centres. The simplified dynamic model of safety culture, together with its enablers and disablers, offers a usable framework with which to explore safety culture deficiencies or vulnerabilities, and a means to identify how best to tackle them. This latter aspect therefore has the dual use of developing safety culture guidance and serving as a safety culture investigation or intervention tool.

THE WAY FORWARD

A roadmap for developing a way to manage safety culture can be seen as follows:

1. Raise awareness and interest in ANSPs in the concept and role of safety culture
2. Verify the results of this study, and where possible enlarge the ‘database’ by involving more ANSPs
3. Further analysis of the mediating role of the supervisor (and technical support) in developing the safety culture
4. Develop initial guidance based on the work in the survey, structured according to the safety culture elements, and enrich such guidance via ANSP participation
5. Develop a safety culture measurement system that can assess an ANSP’s safety culture, identify vulnerabilities and pinpoint areas for improvement
6. Develop a safety culture intervention tool that ANSPs can utilise themselves (with external support) to explore and improve their safety culture
7. Develop a Safety Culture Learning Forum that will enable industry-led advancement in this area.
REFERENCES


ANNEX A - SEMI STRUCTURED INTERVIEW GUIDANCE SHEET

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Management System Indicator(s)</td>
<td>Policy statement</td>
<td>Safety plans (e.g. Strategic and Project Plans)</td>
<td>Organisations, Safety Terms of Reference (Accountability - Responsibility, Safety Meeting Structure / Definition)</td>
<td>ESARR, ENAQ, National Regulations.</td>
<td>Safety case, risk assessment and mitigation procedures, etc.</td>
<td>Planned and regularly performed safety surveys.</td>
<td>Licensing and training requirements</td>
<td>Procurement practices, supplier management practices, etc.</td>
<td>Relevant SMS and related output documentation.</td>
<td>Administrative Controls (e.g. change-management processes, system interrupt)</td>
<td>NDR, 100, Voluntary Reports</td>
</tr>
<tr>
<td>Safety Culture Prompt Question</td>
<td>FQ1: Do you have a Safety Policy statement?</td>
<td>FQ2: Do you perform safety surveys?</td>
<td>FQ3: How is your safety organisation defined?</td>
<td>FQ4: Do you have to comply with Regulations and Standards?</td>
<td>FQ5: Are safety activities conducted in your Centre?</td>
<td>FQ6: Are Safety surveys performed in your Centre?</td>
<td>FQ7: Are competencies obtained and maintained at an appropriate level?</td>
<td>FQ8: Do you work with external partners or suppliers?</td>
<td>FQ9: Do you have any procedures to ensure safety documentation does not go astray?</td>
<td>FQ10: What procedures and controls do you use in order to ensure safety?</td>
<td>FQ11: How is occurrence reporting and investigation performed?</td>
</tr>
<tr>
<td>Safety Culture Follow-Up Question(s)</td>
<td>FQ2.1: How is it defined/developed (participation, promulgation)?</td>
<td>FQ2.2: Are you aware of the content?</td>
<td>FQ2.3: How is it communicated?</td>
<td>FQ2.4: How does it affect your daily work life therein?</td>
<td>FQ2.5: Is it underpinning your own understanding of safety?</td>
<td>FQ2.6: Is it underpinning your understanding of organisation commitment to safety?</td>
<td>FQ2.7: How can you be sure that it is the key driver for safety?</td>
<td>FQ2.8: What is the key factor in your organisation for safety?</td>
<td>FQ2.9: Are the right people involved?</td>
<td>FQ2.10: How are safety reports conducted, reviewed, and followed?</td>
<td>FQ2.11: Is it linked to management? (from ATCO to CEO?)</td>
</tr>
<tr>
<td>Relationships to Model</td>
<td>How the organisation works with safety (perceived by the respondent), hence it can tell us things about: (applied compliance, people’s understanding, organisational commitment to safety, perceptions, influence, and actuality of safety)</td>
<td>&quot;most safety critical aspects. Safety documents are not followed in order to save time&quot;</td>
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</tr>
<tr>
<td>Further Guidance</td>
<td>Regulations and Standards may be applicable at both a high level and a detailed working level. Therefore probe at both of these levels.</td>
<td>These are essentially the enactment of daily safety values. How can it be short-hand, to the necessary level? &quot;How often do you follow safety procedures?&quot;</td>
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</tr>
</tbody>
</table>

**NOTE:** The text above is a structured interview guidance sheet designed to assess aspects of safety culture and management within an organization. It includes prompts and follow-up questions to probe into various aspects of safety management, including policy, communication, participation, and the enactment of safety procedures. The questions are designed to elicit a comprehensive understanding of the organization's safety culture and its alignment with established policies. This approach is intended to help in identifying any gaps or discrepancies in the organization's safety practices, thereby facilitating improvements in safety management and culture.