



Does the concept of safety culture help or hinder systems thinking in safety?



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ABSTRACT

The concept of safety culture has become established in safety management applications in all major safety-critical domains. The idea that safety culture somehow represents a “systemic view” on safety is seldom explicitly spoken out, but nevertheless seem to linger behind many safety culture discourses. However, in this paper we argue that the “new” contribution to safety management from safety culture never really became integrated with classical engineering principles and concepts. This integration would have been necessary for the development of a more genuine systems-oriented view on safety; e.g. a conception of safety in which human, technological, organisational and cultural factors are understood as mutually interacting elements. Without of this integration, researchers and the users of the various tools and methods associated with safety culture have sometimes fostered a belief that “safety culture” in fact represents such a systemic view about safety. This belief is, however, not backed up by theoretical or empirical evidence. It is true that safety culture, at least in some sense, represents a holistic term—a totality of factors that include human, organisational and technological aspects. However, the departure for such safety culture models is still human and organisational factors rather than technology (or safety) itself. The aim of this paper is to critically review the various uses of the concept of safety culture as representing a systemic view on safety. The article will take a look at the concepts of culture and safety culture based on previous studies, and outlines in more detail the theoretical challenges in safety culture as a systems concept. The paper also presents recommendations on how to make safety culture more systemic.

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1. Introduction

The idea that safety culture somehow represents a “systemic view” on safety is seldom explicitly spoken out, but nevertheless seems to linger behind many safety culture discourses. However, we argue that safety culture as it is currently used is not a systems-oriented concept. We argue that the “new” contributions to safety management brought about by the concept of safety culture have never really become integrated with classical engineering principles and concepts. This integration would have been necessary for developing a more genuine systems-oriented view on safety; for example, a conception of safety in which human, technological, organisational and cultural factors are understood as mutually interacting elements, or subsystems. In lack of this integration, researchers and the users of the various tools and methods associated with the concept of safety culture have sometimes fostered a belief that “safety culture” in itself represents such a systemic view

about safety. This belief is, however, not backed up by theoretical or empirical evidence. The present article is an attempt to elaborate on the question: Has safety culture research and practice missed the opportunity to integrate with systemic perspectives?

The historical background on which our further arguments are based is the following: when it was fully realised that safety as a dynamic state represents something more than just technology, more and more attention was directed towards “the human factor”. However, the human factor was often treated metaphorically as an “error prone machine” rather than an intentional and meaning-seeking subject. Introducing the concepts of “organisational factors” and later “safety culture” introduced more conceptual complexity but also an enhanced understanding of why safety-related events may occur, and more attention to other types of threats than those that had been studied in technology and individually oriented human factors research. Systemic theories represent one possible analytical framework to make sense of a complex reality, and such theories can (and have been) utilised in safety science. However, we will argue that the safety culture movement largely failed to make full use of systemic theories in the sense of recognising some of the basic principles common to system

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theories. We have seen several indications on this based on a review of the literature about safety culture but also supported by direct experiences from research and consultancy work. The remainder of this article will elaborate on this issue. We will first take a look at the concepts of culture and safety culture. Then we will outline in more detail the theoretical challenges in safety culture as a systems concept. Finally, we will present some recommendations on how to make safety culture more systemic.

2. Culture and safety culture

2.1. Concept of culture

The concept of culture is associated with many meanings. Good overviews of the origins, developments and controversies of the concept of organisational culture have been written by [Alvesson \(2002\)](#) and [Martin \(2002\)](#). In general, it is possible to distinguish between two broad ideas about culture in an ontological and epistemological sense: interpretative and functionalist approaches ([Smircich, 1983](#)).

Interpretative approaches to culture share an interest in the meanings and beliefs that the members of an organisation assign to organisational elements (structures, systems and tools) and how these assigned meanings influence behaviour ([Czarniawska-Joerges, 1992](#); [Weick, 1995](#); [Alvesson, 2002](#); [Reiman and Oedewald, 2007](#)). Culture in these approaches can be considered a (research) framework for conceptualising the organisation and inspecting various phenomena perceived in the context of the organisation. Culture acts as a metaphor for the organisation; *organisation as a culture*. According to [Alvesson and Berg \(1992, p. 78\)](#), culture as a root metaphor for the organisation means that ‘the cultural dimension can be found in – and not “alongside” – formal organisational structures, administrative systems, technologies, strategies’. In other words, the reality in which the work takes place is socially constructed.

The term “social construction of reality” was introduced by sociologists [Berger and Luckmann \(1966\)](#). They proposed a theory of society based on the ideas of Alfred Schutz, Karl Marx, Émile Durkheim and George Herbert Mead. Berger and Luckmann argued that human beings continually and together construct the social world that then becomes the reality to which they respond. According to these scholars, social order is an ongoing human production. The individual is thus in a dialectic relationship with society; simultaneously constructing and being constrained by it. In the social constructionist approach, culture is considered to be embedded in the social processes and practices of the organisation. It is not an element that can be considered, analysed and evaluated independently of context, since culture is the context.

The *functionalist approaches* build on the seminal work of scholars such as [Parsons \(1951\)](#), [Durkheim \(1982\)](#) and [Radcliffe-Brown \(1958\)](#) on the nature of social systems. According to functionalists, organisational culture includes aspects that are shared by all members and that contribute to the social integration and equilibrium of the system. While interpretative approaches treat an organisation as a culture, functionalist approaches view culture as a variable, i.e. that an *organisation has a culture*. Notable proponents of this view on organisational culture include [Ouchi \(1980\)](#), [Schein \(1985\)](#), [Kilmann \(1985\)](#), [Wilkins and Ouchi \(1983\)](#) and [Barney \(1986\)](#).

[Schein \(1985\)](#) has defined the deepest layer of organisational culture as a pattern of basic assumptions that the group has invented as it has learned to cope with its problems related to adapting to its environment and integrating the group into a functioning whole. This pattern of basic assumptions has worked well enough to be considered valid, as it is taught to new members of the organisation as the correct way to perceive, think, and feel in

relation to those problems ([Schein, 1985](#)). Such basic assumptions are largely taken for granted. They deal with issues of time perspective, the nature of the company's relationship with its various stakeholders, ways of responding to critique, criteria for rewarding and punishing people and so on. In safety-critical fields basic assumptions may concern issues such as what constitutes risk, the main hazards the organisation is dealing with, how one is supposed to speak about risks in the workplace, and what is a valid warning signal that things are risky, for example. The main notion here is that culture is something the company has created for itself, and has an effect on the company. This effect is not necessarily perceived by the company itself, since the members of the organisation consider all things that happen according to cultural taken-for-granted assumptions (“business as usual”). Further, culture has several levels, with artefacts (visible behaviour, technology, etc.) presenting the surface level of culture. Schein's model was influenced by open systems theory ([Katz and Kahn, 1966](#)) as well as the structural functionalism approach by [Parsons \(1951\)](#).

At first, Schein had quite a singular view of organisational culture, but he has since supplemented his theory with ideas of subcultures existing within each organisational culture ([Schein, 2004](#)). Most cultural approaches today acknowledge the existence of at least three types of subculture: a) occupational or professional subcultures based on educational background of the employees, b) departmental subcultures based on the work unit in question, and c) age or tenure related subcultures (see e.g. [Parker, 2000](#)). Despite wide acceptance, the ontological status of subculture is not always clear: is subculture an independent entity or do the subcultures together form a unique organisational main culture? Further, how do the different layers or elements of each subculture interact with other subcultures? The general notion of subculture is vague because it is not always clear on what grounds a subculture is defined. For example, a subculture can be defined in terms of professional groups that transcend a specific organisational boundary (medical doctors, pilots, etc.) or it can be defined in terms of groups according to an organisational chart, or it can be defined as a specific focus domain among others (safety culture, innovation culture, service culture, etc.) or even in terms of things such as age (youth culture). Many of these ambiguities can be found in the application of the culture concept in the safety domain.

2.2. Previous studies on culture and safety

The safety culture concept was born in the aftermath of the Chernobyl accident in 1986, when it became clear that nuclear safety should incorporate more than mere technology. After the accident, various human and organisational issues complemented the then dominant technological and rather narrow human factors view on nuclear safety. Cultural issues also rapidly spread into other areas of safety. Management systems, leadership and a host of other human related factors such as learning, responsibility, values and attitudes were taken into consideration (with varying operationalizations) in safety analyses and development initiatives. The concept of safety culture has today become established into safety management applications in all major safety-critical domains, such as aviation, nuclear power production, petrochemical sector (including offshore oil production), railways, peacetime military operations, maritime, and mining operations.

Safety culture quickly became a popular term despite the fact that a somewhat similar concept, “safety climate”, had already been introduced ([Zohar, 1980](#)). Safety culture development drew more on the organisational culture literature than the safety climate literature. Nowadays the two concepts of safety culture and safety climate are associated with different definitions, research traditions and methods ([Zohar, 2000](#); [Clarke, 2000](#); [Neal and Griffin, 2002](#)). Safety climate is often described as consisting of shared

perceptions of safety related states of affairs (management commitment to safety, rule adherence, safety training, procedures, working conditions etc.) whereas safety culture is more associated with safety related values, assumptions and norms. The safety climate tradition can be traced to the pioneering research by Zohar (1980) and the tradition has been much concerned with psychometric scaling research in order to identify generic safety climate dimensions (Guldenmund, 2007). In practice, the concepts of safety culture and safety climate are often intermingled.

There is a large variance in conceptualisations of safety culture, ranging from descriptive studies on the social construction of safety to normative models of ideal safety culture dimensions. By and large, the models of safety culture bear more resemblance to the functionalist theories of organisational culture than to the interpretative theories (Richter and Koch, 2004). Good overviews of the use of the safety culture concept in empirical research have been provided by Guldenmund (2000, 2007) and Sorensen (2002, see also Silbey, 2009). Our purpose here is to provide some examples of the multitude of approaches to safety culture.

One of the earliest definitions of safety culture was provided by IAEA in 1991: “safety culture denotes the assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance” (IAEA, 1991). Since this, a plethora of definitions have been proposed. For example, Pidgeon (1998) defines safety culture as the “set of assumptions, and their associated practices, which permits beliefs about danger and safety to be constructed”. Clarke (1999) sees safety culture as a “subset of organisational culture, where the beliefs and values refer specifically to matters of health and safety”. Richter and Koch (2004) emphasise shared and learned meanings, experiences and interpretations of work and safety. Hopkins (2005, p. 22) identifies the concept of safety culture with the concepts of mindfulness and risk-awareness and argues that these are “largely interchangeable”.

Based on his extensive review of past research, Guldenmund (Hopkins, 2005, p. 251) adds his own definition of safety culture: ‘those aspects of the organisational culture which will impact on attitudes and behaviour related to increasing or decreasing risk’. He then provides a three-layer model of safety culture adapted from Schein’s model of organisational culture (see above). In Guldenmund’s model, basic assumptions are defined as the “core” of safety culture. In a more recent article, Guldenmund (2007) argues that three major forces are operating on (the behaviour of) the people in organisations: structure, culture and processes. Antonsen (2009), in his book about safety culture, differentiates between structure, culture and interaction, preserving the concept of culture for values and attitudes. He writes: “I see culture as the frames of reference through which information, symbols and behaviour are interpreted and the conventions for behaviour, interaction and communication are generated”. Antonsen (2009) emphasises that safety culture relates to the informal aspects of an organisation, whereas the formal aspects are part of the structure of the organisation.

Social scientists of mostly anthropological or sociological backgrounds have described the nature and dynamics of culture and the social construction of the work and safety in case studies (Vaughan, 1996; Rochlin, 1999; Bourrier, 1999; Gherardi and Nicolini, 2002; Hutchins, 1995; Weick, 1987; Richter and Koch, 2004). Their work is typically descriptive in nature and differs from the normative undertone prevalent in most safety culture research (cf. Guldenmund, 2010). Their findings illustrate the social and interactive nature of organisations and the studies have empirically shown how the central features of work and organisation (including safety) are constructed in interaction with daily work. Alvesson (2002), echoing the above-mentioned scholars, has pointed out

that culture is not so much inside people’s heads as it is between the heads of a group of people. The dynamic and complex nature of safety-critical organisations and their cultures has also become apparent from accident investigations (e.g. Vaughan, 1996; Snook, 2000). However, most of the researchers mentioned above have not applied the concept of safety culture. They have instead talked about “social construction of safety”, “organisational culture and safety”, and “cultural view on safety”, but have tended to avoid calling their object of study safety culture (for an exception, see Richter and Koch, 2004).

One sociologically-oriented study on culture and safety warrants more attention here. Vaughan’s (1996) study on the Challenger accident is cultural in its main approach. She recognised several cultural patterns in NASA’s and its subcontractors’ organisations – cultural patterns that contributed to the accident. For example, the normalisation of deviance refers to a process where small changes – new behaviours, technical/physical/social anomalies or other variations that represent slight deviations from the normal course of events – gradually become the norm (Vaughan, 1996). Normalisation of deviance produces disregard and misinterpretation – neutralisation – of potential danger signals. A signal of potential danger is information that deviates from expectations, contradicting the existing worldview (Vaughan, 1996, p. 243). This is clearly a cultural phenomenon and Vaughan (Vaughan, 1996) indeed refers to the concept of culture quite often in her book. She defines culture as a “set of solutions produced by a group of people to meet specific problems posed by the situations that they face in common” (Vaughan, 1996, p. 64). She further clarifies that the solutions are institutionalised as rules, rituals and values (Vaughan, 1996, p. 64). Vaughan does not use the concept of safety culture, but her work provides an interesting view on the effects of culture on safety through an in-depth accident investigation.

2.3. Dimensions and elements of safety culture

Common to most definitions of safety culture is that they emphasise safety culture as something holistic and shared (Guldenmund, 2000; Richter and Koch, 2004). The focus of much safety culture (and safety climate) research has been on identifying the basic dimensions comprising the concept. In terms of measuring “safety culture”, the identified dimensions are not always commensurate. For example, Díaz-Cabrera et al. (2007) have noted that most conceptualisations of the dimensions of safety culture include tacit or abstract dimensions (such as commitment, learning) as well as dimensions that relate more concretely to working practices (rules, staffing, etc.). Many definitions include dimensions from several levels of the organisation; from individual to group to organisation level variables (cf. Karsh et al., 2013). However, these qualitative differences in the dimensions are rarely made explicit (Reiman et al., 2010; Guldenmund, 2007). Karsh et al. (2013, p. 3) also point out that “the gap within human factors and ergonomics generally is not lack of awareness of context or levels, but that the absence of specific, tested, causal mechanisms between or among levels”.

Another challenge with a lot of safety culture research and practice is that *human related concepts* (assumptions, values, norms, behaviour, etc.) are mixed with more concrete objects such as the structure and quality of artefacts including the technology itself. The definitions of safety culture emphasise the attitudes, behaviour, or knowledge of the personnel to varying degrees, with few definitions placing an emphasis on the structural features of the organisation such as technology, management systems, tools and instructions (see Table 1). Different definitions lead to different ideas about the best means of developing a safety culture and thus also about the best means of developing safety. Also, as

Table 1
Typical elements of safety culture based on a convenience sample of relevant safety culture literature.

Element	General description of the element	Studies associating the element with safety culture
(Basic) assumptions	"A fact or statement (as a proposition, axiom, postulate, or notion) taken for granted" (Merriam-Webster)	Guldenmund, 2007; Pidgeon, 1998
Interpretation frame of reference	frames of reference through which information is interpreted and enacted	Antonsen, 2009; Richter & Koch, 2004
Practices Behaviour	"To do something customarily" (Merriam-Webster) "A: the manner of conducting oneself, b: anything that an organism does involving action and response to stimulation, c: the response of an individual, group, or species to its environment" (Merriam-Webster)	Pidgeon, 1998; Reiman et al., 2012; Patankar, 2003 McSween, 2003; Cooper, 2000; Faridah et al., 2012; INPO, 2004
Beliefs	"Firmly held opinions or convictions" (Merriam-Webster)	Clarke, 1999; Singer et al., 2009; Patankar, 2003; Cox & Cox, 1991; Faridah et al., 2012
Values	"Something (as a principle or quality) intrinsically valuable or desirable" (Merriam-Webster)	Clarke, 1999; Singer et al., 2009; Håvold, 2010; Cox & Cox, 1991; Faridah et al., 2012; INPO, 2004
Attitudes	"A settled way of thinking or feeling, typically reflected in a person's behaviour" (Merriam-Webster)	IAEA, 1991; Cooper, 2000; Patankar, 2003; Håvold, 2010; Cox & Cox, 1991; Faridah et al., 2012
(Shared) meanings	"The thing that is conveyed especially by language" or "the logical connotation of a word or phrase" (Merriam-Webster)	Richter & Koch, 2004; Pidgeon, 1991
Norms	"A principle of right action binding upon the members of a group and serving to guide, control, or regulate proper and acceptable behaviour" (Merriam-Webster)	Singer et al., 2009; Patankar, 2003
Experiences	"Something personally encountered, undergone, or lived through", "a: the conscious events that make up an individual life, b: the events that make up the conscious past of a community or nation or humankind generally" (Merriam-Webster)	Richter & Koch, 2004
Perceptions	"A: awareness of the elements of environment through physical sensation, b: physical sensation interpreted in the light of experience" (Merriam-Webster)	Håvold, 2010; Cox & Cox, 1991
Knowledge and understanding, competencies	Information that people have and their skills, knowledge and abilities for carrying out the work	Reiman et al., 2012; Håvold, 2010
Physical and "objective" features of the workplace (equipment, tools, machines)	Material objects of the world	Cooper, 2000; Reiman et al., 2012
(Emergent) product of various components of the system	Property of a system that is created by (some of) its constituent components	ACSNI, 1993; Reiman et al., 2012

depicted in Table 1, each element of safety culture needs to be further defined—in Table 1 the official definition from Merriam-Webster Dictionary is used as an example definition.

In addition to the content-elements of safety culture, an on-going debate concerns the dimensions of safety culture. These two debates are seldom combined, however, and the terms "element" and "dimension" are not used in a similar manner by the safety culture researchers. Despite varying view on what a "dimension" is, a consensus seems to have been reached that safety culture is a multi-dimensional construct (Guldenmund, 2000). Still, the exact dimensions comprising safety culture have been debated and no agreement has been reached. Some studies or technical reports seek to identify the dimensions of good safety culture and report their dimensions in positive terms that apply to organisations having the presumed good safety culture. As an example, management safety commitment and questioning attitude among employees are clearly normative dimensions. Another way is to conceptualise safety culture in descriptive terms with dimensions that can vary from good to bad, for example the level of management commitment or the strength of safety attitudes of the employees. A third approach would be to define the elements of safety culture in much more open terms, such as "practices", "norms" and "values" (cf. Table 1 for a list of typical elements found in definitions of safety culture). The exact content of these practices, norms and values would then be an empirical question pertaining to the specific culture being studied.

2.4. Misuse of the concept in research and practice

In practice, the concept of safety culture sometimes tends to be used as an "excuse" for not dealing with some more fundamental safety problems involving technological design (Rollenhagen, 2010). This problem is not new and has long been discussed in conventional safety and in old accident models where individuals sometimes should be adapted to technology rather than the technology to the individual. The same pattern is sometimes repeated on a collective level with the use of the safety culture concept: it is argued that the culture should be adapted to the current technological conditions and not the other way around. We have seen this trend in some consultancy projects where the company has tried to compensate its problems with bad/weak technical solutions by emphasising only the improvement of the human component (often conceptualised as a problem of attitude). The basic "production technology" can be considered as setting the constraints and requirements (Reiman and Oedewald, 2007) for the formation of culture (Schein, 2013a). However, once the culture is formed the organisation needs to improve, modify and maintain its technological elements as well as its human elements.

We have often noted an ethical flavour lingering over safety culture discourse. For example, if an organisation has been found to exhibit signs of a weak (or bad) safety culture, this might implicitly be interpreted as a sign of deficient morality associated with the organisation's managers and/or employees. Sometimes the entire

organisation can be considered bad, or evil. Naturally, such interpretations might be correct in situations where an organisation has deliberately focused on production values at the expense of safety values. However, the attribution of blame is not necessarily the best way to proceed, especially if there is no clear evidence of deliberate risk taking at the expense of safety. Looking for “bad apples” has seldom been a fruitful strategy for coping with individual human errors, and, by a similar token, the concept of safety culture may be misused in the sense of attributing moralistic statements towards whole organisations (Rollenhagen, 2010). To blame an organisation for having a weak safety culture has become almost the equivalent easy response to system problems as was blaming individuals for human errors a few decades ago. To understand why an organisation exhibits signs of a weak safety culture, a systemic theory is needed that can analyse the interplay between various factors. This theory should also naturally define what can be considered signs of a weak, or weakening, safety culture and what signs imply weaknesses in other elements of safety.

Many international agencies in the nuclear sector such as IAEA (International Atomic Energy Agency), WANO (World Association of Nuclear Operators) and INPO (Institute of Nuclear Power Operations) have produced lists of safety culture characteristics or attributes to be used by the power companies as well as regulators as basis for developing and auditing safety culture. For example, IAEA (2008) defines five characteristics of (good) safety culture: 1. Safety is a clearly recognized value, 2. Leadership for safety is clear, 3. Accountability for safety is clear, 4. Safety is integrated into all activities, and 5. Safety is learning driven. INPO (2004) talks about “principles for a strong nuclear safety culture” and list eight such principles (WANO has used the same principles, but in 2013 they published a document listing ten principles which partly differ from INPOs). The INPO principles include similar issues as IAEA’s characteristics, but they also emphasize the uniqueness of nuclear power and the importance of trust. WANO (2013) lists issues such as “safety communication”, “respectful work environment”, “problem identification and resolution”, and “work processes” as principles or traits of safety culture. It is hard to deny that these characteristics and principles are all important to safety, to some degree. However, what are less clear are the relationships between the characteristics or the dynamics of how they are developed into an organisation. Finally, one could also ask what is the relationship of the characteristics to other aspects of the sociotechnical system, and ultimately, to nuclear safety itself. Again, we are arguing for conceptual clarity and not claiming that for example leadership or values do not affect safety.

Leadership and management commitment to safety are often considered the cornerstones of good safety culture. Meta-analyses of questionnaire studies have identified management commitment to safety as the most common factor (Flin et al., 2000; Flin, 2007). However, even there the dimension in question could be labelled “employees’ perceptions of management commitment to safety” instead of “actual” management safety commitment, whatever that would entail (cf. Flin et al., 2000; Guldenmund, 2007). Thus, it might be an artefact of the questionnaire method more than the genuinely most important dimension of safety culture, as it often is advertised (IAEA, 1991; Reason, 1997; HSE, 1997; Flin, 2003). The problem is, as already has been mentioned, the lack of specification of how a specific dimension of safety culture (e.g. management commitment) actually influences safety (the concept that is often left undefined).

Our intention here is not to argue that management commitment is not an important component of safety (culture), but rather to point out that the under-specification of the sociotechnical system in many safety culture frameworks makes it difficult to interpret the empirical findings from case studies. A further challenge comes from the fact that safety culture and safety climate

studies are usually dealt with as if they form a united field of research. This is probably more due to the large variance of definitions within both research traditions than a genuine belief that the concepts of safety culture and safety climate would refer to the same phenomenon. For example, in their study, Flin et al. (2000) identified the dimensions of “safety climate”, but many use those dimensions in studies focusing on safety culture. We argue that “perceptions of management commitment to safety” is an adequate empirically defined dimension of safety climate. However, it is much more problematic when based on measurements of perceptions, “management commitment to safety” is deduced as a dimension of safety culture—or judgments are made about the actual management commitment based on measurement of the dimension by e.g. a questionnaire.

The (current) strong focus in the industry on behavioural safety and “human performance” may also be viewed with some scepticism. Some behavioural-based safety approaches treat safety culture as an individual level behavioural issue and neglect other considerations such as collective norms, competence or shared conceptions of safety (cf. Table 1 for the difference between behaviour and practices as elements of culture). Hopkins (2005) also points out how safety culture has been misused in the industry to denote individual attitudes instead of organisation-specific phenomenon. Again, the challenge is not so much the narrow focus of the behavioural-based safety programmes but rather the fact that this narrow focus is not put into the wider context of the sociotechnical system and its safety.

3. Theoretical challenges in safety culture as a systems concept

Wilson (in press) defines a “system” as “a set of inter-related or coupled activities or entities (hardware, software, buildings, spaces, communities and people), with a joint purpose, links between the entities which may be of state, form, function and causation, and which changes and modifies its state and the interactions within it given circumstances and events, and which is conceptualised as existing within a boundary; it has inputs and outputs which may connect in many-to-many mappings”. He also states that in systems the whole is usually greater (more useful, powerful, functional, etc.) than the sum of the parts. Outcomes in systems emerge from a complex network of causal interactions instead of a single causal factor (Leveson, 2002; Dekker et al., 2011). The systems approach refers to an approach that considers the whole system and its interactions instead of focusing on some component of the system in isolation (Wilson, in press; Dekker, 2011). Dekker (2005) describes the systems approach as seeing “sociotechnical complexity not as constituted of parts and their interactions, but as a web of dynamic, evolving relationships and transactions”. The systems approach thus requires taking a holistic view of the topic of interest and defining its relations to the other neighbouring topics. Next we will take a closer look at the theoretical challenges in safety culture as a systems concept.

3.1. Is safety culture a system or part of a system?

The two concepts of “systemic” and “safety culture” are today commonly used terms in connection with safety theory and practice. Both of these concepts share a holistic connotation. To adopt a systemic perspective on safety represents an attempt to perceive a whole (e.g. a system) as consisting of several mutually interacting subsystems and components. The resulting system state of “safety” can be understood as an emergent property resulting from dynamic interactions among people, technology, administration, etc. By a similar token, the concepts of safety culture give a

prima facie impression of being systemic in the sense of representing an emergent holistic state in an organisation. However, there are some important differences between the two conceptualisations of system and culture. Firstly, we may perhaps, without being confronted with too much objection, claim that all cultures can be perceived as systems, but to defend the proposition that all systems are cultures seems absurd. The reason is simply that the concept of a system is not bound to specific predefined natural or non-natural entities: for example, it is common to talk about machines as representing technical systems or we can talk about management systems. When we speak about cultures, on the other hand, we usually mean something associated with people, their assumptions, values, behaviour, etc. (we do not usually refer to a technical system as a culture—although it is a product of culture). Secondly, to understand a system it is often recommended to adopt a set of generic system principles, such as the behaviour of the system cannot be inferred from a study of individual subsystems or components; studying relations among subsystems/components is more important than studying individual parts in isolation; small changes can create large effects (or vice versa), and one can always redefine the system boundaries depending on perspective taken. Such and similar system principles, by and large, define what system perspectives are about. For example, to understand safety we can, departing from a systemic perspective, identify important component classes (subsystems) and from that study how safety emerges. Each subsystem can be understood as a system in itself departing from suitable concepts and principles. Thus, to understand a technological system it is important to study the whole structure of subsystems and components and their dynamics. However, safety cannot be fully understood by departing from the technological system in isolation from the people that construct and use the system. Consequently, we must at least bring in people as representing a specific subsystem within the larger sociotechnical system. Culture is a people-oriented concept but culture transcends individuals. It is reasonable, we will argue, to understand “culture” as being a subsystem that consists of such things as shared assumptions, values and norms. The nature of the concept of “safety culture” is however more difficult to define.

Both dominant approaches to organisational culture, namely the interpretative and the functionalist, have certain problems when it comes to their applicability to the concept of safety culture. Functionalist approaches often suffer from a positivistic, variable-based, view of sociotechnical systems and the means of studying them. Treating safety culture as a variable, or one element of the wider sociotechnical system, is in itself clearly not enough to warrant a systems view of safety. The equation gets more complicated if safety culture is treated as one variable and organisational culture as another.

Often functionalist safety culture approaches are satisfied with merely listing the dimensions of safety culture. However, these dimensions are typically qualitatively very different from one another and can hardly be considered to form a coherent single variable among the other variables of the sociotechnical system. The end result is often a concept that measures a bit of this (e.g. individual attitudes) and a bit of that (e.g. safety management systems, collective norms, practices). This tendency seems to be especially salient in quantitative safety culture measures. This might be due to the fact that the studies have often tried to link the safety culture concept to various negative outcomes such as occupational injuries, adverse events or process disturbances. In order to maximise prediction capabilities of the concept, researchers have tried to encompass a wide variety of different phenomena in organisations. Paradoxically, by using questionnaires to measure personnel’s opinions on a number of issues, researchers have actually moved the concept closer to the interpretative position: the positivistic quest for grasping the objective reality has been

abandoned in the hope of the subjective reality of the employees proving to be a strong enough predictor of objective outcomes. Using these kinds of outcome indicators (Reiman and Pietikäinen, 2012) to validate the link between safety culture and safety is problematic in two ways: first, if safety culture is only one variable among others in a sociotechnical system, it cannot sensibly be expected to correlate with safety without also measuring the other variables. Second, using incidents as a measure of safety neglects important details about the nature of safety as a dynamic and emergent property of the functioning of the entire sociotechnical system (Reiman and Pietikäinen, 2012).

Functionalist approaches to culture offer a natural background to safety culture in their emphasis on the positive effects of culture and the shared nature of culture. However, due to the above-mentioned linear causal views endorsed by many functionalist approaches, safety culture researchers have also looked to interpretative approaches for guidance (Antonsen, 2009; Richter and Koch, 2004). Similar to the functionalist approaches, there is a large variance in the interpretative approaches to safety culture and many do not explicitly categorise themselves into either category. Very few adhere to the idea of safety culture as a root metaphor for the sociotechnical system. Still, interpretative approaches build on the basic conception (a metaphor) that organisations are cultures. Metaphors always highlight certain issues while clouding others. While looking at the organisation and its safety metaphorically from the point of view of the organisation as a culture will most likely bring about important insights, it should not be taken as an all-encompassing truth about the organisation—or safety. It is merely one viewpoint of the organisation.

The challenge is that this holistic view does not leave anything outside culture, but it does not specify what the culture includes either. Thus, such a view is devoid of any meaning without then further conceptualising culture in systems terms. Further, it can be argued that conceptualising technology in cultural terms refers to the social construction of an objective physical reality, not to the physical reality itself. The relation between the socially constructed object and the physical object need to be further defined if the aim is to achieve a systems view of the sociotechnical system. Moreover, the view that an organisation (or a system) is a culture rather than the view that a system has a culture can obscure specific risk contributions, which might be better analysed in technological terms and principles instead of cultural terms. Safety culture is an inherently normative concept since it depicts culture in relation to an objective—safety. While the insights from the safety cultural perspective might be relevant, they are easily considered as by default encompassing all sociotechnical influences on safety. Thus, the view of safety culture as a metaphor for everything that goes on in an organisation is flawed by the fact that such an approach departs from human conceptualisations. It is true that technology and other structural arrangements reflect culture in one way or the other—they are both products of culture and producers of culture. But there are many other phenomena that are not cultural in origin but nevertheless reflect risk and safety—such as natural phenomena (storms, rain, etc.). The holistic view of culture as everything may seriously obscure other perspectives of safety.

Antonsen (2009) has voiced similar concerns about the use of the safety culture concept as we have. He rejects both the functionalist idea of culture as a variable and the interpretative idea of culture as a root metaphor. According to him, the approaches of culture as a root metaphor sometimes take the idea too literally, essentially using culture as a synonym for organisation (Antonsen, 2009, p. 39). The culture as a variable approach, on the other hand, reduces complex phenomena to an entity defined by a set of fixed properties (Antonsen, 2009, p. 41). Antonsen reminds us that his characterisation of an organisation into three elements – structure, culture, interaction – is “only an analytical distinction” (Antonsen,

2009, p. 45). In real life, the different aspects of an organisation are intertwined. Analytical distinctions are necessary for reducing complex reality into measurable and manageable components. However, they may also distort our view of those systems if we do not have a view of the phenomena taking place in the organisations. This issue also relates to the normative nature of the safety culture concept. Nævestad (2009) has also argued that safety culture research “often seems to lack a proper conceptualization of the relationship between culture, technology and structure in high-risk organisations” (cf. Karsh et al., 2013; Guldensmund, 2010).

We argue that one reason for the neglect of the conceptualization between elements of the sociotechnical system is that safety culture has been considered a synonym for the entire sociotechnical system but at the same time the concept has directed attention to social issues instead of technological or administrative/organisational (work processes, procedures etc). Another challenge is the tendency to mix safety culture and organisational culture by giving a definition of culture (e.g. “system of beliefs”) and then using the definition of culture to denote also safety culture. However, the implicit idea that safety culture is then a subset of organisational culture (beliefs associated with safety) is seldom made explicit.

3.2. Is safety culture a process or an outcome, a cause or an effect?

Silbey (2009, p. 359) summarizes her apparent frustration with studies on safety culture (including the cybernetic models of safety used in some of the resilience engineering applications): “The research displays pervasive and persistent refusal to accept the basic feature of complex organisations and sociotechnical systems: They are continually in the making, constructed and reconstructed in every moment with every act. Each new safety process or procedure, each specification of the system, reinstates the system that was into something that is—something new, if not different”. She continues by stating that “what is specifically missing from accounts of safety culture is attention to mechanisms and processes that produce systemic meanings, including understandings of risk, safety, authority, and control” (Silbey, 2009, p. 360). She proposes two main ways to further research on safety: 1) research that challenges hegemonic normalization; identification of processes that successfully unsettle organisational routines to make the unthinkable cognizable and the invisible apparent (cf. Perin, 2005; Weick, 1998; Vogus et al., 2010), and 2) research that addresses power differentials and structured inequality in organisations; this might include topics such as the relation of financial risk and material hazards, influence of stratification of societies on concerns about safety, and the issue of differentially situated interests (Silbey, 2009, p. 362). In her view, current research on safety culture seems to suggest that “responsibility for the consequences of complex technologies resides in a cultural ether, everywhere or nowhere” (Silbey, 2009, p. 362, see also Section 2.4 in this article).

Antonsen (2009, p. 24) points out that safety culture theories have neglected the emerging nature of culture. This becomes apparent for example from the fact that the theories typically do not explain how safety culture is created. We agree with him, but argue that the other components of a sociotechnical system (structure, processes/interaction, behaviour and technology, depending on what the researcher in question includes in the concept of safety culture) also have emergent properties, and thus the overall sociotechnical system can conceivably be assumed to also exhibit emergent properties. All these should be clarified if a systems view on safety is to be achieved.

Emergent phenomena cannot be reduced to the properties or functioning of its components. For example, at an individual level, mental properties may not be easily reduced to neurobiological processes. At the organisational level, emergent phenomena have

been proposed to include e.g. shared beliefs and practices as well as work climate (Sawyer, 2005). These emergent phenomena affect performance at the individual level in a process sometimes referred to as downward causation. In a sense, all organisational practice can be considered emergent. Practice is something that results from the interaction of people with their environment and its regularities, and this interaction cannot be fully understood without considering the practice as something that has been developing gradually in the organisation and something that simultaneously guides individual action and is produced by individuals acting.

Safety can be considered an emergent phenomenon, making a systems view imperative if the aim is to evaluate or develop the safety of the entire sociotechnical system (Reiman and Rollenhagen, 2011). This means that safety cannot be understood or managed by understanding or managing its constituent parts in isolation. If safety culture is treated as a constituent part of a sociotechnical system, the overall system will have emergent properties that cannot be deduced from the study of safety culture alone. Treating safety culture as an emergent property of the sociotechnical system in turn raises the question of what the constituent parts of the emergent phenomenon are and how the emergent safety culture relates to safety.

When we are dealing with an inherently normative concept such as safety culture, it is not enough just to characterise the culture in terms of what the personnel consider important, what they value, and how they perceive their organisation. Karl Weick, drawing on Turner's (1978) ideas, has emphasised that organisations are in fact defined more by what they ignore than by what they attend to (Weick, 1998). He points out that a strong culture can also be a safety risk if the culture provides strong social order that encourages for example the compounding of small failures (Weick, 1998). Cultures are thus determined as much, if not more, by what they ignore as by what they pay attention to and what they consider important and meaningful. This means that safety culture approaches need a theory of the sociotechnical system in order to identify issues that the personnel do not themselves raise. On the other hand, asking personnel to rate preselected dimensions of safety culture in a questionnaire does not necessarily uncover the issues that the personnel neglect to consider or that they consider insignificant for safety. Moreover, the positivism underlying functionalist approaches sets some limits to the phenomena that these approaches seek to capture. Wilkin (2010, p. 236) states that critical social scientists (following Bhaskar) call the “epistemic fallacy” a philosophy (positivism) that espouses the idea that what exists is limited to that which can be experienced, ultimately that which can be observed. He goes on to state that in this positivistic view “the relationship between the necessary (structural relations) and the contingent (the acts of agents as groups or individuals) disappears”. Thus, he argues, positivists can neither make sense of these structural/systemic properties in ontological terms as real things (what kind of things they are), nor can they make sense of them in epistemological terms (how can one gain knowledge about them). The safety culture concept deals with properties of social systems that cannot all be observed in a manner similar to how physical phenomena can. The ontological (and subsequently epistemic) status of social phenomena needs to be clarified in the concept of safety culture (and thus also in the concept of safety).

Schein (1985), in his organisational culture model, makes a distinction between behaviour that is an artefact of culture and behaviour that stems from situational or individual variables. In essence, this means that some physical manifestations in a sociotechnical system are cultural, whereas some are not. However, the ontological difference between these two physical properties of the organisation is not made clear by Schein. Schein's idea of artefacts can also be interpreted to mean that a physical object can be an artefact of some organisational culture, and not necessarily an

artefact of the culture where the object currently resides. An example of this could be certain production technology used by a manufacturing company but designed by an engineering firm and embedding assumptions prevalent in the culture of that engineering firm. This distinction is interesting in terms of reciprocal causality, but it remains undeveloped in Schein's theoretical framework.

3.3. Where is “safety” in safety culture?

There seems to be an asymmetry between discussions about *culture* and discussions about *safety* in mainstream safety culture discourse. This asymmetry is reflected in for example a rather common neglect to discriminate between different types of safety. Several types of safety may exist in the same organisation or industry. For example, the concept of nuclear safety consists of several subtypes where perhaps the most common one explores the risk of environmental radiological release into the environment. However, the concept of “nuclear safety” is also associated with limited (but potentially dangerous) on-site radiological exposure for maintenance workers, fuel handling personnel, non-destructive testing personnel, etc. On top of this, conventional industrial safety is also commonly referred to as being an ingredient in nuclear safety. Thus, the question becomes what is safety culture actually trying to accomplish? What is the “safety” that cultural conceptions, values, norms and practices should form around? Attempts to diagnose safety culture should consider different contexts, technologies, and different types of hazards, since the remedial actions following cultural diagnostics may vary considerably depending on hazard type (types of safety). Also, the types of values and assumptions supporting safety culture can be assumed to vary, depending on type of safety in focus. For example, industrial safety (e.g. personal protection) is related to each person's individual health and well-being, whereas “nuclear safety” interpreted as radiological release to the external environment also involves other (non-site) people and even influences future generations. When considering what an ideal safety culture is, a starting point should be defining what the safety that the culture should promote is.

The various arenas of safety have produced more or less self-contained regulatory regimes. Depending on national laws and regulations, we can find that domains such as “occupational safety”, “patient safety”, “radiological safety” and “chemical safety” are in fact becoming so context-dependent that the common features among these different forms of safety is an emerging problem. Various forms of safety may in fact “compete” with each other in the same organisation—attempts to satisfy the demands in one area can lead to sacrifices in another. Thus, speaking about “improvement of safety culture” or “the level of safety culture” is quite meaningless without first specifying what the safety in question is. Without such an explicit definition of safety, each one interprets the concept of safety culture according to his or her (safety) cultural premises. For example, we have found that there have been challenges in communicating the safety culture requirements to subcontractors in the construction of new nuclear power plants. One of the identified reasons has been that when speaking about safety culture, the nuclear power companies as well as the regulator naturally relate the concept to nuclear safety (due to their cultural assumptions). However, most subcontractors work on multiple construction projects in various industries and associate the concept to occupational safety, which is the only common denominator between their various work settings.

Following the neglect of specifying the concept of safety, definitions of safety culture are often generic in nature. Many approaches seek to create all-encompassing ideal models of how to achieve safety. Research and practice stemming from these generic definitions does not take into account the varying demands of different

industrial domains or different functions operating inside the given industrial domain. For example, how does safety culture manifest itself in a nuclear power plant or a hospital? Should safety culture be different in young companies from mature organisations or in an engineering department from the shop-floor level of a power plant? What is the relationship between national culture and safety culture, i.e. should all national cultures have the same safety culture? Overly generic definitions of the safety culture concept can lead to overgeneralisations about what is the best safety culture and limited usefulness of the approach in actual safety improvement (Reiman and Rollenhagen, 2011).

The concept of “safety climate” represents an ambition to make some of these distinctions between various objects of analysis more explicit, since people's perceptions of various concrete states of affairs in organisations are explored (Zohar, 1980; Flin et al., 2000; Zohar and Luria, 2005). However, safety climate surveys seldom explore how subjective perceptions relate to more “objectively” defined structural dimensions in much detail (see however, Vogus et al., 2010). To do so, we need a model of safety that is rich enough to incorporate human, organisational and technological characteristics in the same framework. No such model currently exists other than in the context of very complex research models with no or little contact with day-to-day safety management. It seems, however, that at least some people in the safety culture tradition nourish a belief that the safety culture concept can somehow serve as a substitute for the lack of systemic grand models of safety. This approach basically conflates safety culture with safety. This point of view can also be questioned. Safety culture, one might argue, is just one aspect of safety and it cannot be used as a substitute for the systemic concept of *safety*.

As noted by Hollnagel (2004), for example, many accident models still share a linear philosophy in describing accident causation and fail to focus on the dynamic interplay among factors. Models of linear causality propose that the effect is proportional to cause—the larger the cause the larger the effect. This means that serious effects (e.g. accidents) are believed to be caused by serious, or big, causes (e.g. major negligence or ineptitude). Instead, in non-linear systems, according to systemic models, small causes can produce arbitrarily large effects. The outputs are not necessarily proportional to the inputs. The way of conceptualising safety and accidents has an effect not only on what kind of characteristics are considered as signifying a good safety culture, but also on what characteristics are considered part of the concept of safety culture in the beginning. Thus, safety culture can be considered a concept that describes how personnel view safety. However, this is not a typical definition of safety culture, as we have already illustrated.

4. Systems view and safety culture—a lost opportunity?

All the critique we have targeted towards safety culture does not entail that the concept is without significance. The concept has had large practical impact in various industries by getting managers and workers to think about the “soft” side of safety. Thus, the concept has been beneficial for safety. However, the concept of safety culture needs to be deconstructed in terms of safety rather than (as is the current situation) foremost exploring what kinds of issues a culture of safety could be made of. It is highly relevant to pay more attention to the concept of safety itself and from that investigate how culture might enter the safety equation. Such an endeavour should not hesitate to return to some traditional ideas about technology and safety principles (such as defence in depth, redundancy, single failure criterion, etc.) and from that further explore how such principles may contribute to safety. The contribution from the safety culture tradition might open our eyes to how basic assumptions and values can influence how we apply (and sometimes misuse) such principles.

The paradox is that the safety culture concept was originally introduced precisely because the phenomena affecting safety are systemic in nature and purely linear models or technological solutions were found inadequate to manage complex sociotechnical systems. Accidents such as Chernobyl and Piper Alpha showed that organisations need to pay attention to the so-called soft issues. The concept of safety culture tried to depict these soft issues in a manner that would allow their development. Probably due to the ambiguities in the concept itself, the research on safety culture has then focused inwards on the dimensions comprising the concept. The systemic possibilities offered by a human-centric concept have so far been largely lost in this neglect of modelling safety culture in the context of the sociotechnical system. As a consequence, safety culture improvements have been made without considering the overall safety of the system and obvious disappointments in the applicability of the concept have ensued.

The reciprocal causality of technology and the human elements of the system tend to be poorly taken into account in the safety management field (Reiman and Røllenhagen, 2011). People create technology, structures and processes, which in turn influence how people think, feel and act. The members of an organisation assign meanings and beliefs to organisational elements (structures, systems and tools, others' behaviour) and these assigned meanings in turn influence the ways in which the members behave (Alvesson, 2002; Schultz, 1995; Weick, 1995). Even the technological solutions and tools are given meanings by their designers and users, which affect their subsequent utilisation. Weick (1988, p. 307) has described the dialectic relation of mental and physical as follows: "enacted [socially constructed] environments contain real objects such as reactors, pipes and valves. The existence of these objects is not questioned, but their significance, meaning, and content is. These objects are inconsequential until they are acted upon and then incorporated retrospectively into events, situations, and explanations". Interestingly, these descriptions also seem to make an implicit distinction between the physical (technology) and the social (interpretation of technology, its meaning). The researchers of culture, being predominantly social scientists, quite naturally tend to emphasise the social aspect, sometimes at the expense of the physical aspect.

Pettersen (2008) notes that structural and cultural theories have difficulties in addressing the actual functionality of systems and the role of individual agency in those systems, "especially related to how such system, as social systems, enable and constrain the actions of their members while simultaneously taking into account that those members are intentional actors who understand, justify and make sense of their actions" (Pettersen, 2008, p. 33). Røllenhagen (2010) points out that when dealing with people, technology and organisations, we are dealing with causally interdependent categories and it makes little sense to attribute (generic) causal primacy to any of the categories in safety models: "To depart from technology in itself without recognition of its interaction with human and organisation makes little sense, and departing from "culture" in itself without understanding how technology and organisations shape beliefs, moral, values, attitudes and behaviours is also problematic" (Røllenhagen, 2010). The role of power and politics in organisations is another topic that is intertwined with culture to such a degree that safety science would benefit from including the concept of power into studies of safety and safety culture (Alvesson, 2009). To achieve this, the concept of safety culture needs to incorporate and take a stance on the idea of causal interdependency.

Schein (2013a) noted in a recent safety management workshop the first author attended that instead of safety culture, we should focus our attention on safety processes. Schein (2013a) was very critical of the whole concept of safety culture. He also emphasized the importance of technology in creating culture because it is the

technology that creates the hazards that need to be controlled (cf. Reiman and Oedewald, 2007). The group in question needs to figure out what to do about the hazards that the technology creates and the kind of safety program they will come up with will depend on the existing culture of that group (Reiman and Oedewald, 2007). Schein shortly after the workshop clarified his position regarding safety culture by pointing out that "culture is a property of a group not a concept" and thus "safety culture" should not have academic conceptual status (Schein, 2013b). Otherwise we would have to grant the same conceptual status to all kinds of "cultures", from "team culture" to "service culture". According to him, the concept of culture has to be linked to a group instead of vague notions such as safety or service. We agree with the importance of technology in safety and the idea of focusing on processes instead of static safety culture attributes. We also acknowledge that it would be conceptually more precise to talk about the culture of a group and inspect how the group views technology and its hazards, and makes tradeoffs between safety and production (Schein, 2013b). However, we see some pragmatic merit in safety culture as a concept and do not present that safety-critical organisations or the scientific community should totally abandon the concept. The concept has been widely accepted in various industries and could act as a bridge between academic and practitioners' conceptualizations (a boundary object of sorts). Rather than abandoning the concept, we propose a better integration of safety culture into a systems view on safety and a better acknowledgement of the limits and boundaries of the safety culture concept.

One example of an approach that looks at the process of producing and sustaining a safety culture is a framework developed by Vogus et al. (2010). They (Vogus et al., 2010) propose a framework of how patient safety is produced and sustained through safety culture. They define three main processes through which practices are gathered into a coherent safety culture: enabling, enacting, and elaborating. "Enabling" means singling out and drawing attention to safety-relevant aspects of the larger organisational culture, and creating contexts that make it possible for people to translate these aspects into meaningful activities in their local work context. These enabling conditions such as psychological safety to speak up or safety climate where the importance of safety is acknowledged must be turned into practices by enactment. Enacting a safety culture requires highlighting and accurately representing latent and manifest threats to safety and acting collaboratively to reduce them. Finally, elaborating a safety culture means to enlarge and refine practices. It includes rigorously reflecting on safety outcomes and using feedback to modify enabling practices and enacting processes. In their view safer practices need to be embedded in a coherent safety culture that sustains the salience and further development of these practices. Their paper concludes by proposing that safety-enhancing interactions between enabling practices and enacting processes may provide a fruitful area for future research on safety culture. (Vogus et al., 2010). In our view their work provides an interesting way forward in elaborating the mechanisms of how safety cultures are created and maintained, and why it is important to create one in the first place.

One possibility of integrating the concept of safety culture into a systemic framework that can meet the requirements for a more complete systemic view on safety would be to start with a definition of safety and introduce the various component classes (people, technology, organisational structure, environment, etc.) that together constitute the resources used to cope with various threats (many of which stem from technology, people, organisational structures, and interaction between these). Such a model could take the definition of safety as "an emergent property of the functioning of the sociotechnical system" as its starting point and define safety culture as the shared mental models (beliefs and assumptions) of safety. This definition offers an opportunity to view

safety culture as one element of the sociotechnical system that produces safety in interaction with other elements. It also avoids the implicit yet false belief that safety culture itself inherently presents a systemic view on safety—or the sociotechnical system, for that matter.

Embedding safety culture into a framework for conceptualizing system safety could provide a much needed counterforce to the prevalent focus in safety science on accidents. Dekker et al. (2011, p. 939; Dekker, 2011) have called for systemic stories of failure. Safety culture at its best could facilitate systemic stories of success and act as a concept that can be used for understanding how organisations view safety and how those views affect the overall safety of the system.

5. Conclusions

Researchers using the concept of safety culture may benefit from reflecting on whether they have taken the following issues into account:

- Has the concept of system safety been defined? (Is safety viewed as a system property? Is it viewed as a capability or as an absence of injuries or accidents, or something else? What are the constituent components of safety?)
- Has the concept of safety culture been defined? (Is safety culture seen as a variable, a description for the entire organisation, or something else? Is safety culture viewed as a subsystem of organisational culture or are these two concepts taken as synonyms? What are the constituent components of safety culture?)
- How has the relation between safety culture and system safety been conceptualised? (Is safety culture seen as a constituent component of system safety? What other components affect safety? How much of system safety does safety culture explain? Can safety culture be postulated to explain outcomes such as injuries or incidents, and to what extent can it do so? What are the signs that would indicate a strong safety culture and a weak, or weakening, safety culture?)
- Have the interrelations between other components of system safety and safety culture been defined? (How does safety culture causally interlink with the other elements of system safety? Can safety culture be viewed independently of the other components? Are there emergent effects from the interaction of components of system safety that may be missed if the focus is purely on safety culture? How does safety culture relate to such organisational phenomena as normalization, power and drift? Are practices and behaviour [or other elements listed in Table 1] considered as aspects of safety culture, manifestations of safety culture or separate phenomena potentially influenced by safety culture?)
- How is safety culture affected, changed and developed? (Can one develop safety culture directly, or should development be targeted at some other component of the sociotechnical system? How can one gather information about safety culture? How does safety culture change as a function of time without conscious intervention to improve it? How has safety culture originally developed into the organisation? Does the organisation have a safety culture from the start or does it develop gradually?)

Finally, researchers may reflect on what makes the concept of safety culture attractive in the given study: has the organisation in question (correctly or incorrectly) labelled their challenges as being related by safety culture or has the researcher noted issues that are hypothesized to be related to safety culture, or is the decision to use the concept based on other criteria (regulatory requirements, funding, personal interests).

Statements such as “we have problems in safety culture” or “the incident was caused by poor safety culture” should be treated with equal scepticism as the old statements “we have a problem with humans making errors” and “the incident was caused by human error” should be (cf. Woods et al., 2010). We can even say that similar to “human error”, “safety culture” should only be the starting point of a further investigation, not its conclusion. In general, safety culture research and practice has so far missed the opportunity to integrate with systemic perspectives. However, some counterexamples of attempts to facilitate such integration exist (see for example Antonsen, 2009; Guldenmund, 2007, 2010; Vogus et al., 2010). We hope this article will contribute to this discourse towards more systemic conceptualization of both safety and safety culture.

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