28

SAFETY CULTURE

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28.1 INTRODUCTION

A "weak" or deficient safety culture has been identified as a substantive issue or factor in the development of numerous human-created disasters, from BP Texas City refinery explosion and Fukushima Daiichi nuclear disaster to Piper Alpha offshore platform, Challenger and Columbia Space Shuttle explosions, Deepwater Horizon disaster (Waring, 2015). Safety culture as a concept originates from the nuclear industry where it was first used to explain the Chernobyl nuclear accident. In various applications, the concept strives to catch the influence of social and organizational phenomena to safety. It reminds both practitioners and researchers of the fact that most accidents are not solely the result of human error, technical failures, or environmental factors such as weather. Rather, accidents often have their roots in organizational and managerial shortcomings, and could thus be prevented by better safety management systems. The concept illustrates that safety cannot ever be guaranteed by technical means alone, but rather safety depends heavily on management, leadership, and so-called human and organizational factors. It also illustrates the importance of reflecting how safety is perceived and valued in organizations, and what things are considered important in achieving it.

The concept of safety culture is currently used in many fields of safety, including occupational safety, patient safety, and process safety. The concept has been applied to explain accidents and to provide a risk estimate for potential events (cf., Strauch, 2015). The concept is variously used either as a safety management principle (a tool for safety improvement) or as a concept describing a real phenomenon in the organization (something that informs about the level of safety in the organization). Both can be valid and useful applications of the concept, but it is always important to clarify the assumptions underlying a chosen approach to safety culture. Providing such clarifications has proven to be a painstakingly difficult exercise judged from the many interpretations and theoretical orientations found in the literature. As an example of some of the difficulties, consider the quotes below.

Chairman Kurokawa of the Fukushima accident investigation board:

> *"For all the extensive detail it provides, what this report cannot fully convey—especially to a global audience—is the mindset that supported the negligence behind this disaster.*
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> *What must be admitted—very painfully—is that this was a disaster 'Made in Japan.' Its fundamental causes are to be found in the ingrained conventions of Japanese culture: our reflexive obedience; our reluctance to question authority; our devotion to 'sticking with the program'; our groupism; and our insularity.*
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> *Had other Japanese been in the shoes of those who bear responsibility for this accident, the result may well have been the same."*
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> (NAIIC, 2012:9)

> *"BP has not instilled a common, unifying process safety culture among its U.S. refineries. Each refinery has its own separate and distinct process safety culture. While some refineries are far more effective than others in promoting process safety, significant process safety culture issues exist at all five U.S. refineries, not just Texas City. Although the five refineries do not share a unified process safety culture, each exhibits some similar weaknesses. The Panel found instances of a lack of operating discipline, toleration of serious deviations from safe operating practices, and apparent complacency toward serious process safety risks at each refinery."*
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> (The B.P. U.S. Refineries Independent Safety Review Panel, 2007)

In the quotations above the concept of safety culture is used as a high-level explanation for the accidents of Fukushima in 2011 and Texas City refinery in 2005. The first quote illustrates one of the inherent difficulties associated with the concept of safety culture, namely the problem of demarcating the concept of culture in general from the concept of safety culture as a specific facet of culture. Pending issues include: How is national culture related to organizational culture? How is organizational culture related to various subcultures in organizations and how is all of this related to the specific facet of culture called safety culture? And finally, is it possible to identify such features of safety culture that would be optimal in any macro-context or does the national culture affect what kind of culture is good for safety?

The second quote illustrates the problem of different types of safety, and different types of safety culture. Here some of the debated issues include: Are the properties of safety culture needed to prevent and respond to major accidents different from safety culture needed to prevent occupational accidents? Do organizations have a single safety culture or should we instead inspect different subcultures such as occupational safety culture, process safety culture, etc.? Combining this with the question of the influence of the national culture, a major controversy revolves around the issues of whether there are universal features of good safety culture, and what are the features or elements of (a good or bad) safety culture.

In this chapter, we inspect the different uses of the concept of safety culture and summarize the critique directed toward the term as well as give recommendations for a way forward. We will focus mainly on safety culture rather than on the related concept of safety climate. The two concepts have many similarities but also differences since they emanate from different research traditions. Safety climate is often perceived as a more shallow aspect of safety culture associated with how individuals in an organization directly perceive various states of affairs related to safety. Safety culture, on the other hand, is associated with norms, values, and basic assumptions directly or indirectly related to safety. However, the demarcation between the two concepts and associated measures are often blurred in practice. For example, the use of questionnaires is common in both research traditions.

Many of the technical principles of safety, such as defense-in-depth, are related to safety culture. This is due to the fact that safety culture affects all the independent layers of defense that the defense-in-depth concept deals with. In fact, most of the chapters in this handbook contain aspects that can be related to aspects discussed in the area of safety culture and safety climate.

The disposition of the chapter is as follows. First, we give two examples of events that illustrate various human and organizational features that are associated with safety culture. In Section 28.2, we begin with a short description of the Chernobyl accident in 1986 since this event is claimed to constitute the birth of the safety culture concept. We then trace the roots of the concept of safety culture to the more general concepts of organizational culture and organizational climate. Numerous definitions have been suggested to define safety culture and we exemplify some of these in Section 28.3 followed by a review of theoretical assumptions about the concept in Section 28.4. Section 28.5 gives selected examples of empirical research and Section 28.6 discusses the use and implementation of the safety culture concept. Some of the criticism directed to the safety culture concept is discussed in Section 28.7 followed by discussion and main message in Section 28.8.

Example 1 Saved by the grace of safety culture—Onagawa NPP
The causes of the Fukushima nuclear disaster have been largely attributed to cultural factors (weak safety culture). However, even more interesting is an example of a nuclear power plant that manifested good/strong safety culture during the Great Asian Tsunami, namely, the Onagawa nuclear power plant operated by Tōhoku Electric Power Company.

The plant has three boiling water reactors (BWR Mark I) commissioned in 1984, 1995, and 2002.

Onagawa nuclear power plant was the closest nuclear power plant to the March 2011 earthquake epicenter. The plant experienced "the strongest shaking that any nuclear power plant has ever experienced from an earthquake" (IAEA, 2012), but was able to shut down safely all its three reactors. No radioactive material was released to the environment. The plant units suffered only minor damage, with some internal flooding in unit 2 and turbine damage in all units.

It can be argued that the safe shutdown of Onagawa in many respects can be attributed to the plant's high level of safety culture (Ryu and Meshkati, 2014). Firstly, the plant clearly practiced conservative decision-making and continuous learning: Before beginning construction in 1968, Tohoku Electric reviewed literature and interviewed local people about tsunamis (there was no simulation technology yet available). These initial predictions showed that tsunamis in the region historically had an average height of about 3 meters. Based on that information, the company positioned its plant at 14.8 meters above sea level, which was almost five times the estimated height of an average tsunami.[1] New studies conducted by the power company raised the estimate first to 9.1 meters in 1987 when preparing the license application for unit 2 and then as a result of in separate study in 2002 to 13.6 meters. Several improvements were made based on the new estimates. Further, Tohoku Electric learned from past earthquakes and tsunamis—including one in Chile on February 28, 2010—and continuously improved its countermeasures.

Secondly, Tohoku Electric's emergency response was well organized, collaborative, and controlled. Protocols were in place for emergencies, including tsunami, and operators had been trained to cope with a variety of simulated emergencies, including the loss of off-site power. Tohoku Electric had established emergency response centers both at the Onagawa plant and at company headquarters. They had reinforced the old administration building with braces and were in the process of building a new seismic isolation building to house an emergency response center. Fortunately, the old administration building survived the quake and acted as a response center. There was good support from the headquarters throughout the disaster. Supervisors and chief engineers were dispatched to the main control rooms of the damaged reactors to make decisions, and information was sent in a timely manner to all levels of the response team.

Finally, the successful shutdown of the plant can be attributed to top management commitment to safety and interaction with all stakeholders in matters of nuclear safety. Yanosuke Hirai, vice president of Tohoku Electric from 1960 to 1975—a time period that preceded the 1980 groundbreaking at Onagawa—was adamant about safety protocols and became a member of the Coastal Institution Research Association in 1963 because of his concern about the importance of protecting against natural disasters. With a senior employee in upper management advocating forcefully for safety, a strong safety culture formed within the company. Representatives of Tohoku Electric participated in seminars and panel discussions about earthquake and tsunami disaster prevention held by the Japan Nuclear Energy Safety Organization. The company implemented strict protocols for disaster response, and all workers were familiar with the steps to be taken when a tsunami was approaching.

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[1] The 2011 Tsunami was of 14.3 meters height at Onagawa and 13.1 meters at Fukushima.

Example 2 Normalizing deviance—NASA and the *Challenger* space shuttle
NASA Space Transportation System, envisioned in 1969, was supposed to provide the Unites States an easy and convenient access to space. It was marketed as a routine "bus-like" transportation to space with one flight every week. The selling argument for the program at NASA was "safe, cost-effective and routine access to space." The original purpose of the system was twofold: to reduce the cost of spaceflight by replacing the current method of launching "capsules" on expendable rockets with reusable spacecraft; and to support ambitious follow-on programs including permanent orbiting space stations around the Earth and Moon, and a human landing mission to Mars. Space Shuttle Challenger (NASA Orbiter Vehicle Designation: OV-099) was the second in its class. Its sister shuttle, Columbia, the first shuttle to commence operations, made its maiden flight in April 1981. Challenger's maiden flight was on April 4, 1983, and it completed nine missions before its fatal last mission, STS-51-L on January 28, 1986.

Challenger exploded 73 seconds after launch. All of its seven crew members were killed. The technical cause of the accident was as follows: A combustion gas leak through the right solid rocket motor aft field joint initiated at or shortly after ignition eventually weakened and/or penetrated the external tank, initiating vehicle structural breakup and loss of the Space Shuttle Challenger during STS Mission 51-L (Report, 1986). The gas leak was caused by failure in the O-rings of the booster.

The shuttle had several O-rings, made of a rubber compound, which were used to seal the solid rocket booster field joints. The solid rocket boosters are made in sections. There are two types of joints to hold the sections together: the permanent "factory joints" are sealed at the Morton Thiokol factory in Utah; the temporary "field joints" are sealed before each flight—at the Kennedy Space Center in Florida (Feynman, 1988). The O-rings measured 146 inches in diameter and were just 0.280 inch thick. Each one was molded in one piece to span the entire circumference of the booster. Each solid rocket booster had three field joints, and the shuttle had two solid rocket boosters.

The weather on launch day was exceptionally cold (36 F, ≈ 2°C), 15 degrees lower than that measured for the next coldest previous launch. Ice had formed on the pad during the night. The durability of the O-rings had not been tested at such temperatures and worries about the effect of temperature to the ability of the O-rings to seal effectively were expressed. Thus, before the launch a teleconference was held between NASA and Morton Thiokol, where the dangers of launching at cold temperature were discussed. After the teleconference a decision to launch was made.

The Challenger accident has been investigated by various groups of people. The official investigation by the Presidential Commission on the Space Shuttle Challenger Accident (1986) found numerous rule breakings and deviant behavior at NASA prior to the accident. They also accused NASA of allowing cost and schedule concerns to override safety concerns. Many have blamed the accident on a fundamental design error in the O-rings. The resiliency of the O-rings was directly related to the temperature. The colder the ring, the slower it returns to its original shape after compression.

Vaughan (1996) shows in her analysis of the same accident how most of the actions that employees at NASA conducted were not deviant in terms of the culture at NASA. She also shows how safety remained a priority among the field-level personnel and how the personnel did not see a trade-off between schedule and safety. They perceived the pressure to increase the number of launches and keep the schedule as a matter of workload, not a matter of safety versus schedule (Vaughan, 1996). According to her analysis,

the decisions made at NASA from 1977 through 1985 were "normal within the cultural belief systems in which their actions were embedded" (Vaughan, 1996, p. 236). Vaughan (1996, pp. 409–410) summarizes: "The explanation of Challenger launch is a story of how people who worked together developed patterns that blinded them to the consequences of their actions. It is not only about the development of norms but also about the incremental expansion of normative boundaries: how small changes—new behaviours that were slight deviations from the normal course of events—gradually became the norm, providing a basis for accepting additional deviance. No rules were violated; there was no intent to do harm. Yet harm was done." The organization gradually drifted to a state in which it no longer operated safely. Earlier danger signals had become part of "normal" work and they were no longer noted.

28.2 ORIGIN AND HISTORY

Since the concept of safety culture was coined after the Chernobyl accident in 1986 we shall provide some more details about this event followed by a discussion about the concepts of organizational culture and organizational climate: two broad concepts that have influenced theory and practice of safety culture and safety climate.

28.2.1 The Chernobyl Accident

The Chernobyl accident was the worst nuclear power plant accident in history in terms of costs and casualties. It is one of the only two nuclear accidents classified as a level 7 event (the maximum classification) on the International Nuclear Event Scale (INES). The other is the Fukushima Daiichi nuclear disaster in 2011. The accident occurred on April 26, 1986 in the Chernobyl Nuclear Power Plant situated in the village of Pripyat in the former Soviet Union (present day Ukraine).

The accident occurred during a test aimed at evaluating how long the turbines would spin and supply power to the main circulating pumps following a loss of main electrical power supply. The test required shutting down some safety systems (e.g., automatic shutdown mechanisms) and to operate the plant at a lower power than was normal. The test went awry and the operators tried to execute an emergency shutdown of the plant by lowering all the control rods into the reactor. However, this action caused a dramatic power surge due to the inherently unstable nature of the reactor.

IAEA's International Nuclear Safety Advisory Group (INSAG) reviewed the evidence concerning the accident and concluded that the "root cause of the Chernobyl accident … is to be found in the so-called human element" (IAEA, 1986, p. 76), and that "formal procedures must be properly reviewed, approved and supplemented by the creation and maintenance of a 'nuclear safety culture'" (ibid., p. 77). The report offered little definition of what this "nuclear safety culture" could entail, but since many references were made to procedure violations as causal factors in the report,

adherence to formal procedures seems to be an important aspect of the report's notion of safety culture. INSAG updated its initial 1986 accident review in 1992 as a result of new information concerning the course of events. For example, it turned out that some of the so-called "procedure violations" were actually approved by the Chief Engineer and was part of the test procedure. Also, some of the hazardous actions made during the accident sequence, and first interpreted as procedure violations by Soviet experts, turned out to have been made without any existing procedural guidance. Thus, the "violations" were probably made without operators' knowledge that they were actually violating something.

The accident turned out to be more systemic in its causes than was envisioned in the first IAEA meeting, and deficiencies in "nuclear safety culture" now seemed an even more reasonable explanation in comparison with when the concept was first introduced. The new information demonstrated lack of feedback of operating experience and problems in communication between designers, engineers, manufacturers, constructors, operators, and regulators. These deficiencies, coupled with a lack of clear lines of responsibility, deference to authority, insufficient procedures, and operators' insufficient understanding of the nuclear hazards and the inherent weaknesses in the RBMK reactors, were found to be critical contributing factors behind the accident. It was also noted that the lessons from the Three Mile Island accident had not been acted upon in the USSR.[2] One can also argue that due to a prevalent belief in the safety of RBMK reactors in the USSR, the emergency preparedness was insufficient. This lack of preparedness for the worst was also illustrated 25 years later at Fukushima accident in Japan (and was also evident to some degree at Three Mile Island, 7 years prior to Chernobyl).

28.2.2 Organizational Culture and Organizational Climate: The Broader Context

In order to further trace the history of safety culture and safety climate we will briefly address the more general terms of organizational culture and organizational climate without the prefix of "safety." Particularly, the concept of organizational climate shall be addressed because there is often confusion about how the concept of climate relates to that of culture. This debate still prevails in some writings about safety culture and safety climate.

Developing a sense of meaning in an organization is supported by many different factors (activities, policies, structures, working conditions, etc.) which then are shared

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[2] Many of these contributing factors seem to echo those of the Three Mile Island accident, including the lack of competence of the operators, lack of operating experience feedback concerning similar previous incidents, problems in human–machine interface and inadequate procedures for dealing with emergency situations. Hauntingly, some of these same elements can again be found in the Fukushima accident of 2011; lack of adequate emergency procedures, belief in the inherent safety of nuclear power, inadequate operating experience feedback (cf., the Onagawa example in the main text).

and integrated among the organizational members (Schneider, 1985). Underneath the concept of organizational climate, a main research focus has been to investigate how individuals perceive different meaning shaping factors found in their social work context. The concept of organizational culture, on the other hand, has been applied more to investigate deeper-level basic values and assumptions as part of meaning creation in organizations. Different research strategies follow from this difference in research focus.

Investigations of organizational climate often focus on how individuals draw conclusions based on what they directly perceive in their organizational context. The idea is that such conclusions become shared among the members to constitute a particular organizational climate (Schneider, 1975). This climate then influences individual perceptions of various arrangements in the organization (including those that are associated with safety). The concept of organizational culture goes deeper, below the perceptions that the employees share. It tries to explain the dynamics among individuals and the system as a consequence of shared assumptions, values, and norms that exist and emerge among the members in an organizational setting. The result of this cultural dynamics is partly expressed in symbolic form (Alvesson, 2002) but also as shared cognitive schemas used to interpret the world. It affects how people think, feel, and act (Schein, 1985) in the long term. Climate denotes the surface features of the culture at a given point in time (cf., Flin et al., 2000). Culture is more stable, tacit, and taken for granted than climate.

28.2.3 Safety Climate

The first study of safety climate was made by Zohar (1980) who distinguished a set of factors which he found reflected individual's perception of different safety-related issues (i.e., their relative importance). For example, among the factors identified were the importance of safety-related training, management's attitudes to safety, and the status of safety committees. After Zohar's pioneering work, many psychometric studies have attempted to identify generic safety climate factors by use of questionnaires and factor analysis (Guldenmund, 2007; Zohar, 2010). A frequently found factor in these studies is management commitment (e.g., Cheyne et al., 1998; Cohen, 1977; Dedobbeleer and Beland, 1991; DeJoy et al., 2004; Donald and Canter, 1994; Hofmann and Stetzer, 1996; Ostrom et al., 1993; O'Toole, 2002; Rundmo, 1996; Rundmo and Hale, 2003; Seo et al., 2004; Simonds and Shafari-Sahrai, 1977; Smith et al., 1978; Zohar, 1980; Zohar and Luria, 2005). In a review study by Flin et al. (2000), the most common factors identified were "management/supervision," "safety systems," and "risk." Also, Seo et al. (2004), in their review of previous studies found a core of generic safety climate concepts; management commitment to safety, supervisor safety support, co-worker's safety support, employee participation in safety, and competence. Despite the long research tradition already existing in the area of safety climate, safety culture development in the 1980s and 1990s drew more on the organizational culture literature than the safety climate literature.

28.2.4 Organizational Culture and Safety Culture

Studies of organizational culture (without the prefix "safety") had already begun in the 1970s and they accelerated in the 1980s. The soil was thus well grounded when the concept safety culture appeared in the late 1980s. The roots to the focus on organizational culture can be found in several disciplines from as early on as the 1930s. Among those are symbolic interactionism and social constructivism (Mead, 1934; Berger and Luckman, 1966) and the Tavistock paradigm (Rice, 1958; Miller and Rice, 1967).

The concept of organizational culture has been approached from many perspectives. One such perspective departs from the history of an organization and how this history is reflected, and embedded in assumptions, values, and practices. A second perspective focuses on culture as a variable among others that can be manipulated and changed (i.e., a functionalistic perspective). A third perspective conceptualizes assumptions, beliefs, and values as shared cognitive schemas that are used to interpret the world and act in it. These perspectives are also used in the context of safety culture.

Sociologically oriented researchers also have had an impact on the safety culture and safety climate development. For example, Vaughan's (1996) influential study on the 1986 *Challenger* Space Shuttle accident is cultural in its main approach. Even though she does not use the concept of safety culture, her work provides an interesting view on the effects of culture on safety through an in-depth accident investigation. She recognized several cultural patterns in NASA's and its subcontractors' organizations—cultural patterns that contributed to the accident. For example, the "normalization of deviance" refers to a process where small changes—new behaviors, technical/physical/social anomalies, or other variations that represent slight deviations from the normal course of events—gradually become the norm (Vaughan, 1996). Normalization of deviance produces disregard and misinterpretation—neutralization—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 (ibid.) indeed refers to the concept of culture quite often in her analysis. 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" (ibid., p. 64). She further clarifies that the solutions are institutionalized as rules, rituals, and values (ibid., p. 64).

Most cultural approaches today acknowledge the existence of at least three types of subcultures: (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). The existence of subcultures in organizations is something that can create conflicts and problems in communication but also positive differentiation and diversity, as has been highlighted by several researchers (Cooper, 2000; Mearns et al., 1998). Connected to this is the question whether grand organizational cultures really exist. For example, Jones and James (1979) and Rollenhagen et al. (2013) found that

different professional groups had developed subcultures related to the type of work they did (professional identity) rather than what organizational unit they belonged to. A subculture can be defined in terms of professional groups that transcend a specific organizational boundary (medical doctors, pilots, etc.) or it can be defined in terms of groups according to an organizational 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). Thus, any organization can be considered a melting pot of multiple subcultures interacting simultaneously.

Such findings point to the importance of being sensitive to what people actually do in the organization as a determinant of organizational culture in contrast with perceiving an organization as an a priori coherent cultural system (Richter and Koch, 2004). However, some order and coherence is to be expected in organizational settings. Research points out that humans tend to form groups and social identities develop in the context of groups (Haslam et al., 2011). An integral part of a social identity is a social comparison to relevant out-groups ("them"). What is defined as a relevant out-group is then important for the social identity of the in-group. In terms of safety, it would be better to compare one's own group to organizations that have a good safety culture and good past safety record. This should raise a desire to develop one's own organization further. However, there is a natural tendency to compare one's group only to those groups that are perceived inferior. This is good for the in-group self-esteem, but it does not benefit learning. Rather, it assures and reinforces the existing identity.

As illustrated above, the general concepts of organizational culture and organizational climate are in many ways intermingled. This also holds for the concepts of safety climate and safety culture. Both concepts highlight human-oriented factors such as perceptions, attitudes, and values, but they do this somewhat differently. Both culture and climate refer to something that is shared among the organizational members; they both are collective properties of a group or an organization.

28.3 DEFINITIONS AND TERMINOLOGY

The concept of "safety culture" was for the first time defined in IAEA (1986) "Summary Report on the Post-Accident Review Meeting on the Chernobyl Accident" as "that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance." Several other definitions have followed. The UK Health and Safety Commission (HSC, 1993) defined safety culture as follows: "The product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management." Pidgeon (1998), in turn, 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 organizational culture, where the beliefs and values refer specifically to matters of health and safety". Richter and Koch (2004) in their definition emphasize shared 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 (ibid., 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." Common to most definitions is that they emphasize safety culture as something holistic and shared among the members of the analytic unit in focus.

It is important to emphasize that safety culture, similar to organizational culture, is not intended to be an individual trait, but rather an organizational collective property in the meaning of what individuals share with each other in terms of behavior, attitudes, values, etc. Thus, individuals do not have a safety culture separated from the social context. As a simplification, culture can be referred to as the "personality" of an organization (Hofstede, 1991; Schein, 2010, p. 14), its natural way of being and behaving (interaction, communication, climate, norms, beliefs, values, attitudes, etc.). Schein (2010, p. 14) notes that "just as our personality and character guide and constrain our behavior, so does culture guide and constrain the behavior of members of a group through the shared norms that are held in that group."

This also means that culture is something real. Thus, instead of being a management principle or tool that is applied or a model that is implemented, culture can be perceived as something that exists in the organization, something that the organization has created and continues to create. Culture then affects all the members of the organization, how they see, think, feel, and act in relation to safety.

Today we find large variance in conceptualizations of safety culture, ranging from descriptive studies on the social construction of safety to normative models of ideal safety culture/climate dimensions. By and large, the models of safety culture bear more resemblance to the functionalist theories of organizational culture than to the interpretative ones (Richter and Koch, 2004; cf., Smircich, 1983).

A consensus seems to have been reached that safety culture is a multidimensional construct (Guldenmund, 2000). However, the exact dimensions comprising safety culture have been debated and no agreement has been reached. Meta-analyses of questionnaire studies have identified management commitment to safety as the most common factor (Flin et al., 2000; Flin, 2007). Other widely utilized dimensions of safety culture include communication, competence, resources, quality of rules and instructions, personnel's risk perceptions, organizational learning practices including reporting of near-misses, and the safety management system.

A comprehensive critique of the various conceptualizations of safety culture can be found in Reiman and Rollenhagen (2014). The main argument of the critique is that safety culture discourse has largely failed to integrate itself with the more technically focused safety approaches and other safety considerations in order to capture a

holistic view of the sociotechnical system. This critique is elaborated in Section 28.7 of this chapter.

An emerging consensus among many safety culture and safety climate researchers is that ideally it would be better to speak about *cultural influences on safety* rather than to portray safety climate/culture as isolated from its broader organizational cultural context (Grote and Künzler, 2000; Hale, 2000; Haukelid, 2008; Hopkins, 2006). However, as the concept of safety culture is well established in safety management it makes sense to use the concept to highlight the special nature of culture in safety-critical organizations.

28.4 UNDERLYING THEORY AND THEORETICAL ASSUMPTIONS

28.4.1 Some Common Features of Safety Culture Models

Despite disagreements on the exact definition of the safety culture as a concept, we can identify several features of safety culture that are widely considered as important. For example, top management's commitment to safety has been heavily emphasized (Flin, 2003; Guldenmund, 2007; HSE, 1997; IAEA, 1991; Reason, 1997). On the other hand, in organizations where management is not committed to safety, disobedience and whistleblowing by the staff could be a sign of good safety culture at a sub-group level (cf., Sagan, 1993). Thus, a questioning attitude (IAEA, 1991), awareness of safety and hazards (Reiman et al., 2012), openness and trust (Reason, 1997), and vigilance/mindfulness (Hopkins, 2005) are also commonly considered signs of a good safety culture. Finally, it is emphasized that safety needs to be integrated into all activities of the organization and not perceived as a separate task (IAEA, 1991; Grote and Künzler, 2000, p. 134).

A good safety culture does not mean that everyone agrees with everyone else or that different opinions about, for example, safety matters always constitute a risk. In fact, too uniform a culture may become blind to its own weaknesses and seek to find corroboration for the old and familiar opinions (Sagan, 1993; Weick, 1998). For the above-mentioned questioning attitude to work, the organizational climate should be of a kind that allows for open discussions of potential hazards, possible countermeasures, and their effects on production, public image, etc. An effective safety management system is also considered both a sign of good safety culture as well as a necessary precondition for creating a healthy safety culture to the company.

In addition to safety culture studies, certain important insights on the criteria for good safety culture can be gained from the High Reliability Organization (HRO) group, and especially the work of Karl Weick and Kathleen Sutcliffe. They emphasize that organizations that wish to operate reliably have to rely on the expertise of the field, be reluctant to simplify things, put expertise over rank, have a preoccupation with the possibility of failure and thus spent resiliently effort to improve and avoid failures (Weick and Sutcliffe, 2007).

28.4.2 Theoretical Frameworks

A common theoretical framework that researchers and practitioners alike proclaim as an underlying view of safety culture is Edgar Schein's (1985) model of organizational culture.[3] Culture has, according to Schein (ibid.), several levels, with artefacts (visible behavior, technology, work environment, rules and instructions, etc.) presenting the surface level of culture, followed by espoused values (what the people say, slogans, mission statements, justifications of behavior). Schein has defined the deepest layer of organizational culture as a pattern of basic assumptions that a 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 organization as the correct way to perceive, think, and feel in relation to those problems (Schein, 1985). Such basic assumptions are largely taken for granted but they have an effect on the way people perceive, think, and feel about their organization, including its core task and the various hazards associated with it.

Examples of the issues where the effects of culture manifest include how risks are evaluated and managed, the way the current safety level is interpreted, and what is considered unacceptable behavior. Safety culture also contributes to defining formal and informal norms concerning, for example, safe behavior or proper workplace conduct. Culture "defines" what is normal to a group, and safety culture thus affects what is considered normal work perceived from safety perspective, how work should be carried out, and what the potential warning signals are.[4]

Basic assumptions concern, for example, issues of time perspective, the nature of the company's relationship with its various stakeholders, appropriate ways of responding to critique, criteria for rewarding and punishing people. In safety-critical fields basic assumptions may concern issues such as what constitutes risk, the main hazards the organization is coping with, how one is supposed to speak about risks in the workplace, and what is perceived as a valid warning signal. Further assumptions may concern issues such as the best ways of improving safety, reasons why people make errors, how to deal with the errors once they occur, what is expected of a professional in the organization, and how persons gain respect and/or power in the organization.

The main notion here is that culture is something the company creates for itself, and which, once created, has an effect on the company. This effect is in many ways not perceived by the company itself, since the members of the organization consider all things that happen according to cultural assumptions "business as usual." Culture

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[3] Although Schein himself is very critical of the concept of safety culture, see, for example, Reiman and Rollenhagen(2014).

[4] Depending on terminology, culture is sometimes seen as defining certain phenomena or being itself composed of those phenomena. For example, some theories treat the way of working and the organizational practices as being part of the organizational culture, whereas other theories see culture as constraining and affecting those practices.

is repeatedly created and recreated as members behave and communicate in ways that to them seem natural, obvious, and unquestionable and as such contribute to a particular version of risk, danger, and safety (Pidgeon, 2012, pp. 20–21). Culture is a result of shared learning experiences that affects how the group will learn in future (Schein, 2010).

Schein (2010, pp. 16–17) identifies the defined characteristics of culture as "structural stability," "depth," "breadth," and "patterning or integration." Structural stability implies that culture is not only shared but it defines the group's identity, and survives even when some members of the organization depart. Depth refers to the fact that culture denotes the deepest and often unconscious aspects of a group. The essence of culture is invisible and intangible, yet it is tangible in its manifestations. Once culture forms, it covers all of a group's functioning (breadth). Finally, patterning or integration means that culture ties various elements, such as rituals, climate, values, and behavior, together into a coherent and sensible whole (cf., Weick, 1995).

Another way of conceptualizing culture is to view it as a "root metaphor" for the organization itself (Alvesson, 2002; Smirhich, 1983). According to this conceptualization, culture is embedded in the social processes and practices of the organization. It is thus not an element that can be considered, analyzed, and evaluated independently of its context, since culture *is* the context. This is called the interpretive approach to culture.

A middle position, and one that has gained increasing popularity, is to treat safety culture as one element (or variable) within the larger system, but at the same time acknowledging the need to look at other elements and their interaction. In this view, culture is not everything, but it is something that is qualitatively different from other elements of a sociotechnical system. This approach treats safety culture as a contextual phenomenon but also differentiates it from its context, such as the technology, tools, procedures, and the personnel as individuals (Antonsen, 2009a, Guldenmund, 2010; Myers et al., 2014; Næevestad, 2009; Reiman and Rollenhagen, 2014). This view makes it possible to inspect and evaluate safety culture but also treat sociotechnical systems more analytically as comprising qualitatively different elements. This can be considered an interpretive-realist framework of culture.

Many scholars have stressed the importance of treating safety culture as a contextual phenomenon, a property of the organization that is connected to other characteristics in a complex web of interdependent causalities (Tharaldsen and Haukelid, 2009). The deep core of culture, shared values, beliefs, and assumptions not only relate to each other but also influence practices, structures, personnel, and technology which, in turn, may have a causal influence on each other as well as on the shared assumptions.

Guldenmund (2007) argues that within organizations three major forces are operating at the same time on (the behavior of) the people who work there. These generic forces are structure, culture, and processes and they are dynamically interrelated, that is, the particular strength of each force is determined by the other two. Antonsen (2009a) differentiates between structure, culture, and interaction,

preserving the concept of culture for values and attitudes. He views 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 (2009a) emphasizes that safety culture relates to the informal aspects of an organization, whereas the formal aspects are part of the structure of the organization. Myers et al. (2014) propose a clearer delineation of culture, that is, the socially constructed abstract systems of meaning, norms, beliefs, and values from concrete behaviors, social relations, and other properties of workplaces (e.g., organizational structures) and of society itself.

In a cultural framework, the social world is seen not as objective, tangible, and quantifiable but as constructed by people and reproduced by the networks of symbols and meanings that people share and make shared action possible (Alvesson, 2002, p. 25). This means that even the technological solutions, production technologies, and other man-made structures are given meanings by their designers and users, which affect their subsequent utilization (and subsequent reinterpretation of this meaning).

It further means that concepts such as safety, reliability, sustainability, or cost-effectiveness are not predefined and set in stone. Rather, organizations construct the meaning of these concepts and act in accordance to this constructed meaning. For example, if the organization socially constructs a view that the essence of assuring safety is to prevent individuals—considered as the weakest links in the system—from committing errors, safety management is likely to focus on individuals and include measures such as attitude training, demotion, and blaming. However, we should not fall in the trap of misplaced social constructivism. Hazards are real and not only social constructions (which can also be considered "real," but in a qualitatively different way) although we develop different ways to think, speak, perceive, and act about them.

Figure 28.1 illustrates culture and its relation to structure and behavior. As the figure illustrates, culture is created and maintained by behavior but it also influences behavior. Structures, such as organizational structure, management system,
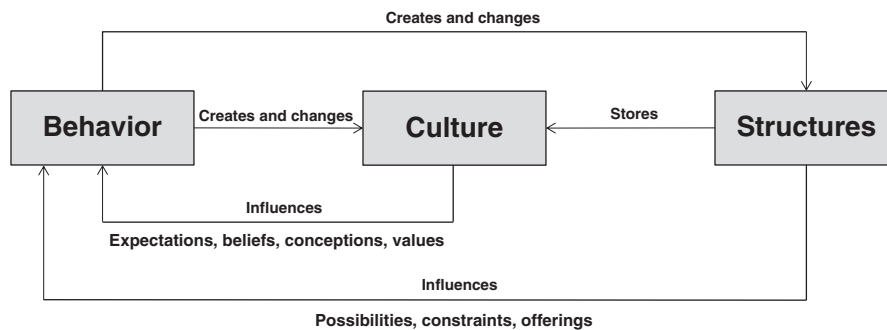

Figure 28.1. The iterative nature of culture.

or production technology, in turn store elements of culture. Structures provide constraints and possibilities for behavior. Culture can be changed by changing both behavior and structures. Behavior is naturally influenced by many other situational and contextual factors. Structure can also be analyzed in more detail, and, for example, organizational processes (Guldenmund, 2007), social relations (Myers et al., 2014), and interaction (Antonsen, 2009a) could be included in the model, but these and other factors (e.g., external environment) have been omitted to highlight the interaction of three central elements: behavior, culture, and structure.

28.5 EMPIRICAL RESEARCH

Safety culture has been a topic of extensive research. Surprisingly few predictive or longitudinal studies exist though (for an overview of predictive studies in health care, see Itoh et al., 2014). Most studies have used past or concurrent safety performance as validation criteria (cross-sectional study design). The reader is referred to reviews by Guldenmund (2000, 2007, 2010), Flin et al. (2000), Sorensen (2002), and Choudhry et al. (2007) for summaries of safety culture and climate studies. Here we shall mention only a few recent studies which we find particularly relevant for the present purposes. We have omitted in this article the large body of empirical research focusing on the content validity and operationalization of the safety culture concept. This branch of safety culture research was briefly addressed in Sections 28.3 and 28.4. Here the focus is on empirical research addressing the predictive validity of safety culture. Studies of safety culture improvement/change are addressed in Section 28.6.

Safety culture studies have often tried to link the safety culture concept to various negative outcomes such as occupational injuries, adverse events, or process disturbances. Using these unwanted outcomes to validate the link between safety culture and safety is problematic in two ways (Reiman and Rollenhagen, 2014): first, if safety culture is only one variable among others in a sociotechnical system, it cannot sensibly be expected to correlate with safety without measuring or controlling the influence of 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; cf., Itoh et al., 2014). Still, studies using incidents or other negative events as outcome variables can provide valuable information about the relation between the different elements of the sociotechnical system.

Morrow et al. (2014) studied the relationship between safety culture and other indicators of safety in the US nuclear power industry. Their questionnaire study included 2876 responses from 63 nuclear power plant sites. The relationships between safety culture and safety performance were more consistent when safety performance was measured concurrently, as opposed to being measured 1 year after the survey administration. However, some interesting correlations were found. Organizations where employees perceived less of a questioning attitude were more likely to receive

higher numbers of allegations from the Nuclear Regulatory Commission in the same year and the following year. Moreover, organizations with lower overall scores on the safety culture survey were more likely to have higher counts of unplanned scrams, and have inspection findings related to inadequacies in problem identification and resolution.

Bergman et al. (2014) studied safety climate as both a leading (climate → incident) and a lagging (incident → climate) indicator of safety-critical incidents. They conducted a survey at a large, multinational chemical manufacturing company, with 7467 responses at 42 worksites in 12 countries linked to over 14,000 incident records during the 2 years prior and 2 years following the survey period. Their main finding was that safety climate predicts incidents of varying levels of severity, but it predicts the most severe incidents over the shortest period of time (cf., Reiman et al., 2013).

Neal and Griffen (2006) identified a relationship between safety climate and subsequent safety-related behaviors and occupational injuries in an Australian hospital. Antonsen (2009b) found in his study of offshore drilling platform before and after an accident happened there that a pre-accident safety culture questionnaire failed to detect safety issues that were identified after the accident. Reiman et al. (2013) found that in a hospital setting, working conditions, management of contractors/external parties (e.g., leased doctors), and management safety leadership correlated with the amount of adverse events, measured independently 16 months after the safety culture survey.

28.6 USE AND IMPLEMENTATION

The concept of safety culture has been used in many different ways in various contexts and for various purposes, as already stated in the introduction. In this section, we illustrate some of the recommended uses of the concept. In Section 28.7 we will point out some misuses of the concept. Before elaborating on these different uses, it should be pointed out that contrary to some of the other safety principles presented in this book, safety culture is a phenomenon and as such it does not need implementation into the organization. Rather, the safety culture that the organization in any case has needs to be developed, maintained, changed, and managed to guarantee optimal safety.

28.6.1 When and Where to Use the Concept?

One reason for using the concept of safety culture is in terms of a leading indicator of the safety level of the organization. That is, it is hoped that by monitoring changes in safety culture, organizational deficiencies can be identified and corrected before they actualize as incidents or accidents. This requires a good model of safety culture as well as its relation to other elements of the sociotechnical system.

Another related use is to use the concept as an analytical tool for safety management. The factors often included as being part of safety culture opens for discussions that otherwise may not have an explicit place in organizations. Safety culture can, despite its often-mentioned definition problems, serve as an umbrella for discussions of safety and can be used to address phenomena that people intuitively may be aware of but which have not been addressed explicitly before.

28.6.2 Safety Culture as an Evaluation Framework

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 (2016) 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. Similar lists of attributes, or normative criteria, have been developed also in other safety-critical fields.

One of the main reasons for the relevance of the safety culture concept for management of modern organizations can be seen against the observed tendency of organizations to gradually drift into conditions where they have trouble identifying their vulnerabilities and the practices that create or maintain these vulnerabilities. Safety science has illustrated that accidents rarely occur as a result of a single malfunction or error, or an entirely new, one-time threat to safety (Hollnagel, 2004; Rasmussen, 1997; Vicente, 2004). Rather, accidents more often seem to be a consequence of "systematically induced migration in work practices combined with an odd event or coincidence that winds up revealing the degradation in safety that has been steadily increasing all the while" (Vicente, 2004, p. 276). A main point here is that due to, for example, cultural blind spots this degradation can remain undetected and no remedial actions are taken before an accident occurs.

Karl Weick (1998) has emphasized that organizations are in fact defined more by what they ignore than by what they attend to. 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 (ibid.) or uniformly neglects some critical safety considerations. Safety 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. Unfortunately, often only an accident wakes an organization to realize the risks that it had been ignoring.

Table 28.1 provides examples of a declining, or unhealthy, safety culture (see, e.g., DOE, 2009; Hopkins, 2005; IAEA, 2002; Oedewald et al., 2011; Snook, 2000; Vaughan, 1996; Weick and Sutcliffe, 2007;).

TABLE 28.1. Signs of an Unhealthy or Declining Safety Culture

Safety is given low priority in decision-making concerning, e.g., investments or production issues. Short-term profits dominate the management attention.

Safety is considered to be the safety organization's responsibility or something that is done only for the regulator. Safety function does not have the authority to influence operative or strategic decisions.

Safety is equaled to technical reliability or component quality. Human influence to safety is seen mainly as a source of errors, or it is not considered at all.

Organization sticks to old categories and dismisses new events as "one-off cases" and new evidence as "false" or not convincing enough. New events are interpreted in line with the typical causal attributions used in the past. The same standard solution is applied to every problem.

The organization sees future as relatively predictable repetition of the past. There are few contingency plans.

Many warning signals, alarms, or deviations are ignored since they recur so often; they have become normalized and considered part of everyday life.

The organization glorifies its past and sees itself as already having developed all the risk control measures it needs. Safety is seen as a static state that has already been accomplished.

In the organization there are a lot of "holy cows" and "taboos" that are not open for discussion.

Individuals and departments optimize their own performance without considering how that affects the overall performance of the organization.

The safety management system exists only on paper and does not guide actual practices. Procedures and instructions are not followed in real life.

The organization is in a fire-fighting mentality. All time goes to taking care of issues that are considered acute, leaving no time for developing activities or even normal daily work.

Personnel feel they have too much work and report stress. Sick leaves are higher than average in number and longer in duration than the average.

Organization is condescending to its negative conditions and does not seek to improve them.

There is low tolerance for uncertainty and a strong focus on finding permanent solutions to ambiguous issues. Discussions without immediate corrective actions are discouraged.

There is a fear of punishment if one reports a safety concern, human error, near-miss, or an incident. This leads to fewer reports of near-misses compared to actual incidents.

The organization isolates itself from the environment, does not share information with others, or seek to learn from others. Organization's self-image can be overly positive.

Organization's internal dynamics create vicious circles where small problems or arguments escalate quickly into major problems and conflicts.

The boundary between acceptable and unacceptable behavior is blurry. Personnel and managers may behave erratically and even hostile toward others, and may break rules without the organization considering this unacceptable.

To understand why an organization exhibits signs of a weak safety culture, a systemic theory is needed that can analyze the interplay between various sociotechnical factors (Reiman and Rollenhagen, 2014). This theory should define what can be considered signs of a weak, or weakening, safety culture and what signs imply weaknesses in other elements important to safety.

28.6.3 Developing Safety Culture

Studies of culture change in the safety field are scarce (Hale et al., 2010). It has also been argued that the vagueness of the safety culture concept makes it difficult to translate into change efforts (Nielsen, 2014, p. 7). It is difficult, if not impossible, to influence safety culture directly. Rather, improvement efforts are directed to the manifestations of culture such as organizational structures, practices, or tools with an overall goal of changing the culture via its manifestations. It has also been proposed that safety climate offers "an access" to safety culture, climate being more superficial and more easily influenced than culture (Nielsen, 2014, p. 8).

As in the safety culture literature in general, the role of management is emphasized in safety culture change and improvement (see also Schein, 2010; Zohar, 2002). A related term of "leadership" is sometimes used to denote not only official managers but also other influential people in the organization. Schein (2010, p. 3) calls leadership and culture "two sides of the same coin". Kello (2006) points out that in order to change safety culture, the safety professionals need to redefine their role more broadly as facilitating organizational transformation instead of narrow spot changes. This reflects the growing recognition of the complexity of modern organizations and realization of the limits of traditional top-down management models (Reiman et al., 2015). This view of an organization draws on lessons from complexity science and complex adaptive systems, and instead of structures pays attention to interactions and emergent properties (McMillan, 2008). So far, the applications to safety culture development have been few.

Nielsen (2014, p. 8) argues that "by combining theories on organizational culture, (safety) climate and complex adaptive systems, it is feasible that cultural change can be created by changing the patterns of interactions between organizational members." He shows in his study of a Danish industrial plant how creating more and better safety-related interactions also affected safety climate and culture.

In the studies of safety and safety culture improvement, there has been a lot of discussion about the relation of behaviorally oriented and more structurally oriented development approaches. Often a difference is made between behavioral and cultural improvement programs. Behavioral strategies represent a more direct focus on individual behaviors and human performance whereas cultural strategies focus more on values and attitudes, as well as various structural arrangements in the environment (DeJoy, 2005). Some behavioral-based safety approaches treat safety culture as an individual level behavioral issue and neglect other considerations such as collective norms, competence, or shared conceptions of safety (Reiman and Rollenhagen,

2014). Hopkins (2005) also points out how safety culture has been misused in the industry to denote individual attitudes instead of organization-specific phenomenon. These approaches then dismiss the discussion of differences between safety culture and behavior by essentially treating them as the same thing. Authors such as Tharaldsen and Haukelid (2009) have argued for a "balanced strategy" where both types of interventions are needed, behavioral and cultural.

Safety culture can also be used as a tool for reflection. For example, the influence of shared assumptions to communication can be considered through cultural lenses; many problems in communication stem from differences in cultures, even inside organizational subcultures. These problems may remain unsolved because it is hard to pinpoint the actual problem since the assumptions typically remain implicit for both parties. Just making these differences in perception visible may help in at least understanding why misunderstandings can, and have, taken place. This issue can be extended into coordination and integration of activities. Culture can act as coordinating or disintegrating, depending on its contents and level of sharedness among the members.

28.7 WEAKNESSES AND CRITIQUE

The concept of safety culture can be criticized on many grounds. A main critique targets the fact that despite several decades of research there is no consensus on what the concept actually denotes. We have previously criticized the concept for its lack of integration with classical engineering principles and concepts as well as for failing to facilitate a systems view on safety (Reiman and Rollenhagen, 2014; Rollenhagen, 2010). This is due to several reasons, for example, the neglect of emergent system phenomena, often undefined nature of safety and focus of research on the internal dimensions of safety culture instead of the context where this "safety culture" is supposed to exist (i.e., the other aspects of the sociotechnical system). Next, we will elaborate on a few points that can be considered weaknesses in the various approaches to safety culture.[5]

Safety culture theories treat organizations in simplistic terms. The reality of organizational life is usually very different from that described in formal documents. This is natural in all social contexts and not necessarily a bad thing. Few safety culture approaches share this view however. The underlying assumption rather seems to be that the prescribed logic of the organization has to coincide with the logics of practice in the field. There are several challenges in this view from systems point of view. The search for deviations from the prescribed logic of the organization may in fact

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[5] It is important to note that since the approaches to safety culture vary considerably, the critique probably does not fully apply to any single theory or model of safety culture. On the other hand, it can be argued that most approaches suffer from at least some of the mentioned limitations (Reiman and Rollenhagen, 2014).

camouflage the reality since causes are attributed based on observed deviations rather than exposing contextual factors that unfold the reality of organizational activities. Safety culture risks becoming just another prescribed logic that remains disconnected from the daily reality of the organization (Reiman and Rollenhagen, 2014). For example, Schein's model of culture was originally influenced by open systems theory (Katz and Kahn, 1966) as well as the structural functionalism approach by Talcott Parsons (1951).[6] These models have recently been challenged for presenting an oversimplified view of how organizations function (Reiman et al., 2015).

The concept of safety culture has sometimes been treated as too monolithic, as denoting a total agreement on everything. These views have two weaknesses. First, they downplay the role of power in organizations—there are always power plays and people who have more influence than others. Dekker and Nyce (2014) criticize safety science in general for neglecting the role of power (see also Antonsen, 2009a). Power can have both positive and negative influences on safety. Second, strong and cohesive culture does not always mean a safe culture. On the contrary, there is growing evidence that diversity, conceptual slack, and even conflict can in many ways contribute to safety (Grote, 2007; Reiman et al., 2015; Schulman, 1993; Weick et al., 1999). As noted above, all cultures ignore issues they do not consider relevant. Strong cultures strongly agree on those issues, whereas less homogenous culture can incorporate multiple views on what is relevant and what is not.

Little discussion has been devoted to the concept of "safety" in safety culture discussion. It is rather often taken for granted that the concept of safety is self-explanatory which is far from the case. For example, there exists many different types of safety (occupational safety, process safety, etc.) and it is far from self-evident that the measures and the factors or dimensions used to explore the corresponding safety cultures are the same. Development of generic safety culture assessment tools assumed to be relevant for all types of safety and braches should, according to our view, be viewed with a skeptical stance.

The moral/ethical dimension is often implicitly interwoven in safety culture discussions but seldom explicitly so (but see, Reiman and Rollenhagen (2011, 2014), Ersdal and Aven, 2008; Hansson, 2007a,b; Kastenberg, 2014). A stronger focus on ethics in consideration of safety culture could open new areas for inquiry and a closer connection with the research of ethics.

Safety culture theories lack attention to mechanisms and processes that produce systemic meanings, including understandings of risk, safety, authority, and control (Silbey, 2009, p. 360). More interest has been put on defining the factors or criteria of good safety culture than on defining the dynamics of the safety culture itself. This is understandable given the normative and instrumental role of the safety culture

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[6] Sometimes this view has led to an approach that conceptualizes safety culture as one variable among others, as one factor to be considered in a similar manner as other factors (technical, social, etc.). This is a limited view if the variables are considered independent of each other, or if these dependencies are not made explicit (Reiman and Rollenhagen, 2014).

concept as a tool for safety evaluations. However, we argue that this emphasis has alienated the concept from its roots in the scientific organizational culture literature, and more importantly, adopted an oversimplified view of cause–effect relations. It also reflects the prevalence of safety culture concept in safety evaluation rather than safety management. The safety culture concept has in some cases become a similar catch-all category as human error used to be (see also Cox and Flin, 1998; Guldenmund, 2010; Pidgeon, 1998;). To blame an organization for having a weak safety culture has become an easy response to problems. This leads us to our next critique.

Safety culture is used in situations and contexts where it is not applicable. For example, individuals do not have safety culture and individual acts may not reflect safety culture at all. Still, people are prone to make quick judgments about safety culture based on very limited evidence. On the other hand, the concept of culture does not easily lend itself to measuring by the traditional psychometric instruments. Guldenmund (2007) points out that researchers need to balance between the empirical properties of the analyzed culture (i.e., the natural unit of analysis, such as a hospital ward) and the psychometric requirements of statistical analysis (i.e., the sample size that is needed for certain analyses, e.g., to confirm the validity of the questionnaire's factor structure). This discussion relates to the debate on whether there are organization-wide cultures or whether the concept of (organizational) culture should in fact be reserved for group-level phenomena. Edgar Schein (2010) has argued that culture is a property of a group of people interacting with each other. Thus, organizations seldom have only one culture. Schein is also very critical of the idea of "safety culture" as a real phenomenon (see Reiman and Rollenhagen, 2014, p. 13). In line with the above critique it can be questioned whether there is a single safety culture (with potential subcultures) in any organization, or is there a "separate" safety culture for each domain of safety; thus we could distinguish, for example, occupational safety culture, process safety culture, environmental safety culture, and product safety culture. These cultures would naturally be partly overlapping and interacting, but could still be considered analytically distinct concepts.

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). Organizations can try to compensate their problems with bad/weak technical solutions by emphasizing only the improvement of the human component (often conceptualized as a "problem of attitude" or "problem of management"). Using the concept of safety culture in this manner can underemphasize the importance of technology and thus be detrimental to safety in the long run.

Everything is treated as a manifestation of culture. Schein (1985) makes a distinction between behavior that is an artefact of culture and behavior 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 organization 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 organizational 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. The relation between culture and technology is an important one and seldom made explicit in safety culture conceptualizations. The basic "production technology" can be considered as setting the constraints and requirements (Reiman and Oedewald, 2007) for the formation of culture (Schein, 2010). However, once the culture is formed the organization needs to improve, modify, and maintain its technological elements as well as its human elements.

28.8 MAIN MESSAGES AND WHAT THE CONCEPT TELLS ABOUT SAFETY

Safety culture is foremost about people's collective values, beliefs, and assumptions—it is a collective mindset that characterizes a group, not a property of any one individual. When developing or studying safety culture it is necessary to go beyond individual attitudes about safety to the level of shared thinking and the administrative structures and resources that embed ideas of what is means to be safe, and how safe we are now (cf., Pidgeon, 2012. pp. 20–21). A safety culture is built on these mostly implicit assumptions and associated practices that inform beliefs about danger and safety (Pidgeon, 2012. pp. 20–21). And, as Weick (1998) has noted, organizations are defined as much by what they (or their culture) ignores—ignorance that is embedded in assumptions. However, at the same time, it has to be remembered that safety culture is not everything; it does not reduce the importance of other perspectives on safety. Thus, safety culture approach is not intended to replace the other, more technical or administrative, perspectives. Rather, it complements them and it also challenges them to reveal their assumptions about safety. It matters what the people's conceptions about safety are. This is so because how people perceive safety and risks affects what is done and not done, what is talked about, what is communicated and subsequently what is perceived as being real.

Safety management and development of safety does not need to start from a critical event or identification of risks, but from constantly building organizational capacity for increased risk perception and risk management. This starts from a realization that safety is a long slow continuous process that needs encouragement and constant attention. The focus on organizations in often very much on how to manage the identified hazards, but safety culture thinking reminds that there also needs to be attention on the possibility of emerging or unidentified hazards that fall outside the organization's existing view on safety. To identify these emerging risks, the organization needs to have enough requisite variety in imagination and mindfulness to conceive events that have not yet taken place, but could have. Thus, when speaking about a "strong"

safety culture it has to be remembered that a way of seeing is always a way of not seeing (something else), and thus "strong" should not refer to unanimously shared views and beliefs. Rather, "strong" should refer to a moral commitment about the importance of safety as a value.

Safety culture affects how the environment is enacted, what kind of causal attributions are made between discrete events, and thus how the meaning and relevance of various external and internal events is constructed. It can be argued that safety culture dictates what constitutes an "event" in the first place, since "business as usual" is not considered "eventful." However, even the business as usual shapes culture in a more subtle way by strengthening the underlying assumptions and the associated norms, practices, and values. Thus, safety culture is simultaneously a result of safety management and a force affecting the way the organization conducts its everyday work, including the management of safety and implementation of the other safety principles described in this handbook.

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