Beyond the organisation: identifying further contributors to Railway Safety Culture

Bart ACCOU, project officer, European Union Agency for Railways

Sailing on the widespread belief across sectors that a good safety culture is paramount for good safety performance in organisations that deal with major hazards, the recently renewed European legislation on railway safety (1) has introduced the concept of safety culture as a feature of good safety management. This requirement will soon be further strengthened in secondary legislation and accompanying guidance and, as a logical consequence, will have to be assessed and regulated in the future. But is it possible to influence the safety culture of an industry duty-holder from outside, in the first place? Who should do it? And how?

1. Organisational safety culture

To be able to answer these questions, one should at least have a basic understanding of what safety culture is. Since its introduction in the late eighties of the last century, a vast amount has been written about the topic, resulting in considerable confusion and disagreement on what safety culture really is; at the risk of the concept becoming meaningless (2,3).

1.1. Culture as an organisational attribute?

Most of the described approaches consider safety culture as a characteristic, consisting of several factors, an organisation either has or has not (enough); reducing the concept to a set of traits that can be easily measured and changed. This is also how the concept often is used in accident investigation: an underlying cause to explain a range of individual or organisational, and sometimes political conditions that created the accident and, at the end, reducing all aspects of safety management to matters of culture. Such an optimistic (or is it simplistic?) understanding of safety culture and the possibilities to change it, although probably very attractive for managers and regulators, will rarely live up to its promises (4). An alternative approach is advocated, starting from a contrasting viewpoint that safety culture is not something that can be agreed between management and workers or between a safety authority and a regulated company based on a norm or standard, but rather that "cultures emerge where people interact and have to accomplish something together" (5,6).

1.2. The development of (safety) culture

Therefore, to understand if and how (safety) culture can contribute to better and sustainable safety performance and by what type of internal and/or external interventions it might be influenced, at least a basic understanding of the complex social processes that create culture within an organisation is needed. A straightforward way to look at safety culture in an organisation is to consider the factors that contribute to behaviour. At the organisational level, the safety management system provides the foundation by defining and prescribing what is required through policies, procedures and training. Management and staff make sense of the content of the safety management system based on their attitudes, values and beliefs derived from personal experience and training, combined with behavioural norms of the work place, the organisation and society.

With all limitations a model has in representing the complexity of real life, the ideas of Antonsen (6) and Guldenmund (5) on the subject, summarised in Figure 1 and explained further in the text, provide a good starting point for further reflection.

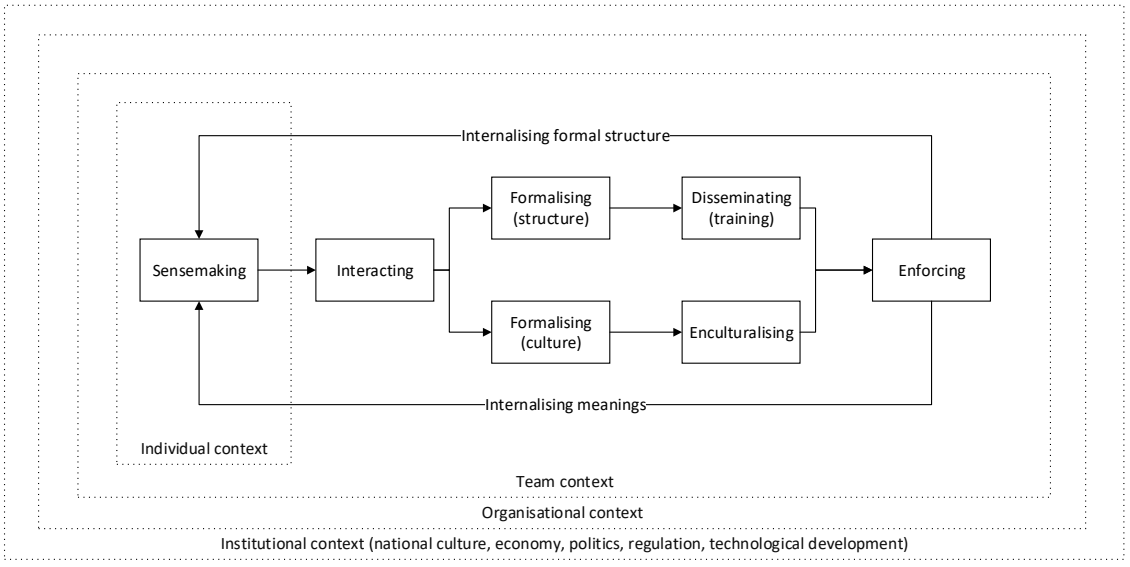

Fig.1: Creating safety culture, adapted after Antonsen (2009), Guldenmund (2015)

In the above figure, the left box 'Sensemaking', represents a member of a group experiencing a specific situation, of which he (or she) develops his own perceptions and makes specific sense. It is his individual understanding of reality, influenced in the first place by his own individual context (knowledge, individual attitudes, skills and ability, personal characteristics, emotions, state of mind, history, etc.) and defining his perception of what is risky or safe behaviour. In the 'Interacting' step, members of a group exchange meanings through formal and informal dialogue, giving rise to mutual adjustments, agreements and expectations with regard to each other's behaviours. This stage eventually results in partly shared understandings, both as meanings and as rules and norms accompanying those meaning. In the 'Formalising' stage, the organisation starts officialising a specific set of shared representations and actions. Here, the current splits in two: one flow representing the formalisation of structure (i.e. the distribution of tasks, roles, and responsibility, the description of procedures and rules as well as more physical structures like technology) and the other flow representing the development of symbols and meanings (of safety). In the 'Disseminating' stage of the model, the currents remain separated, although the dissemination of formal structures and informal meanings often go hand in hand. Organisational structures, rules and procedures are instructed in various forms of education. Meanings, on the other hand, are often disseminated 'between and behind the lines' of spoken and written language and acquired through various socialisation processes, here called "enculturalisation". At the 'Enforcing' step, meanings, standards and expectations are accepted as the 'way to do things'. Members of the group will now share a comparable understanding of reality, and structures and meanings are enforced and reinforced through various organisational processes, with an important role played by leaders. Finally, both structures and meanings pass through an 'Internalising' step and are woven into existing patterns of thought and action by the

members of the group. This will be the reference for individuals within this group to understand and cope with reality, which will influence the way they make sense of and act on situations they experience.

1.3. The duality of safety management

The model clearly illustrates the duality of safety management, as also highlighted by various other leading authors on safety culture (7,8,9). On the one hand, there is the formal side: all production activity requires at least some form of planning activity. In function of the supposed working conditions and the expected outcome, an organisation will define a preferred way of working and technical means to support the activity. In order to perform safely, the organisation will in the best possible way anticipate adverse situations to expect, and will implement rules and means to deal with them in a safe way. For railways and other high hazard industries, where a high degree of control is desired, this results in an organisational structure and design that form the safety management system, with all its composing elements: a safety policy, risk identification, the distribution of roles and responsibilities, rules and procedures, resources and technology put available, incident reporting schemes, training, systems of incentives, etc. Next to that, there is the "behavioural world" of the organisation: qualities, feelings, meanings and games of power that condition patterns of interaction among individuals within the organisation in such a way as to affect the thinking and acting. This informal or cultural side mainly refers to the 'unwritten rules guiding the behaviour and decisions of a group of people' (9). Together, the formal and informal part of the organisation facilitate (or inhibit) organisational performance.

Some managers and organisations still rest on the assumption that safety can be achieved by integrating safety in investments, hiring safety experts to build a formal safety system and relying on all levels of management to promote and enforce compliance with rules and prescriptions. And if rules are not complied with their logic reaction would be to introduce yet more rules and procedures, creating the illusion of managing safety. When formally introducing the concept of a certified safety management system in 2004 (11), as an excluding condition to operate railway services or to run activities as an infrastructure manager, the European legislator may even have reinforced this idea. A high risk however exists that such a bureaucratic approach to safety management will contradict with operational reality and will result in a safety management system taking a life of its own: all effort is put in designing, maintaining and even proving the existence of a documented system, ignoring the operational input that is needed to actually make it work as intended, and creating a gap between 'work as imagined' and 'work as done' (6,12).

On the other hand, there is the possibility to deploy the safety management system as an instrument to exert a positive influence on an organisation's safety culture and impact the physical environment as well as the behaviour of employees in a manner that promotes and facilitates safety (10). It is the match between the formal and informal part of the organisations that ultimately creates safety. In order to assist people in carrying out their task, an organisation needs to understand how humans (with their capabilities and limitations) use specifications to solve problems and take this knowledge into account when designing their work environment (13). The same goes for rules and regulations: as long as the workers implementing them are not considered when designing working procedures, they will be

forced to break rules in order to get work done whenever contradictions or conflicts occur (14).

Another aspect that is highlighted by the above cultural development model is that safety culture, as common patterns of behaviour and thinking, is constructed through the interactions between actors, in the context of an organisation that needs both to adapt to its environment and ensure the integration of all its members. This explains the high importance that is given in most safety culture norms and models to traits like transparency, trust and leadership. The signs given by management through organisational decisions and managerial behaviour (listening attitude, recognition, sanctioning, etc.) not only impact the behaviour of sharp end operators through positive and negative reinforcement (15); they also impact an organisation's capacity to learn (7) and to make the designers, whether of technical or more organisational aspects, aware of operational needs and enable them to create a real match between formal and informal parts of the organisation.

1.4. Creating sustainable safety: understanding workplace reality

Most people come to work to try to do a good job and show concern for the quality and safety of their performance. Yet, they do not always follow procedures, nor should they. Even if not originated in a bureaucratic safety management environment, it is often impossible to provide a complete specification for complex socio-technical systems as railways: because of their complexity, systems may be underspecified, they adapt and change over time, sometimes faster than can be described, and also the environment (economical, technological, institutional …) is far from stable. To compensate this, the flexibility of humans and their capability to improvise and adapt to changing conditions is necessary as a buffer between subsystems and between the system and its environment in order for the systems to keep functioning (16,17). Rather than blaming people for not following the rules and making adjustments, every deviation from a prescribed safety process should be seen as an opportunity to understand how the actual work practice (why operators do the things they do, in the way they do them) is influenced by contextual factors like overly complex rules, an unpractical and unworkable work environment, production pressure, peer pressure, personal conditions, etc.

Only by understanding why certain types of behaviour and decisions stand out as the right things to do, it becomes possible to know what to do about it and create the right foundations for sustainable safety performance. Therefore, in order to know whether an organisation is and will continue to perform safely, it is not the eventual decrease in accident and/or incident rate but rather the match between work as designed and work as actually performed that should be monitored continuously (6,15,16). Any need that workers feel to deviate from a prescribed safety process, may be the indication of a system that is not working, a 'mistake' that keeps getting repeated (pattern of actions and thinking) or a process that seems inefficient. An organisation's capability of measuring these "tensions", will create the potential to understand work place reality (the way things are really done at the sharp end) and to process the gained insight into the creation and maintaining of conditions that allow work to succeed and to ultimately prevent major accidents (6,16,18).

1.5. Busting the myths of safety culture

Next to forming the basis for better understanding the role of culture for managing safety in a sustainable way, the above model of cultural development also offers the insight to bust some

of the most persistent myths that surround safety culture initiatives. An approach that equals safety culture to pure compliance to rules and procedures e.g. will never be successful. Preventing major accidents can never be based on actions that only focus on changing the general behaviour or attitude of front line operators to ensure compliance with safety procedures. Changing elements of safety culture, as the common paths of thought and action at all levels of the organisation and influenced by constant interactions and organisational conditions, requires the involvement of the whole organisation. For the same reason, also narrowing safety culture to only the positioning by management of safety against other, competing objectives is simplistic. Safety culture should also not be seen as the 'next big thing' when safety performances reaches a plateau; a palliative measure when it is considered that no further improvement can be made to safety barriers and procedures. It should furthermore be clear that safety culture cannot be prescribed or shaped at will by managers, regulators or legislators and the organisational development that is required to change an organisation's culture – if at all controllable – certainly doesn't work with the 'quick fixes' managers like so much. It's on the contrary the decisions they take, the positive or negative judgments they have – particularly in critical situations – that, through interactions with the other actors, progressively forms the organisational culture.

The above model illustrates that culture is produced and reproduced through daily interaction of individuals and highly influenced by local conditions. Managing safety (culture) will therefore require constant effort and attention. Moreover, since the interactions take place between actors at different levels of the organisation (top management, employees of different departments, different professions and/or differently located, etc.), all with different experiences, background, conditions to deal with and maybe even different goals to achieve, it is a too optimistic assumption that an organisation can (or should) have a unique safety culture. In reality, within a same organisation, a great diversity of organisational practices and subcultures will exist, both on paper and on site (14). Together with the undeniable complexity that characterises cultural development, this might also explain why organisations, sometimes despite enormous efforts, continue to struggle to implement practical strategies to improve their level of safety culture maturity.

1.6. Influencing safety culture

Safety culture refers to that part of an organisation's culture, i.e. a combined way of acting and thinking that is largely in common to a group of actors in the organisation, which can impact the management of major risks related to its activities. It has been progressively constructed through interactions and communication between the concerned actors and continues to evolve, encouraged or discouraged by people or systems over time. This informal part of safety management cannot be seen in isolation from the structural (the safety management system in all its aspects) nor the interactional aspects of an organisation. It is rather the interplay between the different aspects that can ultimately create sustainable safety performance. Efforts to influence safety-related practices and behaviour, in order to successfully create a sustainable change, will have to take that into account. The way to do this, based on the introduced model of development of culture, would be to change the 'growing conditions' (6) of culture and to choose a set of interventions that might influence the several stages within the model: interacting, formalising, disseminating and enforcing (5), with a primary focus on the alignment between the formal and informal aspects of work organisation.

2. Beyond the organisation

The railways form a complex socio-technical system, where the regulatory framework -at least in Europe- has introduced a multi-layered risk regulation regime with dedicated roles and responsibilities for member states, national safety authorities and investigating bodies, certification bodies, duty holders etc.

2.1. A supporting legal framework

Although this regime clearly puts the responsibility for controlling the risks of operating the railways with the undertakings and infrastructure managers and has identified the concept of safety management systems as the cornerstone to achieve this (1), it is evident from the above reflections that culture in railways doesn't stop at the border of one organisation or its safety management system. All actors in the regulatory or wider institutional framework (e.g. prosecutors) embody, enact or transmit safety (management) norms and values and will therefore be an obvious source of external influence to which organisations must adapt (9). These adaptations will most certainly imply an evolution in an organisation's culture, either in a natural way, sought for as a managerial (re)action, imposed by a safety authority or required by institutional changes.

At this level as well, the formal part (legislation, norms…) needs to be aligned with and take into account the more informal part of operational practice. Next to encouraging railway undertakings and infrastructure managers to take responsibility for their own actions, safety authorities and legislators need to avoid anything which makes it more difficult for these duty holders to meet their responsibility for safety. To support this, a framework of legal, institutional and cultural conditions needs to be made available in which learning from operational experience (i.e. the understanding of operational reality by all levels in an organisation) is encouraged and rewarded (10).

2.2. A new regulatory challenge

The role of the national safety authorities (i.e. the safety regulator) is particularly important here. Because of its nature, as the informal and difficult to measure part of safety management, safety culture may pose a difficult challenge for safety authorities. The concept, in all its complexity, may confuse and attract attention of both the industry and regulatory authority away from the more tangible and operational issues (9). It is also seldom clear, from the early signs of safety performance problems, what the underlying mechanism could be and without tangible evidence the operator may not agree on the nature and extent of the identified problems (20). To a certain degree, this stretches the problems that safety authorities may have already experienced when moving from a prescriptive regime, where risk was regulated by the means of detailed rules enacted by the safety authority or the legislator, towards a performance based regime built around the certification and supervision of safety management systems, where the discussions between the safety authority and regulated organisations should already have moved away from questions of pure compliance and non-conformities alone towards discussions on the interpretation of requirements that are only vaguely defined, like e.g. continuous improvement or the acceptability of risks, and how to implement them.

The national safety authority should strive to reach a common understanding of the regulatory framework, to the extent that the responsibility for managing safety and the perception of what is considered safe is recognised, understood and accepted by all duty holders. Discussions on what is regarded as dangerous and the definition of risk acceptance criteria require however a more democratic and constructive approach to safety regulation, than the traditional 'command and control' strategy. The focus of regulatory intervention should be to have discussions with corporate management to be sure they understand the nature and seriousness of the requirements and the eventual issues in their organisation that raise concern (20,21). Helpfully, the introduction of requirements related to culture provides the safety authority with a legal basis for asking new questions that will have to be asked to the top management of the regulated organisations with a focus on their role in reducing the risks for major accidents. In addition to this bilateral communication between safety authority and the regulated, the role of the safety authority should be extended to setting the agenda for an entire institutional field, by facilitating dialogue, creating arenas for learning between the different actors in the industry and by taking on a more proactive and informative role, in addition to their traditional control activities (9).

2.3. The role of accident investigating

The concept of safety culture finds its origin in the investigation of the Chernobyl and Challenger disasters (4) to explain organisational shortcomings and has ever since mainly been used in accident investigations as a universal root cause, just like 'human error' before. Linking an observation or finding to (an attribute of) safety culture – or another source of performance variability – must not be considered as an end but rather as a starting point for further investigation. The important point is to describe what is behind the link and seeking to shed light on the underlying reasons as to why e.g. rules where ignored (22). Also, as a starting point for the investigation, a deep understanding of the workplace situation is what an accident investigator should be looking for. Rather than seeing accidents as a function of bad individual choices, the contextual factors (both formal and informal) that contributed to the accident or incident should be identified. This should lead towards the further investigation into the organisation's implementing (train, equip, organise) and controlling (specify, verify, adapt) processes and the identification of roles and responsibilities of actors at all levels of the organisation (and beyond) to create and maintain the conditions that support sustainable (safety) performance.

3. Over-speeding as a practical example

The next chapter will try to illustrate the principles that are developed above with a concrete railway example. As long as not all infrastructure and rolling stock is equipped with an automatic train protection system that continuously controls speed requirements, derailments because of over-speeding will remain a major risk of the railway system, as has been demonstrated by several of the most lethal railway accidents over the last decades.

3.1. Managing the risk of over-speeding

Speed requirements within the railway system, and in particular speed restrictions, are imposed by the assets that are used, in particular through the characteristics of used rolling stock and infrastructure (through design or its actual state). Without an automatic train protection system in use, these constraints are traditionally communicated to the train driver via the lineside signalling equipment. In addition, the trained driver is required to have

acquired the necessary route knowledge so that he knows what signalling aspects to expect and where on the line.

Applying the principles of good safety management that were developed above (continuously monitoring the match between work as designed and work as actually performed) would require a railway undertaking (and/or the infrastructure manager) to continuously monitor the speed of its trains. Not in order to check driver-compliance, as is traditionally done, but to understand work place reality and to identify those performance shaping factors (formal and informal) that help to shape risky situations and to adapt the management of these conditions to better support sustainable and safe performance.

A logical entry point for a safety authority would be to check a duty-holder's capacity to monitor the speed of its trains, to analyse it and to learn from experience. More general, the safety authority should look at the way the monitoring system is specified and whether this will enable the objective of monitoring the match between work as designed and work as actually performed (with eventual inadequate patterns of thinking and acting). If this is the case, a logical follow up action would be to check what is done with the information and whether the conditions are adapted accordingly. When issues are discovered, it should be obvious that the discussions with the duty-holder will no longer be on the driver not respecting a speed limit and the individual corrective actions that need to be taken, but on the objectives of the monitoring process and the related management responsibilities.

3.2. Reviewing accident investigating reports

Since in the short period of writing this paper, no activities of safety authorities could be reviewed to assess the eventual implementation of the above principles, as an alternative, a set of six accident investigation reports has been selected (23,24,25,26,27,28) to check their depth and focus when investigating derailments caused by over-speeding. This selection has been made taking into account a geographical spread, the similarity of the accident (derailment of a passenger train due to over-speeding[1]) and the availability of the report in a language that can be read by the author of this paper.

Integrating the above developed safety management principles into the accident investigation process, would result in the following investigation logic:

- (1) The specific performance is identified
- (2) The specified task is identified (work as designed) as well as the usual pattern of acting and thinking (work as done). It should be noticed that the latter may be tacit rather than explicit, that it may not match the specified task as well as both may not match the specific performance under investigation. At this stage, should be identified whether a mismatch between work as imagined and work as done is at the source of the specific performance. If a clear mismatch is detected, the process of specifying the specific task should be further investigated.
- (3) The conditions (both structural and cultural) that shaped the performance are identified, in order to gain a best as possible understanding of the work place conditions and the reason behind why the things have been done, in the way they have been done. Once these conditions identified, the investigation can continue

[1] The derailment in Nykirke (Norway) on 15/02/2012 occurred during continuous on-track testing, but the investigation report states that "this accident could also have happened to other types of train if they had been traveling at the same excessive speed" (23)

this path by looking at how the organisation is managing the identified variability of these conditions.

- (4) The capability of the organisation to monitor a system's performance is investigated, and in particular their capability to monitor the variability that was identified in the previous step.
- (5) If this variability was identified previously, the capability of the organisation to learn and adapt from these finding is further investigated.

Applying this flow to the over-speeding case, would result in the following scope to be expected as subject of the investigation, which is used for reviewing the selected accident investigation reports:

- The driving performance
- The task specification and the usual pattern of acting and thinking
- Possible sources of performance variability (both formal and informal) that might explain the activity as performed
- (Further investigation in how this variability is managed)
- Whether train speed is continuously monitored, to understand variability
- (If variability is measured, how is it addressed?)
- How the monitoring process is designed
- How the safety authority is supervising the duty-holder's monitoring process

Based on this reference, the selected accident investigation reports have been reviewed, with the result summarised in the Table 1 below:

Investigation report	Amagasaki (2005)	Nykirke (2012)	Ontario (2012)	Compostela (2013)	Philadelphia (2015)	Buizingen (2015)
Performance	116 km/h driver distraction	130 km/h driver distraction	67 mph misinterpretation of signal	179 km/h driver distraction	106 mph loss of situational awareness	120 km/h driver expectation
Specification	70 km/h driver respecting speed – LS	70 km/h driver respecting speed – LS	15 mph crew respecting speed – LS	80 km/h driver respecting speed – LS	50 mph driver respecting speed – LS	50 km/h driver respecting speed – LS
Sources of variability (formal)	-	sign missing at departure station line knowledge	no requirement to communicate route change 3rd crew member	infrastructure design	infrastructure equipment	work planning
Sources of variability (informal)	taking notes negative reinforcement	-	-	use of cell phone	use of radio	traffic management
Train speed monitoring	investigated: incident reporting and speed monitoring in curve	investigated with focus on ATP direct intervention	NI	NI	NI	Investigated: focus on incidents reporting and analysis
Designing the monitoring process	NI	NI	NI	NI	NI	NI
Safety authority supervision	Nothing on supervision, improvement to legal framework suggested	NI	lacking regulatory activity to implement additional barriers	NI	Commenting delay in implementing legal technical requirements for track equipment	NI

LS: lateral signalling, NI: no trace found in the accident investigation report, so presumably not investigated

Table 1: The investigation of over-speeding accidents

In conclusion of this short analysis, it is clear from this selection of investigation reports that monitoring train speed in order to identify work place conditions that might influence over-speeding is not common practice in the railway sector. Furthermore, the investigation of serious derailments caused by over-speeding is in general missing the opportunity to address the possibility of pro-actively monitoring this precursor of a known risk and to point at the responsbility of duty-holders' management to design (and of safety authorities to supervise) this.

4. The role of the European Union Agency for Railways

Through its activities, the European Union Agency for Railway has become a dominant actor within the European railway system.

4.1. Formalising the structure

Secondary legislation like Technical Specifications for Interoperability or Common Safety Methods on the one hand, and complementing guidance setting the standard for the good implementation of this legislation on the other hand, set to a great extent the norms and values for the design and management, both at an operational as well as an institutional level for the entire sector. Furthermore, the importance of the Agency's role will in the near future increase, when taking up "operational" activities for vehicle authorisation, safety certification of railway undertaking and even supervising the placing in service of lineside equipment as design authority for the European Rail Traffic Management System (ERTMS).

Like the safety management system is one of the elements that provides context and influences behaviour at an organisational level, the overall Railway Safety Culture (patterns of thinking and acting) will at least partially be defined by the requirements of this regulatory framework and how regulatory authorities make sense of them. Consciously shaping this formal structure and aligning it with the needs and practices of stakeholders could therefore be an effective way to positively influence Railway Safety Culture throughout the entire railway system.

4.2. Safety Culture Fundamentals

To put this idea in practice, the European Union Agency for Railways has started a Safety Culture Programme that aims at driving change in the Railway Safety Culture by systematically integrating « Safety Culture Fundamentals », i.e. the basic and underlying principles that are needed to construct a positive safety culture, in the Agency's own products and services.

Although, at the moment of writing this paper, these Fundamentals are still under development, the reflections in this paper already provide some clear indication of the direction to follow. Without wishing to pre-empt their further development, it appears that following statements seem at least suitable candidate-Fundamentals to facilitate the discussions:

- Behaviour is affected by the context in which it occurs
- Safety must be created continuously
- Cultures, as shared patterns of behaviour and thinking, emerge when people interact and have to accomplish something together
- Sustainable safety performance requires the alignment of formal (safety management system) and informal (safety culture) aspect
- …

4.3. Interacting with other institutional actors

Like the Agency, also certification bodies, regulatory authorities as well as other government bodies need to be aware that behaviour at each level in the railway socio-technical system contributes to the shaping of safety culture and need to accept that also their decisions and activities and behaviours (the walk) and policies (the talk) influence whether the total system outcome will be safe or not. Improving railway safety culture will therefore demand the commitment from all stakeholders within the system.

To facilitate the interaction with and among stakeholders in order to raise awareness on the concept of safety culture, how it can help to improve railway safety performance but also to make them aware of its risks and pitfalls, the Agency will pro-actively run activities to raise awareness conferences, trainings, workshops, etc.

5. Conclusion

The introduction of the concept of Safety Culture as a requirement in the European regulatory framework creates the opportunity for the Agency to address the different operational and institutional stakeholders in a new, enhancing way. By duly taking into account the processes and mechanisms that are underlying the development of culture, the Agency believes that – together with safety authorities, investigating bodies and other regulatory bodies – it can drive change in the Railway Safety Culture and ultimately move towards a system that performs safely in a sustainable way.

References

(1) The European Parliament and the Council of the European Union (2016). Directive (EU) 2016/798 on railway safety. Official Journal of the European Union, L138 (102-149).

(2) Fleming, M. (2013). From Survey to maturity models: lessons from 20 years of trying to improve safety culture. Presented at the 2013 IRSC in Vancouver.

(3) RSSB (2015). Safety culture and behavioural development: Common factors for creating a culture of continuous improvement. RSSB Research and Development.

(4) ICSI (2017). La culture de sécurité; Comprendre pour agir - n° 2017-01. Institut pour une culture de sécurité industrielle.

(5) Guldenmund, F. W. (2015). Organisational safety culture. In S. Clarke, T. Probst, F. Guldenmund, & J. Passmore (Eds.), The Wiley-Blackwell Handbook of the Psychology of Occupational Safety and Workplace Health. Chichester (UK): John Wiley & Sons Ltd.

(6) Antonsen, S. (2009). Safety culture: theory, method and improvement. Ashgate Publishing Limit.

(7) Argyris C. and Schön D.A. (1996). Organizational Learning II - Theory, Method, and Practice. Addison-Wesley Publishing Company.

(8) Hale, A.R. (2000). Culture's confusions. Safety Science 34 (2000), 1-14.

(9) Antonsen, S. et al. (2016). Regulating the Intangible, Searching for safety culture in the Norwegian petroleum industry. Safety Science 92 (2017), 232-240.

(10) Swiss Federal Nuclear Safety Inspectorate ENSI (2016). Oversight of Safety Culture in Nuclear Installations - ENSI Report on Oversight Practice.

(11) The European Parliament and the Council of the European Union (2016). Directive 2004/49/EC on safety on the Community's railways (Railway Safety Directive). Official Journal of the European Union, L220 (16-39).

(12) Dekker S. (2006). The Field Guide to Understanding Human Error. Ashgate Publishing Limit.

(13) Leveson, N.G. (2000). Intent Specifications: An Approach to Building Human-Centered Specifications. IEEE Transactions on software engineering, VOL.26, NO.1, 15-35.

(14) Bourrier, M. (2005). The Contribution of Organizational Design to safety. European Management Journal Vol.23, No.1, (98-104).

(15) Agnew, J., Daniels, A. (2010). Safe by Accident? Take the LUCK out of SAFETY: Leadership Practices that Build a Sustainable Safety Culture. Performance Management Publications.

(16) Hollnagel, E. (2014). Safety-I and Safety-II: The Past and Future of Safety Management. Ashgate Publishing Limited.

(17) Leveson, N.G. (2016). Rasmussen's legacy: A paradigm change in engineering for safety. Applied Ergonomics 59, 581-591.

(18) Robertson, B.J. (2015). Holacracy; The revolutionary management system that abolishes hierarchy. Henry Holt and Company.

(19) Antonsen, S. (2008). Safety culture and the issue of power. Safety Science 47 (2009), 183-191.

(20) Nuclear Energy Agency (2000). Regulatory Response Strategies for Safety Culture Problems. OECD/NEA.

(21) International Atomic Energy Agency (2013). Regulatory Oversight of Safety Culture in Nuclear Installations. IAEA-TECDOC-1707.

(22) Bernard, B., 2014. Safety Culture as a way of Responsive Regulation: proposal for a nuclear safety culture oversight model. International Nuclear Safety Journal, vol.3 issue 2, 2014, 1-11.

(23) Aircraft and Railway Accidents Investigation Commission (2007). Train Derailment Accident between Tsukaguchi and Amagasaki Stations of the Fukuchiyama Line of the West Japan Railway Company, April 25, 2005. Report RA2007-3-1.

(24) Accident Investigation Board Norway (2013). Report on derailment near Nykirke station, the Vestfold line, on 15 February 2012, train 12926. Report JB 2013/02.

(25) Transportation Safety Board of Canada (2012). Main-track Derailment VIA Rail Canada Inc. Passenger Train No.92 Aldershot, Ontario, 26 February 2012. Railway Investigation Report R12T0038.

(26) Railway Accidents Investigation Commission (2014). Final report on serious railway accident NO 0054/2013 of 24.07.2013 near Santiago de Compostela station (a Coruña). Investigation report ERA-2014-0070-00-00-ESEN.

(27) National Transportation Safety Board (2016). Derailment of Amtrak Passenger Train 188, Philadelphia, Pennsylvania, May 12, 2015. Railroad Accident Report NTSB/RAR-16/02 PB2016-103218.

(28) Investigation Body for Railway Accidents and Incidents (2017). Derailment of a SNCB/NMBS passenger train, Buizingen – 10 September 2015.