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THE ORGANISATIONAL SIDE OF MAJOR ACCIDENTS AND SAFETY: PERSPECTIVES ON TRANSFORMING KNOWLEDGE INTO PRACTICES

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In September 2006, Michel Llory, an author in the field of the organisational side of major accidents (1996, 1999) organised a two days seminar focused on the organisational dimension of safety. Following twenty years of research in the field, from the debates around the High Reliable Organisation (i.e. Roberts, 1990) and Normal Accident (i.e. Perrow, 1984), through the Normalisation of deviance (Vaughan, 1996) and some recent important investigations following major accidents (Paddington, 1999, Columbia, 2003) and other insightful contributions (Hopkins, 2000, 2005), the theme of the seminar was to question the state of the art regarding the core concepts and methodologies of the organisational side of safety, but also to address its practical impact within industry. Contributors from various French bodies where present (INERIS, National Institute for Environmental Safety; IRSN, Institute for Nuclear Safety and Radioprotection), but also researchers in the field as well as companies (Air France, EDF, CEA). Several themes from the organisational side of safety were debated such as:

– The tradeoff between production versus safety,
– the dark side of organisations,
– the nature of the accident dynamic,
– the assessment of organisation,
– the organisational side of safety in the practices of the industry and development strategy.

This paper provides a summary of one of the contribution proposed by the authors of this paper for the seminar. The contribution deals with the development of the organisational dimension of safety into industry practices. In order to elaborate on this topic, the paper distinguished among several concepts such as safety management systems, behaviours, human factors and organisational factors. It is stressed that these various expressions cover different understanding of sometimes similar phenomena. The meaning of these terms vary from managers, in companies to researchers in human and social sciences. An important part of this paper is dedicated to an attempt to clarify these different meanings. This is seen helpful to clarify some of the problems. Some directions are then suggested to help for the development of the organisational side of safety in practices.

KEYWORDS: accident, safety management system, organisational factors, human factors, behaviour

CONTEXT OF THE STATEMENT, THE ANALYSIS AND THE PROPOSALS

This paper is based on some years of experience by the authors in developing various type of research programs dealing with the integration of human and organisational factors into risk assessment, safety auditing and investigations following accidents. In parallel to these research programs, consultancies have been regularly performed for the industry and control authorities, mainly in the field of investigating accidents and auditing safety management systems, but also in the more traditional field of risk analysis. On the basis of practices in design, risk analysis and assessment, safety studies and accident investigations widely in use in industry and existing consulting activities, one of the aim of INERIS, along with developing knowledge in the field, has been to try to introduce and transfer human and social sciences (through human factors and organisational factors) into these practices, while also questioning the ability to do so, when background regarding these issues is limited within the industry, where engineering is the most dominant profile. Our initial engineering background has been used as a support for a better understanding of the gaps between the different views that are presented in this paper. The industry domain covered is mainly the chemical, petrochemical industry.

DIFFERENT UNDERSTANDINGS OF HUMAN FACTORS, ORGANISATIONAL FACTORS AND SAFETY MANAGEMENT SYSTEMS

In this part we suggest a way of distinguishing the expressions in use for considering different domains, according to what they represent. This helps to identify some of the issues.

Safety management systems (SMS), human factors (HF) and organisational factors (OF)

Safety management systems (SMS)

According to our experiences, when the term "organisation" is used and thought within the industry when it comes to safety, it is strongly associated with the principles of Safety Management Systems (SMS). It implies a rather "structural" or also "rational" vision of the organisation. By "rational" or "structural", we mean that functions, responsibilities and skills are clearly defined for people according to specified goals, and as a result, the organisation should behave in a rational way, according to its description and purposes. This type of representation is influenced by the quality approach, associated with the "Plan, Do, Check, Act" (the Deming wheel) and "continuous improvement" principles. This representation leads to a decomposition of the system in activities or processes (often described by procedures) that are articulated in order to provide the expected outcomes of the system. This approach is aimed at managing and monitoring the activities thanks to appropriate indicators. This principle is at the core of many standards (such as ISO 9000, ISO 14, 000 but also OHSAS 18, 000) but can be also found in a way, although not detailed as much as in these standards, in regulations such as in Seveso II Directive framework. In safety, activities such as risk analysis and assessment, emergency preparedness, management of change, roles and responsibilities etc need to be described and implemented for managing safely. It is often therefore that the description of the activities becomes consequently the "reality" against which people should be complying, and therefore be assessed. It represents an "ideal" or "rational" system to be put in motion. This is sometimes described in companies as a "system approach", although we would not associate it to a systemic approach (but this is a question of definition).

Without understanding that this is what managers and safety managers, when influenced by a engineering background, have in mind when they talk about organisations and safety, it is hard to see why difficulties arise when other approaches of organisations, bringing other ways of thinking the organisational dimension, are suggested (this point is discussed after). But in order to go ahead, we introduce now the human perspective (human factors) such as it is introduced, according to us, in companies, along with the SMS approach. This will also help, we hope, to clarify better the situation.

Human factors (HF) and Safety Management Systems (SMS)

The way Human Factors are seen is summarised in the following figure (figure 1).

This type of representation implies that following technology, engineering efforts and implementation of safety management systems, the next improvement should be through the human factor dimension. It is an interesting representation, that Hopkins (2006) has commented this way:

"It has to be said that this three stage analysis is highly contestable; indeed the analysis of Hale and others flatly contradicts it. They assert that a first age of technical, engineering improvements was succeeded by a second age, in the 1960s and 1970s in which human factors were seen as the central issues to be addressed. The late 1980s saw the dawn of a third age in which the structure and functioning of management was seen to be crucial (Hale and Hovden, 1998)."

We also think that this representation is the symptom of a gap between a research community from various disciplinary backgrounds (dealing with human factors and organisational factors) and the industry in general (but this gap would probably be different depending on the industries: nuclear, chemical, aeronautical, transport...). The gap is in the way human factors are understood in industry, compared to how it is understood in the research community. Based on our experience, human factors in industry concern mainly the "last bit" that can't be totally controlled and that need to be solved by providing the appropriate procedures, but also by providing the proper work situation, with a rather physiological approach of this work situation (light, space, size etc). Indeed, when you have made all the efforts to write down and to articulate the activities of

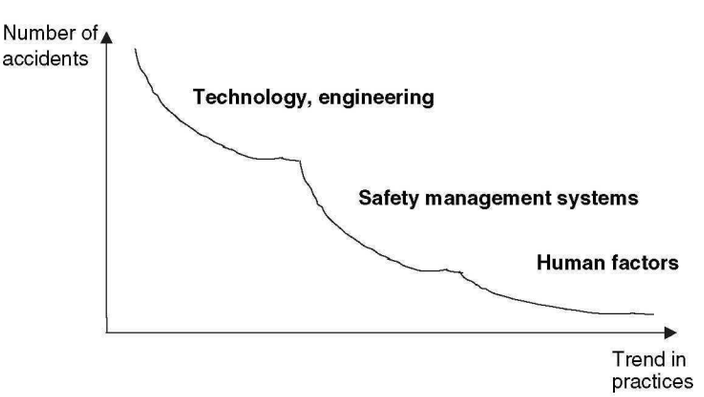

Figure 1. From engineering to HF following SMS

a safety management system and also taken into account the work context, then the only problem arise when people do not comply with what they are supposed to do. As a consequence, following safety management system, the next step is to ensure that "disciplined" people will follow what is expected from them to do. This leads to figure 1 type of rationale. It might sound as an extreme way of describing the underlying models behind safety management system and human factors within industry, but our experience is that this type of rather technical way of thinking (namely that people are "components" to fit into a well defined – and well thought – organisational structure), is widely shared. To go with this, three principles are often brought into the explanation for human behaviour that would not comply with what has been defined:

- the motivation issue (everybody remembers the Maslow pyramid ...)
- the impact of external life into the practices *("when someone has a bad time at home, this is when human factors can have an impac*t")
- the analogy with the situation of driving above the speed limits for an illustration of by-passing procedure

This type of "models" (that are mainly "behaviourist") for interpreting human behaviour are rather limited and lead to difficulties when it comes to explaining incidents and accidents, or also to audit working situations where discrepancies are for instance noticed between procedures and "real" activities. The use of check list integrating human factors dimensions are often supporting tools for incident investigation or for short audits of practices. But, how can these checklists be used when so little knowledge is available for users about human factors and behaviour? Key items in check lists do not mean much when there is no theoretical background helping people to describe and understand situations, and to articulate together these various dimensions (for instance, from "procedures" to "light" through "stress" items). It is as if for understanding a chemical reaction, we would rely on common sense, with no background models in chemistry. The comparison with human factors assessment is not much different at a first level of analogy. How do you integrate in a appropriate way the potential effect of "procedures", "stress" and "light", for making sense of a situation (following an incident or a working situation) and assess it? It is quite a complex situation to deal with. Of course, we, as humans, do experience the presence of procedures, we do experience at times stressful situations and we have a good idea (in a "common sense" perspective) of what the impact of light on an activity is about. We do experience these probably enough to have an idea of how to proceed to evaluate other situations that people face or have faced, based on our own experiences. In comparison, it is true that we don't, everyday, experiment chemical reactions, with no knowledge on chemistry. The analogy with chemistry and process has therefore its limits. But it has definitely its interest too. Indeed, because of this feeling that "common sense" can be used for dealing with human factors, it leads to think that no specific knowledge or sophisticated one is available (it is "soft" sciences, after all). As a consequence, they don't need to worry much about the conceptual dimension behind it. And without it, things do work pretty well anyway. Until incident and accident happen of course and reveal that situations (technically and organisationally) were maybe not that adequate and not that well thought of. As a result, the representation of what human factors are in the industry (from our point of view) is far from what it is for human factors scientists. It is not a major problem because people can't be expert in everything, that would make no sense and a technical and engineering background is necessary for operating plants. But when the level of awareness is very low regarding the nature of knowledge implied for dealing with human factors, then it becomes extremely difficult to support its development in practices. And the issue is very similar when we move from human factors to organisational factors.

Safety management systems and organisational factors

When we move away from the "isolated"[1] individual behaviour at the level of the work space, and get into another dimension of the problem, closer to the organisational factors such as described in the literature, then we penetrate into the area of what is often identify in the industry as the "safety culture" where "*safety first*" and "*safety is everyone business*" are the key drivers for bringing some "oil" into the safety "rational" management system. However first, there are difficulties with the concept of culture (Hale, 2001, Hopkins, 2005), because it is a rather abstract concept, difficult to identify, difficult to assess but also to manage directly and practically. Moreover and secondly, Hopkins (2005) has shown how the cultural approach was understood within the industry (here again, the statement should not be understood as too generic and representing all industries): it is ultimately understood that the "safety culture" is located in individuals mindset. It is not understood as a feature of the organisation, as an emergent properties resulting from the safety practices and multiple daily tradeoffs regarding production and safety between managers and workers, that can't be attributed only to individuals, at the sharp end. In fact, many of the organisational insights provided by the literature on accidents and safety provides conceptual elements to think more globally the issue of safety, to escape a narrow vision focused on the individual and on a limited vision of what a "safety culture" is (or could be). Dimensions such as social redundancy, bounded rationality issues that apply to all decision makers from managers to workers, organisational learning, the impact of centralisation or decentralisation on practices, the presence of counter intuitive effects and the use of power, are never in the explanation of incidents or never integrated in safety auditing[2]. As noted above, all these conceptual elements

[1]Of course, nobody is ever really isolated, we always interact with others and the physical environment, it is more a way here of defining a level of description, in a "common sense".

[2]For a better description of available organisational models in accident and safety but also more generally in organisational theory, see Le Coze (2005).

do not fit in a vision of the organisation where some principles derive from a more technical or engineering perspective of it. Génelot (2001), a consultant and researcher in management has identified some core principles still widely shared among managers:

- Management by planning and objectives,
- The implementation by tasks and coordination by standardisation,
- The assumption of an optimal organisation,
- The primary importance of the structure,
- The principle of discipline,
- The focus only on economical results.

With such a definition of the organisation, it will indeed always be ultimately the individuals, or in an "disembodied" way, the "ideal" structural safety management system that didn't work as expected, as if structures and activities themselves were behaving without individuals implementing them. Without another vision of the organisational factors, then "common sense", as for human factors, gets back into the picture and understanding incidents or safety auditing can therefore be done without getting into the details of other available and more elaborated models of organisation behaviour. We find ourselves in the same situation as with human factors, where people interacting, at several levels of the organisation need to understand how, through their interactions and the problem that they face collectively, generate patterns leading to safety problems. This is what organisational factors are about. But this again is a situation where a deep gap exists between available models from the researches compared to the models used in practices.

On top of this, that makes it even more difficult than with human factors; these patterns are, first and as explained, complex to describe for untrained people (they need some conceptual support), but secondly as well as more importantly, most managers see it in a bad way to be included "in the loop". Managers see in a bad way to be identified as important contributors generating and sustaining inadequate safety patterns. This issue of including higher levels in the explanation is also one of the difficulty, on top of the conceptual difficulty. Managers do not like to be the targets of the audit or investigations following accidents or incident. It is indeed much better to limit the problems to the operator level. For obvious reasons, when you have the power not to be seen as the source of the problem, you get away with it. It is much better for your self esteem first but also for your carrier, that depends on those who assess your ability to manage. If you appear to be part of the problem, that's not really good. And this leads to the search for the scape goat. We have faced it in almost all incident and accident investigation. It is always an operator fault, an inadequate behaviour of an "isolated" individual, sometimes even if it is within a team, one of them will be chosen as the faulty operator. If not, and if the accident really need to take into account organisational issues, then the structural, "disembodied" safety management system will be targeted. This will be done without indicating much about what decisions were taken at the higher levels within the safety management system. There is nothing much new here, but it is very much a difficulty on top of the conceptual one. The conceptual and accountability difficulties are, we think, very interdependent as we illustrate it with the example of "prevention, not blame".

Some of the advanced companies in safety management have captured messages coming from the research area about the inadequacy of focusing on "human error". As a result, we can therefore sometimes hear that what should be the approach is "prevention, not blame", so that investigation or auditing should be done without focusing on individual behaviours with the idea of blaming. The result is sometimes that behaviours are never investigated and understood because the aim is to prevent, and not to blame. So initially, the good idea of not blaming leads eventually to not taking behaviours at all into account in incident or accident investigation. We have seen this situation at least on one site. This, we believe, results partly from the fact that people find difficult to judge a mistake without deep understanding of human behaviour in technical, collective and organisational contexts. Blame should not be a problem if the situation requires it, but how to make the judgement without a good idea of what are the relevant models to be used for judging? It is true that, naturally, when going back to the events leading to an incident and accident for example, every decision appear to participate to the occurrence of the event. Everyone taking a *decision "shaping the landscape of risk control"* (Rasmussen and Svedung, 2000) can potentially be seen as one to be blamed. It is not an easy situation to deal with because safety patterns are generated by people interacting. Dekker (2006) has well identified some of the traps of this perspective when investigating "human error" at the sharp end. A similar problem is faced when organisational dimensions are taken into account, when it leads to higher levels that are identified as creating the circumstances for the incident or accident to happen. The issue of blame do not always accommodate well with the systemic type of understanding. Often, the generated pattern can't be attributed to a single individual and the blame is diluted within the global organisation behaviour. However, if the purpose is certainly not to blame straight away, a good understanding of decisions and behaviours of many actors at different levels can't be avoided if we want to learn something from the point of view of the organisational dimensions of safety, and to think of appropriate preventing measures. If behaviours are not taken into account because the issue of blame is to difficult to deal with and meet accountability inhibition, then opportunities for learning may be more difficult.

SOME SUGGESTED DIRECTIONS FOR DEVELOPING ORGANISATIONAL FACTORS

This discussion on the definition of "safety management systems", "human factors" and "organisational factors" from the perspective of the industry and from the perspective of the research community indicates a real gap. This

gap has strong impact on the opportunities for developing organisational factors in the industry. We have raised the problem, in the field of learning from accident, by distinguishing the purpose of models (Le Coze, 2007). From prescriptive (with a more practical perspective) to descriptive models, the range of approaches is wide and generate different type of problems. We have for example identified models created by scientists with the purpose of generating new insights, from models used by professional investigators within bodies or within internal company departments (this role is sometimes played by safety managers). Other models are those models designed specifically for providing recommendations, because based on best practices for dealing with some human and organisational factors dimensions. The best practices articulated in the model are extracted from the industry. According to the purpose then resources needed (time, access to information, competencies) are very different. The same type of approach can be retained for human and organisational factors in general, and if we leave the field of learning from accident. Depending on the purposes, and resources available (skills, access to data, time etc), different things can be done. When it comes to human factors and organisational factors in the industry, the level of resources (access to data, skills available from human factors and organisational factors specialists, time available) is often rather low. Given the purpose to improve the management of safety by introducing human and organisational factors, the existing constraints are quite important. It makes developments really difficult. We can therefore only subscribe to the following statement by Hollnagel and Woods (2006) "*A model that is cumbersome and costly to use will from the very start be at disadvantage, even if it from an academic point of view provides a better explanation. The trick is therefore to find a model that at the same time is so simple that it can be used without engendering problems or requiring too much specialised knowledge, yet powerful enough to go beneath the often deceptive surface descriptions. The problem with any powerful model is that it very quickly becomes "second nature", which means that we no longer realise the simplifications it embodies. This should, however not lead to the conclusion that we must give up on models and try to describe reality as it really is, since this is a philosophically naive notion. The consequence is rather that we should acknowledge the simplifications that the model brings, and carefully weigh advantages against disadvantages so that a choice of model is made knowingly*". However, the challenge is great.

As a way of moving forward, we suggested 2 directions in our contribution to the seminar:

1. There is a great need for making usable some of the concepts from the organisational factors domains.
2. There is a need to introduce human and social sciences and systemic thinking in engineers training.

For the first direction, research should focus on the ability to introduce within the safety management system framework, some of the important messages regarding organisational factors in safety. This is a difficult position where research should be carried out with the intent to introduce within current practices, as far as possible, some concepts from the organisational factor literature that have not been thought for being part of safety management systems. It would imply therefore a action-research type of approach, where the practical dimension is the purpose of the theoretical developments, so that the modelling results can fit in the current mindset, by "enhancing" it with regards to organisational factors. This is to be linked with the quote in this paper from Hollnagel and Woods. This approach might however not be expected to be able to produce too much and reach great results, when lack of basic knowledge regarding social sciences within industry (we imply here the chemical and petrochemical industry) is very important.

This therefore leads to the training needs for engineers. Training for engineers really needs to include recent developments from the social sciences, but also from recent epistemological and scientific developments regarding our understanding of the world, as for example the developments in the field of complexity. We have suggested this idea in a previous paper (Le Coze et al., 2006), by discussing the importance for thinking the complexity of the problems involved in safety and accident when dealing with human, organisational and social issues. As the Turnbull report indicated: *"Engineers are accustomed to dealing with uncertainties in the properties and behaviour of materials (...) while undoubtedly there is in some of these situations elements of technology inadequacy or failure, the main difficulties and problems lie at the interfaces of technology with commercial, political and social constituencies. The uncertainties inherent in these external constituencies are quite different in kind from the uncertainties that engineers traditionally deal with in addressing technological issues. They are much more qualitative than quantitative and they embrace a whole raft of cultural and emotional factors that often contradict apparently obvious logic. Engineers find this difficult domain to deal with."* An effort has to be done for changing mindset and worldviews so that other type of approaches will get introduced into current practices. This is true for engineers being currently trained but also for engineers now working in the industry. Improvements in the way organisational factors (but also human factors) are perceived can evolve. It does happen, although following exceptional circumstances (the Columbia accident in 2003): *"As an engineer turned manager for a time, I shared many in the science community's scepticism of organisational theory, such as discussed in this volume. Observing NASA management struggle with the shuttle and space station, I have gained a better appreciation of how these theories can help structure a more effective high reliability learning organisation in a very complicated high technology environment replete with ambiguous safety signals."* (Mc Donald, 2005).

THANKS

To the French Ecology and Sustainable Development Ministry that financed our studies.

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