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Safety culture as a rational myth: why developing safety culture implies engineering resilience?

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Abstract. Work on resilience engineering has stimulated an ever growing interest illustrated by the increasing number of publications on the subject. While at the same time, the older notion of safety culture continues to interest scientists and practitioners. The purpose of this article is to build a managerial approach of safety culture which takes in resilience engineering. It first describes the epistemological background of this approach based on intervention-research. This aims at introducing the notion of "rational myth" that describes the principles on which organized action bases itself at a given time. Secondly, the article identifies and presents three managerial principles on which risk mastering is centered: the principle of responsibility, the principle of anticipation and the principle of resilience. It then shows that the notion of safety culture as historically defined after the Chernobyl disaster and taken into account by managers can be analyzed as a rational myth for risk mastering including these three principles. It illustrates this by an example taken from an intervention led in partnership with the French pharmaceutical company Sanofi-Aventis. The article finally concludes that developing safety culture is more adapted to risk mastering principles than engineering resilience.

1 INTRODUCTION

During the past 20 years, many studies have shown that the notion of "safety culture" was a key factor for efficient risk mastering [Guldenmund, 2000, Sorensen, 2002, Olive *et al.*, 2006]. The notion of safety culture has been successful both with researchers and practitioners. Those who developed the younger and quickly expanding notion of "resilience engineering" now wish to found *a completely new way of thinking about safety* [Woods & Hollnagel, 2006, p;2]. The purpose of the article is to confront the notions of safety culture and resilience engineering in order to show that resilience engineering is included in the wider managerial plan of developing safety culture. We propose to give an answer to Hale and Heijer's questioning: *If resilience is used with its common meaning of survival in adversity, we do not see it to be of interest to us. If its definition is extended to cover the ability in difficult conditions to stay within the safe envelope and avoid accidents it becomes a useful term. We would, however, ask whether we do not have other terms already for that phenomenon, such as high reliability organisations, or organisations with an excellent safety culture* [Hale & Heijer, 2006, p.40].

This article is issued from research undertaken about risk mastering as defined by [Leroy & Signoret, 1992, p.109]: *risk mastering concerns all the actions undertaken to maintain risks inside limits considered as acceptable*. We have used in preference the notion of "risk mastering" because it contains an idea of efficiency compared to the

more technical notion of "risk management". Previous work has shown that the notion of safety culture defines a managerial project for risk mastering [Chevreau, 2006]. To go a step further and specify the constitutive elements of this managerial project, the present article will propose a model of safety culture integrating five principles of risk mastering: the principle of responsibility, the principle of prevention, the principle of defense in depth, the principle of dependability and the principle of resilience. Engineering resilience will be therefore shown as being a means for developing safety culture.

The article will be divided into three parts. The first part will present the epistemological background of the article. In particular, it will introduce the notion of rational myth. The second part will describe five managerial principles (responsibility, prevention, defense in depth, dependability and resilience) which make up risk mastering. The third part will propose an approach of safety culture as a rational myth for risk mastering which takes in the notion of resilience engineering.

2 EPISTEMOLOGICAL BACKGROUND: THEORY OF ORGANIZED ACTION AND INTERVENTION-RESEARCH

The epistemological background of our research is related to the field of "intervention – research". The main objective of intervention – research is to describe the rationalization processes occurring inside organizations and structure the base axioms of a theory of organized action [Hatchuel, 2000]. These axioms, that must be admitted principles, must lead to the identification of the central concept in this field of management studies that is the concept of "rational myth". This apparently oxymoron was forged to describe the principles on which organized action bases itself at a given time, *hic et nunc*. The term "myth" means that organized action is oriented through a vision of a world that doesn't exist yet. The term "rational" means that organized action is framed by a conceptualization of the world based on reason even though it is relative and temporary. In other words, rational myths correspond to projects of transformation more or less defined based on certain rationalizations of the world [David, 2000].

The position taken by this research implies that the traditional objects of management studies should be reconsidered. Organizations for instance can not be considered as static phenomenon reified by immutable and totalitarian principles (*e.g.* actors always act so that they maximize their profits or actors always act so that they maintain their power in the organization). Organizations are considered as being the result at a given time of collective learning and rationalization processes that evolve through action. In this point of view, even organizational structures can be analyzed as consequences of action (*e.g.* Fayol's principles of management can be seen as the illustration of a particular rational myth for hierarchical authority). Management concept is revised as well. Managing can not be described as just strictly applying strategic plans based on the decisions of an omnipotent chief. Managing is rather *modifying representations that determine an organized action and initiating collective learning processes* [Hatchuel, 2000, p.27]. In that sense, managerial tools (scorecards, databases, *etc.*) and devices

(work division, remuneration system, *etc.*) are to be analyzed as artifacts aiming at favoring learning.

Interventions aim therefore at studying the conditions, the forms and the effects of these learning processes [Moisdon, 2004]. Contrary to experimental studies and ground observations, interventions are based on continuous and situated interactions with organization members and activities. Researchers therefore take part in the organized action and contribute to modifying learning processes [David, 2000]. In particular, they intervene to help conceiving and implementing management tools and devices from a more or less defined *a priori* transformation project (rational myths). The help provided by this way of thinking to groundwork activities contributes to the construction of scientific knowledge often translated through evolving stories which draw out their *own elements of justification* [Moisdon, 2004, p.153].

3. RATIONALIZATIONS AT WORK IN RISK MASTERING

3.1 Principle of Responsibility

Principle of responsibility is included in the European legislation for occupational risk prevention. The principle of responsibility of the employer is even the base of the whole legislation in this domain. Within the context of his responsibilities, the employer has therefore the obligation to take the measures necessary for the safety and health protection of workers, including prevention of occupational risks and provision of information and training, as well as provision of the necessary organization and means[1]. Violation of this obligation of results can be considered as a criminal negligence by the courts.

Even if the principle of responsibility concerns employers first, employees also have some responsibilities in risk prevention. Each employee has to take care of his and other employees' health and safety in accordance with his capabilities, training and instructions. In particular, employees must make correct use of production and protective equipment. They must also inform and cooperate with their employer to enable the employer to ensure that the working environment and working conditions are safe and pose no risk to safety and health within their field of activity[2]:

Safety management systems also define responsibilities for risk mastering among the organizations. For instance, each work procedure describes the specific ways tasks must be conducted but also the persons responsible for it. Safety management systems even define who is responsible for writing and validating work documents. Safety management systems therefore imply a multiplication and a reinforcement of responsibilities for risk management. The principle of responsibility therefore concerns employers as well as employees: risk mastering is "everyone's business affair" [Cuny & Gaillard, 2003].

[1] Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work (Article 5).
[2] Council Directive 89/391/EEC of 12 June 1989 (Article 13).

3.2 Principle of Anticipation

The principle of anticipation defines an approach of risk mastering based on control and analysis: *anticipation is a mode of control by a central mind; efforts are made to predict and prevent potential dangers before damage is done* [Wildavsky, 1989, p. 77]. We can identify three strategic orientations sustaining anticipation: prevention, defense-in-depth and dependability.

Prevention can be defined as *all the steps or measures taken or planned at all stages of work in the undertaking to prevent or reduce occupational risks*[3]. It is based on the logic that avoiding an accident is worth more than repairing its consequences. In other words, prevention lays down that risk mastering and must be a priority for the organization [Viet & Ruffat, 1999]. This is done through three types of actions[4]:

- avoiding risks, evaluating the risks which cannot be avoided, treating/tackling the risks at the source, replacing the dangerous by the non-dangerous or the less dangerous;
- adapting the work to the individual, adapting processes to technical progress, giving appropriate instructions to the workers;
- giving collective protective measures priority over individual protective measures, developing a coherent overall prevention policy.

Defense-in-depth consists in confining a danger by interposing a coherent set of safety barriers between it and potential targets. These barriers must form independent defense lines in order to avoid common modes between them. The French legislation determines eight levels of defense[5]:

- conception, construction, maintenance, inspection, training;
- control systems, human supervision;
- safety alarms, human intervention;
- safety automation,
- ultimate barriers;
- internal contingency plan;
- urban development control, public information;
- external contingency plan.

The maintenance of these barriers must be integrated into everyday practices, even those that seem far from risk mastering. Only this can effectively prevent latent errors to slowly damage lines of defense [Reason, 1993].

[3] Council Directive 89/391/EEC of 12 June 1989 (Article 2).
[4] Council Directive 89/391/EEC of 12 June 1989 (Article 6).
[5] Technical Glossary for Technological Risks, French Ministry of Ecology and Sustainable Development.

Dependability can be defined as *the aptitude of an entity to satisfy one or several required functions in given conditions* [Villemeur, 1988, p.23]. Dependability concerns all the means which produce and maintain a certain level of trust in the success of an activity and its safeness. This level of trust is evaluated through four parameters: reliability, maintainability, availability and safety. Suppliers and industrialists built up data bases containing information on technical devices (software, mechanical parts, *etc.*) allowing them to estimate the appropriate level of trust. Normalization also contributes to objectively determine trust. This is more difficult for human or organizational components. A level of trust can be evaluated only if individual and collective behavior which can be reproduced over time. Human reliability can be for instance defined as *the aptitude of a human operator to accomplish a required task, in given conditions and during a certain time* [Villemeur, 1988, p.426]. Dependability requires therefore a certain normalization of practices within organizations.

3.3 Principle of Resilience

The principle of resilience defines an approach of risk mastering based on adaptation and improvisation: *resilience is the capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back* [Wildavsky, 1989, p. 77]. Systems' stability relies therefore on dynamic and adaptive mechanisms to unanticipated situations. Organizations, groups and individuals are resilient if they are able to *recognize, adapt to and absorb variations, changes, disturbances, disruptions, and surprises - especially disruptions that fall outside of the set of disturbances the system is designed to handle* [Woods & Hollnagel, 2006, p.3].

Being resilient isn't only being able to recover from disruptions and come back to a previous state. Resilient properties are therefore based on learning capacities available throughout organizations: *developing* [..] *knowledge, sharing it and improving the image of people who own it* [is] *the most important ways of increasing the resilience of organizations to hazardous situations* [Wybo, 2004, p.31]. Communication also takes an important part in this co-construction of a shared vision of encountered events [Weick & Roberts, 1993].

Resilience engineering depends on management practices: *resilience is a dynamic process of steering and not a static state of an organization* [Hale & Heijer, 2006, p.35]. Resilient organizations are able to preserve a satisfying balance between performance goals and safety issues. For instance, managers should be able to encourage whistleblowers even if it results in false alarms. If they are able to accept unnecessarily sacrifices on production goals, organizations stay resilient. In one word, *resilient organizations treat safety as a core value, not a commodity that can be counted* [Woods, 2006].

3.4 Risk Mastering as a Balance Between Different Rationalizations

We have identified three principles describing the rationalizations on which risk mastering is based. These principles are necessary and sufficient because they answer the two following questions: who is in charge of mastering risk? how risk must be mastered? To

go one step further, we can sum up the different rationalizations defined by these three principles:

- risk mastering must be "everyone's business affair";
- risk mastering must be a priority for the organization;
- risk mastering must be integrated into everyday activities, even those that seem far from risk mastering;
- risk mastering requires a certain normalization of practices within organizations;
- risk mastering requires that actors learn and share common elements in the organizations.

These rationalizations can orientate actions in opposite and contradictive ways. For instance, normalizing behavior and allowing improvisation don't really go together. In the same line of thought, maintaining simultaneously the system stability and its capacity to change can be paradoxical [McDonald, 2006]. Everyday managerial practices generally aim at rationalizing production means and can reduce resilience properties within organizations [Webb & Chevreau, 2006]:

- excessive bureaucratization brings organizations to openly devalue and drastically under-utilize the vast reservoir of creativity possessed by their members;
- excessive work division isolate risk experts from other members of the organization that are not encouraged to think about how they might participate in risk mastering;
- excessive use of technical solutions place human operators further and further from real situations, reducing their knowledge on the production system;
- excessive contingency planning keeps human operators in the illusion that everything is under control;
- excessive communication on success stories hides errors and failures within organization, preventing people from honest and useful learning.

These different barriers to resilience also illustrate the contradictions existing between the principle of responsibility and those of anticipation and resilience. To disclaim its responsibility in risk mastering, employers can decree rule after rule favoring bureaucratization and building a *sheet safety* system giving the illusion that risks are well anticipated [Grollier-Baron, 2002]. On the contrary, allowing too much improvisation within organizations can dilute responsibilities and therefore normalize deviance.

However, whatever contradictions can be identified between these three managerial principles, we can assert that all three should be implemented in order to assure an efficient risk mastering. In fact, we can state that risk mastering efficiency relies on the dynamic balance maintained between these three principles. This can be represented by the following figure:

Fig. 1. Managerial principles and rationalizations on which risk mastering should be based.

In this description, we can see that resilience can't ensure risk mastering on its own. Risk mastering should be based on anticipation as well as on resilience. Risk mastering strategy should therefore combine the both and involve all active persons.

4 SAFETY CULTURE AS A RATIONAL MYTH INCLUDING RESILIENCE ENGINEERING

Safety culture was historically defined as *that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority,* [..] *safety issues receive the attention warranted by their significance* [INSAG, 1991, p.1]. Safety culture, which first concerned nuclear safety, quickly spread to other industrial sectors like transportation or chemistry. At the same time, scientists started to intensively study safety culture. In fact, a main stream of research has emerged: the notion of safety culture is predominantly analyzed in the anthropological tradition (study and eventually modeling of values, norms or shared symbols more or less linked to safety) [Guldenmund, 2000] and the definition of good practices aiming at developing or enforcing a "good" safety culture [Reason, 1998].

Our work on safety culture within the French pharmaceutical company Sanofi-Aventis led us to propose an alternative approach to safety culture based on intervention-research [Chevreau, 2006]. It aims at analyzing safety culture as the characterization of a managerial project defining risk mastering strategies. We have shown that risk management processes (work procedures elaboration, training, experience feedback, *etc.*) could contribute to the development of safety culture on the condition that they were driven at least by two principles: they involve every members of the organization using criteria from their own frame of reference to measure their efficiency. For instance, the risk analysis process as we analyzed it in the chemical branch of Sanofi-Aventis concerned every actor (development department, design department, process safety department, production department). Each one actively took part in the process and could

put it on hold in the case of disagreement with other actors. The results of risk analysis were therefore validated collegially and were coherent with the company objectives. The risk analysis process was therefore efficient in terms of the organization and contributed to safety culture.

To go one step further in this analysis of safety culture, we propose to mobilize the notion of rational myth described previously. This means describing safety culture as a rational myth for risk mastering. To do so, we will first discuss culture, then safety and lastly the both together.

Culture can be defined as *that complex whole which includes knowledge, belief, arts, morals, laws, custom, and any other capabilities and habits acquired by man as a member of society* [Tylor, 1871, p.1]. On the one hand, culture seems to be rational because everyone can observe some regularity in behavior or mentality among people ("Americans take risks", "Germans hate taking risks"). But on the other hand, culture seems to be a kind of myth because one can not describe it precisely: a*n individual, like a group, is a motley collection of ambivalent feelings, contradictory needs and values, and antithetical ideas. He is not, and cannot be, a monolithic totality, and the modern effort to bring this myth to life is… delusional and ridiculous* [Slater, 1970, p.27].

Safety can be defined as *the aptitude of an entity to avoid making appear critical or catastrophic events in given conditions* [Villemeur 1988, p.24]. On the one hand, safety seems to be rational because a plethora of tools and methods exist to evaluate risks, define safety barriers or analyze accidents. But on the other hand, the "dynamic non-event" that is safety also seems to be a kind of myth because one can not take into account the complexity of the situations where safety is at stake: *safety [..] is an ongoing intersubjective construct not readily measured in terms of [..] commonly used descriptors of technical or organizational attributes that fail fully to take into account collective as well as individual agency* [Rochlin, 1999].

When joined together, "culture" and "safety" compose the notion of "safety culture" bringing both rational and mythological dimensions to it. As we said before, we can consider that the notion of safety culture defines a managerial project and can therefore be considered as a rational myth. Furthermore, it is consistent with the five principles of risk mastering we identified previously:

- "risk mastering requires that actors learn and share common elements in the organizations" and "risk mastering must be "everyone's business affair": culture is composed of elements (characteristics, attitudes, etc.) shared among every member of the organization;

- "risk mastering requires a certain normalization of practices within organizations" and "risk mastering must be integrated into everyday activities, even those that seem far from risk mastering": culture expresses itself through practices;

- "risk mastering must be a priority for the organization"

The following figure represents the construction of the notion of safety culture as a rational myth.

Fig. 2. Safety Culture as a rational myth for risk mastering.

5 CONCLUSION: DEVELOPING SAFETY CULTURE IMPLIES ENGINEERING RESILIENCE

When we consider the notion of safety culture as a rational myth for risk mastering, we can identify the main orientations that can be given to health and safety policies. Developing safety culture requires the defining of good practices integrating safety issues (through work procedure definition, safety management system audits, rewards/sanctions, *etc.*), learning and sharing among every member of the organization (through training, communication, teamwork, *etc.*) and involving people in safety issues (through leadership, empowerment, personal awareness, *etc.*).

In this sense, developing safety culture takes in engineering resilience. It also gives a more balanced comprehension of risk mastering. Of course, studying resilience in organizations allows us to understand some very important adaptation mechanisms but, as the notion of safety culture has already been adopted by researchers and scientists, why should we replace it?

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