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THE CONTRIBUTION OF "HUMAN" AND "NON-HUMAN" ACTORS TO A COLLABORATIVE HEALTH AND SAFETY INSPECTION PROCESS FOR CIVILIAN NUCLEAR POWER

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ABSTRACT

As the international standards OHSAS 18001 and ISO 31000 bear witness, interest in safety management is growing worldwide. At the same time, it is becoming more and more complex, which has led to increasing reliance on procedures. On the one hand, control procedures are embodied in inspection services, who are gaining in knowledge and experience and creating frameworks and tools. These changes have provided a better understanding and definition of the role and responsibilities of inspectors in compliance control. On the other hand, industries need to adapt to cultural and technical changes resulting from economic needs. The complexity of the situation has led industries to adopt management tools; amongst them new, but promising software packages. Decision support systems are growing in popularity with safety stakeholders. Feedback, indicators, monitoring: the toolbox continues to expand. At the same time, the information that is shared is expanding. Our work relates to the regulation process: do enhanced legal powers lead to improved control? Improvements in safety require a virtuous relationship between stakeholders and improved communication. This article looks in detail at the role of occupational health and safety inspectors in France and their relationships with industrial partners.

Keywords: Inspection – Control – Actor-Network theory – Social regulation theory – Nuclear safety – Industrial safety

INTRODUCTION

On 21 September 2001 a disaster occurred at the AZF fertiliser factory in Toulouse, France. Inspection reports[1] stated that the hangar in which the explosion occurred did not comply with chemical industry regulations in force at the time. In its judgment of 24 January 2013, the Administrative Court of Appeal of Bordeaux acknowledged, for the first time in France, that the State was partially responsible. Over and above the legal implications, this ruling raised questions about the limitations of the control model of safety. Classically, safety is guaranteed by safety management systems (Cambon et al., 2006) that are developed by businesses, and legal provisions that are enforced by State entities. Typically, this relationship manifests in various processes (such as regulatory monitoring and legal compliance) and inspections.

[1] Inspection reports from December 2001–February 2002 concerning the accident at the AZF *Grande Paroisse* factory in Toulouse on 21 September 2001.

Inspections, which are one of the founding principles for the control of industrial installations, mobilize various human and non-human actors (Law, 1992). The considerable progress made in information technology and communication has led to the emergence of “non-human” actors in the form of databases, decision support software, and more recently, communication and collaborative solutions with high added value.

The “system of actors” has therefore become both more extensive and more complicated. Consequently, a characterization of the relationships and interactions between human actors, non-human actors, and human and non-human actors merits close analysis.

In this study we focus on the French Atomic Energy Commission (*Commissariat à l'énergie atomique et aux énergies alternatives*, CEA) to characterize this complexity. The CEA is a longstanding member of the French nuclear community. In addition to its inspection responsibilities (nuclear security, occupational health and safety, and environment), it lies at the crossroads between central government, which is driven by political and industrial imperatives (Foasso, 2010) and local facilities that must respond to technical and scientific requirements, and human and organizational needs (workers, suppliers, local residents), which are distributed across the country. In practice the CEA has two hats: it is both “controlled” and it is the “controller”. The latter role is equally important in terms of internal (the State and accredited bodies) and external (IGN, CSNSQ[2]) controls.

This paper begins with a general typology of stakeholders and their organization. Next, the theoretical framework is described in detail in order to integrate it into the framework of our work and with the aim of modelling collaboration between actors. Finally we analyse our initial, exploratory field interviews, which demonstrate how a collaborative management software platform is used in the actor network.

1. THE CONTROLLER/ CONTROLLED RELATIONSHIP: CURRENT PRACTICE

Classically, the actors involved in nuclear control activities are divided into internal and external stakeholders. In this section, In order to organize and classify the actors, we rely on the Chiapello (1996) typology of control process. It permits to categorize the principal actors involved in control into four subsystems: self-regulation, internal inspection, external agencies and State inspectors.

1.1 The CEA

French risk prevention regulations define the obligations of employers and operators. These obligations, which relate to the fields of Occupational Health and Safety (OHS), the environment, and nuclear safety, require operators to have a good understanding of the regulatory framework. They must both meet regulatory requirements[3] and ensure that they are followed in the field.

Most CEA centres have been awarded triple certification: ISO 9001 (quality management), OHSAS 18001 (occupational health and safety) and ISO 14001 (environmental management). In order to meet the requirements of the French government and international standards, the CEA’s central administration has developed a Quality, Safety and Environment policy, which is supported by an internal Risk Management Department (*Pôle de Maîtrise des Risques*). The policy is based on the following safety standards:

- Design of facilities must adhere to strict rules.
- Construction must meet the highest quality standards and include multiple control checks.
- Rigorous, programmed maintenance schedules that incorporate significant safety margins with respect to the failure of materials.
- A prudent approach to operations, framed by clearly specified rules,
- Periodic re-evaluations of safety, leading to action plans that reflect the most recent safety standards.

The CEA must be able to respond to a wide variety of risks. This high level of vulnerability has prompted the deployment of a complex safety management system (SMS) that comprises internal experts and external service providers. The semi-exploratory interviews that we carried out with members of the various inspection services made it possible to establish an overview of the actors involved in nuclear control (Figure 1).

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[2] The General and Nuclear Inspectorate (*Inspection Générale et Nucléaire*, IGN) and the Nuclear Security, Safety and Quality Unit (*Cellule de Sûreté Nucléaire Sécurité et Qualité*, CSNSQ) are the internal CEA organs (central and local, respectively) responsible for the supervision and control of nuclear safety and security.
[3] Act No. 2003–699 of 30/07/03 relating to the prevention of technological and natural risks and compensation for any damage.

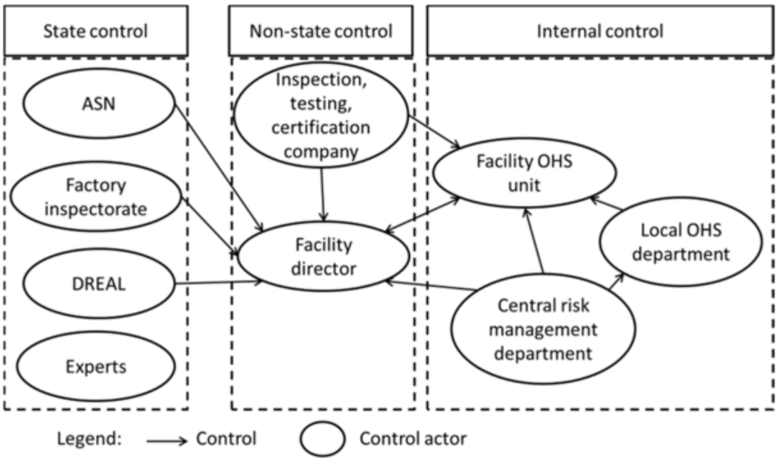

Figure 1 Overall organization of CEA controls

The overall system is divided into two subsystems: internal controls (consisting of self-regulation and inspection/ internal audit procedures), and external accredited bodies (consisting of control agencies).

The work of Audiffren et al. (2012) and in particular a survey conducted in 2009 and 2010 by Audiffren et al. (2013) characterized the internal actors involved in the SMS: the "prevention specialists". Despite the diversity of job titles (e.g. "safety officer", "safety manager" or even "QSE officer"), a clear typology emerged (Table 1).

Table 1 Typology of OHS professionals (Audiffren et al., 2012)

	OHS formation	OHS Policy participation	Abilities	Budget	Compliance management
OHS manager	Initial and further training	Build OHS policy in the company	OHS management expertise	High budget	Legal watch Compliance evaluation
OHS filedworker	Further training occasionally	Policy intermediary in the filed	Technical abilities	Limited budget	Compliance evaluation Road map
HSE officer	Occasional training	No decision power	Field experience and culture	Low budget or no budget	Road map

Figure 2 makes it possible to compare this typology with the CEA's mode of operation.

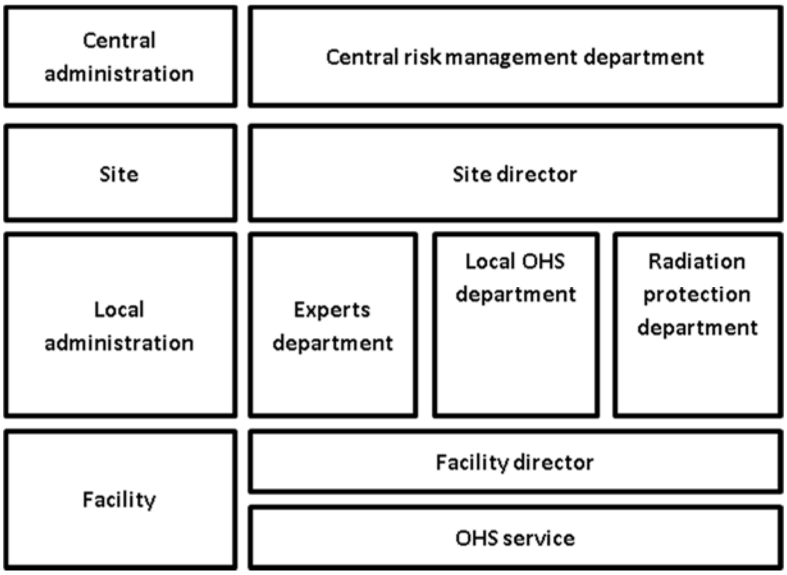

Figure 2 A typology of internal CEA OHS actors

The CEA shares the commitment to safety culture that is typically found in the nuclear sector. Each worker is a "ground-level" actor. OHS "fieldworkers" work in the safety and security services at facilities and are responsible for internal self-regulation. OHS "managers" are responsible for internal audits and inspections; they work at managerial level at sites and in the CEA's Risk Management Department, which is under the control of the central administration.

1.1.1 Self-regulation

The head of a facility (the facility director) holds delegated authority from the site director; this delegation confers authority to decide and execute the actions needed to ensure risk management at the facility and all other areas of safety.

Support is provided by the facility's OHS unit. This is composed of engineers (OHS fieldworkers, as described in Audiffren et al., 2013), who are responsible for local controls. The main responsibility of the facility director is to provide Level 1 controls, which involves verification that the facility complies with regulations, and the management of safety and security. The service is guided by recommendations provided by OHS managers and CEA best practice[4]. It represents the front line of safety, and is subject to both internal (IGN, CSNSQ) and external (ASN[5], DREAL[6], control agency) inspections.

In order to meet these internal and external requirements, the OHS unit is responsible for local self-regulation. This involves the following processes:

- Regulatory monitoring (internal, international and legal standards).
- Local compliance assessments.
- Planning of remedial actions.
- Management of priorities.

The distinctive feature of the unit is that it is close to the situation on ground and has considerable expertise. As it is centralizes the facility's technical, human and organizational knowledge, it is also an asset in dealing with the various State inspectors and auditors. It constitutes the initial point of contact with external agencies and is able

[4] General Rules of Operation (*Règles Générales d'Exploitation*): the CEA's internal guide to operations and best practice.
[5] The Nuclear Security Authority (*Autorité de Sureté Nucléaire*) is an inspection agency responsible for nuclear security.
[6] The Regional Directorate of Environment, Planning and Housing (*Direction Régionale de l'Environnement, de l'Aménagement et du Logement*) is a decentralized state service responsible for the inspection of classified installations.

to respond in many different ways. For example, one facility has designed and developed a computerized system for monitoring actions to be taken in cases of non-compliance with regulatory requirements.

However, the effectiveness of self-regulation often depends on the quality of the relationship between OHS professionals and the operator on the one hand, and between OHS professionals and the facility's inspector on the other.

Figure 3 shows how self-regulation can be organized within a facility.

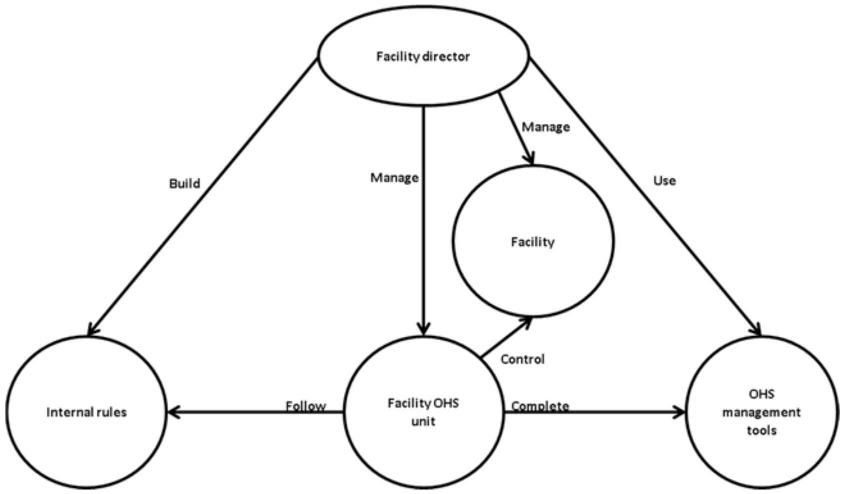

Figure 3 Self-regulation within a facility

1.1.2 Internal inspection

Internal inspections are carried out by the CEA's central administration represented by the PMR (in particular the IGN) and OHS managers at the facility. It operates at two levels of control:

- Level 1: a physical inspection of facilities and activities (IGN).
- Level 2: an evaluation of the SMS (verification of processes and documentation).

Interlocutors include the site director, the facility manager and its OHS mangers and units.

The exercise consists of an inspection and audits prepared by the central administration carried out by the actors listed above, and internal audits prepared by OHS managers. In both cases, they are based on feedback from the field (local expressions of needs) and the broad headings found in international standards (measurement, continuous improvement, etc.). This makes it possible to verify compliance with the facility's safety and security policy and suggest improvements in response to feedback that is shared with other sites.

However, the actors involved in these internal controls report that not all information is shared. While the audits that are carried out by OHS managers are welcomed and enable open and honest discussion, the stakes are high in PMR inspections (which are viewed in the same way as State inspections), and discussion is strictly limited to meeting the demands of inspectors.

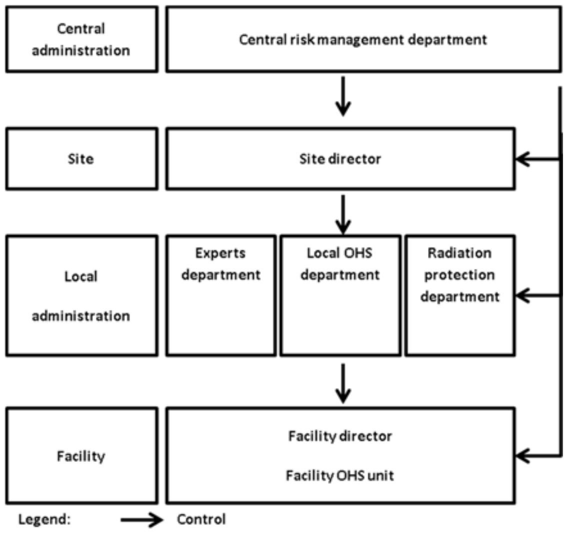

Figure 4 The organization of internal controls

1.1.3 Non-State control agencies

Inspection services can share their workload with accredited organizations such as control, consultancy and advisory agencies. These agencies provide corporate clients with expertise that is deployed directly on-site by specialized professionals in order to carry out various checks (fire extinguishers, equipment compliance, etc.). This "audit" is carried out by an external expert who is accredited by the French Accreditation Committee (*Comité Français d'Accréditation*, COFRAC) and it is another key process. It consists of the "verification and assessment of all aspects of a structure, an organization or a system" (Dictionary of the Environment). Its objective is to highlight "non-compliance with standards or regulatory requirements" and "the strengths and weaknesses of the company's approach to occupational risk prevention" (Esen Education[7]).

These control agency auditors contribute significant expertise in the investigative techniques (field visits, interviews, reviews of documentation) deployed in an audit (Innes, 2009). They are involved in both regulatory compliance assessments (e.g. for classified installations) and normative audits (e.g. compliance with ISO 14001[8]). Consequently, they are seen as external experts whose opinion on the operation of the facility is both valued and respected. Nevertheless, OHS units and facility directors do not share any more information with them than with internal auditors.

There is one more external participant whose opinion can create problems for the facility.

1.1.4 State inspectors

1.1.4.1 Current State inspections

Safety controls are the primordial responsibility of State inspection services. These entities work with accredited organizations that provide complementary services or have other responsibilities delegated to them by the State; they can also carry out internal controls.

Our study looks at three specific inspections that apply to the nuclear industry:

- Inspectors of Classified Installations;
- Labour Inspectors; and
- Nuclear Inspectors.

Figure 5 shows how these three services are organized, from national to local level:

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[7] Source: Ministry of National Education (*Ministère de l'éducation nationale*) website.
[8] http://www.boutique-certification.afnor.org/

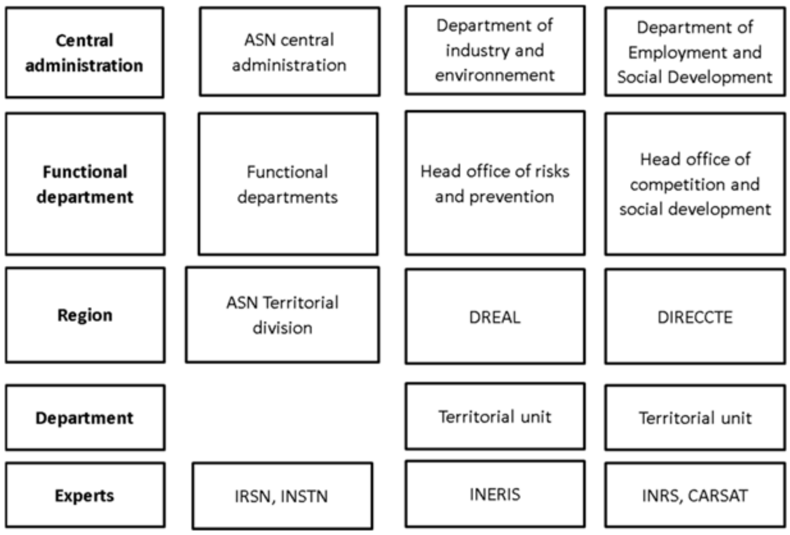

Figure 5: The organization of State inspections in France

Inspections are carried out nationwide and are the responsibility of both the central administration and decentralized services. Policies are defined at national level and integrate local-level feedback that contributes to centralized procedures which are deployed according to local needs. They are framed by a multi-year national strategic plan, which is divided into yearly national actions applied to regions. These inspections share several responsibilities:

- specification of the regulatory framework;
- monitoring of companies; and
- public information.

These principal responsibilities of each inspectorate are complemented by specific responsibilities that apply to individual inspection services:

- Labour Inspectorate: provision of advice to business, the fight against black-market work, accident inquiries.
- Inspectorate of Classified Installations: accident inquiries, complaint management.
- Nuclear Inspectorate: monitoring of significant events involving radiation.

Nuclear inspectors in particular benefit from a number of prerogatives:

- Unannounced and unimpeded visits at any time[9].
- The right of immediate access to all mandatory documentation.
- The right to interview any employee/ manager/ director with respect to any legal provision.

As for the Labour Inspectorate, it has an arsenal of punitive measures to facilitate its work:

- *Procès-verbaux* (official reports of observed offences)
- *Mises en demeure* (time-limited enforcement notices that are issued by the inspector or the regional director as provided for by the French Labour Code)

1.1.4.2 Changes in inspection practice

The current form of inspections in the civilian nuclear sector finds its origins in a Napoleonic decree of 1810 on polluting sites[10]. The regulation of industrial facilities came about through a "combination of competing interests" (Bonnaud 2002, p.177), at a time when it did not make sense to distinguish between industrial development and inspection. This combination of liberalism and State intervention has guided regulation, which

[9] Inspections of classified and nuclear installations: Article L.514-5 of the Environmental Code.
[10] Decree on troublesome or dangerous factories and sweatshops, 15 October 1810

supports development through the implementation of best practices (Bonnaud, 2002, p.178). Initially, the role of the inspector was entrusted to the municipal police force and concerned the maintenance of public order under the supervision of the *préfet* (the appointed local representative of the State).

During the nineteenth century, safety at classified installations was perceived primarily in terms of public health. The responsibilities of inspectors tended to focus on hygiene[11]. At this time, inspectors were mainly recruited from the medical world (doctors, pharmacists, etc.) and there were few technical experts (e.g. from the Ministries of Industry, Bridges and Highways) (Bonnaud 2002, p.186).

Inspection procedures for classified installations were formalized at the beginning of the twentieth century. The principle of the inspection visit was established, and a body of professional experts responsible for their inspection appeared. This came under the responsibility of the Labour Inspectorate (Act of 2 November 1892) immediately after the First World War (Act of 19 December 1917). This change made it possible for the State to take full control of industrial practices and to homogenize them at the national level.

In 1966, a catastrophe at the Feyzin refinery near Lyon in France highlighted two weaknesses of the system: the lack of technical knowledge of labour inspectors and regulations that had not kept pace with industrial practice (Bonnaud, 2002, p 255.). Consequently, responsibility for the inspection of classified installations was handed to the Ministry of Industry. This transfer led to the embodiment of responsibility for technical, administrative and legal issues in a single person: the inspector. It also enhanced the legitimacy of the actions of inspectors of classified installations and left labour inspectors to focus on their priority, the health and safety of workers.

At the same time, the emergence of military and civilian nuclear energy led to the creation of a new profession: the inspector of nuclear installations. It should be noted that given the specificities of the nuclear sector, some occupational health and safety obligations were transferred from the labour inspectorate to the nuclear inspectorate, resulting in joint inspections and the transfer of skills and knowledge.

Although the three inspection services share a common origin, it is important to note the significant cultural difference between labour inspectors and inspectors of classified and nuclear installations. In the latter services "technical" inspectors share the same industrial engineering background, which means that personnel often move between them. This similarity was highlighted by the Feyzin disaster. The "new" inspectors of classified facilities based their relationship with the industry on technical issues, unlike the legal approach taken by the Labour Inspectorate (Bonnaud, 2002, p. 255).

1.1.5 Management tools

The stakeholders of the nuclear industry have grown in complexity and size all along. It led to complicate the organization of this particular industry. As Cambon (2007) points out, the mechanism used create a management system to answer to the general processes. Safety as a process has its own management system (SMS). The 'structural' facet of the SMS can be defined as the formal description of all the efforts that are made by the company into managing health and safety at the workplace.

1.1.5.1 Typology of management tools

Following (Zwetsloot, 2000; Cambon, 2007) ,we split safety management tools in four levels. From the *ad hoc* answer to the global safety view:

- The *ad hoc* way, shows a poor safety management experience. Safety action waits accident or inspection visit to start. This view is based on a performance and production efficiency way of management. Most of the small business stays in this first level. In the nuclear industry few subcontractors are in this case.
- The proceduralization management system, keep an eye on the legal regulation and few salaries specialise themselves in safety. At this level a periodic legal watch is sometimes built and HSE officer or OHS fieldworker could be hired or promoted. Still, an OHS consultant such as Bureau Veritas is necessary to help the company. Most of the small-size nuclear industry subcontractors are in this case.
- In the "systemic" view, a standard proceduralization in complete. OHS policy, devices and procedures are operational. The top management deals with means and resources applied on OHS. The director encourages safety prevention participation. OHS responsibilities are clearly identified and the focus is

[11] Letter from the Parisian *Préfet* of Police to the *Préfet* of the Rhone, 20 November 1821

on OHS planning. The company use self-regulation with periodic audits and improvements. Most of the medium-size subcontractors follow this kind of SMS.

- In the integrated management system, OHS is part of each and every process in the company. OHS managers are part of the top management and the SMS is integrated from the corporate to local entities. The CEA currently follows this approach. As shown in the 1.1.2, safety is included from the start in all processes. Safety departments are deployed from the corporate (Central risk management department) to the facilities (experts, OHS local department, radiation protection department).

SMS maturity depends on the company organization and safety approach. The higher the level is the higher the complexity of the SMS is.

1.1.5.2 Software management tools

Helping companies to deal with their management systems, software tools have grown in popularity since the 2000's. As for other processes such as finance, production, etc…safety has its own kind of software. Currently six software solutions are used:

First, the online knowledge databases shared raw information. Most are open sources with large data but their use isn't simple (complex search engines) and the information often use very specific languages (law for jurists databases, maths and physic for engineering databases).

Secondly, we found home-made solution. IT department builds databases or software based on the company great expertise. Data contents are often high-level material. But the update and maintenance cost is often too high. In addition, ergonomics are hard to maintain. Most of the companies choose to migrate to external solutions such as SaaS (software as a System).

Thirdly, there are institutional solutions. Handled by public or para-public OHS institutions, the offer deal with databases (sometimes pay-access). They propose legal watch often without a lot of added value information.

The fourth group consists of the publishers of legal information. It is the actors 'historical' market. They offer rich and documented databases. Texts benefit analysis tailored to lawyers or experts in SSE but much less to field preventers or operational managers. The regulatory information, inaccessible, must be systematically adjusted by SES experts or internal legal companies to operate in terms of applicability and specific actions to be implemented.

The fifth group is the control or advisory offices. They are accustomed to support companies daily. In fact, they market databases to more technical oriented approach to OSH but the texts are not actually translated into specific regulatory requirements and the use of counseling and coaching is still necessary, even indispensable.

The last, in which the company Preventeo® (partner of this research work) is, consists of specialized editors. They offer particularly developed databases. The sections of regulations generating obligations for employers / operators are highlighted (in a more or less detailed depending on the actors). Some actors CEA consist of multiple sets of regulations that interact and provide a shared system of negotiated rules offer, beyond regulatory monitoring, real risk analysis tools and decision support.

These sources each have a specialty at the level of information provided. It is usually possible to make searches according to different filters such as date, type the desired text or a topic (legislation applicable to Classified Installations for Environmental Protection (ICPE)) in particular. For a prevention agent, however it is difficult to locate in these different sources, laws change, new are voted. Regulatory watch using these sources is proving long and tedious for a domain expert, and almost impossible for a novice because of the number of texts and conditions the applicability of each.

2. FRAMEWORK

We based our work on a theoretical base and the use of a society platform. We selected two major sociological theories in order to analyse and understand the interactions between the actors involved in control activities: actor-network theory (ANT) and social regulation theory (SRT). The former makes it possible to analyse the broader organization in terms of technical objects (human or non-human actors). The latter makes it possible to better understand the relationship between external and self-regulation. The management tool choose has improve a ten years assessment in various industrial fields (Energy, transport, aeronautic, petroleum, etc…) and propose an adaptable framework which permit the creation of a specific tool for the experimentation.

2.1 Theoretical base

2.1.1 Actor-network theory

Various authors (Latour, 1991; Callon, 1991; Law, 1992) have investigated the influence of the technical object on its environment (geographical, political, social, etc.). Madeleine Akrich (1991) studied the influence of human and non-human actors on each other. From this perspective the technical object is not passive, but instead participates in the creation of the socio-economic-technical system (Law, 1992). The distinguishing feature of ANT is that it sees both human and non-human stakeholders as equal, and actors communicate via a "translation centre".

The relationship between controllers and the controlled, which combines physical characteristics and forms of usage (Akrich, 1996) is rooted in this framework. As Lascoumes (2004) points out, the focus is not on theories, but the instruments and devices that they give rise to. In other words, it is tools ("technical objects") that enable the management of nuclear safety, notably with respect to radiation protection.

The concept of "Punctualization" (Law, 1992) is useful in clarifying the system of actors. Actors are defined as local networks that are transformed into "black boxes" in the form of irreducible resources in order to improve the creation of the network in question. For example, increasing reliance on procedures leads to greater weight being given to legal, technical and accounting provisions and a generalization of norms and standards, which can be grouped under the heading "regulation".

The heterogeneity of actors creates a need for translation (Callon, 1986). Translation centres undertake the work of making the network intelligible. For example, the profusion of regulations has led to the development of management tools (Moisdon, 2005) that represent "arrangements" for people and "objects". These tools make it possible to highlight the different dynamics at work in "orienting" the network (Law, 1992). Actors and organizations "translate" parts of the network in order to orient it towards their "aspirations". Translation is also therefore a way to exercise power and is seen, for example, in the interpretation of regulatory texts by inspectors according to the situation.

ANT highlights three safety actor profiles:

- People: meaning both physical human beings and their skills and ability to adapt (Sonntag, 2007). Consequently, an engineer who is an OHS manager is both an facility auditor and an IGN controller.
- Materials: represented by measuring instruments, regulatory texts, etc. Materials can direct the way in which people behave (Akrich, 1987). At the CEA for example, legislation is translated by a dedicated service which aims to provide operational guidance to OHS professionals. However, this translation centre lacks resources, and it has become necessary to have a further translation of the actors involved in "legal regulation" and "normative regulation" in order to keep up to date.
- Management tools: these are innovative technical objects used to analyse the requirements of authorities that are phrased in terms of controls.

Information technology is widely used by stakeholders who use it rationalize and justify their actions. These "mental prosthesis" (as they were termed by Moisdon, 2005), are targeted at the level of the system and form an integral part of an ongoing process of "governmentality". For example, the CEA has developed a nationwide management tool in the form of an intranet that brings together and centralizes information about each site and each of its facilities.

These tools can also improve collaboration between controllers and controlled. Bollecker (2003) argues that the outcome of controls depends first and foremost on a mutual understanding of the benefits. When performance is linked to objectives that include control criteria, efficiency is guaranteed. The design, development and use of these technical objects is therefore paramount in order to ensure effective controls and enhance interactions between actors.

The correct translation of the aspirations of people via management tools operates through four fundaments:

- Sustainable: the need for sustainable actors (e.g. regulations).
- Mobile: the need for mobile actors (e.g. inspectors or OHS specialists).
- Anticipation: the need for responsive translation centres and alert actors (e.g. through regulatory monitoring processes).
- Strategy: the need for "visionary" and well-organized actors (e.g. SMS).

In the nuclear context, a number of specialized management tools with varying capabilities have emerged in the areas of OHS, the environment and nuclear safety (Vigneron et al., 2013).

- Simple regulatory monitoring (public structures, publishers of legal information).
- Consulting (control or advisory agencies).
- In-house solutions (internal information systems).
- Specialised publishers (integrated health, safety and environment performance management tools including assessment and reporting tools, action plans and performance indicators).

2.2.1 Social regulation theory

If ANT laid the groundwork for the system of actors, social regulation theory (SRT) provides a better understanding of the interactions between them. It argues that any organization is governed by regulations (de Terssac, 2003, p.10): regulatory controls on the one hand and self-regulation on the other, which cohabit via negotiations that lead to joint regulation (Figure 6).

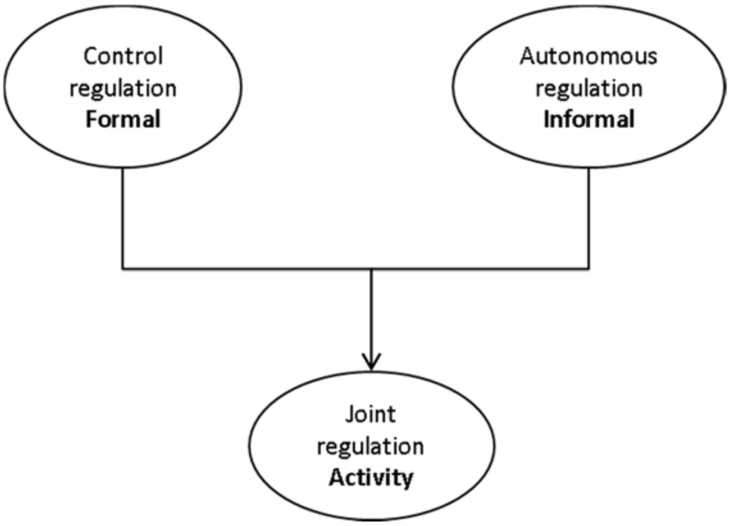

Figure 6 Model of joint regulation (Revue française de gestion, 2008/3 n° 183)

Regulation is mainly used as a normative concept (de Terssac, 2003): in other words, adjustments to rules (injunctions, prohibitions) act as an organizing principle (Reynaud, 2005) This approach to safety management is partially based on the argument put forward by March and Simon (1958) that actions do not flow naturally from rules. Similarly, organizations are not regulated by a single optimal rationality. Instead, there is an ongoing process of adaptation centred on interactions between regulatory controls on the one hand (the State, central administration, management) and autonomous regulation (decentralized State services, executive agencies, subsidiaries, etc.) on the other.

Here, we focus specifically on regulations that are designed to manage interactions between control organizations (internal or external) and those they control (who may themselves be controllers).

Control begins with legal provisions put in place by the State and self-regulation. Consequently, as Jammaud (2003) underlines, there is a plurality of sources of rules that are not only legal or statutory. For example, the CEA must comply with both external regulations, and its own General Operating Rules. During an inspection the two sets of regulations (external and internal) are harmonised through a mutual adjustment process (letters detailing corrective actions to be undertaken known as *lettres de suite*) leading to a negotiated compromise (Reynaud, 2005) and joint regulation (the operating license).

Rules are adjusted by each party via adaptation mechanisms, notably through demonstrated respect for effective compliance (de Terssac, 2013). The process takes into account how regulations are actually applied in the field (Alter, 2003), for example during site visits by State entities, and the implementation of their recommendations. Effective respect requires the implementation of the usage rules proposed by de Terssac (2013). It reflects the ability of managers (Amblard et al., 2005) to mobilize stakeholders, notably through reciprocal requirements, in order to legitimize their actions (the rule of engagement). Then they must convert passive stakeholders into proactive actors (Morel et al., 2008) (the rule of ownership). This step requires adaptation to safety rules: it is the outcome of negotiations (control and safety rules) and relevant know-how (self-regulation). The third step concerns learning by doing (the rule of understanding). An example of this is feedback processes (Morel, 2009) that are free from sanction. The last step focuses on increasing the maturity of the system. It concerns the ability of each actor to support the development of regulations (the rule of confrontation), for example through roundtable discussions, or internal practices such as “safety Tuesdays” suggested by some inspection services. This brings us to the question of the integration of an ongoing, endemic improvement process (Blazsin et al., 2013), which could perhaps be called a safety culture (Lefranc et al., 2012). Complex systems such as the CEA consist of multiple sets of regulations that interact and provide a shared system of negotiated rules – a process that promotes more effective safety management system (Cambon, 2007).

ANT provides an insight into the mutual influence of human and non-human actors in a complex socio-technical system such as the CEA. Coupled with SRT, it offers a way to describe and analyse the network of actors that are stakeholders in the control process. Figure 7 provides an initial overview of their respective contributions.

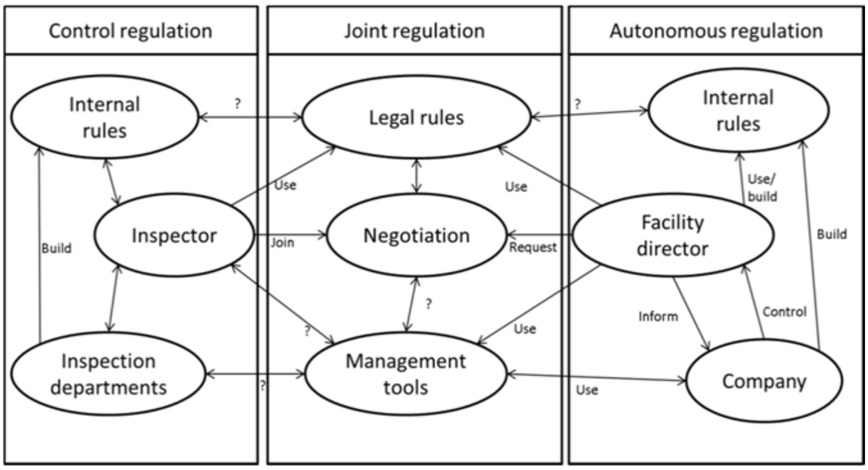

Figure 7 SRT – ANT model

2.3 Implementation and modelling

The work carried out by Audiffren et al. (2013) on safety compliance and that of Lefranc et al. (2012) on safety culture contribute to our modelling approach. As the control relationship is intimately linked to the question of compliance (Audiffren, 2012, p.34-35), the normative compliance models developed by Audiffren and Lefranc provide a starting point for our model. The quantitative survey conducted by Audiffren et al. (2013) highlighted a number of issues related to corporate management systems; in particular the importance of compliance to the optimization of safety.

The model is based on the typology of models developed by Le Moigne (1987). Specifically, we selected a prescriptive normative model, which provides an ideal representation of the system of actors. Following Walliser (1977), general expectations are based on the objectives to be achieved: here, radiation protection management and the use of a collaborative platform between actors needed to achieve this goal.

The role of inspectors is to identify divergences from a given repository and the company’s SMS is used to implement the measures necessary for compliance management.

In the following sections, we present the key compliance processes suggested by Audiffren et al. (2012). We model exchanges between actors involved in radiation protection control (inspectors, the CEA and the collaborative platform). The two main human actors in this process were identified by Audiffren et al. (2012) as the “prevention manager” and the “prevention fieldworker”. Figure 9 suggests the links between the human and non-human actors.

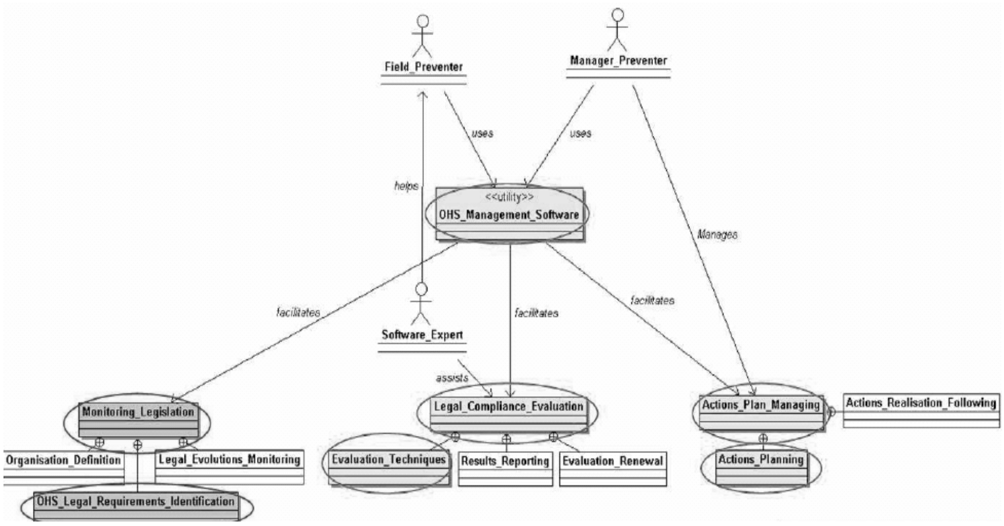

Figure 8 Legal compliance management (Audiffren et al., 2012)

The software tool acts as a relay and a central point to store information. Thus, the two human actors involved in control (the prevention manager and the fieldworker) can use it to communicate.

However, Audiffren and Lefranc's work was limited to internal management systems and focuses on a single control process (compliance). Our study includes external control actors and an objective (radiation protection safety management), i.e. the effectiveness of compliance regulations controlled by the inspection process.

Classically, the inspection and control process is based on an assessment of compliance with regulations. Here we focus on the support that can be provided by collaborative software. Specifically, we look at software solutions from specialized publishers such as the company Preventeo (a partner in this research). The following sub-processes can be identified (Audiffren et al., 2013, Lefranc et al., 2013):

1. Company configuration
2. legal measurement
3. practice measurement
4. Management,
5. publication of data and knowledge bases

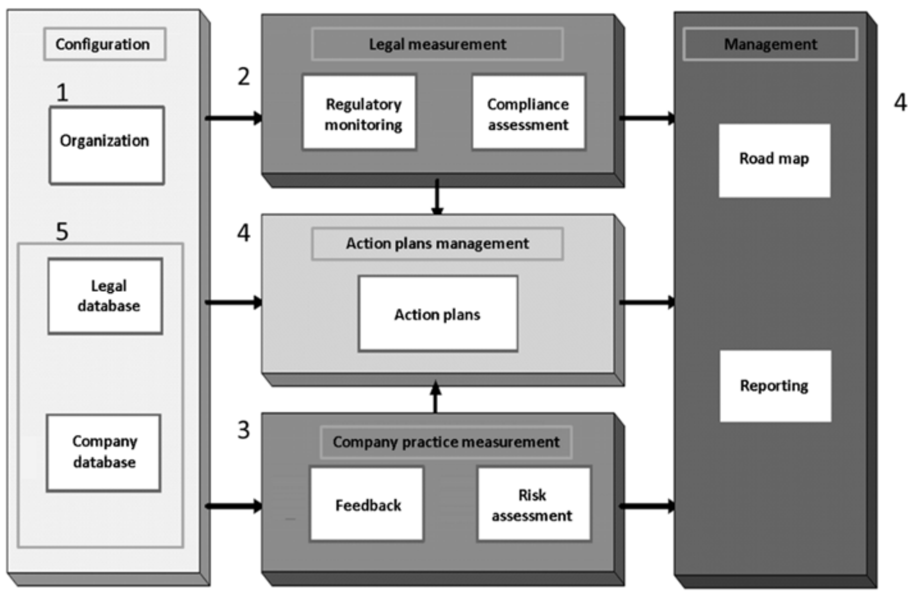

Figure 9 Compliance management sub-processes (Audiffren et al., 2012)

Each of these sub-processes corresponds to a module in the Preventeo platform.

The first module, “organization” (1) concerns how the business is organized.. The “organization” module centralizes all the information generated by the software package.

Each part of the organization is able to monitor applicable regulatory texts via the “regulatory monitoring” module (2). The regulatory scope applicable to each business unit is divided into three areas: OHS, Environment and Nuclear.

Once the scope has been determined (with the help of the regulatory monitoring module), it can be evaluated in detail via the “compliance assessment” (2) module. This aims to create a detailed assessment of compliance based on classical audit techniques (Innes, 2009) and improve the quality of associated reporting (compliance reports).

On the other hand, the “feedback” and “risk assessment” modules (3) allow taking a closer look to the real deal inside the organization. These “company practice measurement” tools provide internal information about the safety management.

The results of the compliance assessment are centralized in a fourth module dedicated to the daily monitoring and management of action plans (4). OHS managers and the IGN can use this module to manage internal CEA action plans and suggest additions resulting from requests from inspection services and comments from accredited bodies.

The knowledge bases and assessment questionnaires that make up the monitoring and compliance assessment (2) modules are created using a fifth module called the “knowledge base editor” (5). This module enables the creation of legal, normative or internal databases. The editor makes it possible to divide texts into requirements, which then take the form of audit questions.

The previous elements allow us to gave a more accurate view of the interactions between the safety stakeholders and the place of a collaborative platform as a management tool in the control relation.

3. RESULTS AND DISCUSSION

In order to organize and classify the interactions between the stakeholders by the collaborative platform, we categorize the flow of their interaction with the management tool.

3.1 Initial results

The value of our work lies in the ability to understand the interactions and aspirations of each actor. It provides a neutral space for discussion leading to mutual support in order to fulfil shared safety goals and meet each actor’s objectives. The typology of actors provides an initial representation of a control process that integrates a collaborative dimension. We illustrate the process through the role played by a collaborative software tool implemented at a facility.

The first step was to define the system of actors likely to contribute to the inputs of the software platform. Figure 10 shows these contributors.

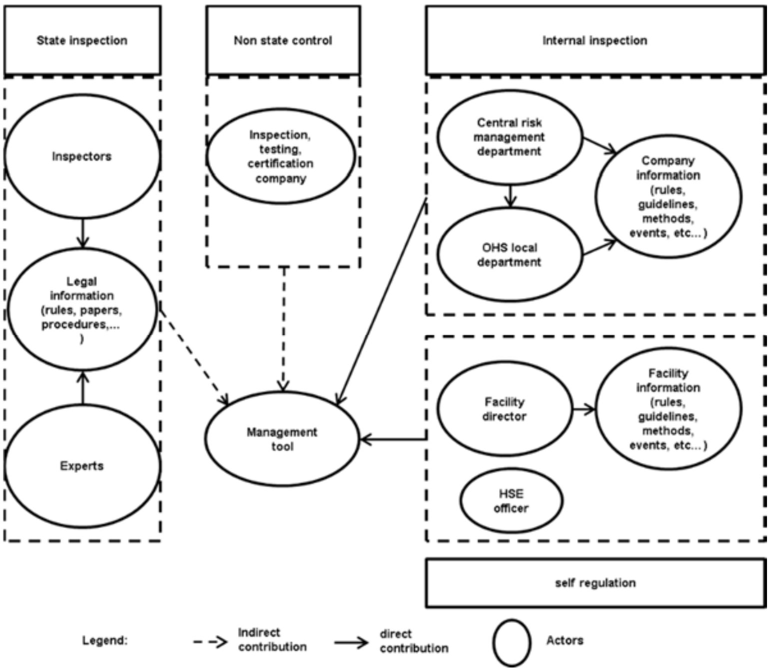

Figure 10 Collaborative control platform, contributors

This representation highlights the contributors of management tools in all stakeholders. There is two kinds of them: direct and indirect ones. The first ones upload directly the input in the platform, instead of the other ones whom gave information but don't upload them to the platform (as a free download platform who provide information but don't analyse them). As we can observe, the direct contributors are internal (company OHS managers and fieldworkers) and the indirect ones are mostly external (inspectors and the testing companies) but also internal (HSE officer). It is completed by an analysis of the stakeholders' users of the outputs (Figure 11).

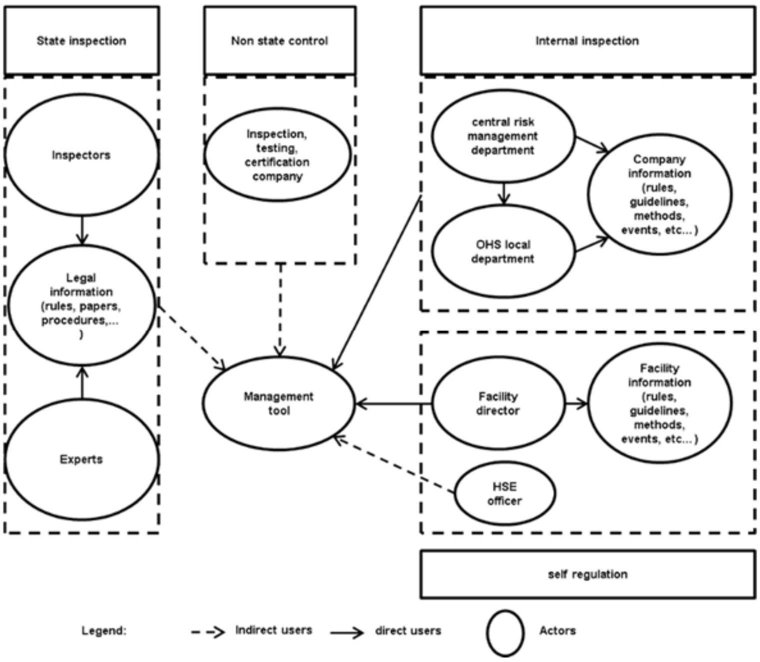

Figure 11 platform users

As for the contributors, this figure proposes two categories of users: direct and indirect. First ones take the outputs directly from the platform, instead of the indirect users which rely on the direct users to get information. As we can observe, the direct users internal (company OHS managers and fieldworkers) and the indirect ones are the mostly external (inspectors and the testing companies) but also internal (HSE officer).

These two schemes provide a lot of information about HOW information around the platform are used. The next figure will provide information about WHICH information are uploaded/downloaded on the management tool (figure 12):

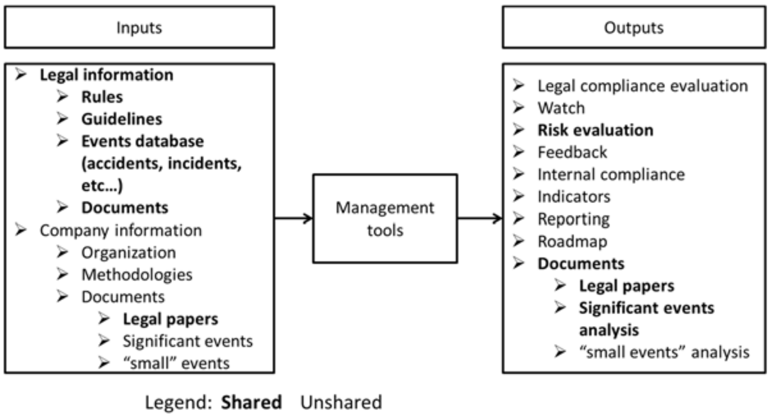

Figure 12 inputs/outputs sharing

This scheme figure out information provide to the platform (inputs) and ones get in return (outputs). It is completed by a categorization between information shared or unshared by the stakeholders. As we can see shared information relies on legal information. Others information aren't shared.

3.2 Discussion

As say in the introduction, these results are based on initial, exploratory field interviews. They focus on two data: contributors/ users stakeholders and inputs/outputs. They allow to see the network organization with the management tool as a centre.

Of course, we have to stay cautious with the results. The actual actor network doesn't represent the platform builders and their role in the indirect data inputs collect. Even if it take in account the formal human stakeholders of the control process, new perspectives open the door of a stakeholders extension with associations and population involvement (Granier, 2009). The qualitative analysis use in this work is a bias as well. Because we only did a few interviews and test one software solution, results are threaten by subjectivity and have to be taken as a concept proof and not a globalization. Finally the actual vision stay a macroscopic view of the situation and a more precise case study should be conducted about a significant event to analyse precisely the actor network.

Results show that the use of a management tool increases the legal requirements understanding (watch, compliance) and the ways of deal with it (framework and formalization, self-regulation). As a mainly company used tool, the platform develop the capacity of the OHS managers and fieldworkers to respond to the inspections demands (compliance). In this purpose, they use watch tools which give them an overview of present legal rules (laws, acts, guidelines, etc…) and futures ones (law projects, state studies, etc…). It lead to a better monitoring of safety management. These evolutions increase the legal compliance of the company and the understanding between inspectors and OHS managers and fieldworkers. However, as De Terssac (2003) say, we have to stay cautious about the effectiveness of the measures took. Focus on legal compliance can lead to a superficial safety management which rely on the indicators more than field reality. In the other hand, the platform proposes a framework which help the company to formalize its methods (methodologies, analysis, and organization) and insure a correct safety culture (self-regulation initiatives, internal rules OHS organization). Despite the enthusiasm of OHS and corporate managers about these solutions, there are risks to overestimate their potential and lead to a standardization of the safety process and methods which don't take in account differences between facilities. Also there is the question of the flexibility of the platform solution: could it adapt easily to a new legal context as current hardness legal (*Pénibilité*) questions in France? Anyway, even if there are lots of question about how collaborative platform can challenge the safety performance. The interest and will of the OHS managers and fieldworkers to come to a collaborative platform solution is a good reason to take a closer look to these solutions and the way to improve their efficiency. Finally, the current biggest question is about the involvement of inspectors in this collaborative platform use.

CONCLUSION

It is clear that while the management tool is mainly useful internally, it provides a better understanding of the demands of the various inspection services and therefore, initially, can help in compliance management. In addition, it can improve monitoring of occupational health and safety with respect to radiation protection management, as it offers an overview of both compliance and preventive actions that have been implemented (e.g. management of protection barriers and responses to a significant event). The limitations of the tool relate to excessive formalisation, which rigidifies procedures and does not take account of changes in the business. It is clear that an innovative and powerful tool must, above all, adapt to changing circumstances while remaining objective and scalable. This demonstrates the importance of the selection and use of management tools in nuclear safety. An avenue of research for future work will be to integrate State inspectors into the collaborative process. Another one will be to analyse through an accident case study how to improve these management tools and how they provide better safety prevention.

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REFERENCES

Amblard, H., Bernoud Ph., Herreros G., Livian Y.F., 2005. Les nouvelles approches sociologiques des organisations, le Seuil (ed.), Paris.

Akrich, M., 1996. Le médicament comme objet technique. Revue internationale de psychopathologie 21.

Akrich, M., 1991. La gestion de la recherche, D. Vinck (ed).

Akrich, M., 1987. Comment décrire les objets techniques. Techniques et Culture 9.

Audiffren, Th., Rallo JM., Guarnieri, F., 2012. The contribution of case law to compliance management in Occupational Health and Safety (OHS) in France. In: European Safety and Reliability Conference, ESREL 2012, Finland.

Audiffren, Th., Rallo, JM., Guarnieri F., Martin Ch., 2013. A quantitative analysis of health, safety and environment policy in France. In: 22nd European Safety and Reliability Conference, ESREL 2013. Netherlands.

Audiffren, Th., 2012. Contribution à la maîtrise des conformités légales en Santé et Sécurité au Travail. Ph.D thesis at Mines ParisTech

Blazsin, H., Guarnieri F., Martin Ch., 2013. Safety at the Sharp-End: A Case Study in the Gas Sector. In: 22nd European Safety and Reliability Conference, ESREL 2013, Netherlands. CRC Press, Safety, Reliability and Risk Analysis: Beyond the horizon.

Bollecker, M., 2003. La dimension sociologique du contrôle de gestion par l’analyse des relations de coopération entre contrôleurs de gestion et responsables opérationnels. Cahier de Recherche du GREGOR de l'IAE de Paris 1.

Bonnaud, L., 2002. Experts et contrôleurs d’Etat: l’inspection des installations classées de 1810 à nos jours, thèse présentée en vue de l’obtention du grade de docteur, Ecole Normale Supérieure de Cachan.

Callon, M., 1991. Techno-economic networks and irreversibility. In: Law J. (ed.), A sociology of monsters. Essays on power, technology and domination, Routledge, London.

Callon, M., 1986. Éléments pour une sociologie de la traduction: la domestication des coquilles St-Jacques et des marins pêcheurs dans la baie de St. Brieuc. L’Année Sociologique, numéro spécial La sociologie des Sciences et des Techniques 36.

Cambon, J., 2007. Vers une nouvelle méthodologie de mesure de la performance des Systèmes de Management de la Santé et de la Sécurité au Travail. Ph.D thesis at Mines Paristech.

Cambon, J., Guarnieri, F., Groeneweg, J. 2006. Towards a new tool for measuring Safety Management Systems Performance, 2nd symposium on Resilience Engineering, 2006, Antibes, France.

Chiapello E., 1996. Les typologies des modes de contrôle et leurs facteurs de contingence: un essai d’organisation de la littérature. Comptabilité – Contrôle – Audit 2. pp 51-74

De Terssac, G., 2003. La théorie de la régulation sociale de Jean-Daniel Reynaud. Débats et prolongements, la Découverte.

De Terssac, G., 2013. De la sécurité affichée à la sécurité effective: l'invention de la règles d'usage. Gérer et Comprendre.

Foasso, C., 2010. Du service à l'autorité: les ingénieurs des Mines et la sûreté nucléaire. In: GARÇON, Anne-Françoise (dir.); BELHOSTE, Bruno (dir.). Les ingénieurs des Mines: cultures, pouvoirs, pratiques: Conference 7 and 8 October 2010. Nouvelle édition [en ligne]. Paris: Institut de la gestion publique et du développement économique, 2012.

Granier, F., 2009. Le rôle des contrôleurs – inspecteurs du censeur au co-producteur de normes. In XII èmes Journées internationales de Sociologie du Travail, Nancy, France.

Guarnieri F., Travadel S., 2014. Fukushima-Daiichi, engineering thinking in an ongoing emergency. Research paper published by the Centre for Research on Risks and Crisis (CRC), MINES ParisTech, July 2014

Innes, J., 2009. Health and Safety Auditing. Safety Line Institute, Worksafe.

Jammaud A, 2003. Théorie de la régulation sociale et intelligence du droit. In: De Terssac (dir.), La théorie de la régulation sociale de Jean-Daniel Reynaud. La Découverte (ed.), Paris.

Latour B., 1987. Science in action: how to follow scientist and engineers through society. Open University Press (ed.), Milton Keynes

Lascoumes P., 2004. Gouverner par les instruments, Science Po, Les presses (ed.).

Law J., 1992. Notes on the theory of the Actor-network: ordering, strategy and heterogeneity, Systems practices 5. pp. 379-393.

Lefranc G., Guarnieri, F., Rallo JM., Garbolino E., Textoris R., 2012. Does the management of regulatory compliance and occupational risk have an impact on safety culture? In: 21st European Safety and Reliability Conference, ESREL 2012, Finland.

Le Moigne, J.-L. (1977). La théorie du système général. Théorie de la modélisation. Paris: Presses universitaires de France.

March J.C., Simon H., 1958. Organizations. John Wiley & Sons (ed.), New York.

Moisdon J-C, 2005. Comment apprend-on par les outils de gestion? Colloque de Cersy, entre connaissance et organisation: l'activité collective.

Morel Ch., 2009. Connaître ou punir? Traiter les erreurs dans les organisations. Le Débat 157.

Morel M-L, Amalberti R., Chauvin Ch., 2008. Articulating the differences between safety and resilience: The decision-making process of professional sea-fishing skippers. Human Factors 50.

Reynaud J.D., 2005. Ce que produit une négociation collective, ce sont des règles. Négociations 4.

Sonntag M., 2007. La conception au Cœur de la formation professionnelle. Les sciences de l'éducation pour l'ère nouvelle 40.

Vigneron J., Guarnieri F., Rallo JM., 2013. The contribution of ontologies to the creation of knowledge bases for the management of legal compliance in occupational health and safety. 22nd European Safety and Reliability Conference - ESREL 2013, Netherlands.

Walliser, B. (1977). Systèmes et modèles. Paris: Seuil

Zwetsloot, G., 2000. Developments and debates on OHS system standardisation and certification, in: Systematic Occupational Health and Safety Management. Perspectives on an International Development. Frick et al. pp. 391–492.