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Testimony of Fukushima Daiichi's Director: What Lessons for Crisis Management?

Masao Yoshida's 'Entry to resilience'

Cécile GEOFFROY

On 11 March 2011, the Fukushima Daiichi (FDI) nuclear power plant experienced the most significant disaster since Chernobyl in 1986. The events extended until 15 March, where all formal frameworks, procedures or written norms failed completely. This paper aims to examine a specific process (*entry to resilience*) that takes place in industrial organizations in the occasion of highly disruptive events. *Entry to resilience* begins after an highly disruptive event introduces a cut between the past and the future; ways to understand and interpret what is happening are lost (Bensa & Fassin 2002; Deleuze 2009). With no reference, such unprecedented events cause a shock. Accordingly, this shock leads to a "liminal" phase: an "in-between" moment (Van Gennep 1909; Turner 1967, 1990) during which structures are suspended, habits are broken and processes are interrupted (Powley & Cameron 2008; Powley & Piderit 2008; Powley 2009). In order to restore order, crucial decisions and actions are necessary. It is during this ambiguous phase of *liminality* where the possibility or impossibility to act is revealed.

Several investigations were undertaken to examine the FDI disaster. The investigation literature on FDI provides us with a great deal of original data offering new perspectives to study crisis management. Masao Yoshida, director of the plant and a key actor of the crisis management cell, has been interviewed by the Independent Committee on the Accident at the Fukushima Daiichi Nuclear Power Stations (ICANPS 2012). His enthralling testimony gives us rare insights to what really happened on the ground. What makes this testimony unique is the unfeasibility to restage such events and that it is the first time researchers have access to such intriguing material. It allows us to compare official inquiries on accidents that usually alter and simplify facts (Boudés and Laroche 2009), to Yoshida's own version of reality. We seek to examine Yoshida's testimony across the official Japanese (ICANPS 2012; NAIIC 2012) and international (IRSN 2012; NRC 2014; IAEA 2015) investigations.

We also raise methodological questions about the testimony. We intend to explore data manipulation and ways to use a testimony of one individual to explain an accident threatening an entire organization. We define and categorize our data to identify what we can learn from it. Finally, by analyzing the testimony and official investigations, we propose an original model of *entry to resilience*, one that can be used to explain the processes that took place during the FDI accident.

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The Fukushima accident and ontologies of nuclear safety

Aditi Verma

The Fukushima accident in 2011 led to an ontological crisis in the nuclear operating, design and regulatory communities leading each to re-examine what it meant for a reactor to be 'safe'. Even as these communities sought to forge consensus on the 'root causes' of the accident, several reactor design projects were underway. In a cross-sectional study of these contemporary reactor design projects through in-depth, open-ended interviews with 26 American reactor designers, I show how the lack of an industry-wide consensus led these designers to have individual experiences of and interpretations to the accident, leading ultimately to diverging design responses. With the Fukushima accident in the foreground and wishing to make their reactor designs safer, these designers sought not only to elevate levels of safety in an absolute sense but discovered novel design moves that made their technological designs safe in new ways. What is striking is that no new scientific or technological developments were needed to create these new designs, only a perceptual shift in the reactor designers' notions of safety.

Eventually a consensus emerged within the regulatory and operating communities, identifying 'culture' as the culprit at the site of the Fukushima accident while reaffirming previous a previous generation of safety standards. By then however, the reactor designers had reconstituted what it meant for a reactor to be safe which led to two diverging narratives of safety – one for the old reactors and one for the new. This case of nuclear reactor safety suggests an argument that may apply more broadly to the governance of complex technical systems. Homogenous analytical cultures create a tunnel vision such that key players are unable to recognize opportunities for invention and improvement in the design and regulation of complex systems thus stymying their technological evolution and making them vulnerable to failure and instability.

Using accident stories and knowledge for expertise in management of safety

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Abstract :

Industrial accidents and disasters have occurred in every industry and country especially since WWII. Investigations have aimed at identifying lessons to be learned in order to implement corrective actions and prevent similar accidents from recurring. This learning process has produced effects with an overall reduction in industrial accidents over the last 50 years. However, industrial accidents continue to occur, and failures to learn are observed with similar accidents recurring at NASA at BP and in the Japanese nuclear industry.

Moreover lessons from accidents are not learned sufficiently nor used sufficiently in practice. Indeed, our analysis of industrial accidents has shown that similar root causes recur whatever the industrial sector, the country, the culture or historical period (Dien, 2004, Dechy et al, 2008)). This empirical statement opens the possibility of consolidation of lessons from accidents into a structured 'knowledge of accidents' (Dechy et al, 2010). Similar research have given rise to the notions of 'pathogenic factors' (Reason, 1997) and 'pathogenic organisational factors' (Dien et al, 2004, 2012, Rousseau et al, 2008). In addition, we want to address also the forms of actionable knowledge in order to facilitate and strengthen the use in practice via the concept of 'culture of accidents'.

In this paper, our goal is to address some learning mechanisms and some associated devices the stories (e.g. Hayes and Maslen, 2015) and knowledge of accidents, have been used in practice during safety management assessments conducted at IRSN in the nuclear industry.

This knowledge of accidents generated from stories and the associated methods were particularly useful at two stages of the safety management assessment (Dechy et al, 2016):

- Firstly, at the beginning, it helped to identify the scope of the assessment, to better justify the key areas for investigation and to establish the framework of the safety assessment
- And secondly, at the end of the diagnosis, to interpret some data and findings,

By relying on our first-hand data as actors in these processes, as researchers, as knowledge providers and as operational users, we aim to describe our activities and the learning procedures, devices, tools that supported them. In the end, we aim at discussing some underlying factors, conditions, configurations that facilitated these processes and also the barriers we have had to overcome. This will give a basis for further discussion and generalisation of generic mechanisms and pave the way towards some engineering and management proposals.

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Abstract proposal for the 2nd Agoras Conference, « *Lessons learned* » ? *Studying learning devices and processes in relation to technological accidents*

Lesson learning as a means of governing unforeseen events: The case of French lessons from Fukushima

Social science contributions on the “lessons” from disasters often focus on the barriers to “effective” learning (Birkland, 2009; Blandford & Sagan, 2016), considered a necessary response to disastrous events in a normative perspective. Others aim to suggest a more “informed” narrative on disregarded lessons or unconsidered causes of disaster (Balleisen et al., 2017; Fujigaki, 2015). Few studies have tried to understand the stakes and challenges of large-scale negotiation processes over lessons for different actors taking part in them or tried to explain the phenomenon of a multiplication of “lesson-learning devices” and procedures themselves (Hutter & Lloyd-Bostock, 2017).

We suggest to study the process of lesson learning from the Fukushima accident in France conducted by nuclear safety agencies. One of the key challenges of this process is the integration of conflicting demands from political, industry and challenging actors. In the context of heightened public attention on nuclear accidents, agencies work as boundary organizations (O’Mahoney & Bechky, 2008) by rendering social and political demands compatible with the technical and economic imperatives of regular practices of regulation and electricity production. In the case of nuclear accidents, this work takes place in particular through the creation and transformation of socio-technical devices, such as the “hardened safety core”. This device allows, at first, to respond both to European and international testing procedures as well as French challenging actors. The negotiations with industry actors contribute, in a second step, to redefine the initial concept into a feasible set of regulations and technical adjustments. This paper describes these different stages in the transformation of this device that materializes the Fukushima lessons and helps at the same time to end – at least temporarily – a period of conflicting mobilizations over the government of nuclear accidents.

Based on this case study, we develop the hypothesis that lessons from disaster aim to control the boundaries of a potential crisis situation and produce a capacity to verge periods of urgency through multiplying, testing and narrating accidents in relation to ordinary work practices. They can therefore be understood as an attempt to create a new capacity for public actors to govern unforeseen events, which operates less on the prevention of disaster than on the control over their consequences.

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*Normal and Exceptional:
Disaster Response Evaluations by the State*

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This paper uses the cases of Hurricane Katrina in the United States in 2005 and the 2011 Japanese tsunami to examine how developed nations struggle to evaluate their responses to disasters.

Despite the near-inevitability of government evaluation reports after a major disaster, this paper finds that in both cases, the reports were put together in an ad hoc manner decided after the catastrophes. There was little or no standardizing of evaluation processes, success indicators, or report formats across jurisdictions or across time, even though in funding international disaster response both of those governments encourage non-governmental actors to refer to existing standards and indicators. In the United States three different national reports were produced, and while there was overlap there were also significant differences in findings and recommendations. Although the evaluations are ostensibly for the purpose of learning, the multiplicity of reports and lack of standardization tend to obscure any definite conclusions.

This tension between the insistence on formal evaluations and the reluctance to formalize the terms of those reports reflects a deeper conundrum for governments dealing with significant disasters. The existence of the crisis, by definition, implies some break with stability; but admitting too large a break threatens the State's image, its *raison d'être*, possibly its existence. The narratives must therefore express the dislocation of the crisis – thereby both recognizing lived experience and demonstrating the importance of stability – while also eliding any gaps in the State's authority and competence and, therefore, legitimacy.

This contradiction between viewing the specific disaster as a normal part of the State's business and seeing it as an exceptional, unpredictable, unmanageable event has serious consequences for the question of learning. This paper traces the ways in which temptation to see the disaster as exogenous and unusual affects the potential for learning through both the process and contents of disaster response evaluations.

The paper draws from the evaluations themselves along with data from original interviews with actors involved in their composition in both the United States and Japan.

Bastien BROCARD, Nicolas LOT

EDF LAB

From external accidents analysis to their appropriation by operational staff: the example of the accidentology approach conducted at EDF

This communication will focus on the monitoring of external events, conducted since 1999 within EDF Research and Development. This monitoring focuses on accidents, incidents and crises outside the company, in a feedback process for EDF. Its purpose is to stimulate a reflection on the organizations and practices specific to EDF and to constitute a tool of organizational vigilance aiming at several objectives: to recognize that catastrophes are possible, to understand the factors, mechanisms and dynamics of these events, to help identify accident situations and promote debates and discussions.

The communication will articulate 3 axes. The first one will discuss the distancing of the operational and daily reality that the analysis of external events allows, in order to provoke a reflection on the organizations and practices specific to EDF. Speaking of external events initially neutralizes the inevitable defensive reflexes of the actors, supporting the release of the speech.

The second axis will focus on the methodological choices made to achieve this and will mobilize the notions of storytelling and narrative immersion. The construction of storytelling involves an important work of analysis (by aggregating available public reports), as well as an understanding of both sociotechnical systems. The narration of the accident must also make it possible to grasp the logic of action and to deduce generic socio-organizational mechanisms which give rise to a debate on internal practices. Various skills and knowledge are necessary for this: immersion in another socio-technical system, knowledge of various security models, their strengths and their limits, combination of a historical and dynamic approach and articulation of micro dimensions with macro causes, are all required to achieve the objectives of the approach.

The third focus will be on how to transpose and take ownership of these external analyses within EDF. The knowledge produced must be recovered and exploited in the company, in particular by the operational actors in charge of installations safety. The transposition of these analyses is accompanied by the various business lines within ad hoc discussion forums, allowing reflexivity and the contribution of stakeholder issues and their discussion.

These different ideas will be illustrated by examples of analyses recently conducted (accident of the

AF447 and derailment of a train at Brétigny).

Abstract proposal for the 2nd AGORAS Conference - *“Lessons learned?” Studying learning devices and processes in relation to technological accidents*

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Designing innovative nuclear reactor: a study of technological innovation in contested industries through learning and unlearning processes

Innovating in the nuclear industry is a very long-term endeavor that lasts decades rather than years. Even when designing a new technology, actors rely on knowledge accumulated through the design, construction and operation of previous nuclear reactors. But last projects, notably the EPR, have shown that knowledge does not constitute a stock available once and for all but needs to be actively maintained. A key feature of nuclear industry is its intermittence, alternating between periods of intense deployment of new projects and long periods without any design or construction activities. These restarting periods are specific and highly critical in terms of safety, since errors in design or construction may have catastrophic outcomes, even years or decades later. They constitute very interesting moments to study since safe design and construction require both creating new knowledge related to technological innovation and reactivating existing but old knowledge and practices.

This papers aims at studying the entanglement of learning and relearning dynamics through the comparison of two case studies: the EPR project and the ASTRID project. The EPR (European Pressurized Reactor) is currently close to the end of its construction phase and has experienced lots of delays, which have given rise to concerns in terms of industrial performance and safety. The ASTRID (Advanced Sodium Technology Reactor for Industrial Demonstration) is currently in its basic design stage and its construction is highly hypothetical. In both cases, these projects are supposed to combine both a technological inheritance from past operated reactors and innovation, notably in terms of safety and accident prevention.

This qualitative research first highlights that actors tend to underestimate to what extent some pieces of knowledge have been lost during low activity periods. This invites to take a closer look at unlearning as a specific risk in conducting these highly critical projects. It questions the appropriate design and project management practices when it comes to steer projects with both high exploitative and high exploratory goals in contested and intermittent industry.

Playing with Fire: The Crisis of Iran's Petroleum Industry

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Over the past decade, about 40 fire incidents have taken place in the Iranian petrochemical industry, which have left decades dead and injured. In addition to human casualties, these events often result in the destruction of the technological infrastructures, environmental degradation and economic losses. The occurrence of these incidents in one of the oldest Iranian industries, have created many questions and ambiguities.

The studies show that the three main reasons for the occurrence of these events are organizational and managerial challenges, problems with safety standards and the challenges due to the lack of proper technologies for the establishment and commissioning of petrochemical refineries in Iran.

Analysis of the data gives us some useful information about which reason plays as the main factor. According to the findings of this paper from 1912 (In that year the Abadan refinery as the first Iran's oil refinery was completed) until 2010, in no decades as much as the last decade there is not an increasing trend of fire incidents in refineries. The statistics show that as the same time with the increasing privatization of state-owned enterprises in the petrochemical industry in 2010, the number of accidents are increased. In these years under the Article 44 of the Constitution of the Islamic Republic of Iran, privatization in the country accelerated rapidly, and most of the petrochemical complexes privatized.

In this period, due to the huge profits generated by the operation of the refineries the new owners of the refineries tried to increase refinery outputs rapidly, without providing the necessary safety standards or even creating incident insurance coverage for refineries.

Evidences show that the government, or specifically the Oil Ministry, has not done its job properly in the privatization process. The fact that it can analyzed through government intervention models, states that the government has only privatized the petrochemical industry in order to reduce its financial problems. The role of government regulation is one the most important issue that it effects on organizational process such as safety management in the petrochemical refineries.

These fire incidents, although causing a lot of damage to the country, but the analysis of them gives us some good lessons on how to correct some of the government's procedures in the process of privatization of industry.

Auteur : Olivier CHANTON

What does the French nuclear regulatory system learn from extreme climatic events: A case study of the 2003's heatwave and drought?

In 2003, an unprecedented heatwave led to the hottest summer on record in Europe and in France. Apart from the health crisis triggered by this event, many French nuclear power plants had to shut down or to reduce their production because of rivers low-flows or thermal pollution (Létard, Flandre & Lepeltier, 2004). The main actors involved in the regulation of nuclear safety consider these events as consequences of the climate change, anticipate more extreme and more frequent climatic events in the future and acknowledge the emerging political concern about adaptation of the electricity production and distribution infrastructures (Linnerud & al., 2011).

In this paper, we will present a socio-historical analysis (Noiriel, 2006) of how, from 2003 to nowadays, these actors have constructed and negotiated solutions to adapt to drought, heatwaves or river low-flows and a shared vision of the future to adapt. Our socio-historical analysis is based on the analysis of numerous archives and testimonies of the work led during fifteen years by the French actors regulating nuclear safety (Chanton, Mangeon, Pallez & Rolina, 2017). This type of analysis appears to be particularly fruitful to shed light on what has been learnt or not, to draw general conclusions about what can inhibit or facilitate this learning and about the effects of these learnings (Baudot, 2014).

Based almost exclusively on technical safety and risks issues, the vision constructed by the authorities is the product of a combination of existing techno-scientific tools (models and statistics) aiming at drawing two types of predictions (hindcast and forecast, cf. IPCC-AR5, 2014), with differing effects in terms of learning, concerning various problems, from climatic hazards to the calculation of the reliability of technical barriers. However, we will show that this work led to what could be viewed as “blind spots” and “limits” in the way the issues at stake are tackled. Moreover our analysis shows how “uncomfortable knowledges” (Rayner, 2012), knowledges that contradict important beliefs, are managed through regulatory arrangements together with normative and strategic ideas about what should be done and by whom (Dedieu & Jouzel, 2015) in face of climatic hazards. Emerging as a core element of this vision, we find the notion of resilience. The incorporation of this notion constitutes a major shift in the way risk and safety management are conceived and implemented (Boudia and Jas, 2015). We will show that this emergence is the consequence of a strategic reframing of the uncertainties, as a boundary-ordering device (see Shackley & Wynne, 1996), based on a judgement about the predictability of extreme (or not) climatic events and their consequences. We will conclude our presentation by drawing some of the implications of the normative shift toward resilience on risk assessment and learning capabilities and discuss the notion of ecology of ignorance (Luhmann, 1998; Rabinow, 2003).

Keywords: Socio-historical analysis, learning capabilities, resilience, boundary-ordering device, ecology of ignorance.

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*Studying learning devices and processes
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Abstract proposal

**The critical potential of ignorance:
(Re)Writing expertise reports on the Brétigny derailment (France)**

This paper tackles mechanisms of knowledge production after accidents comparing four expert reports on the last major derailment in France (at Brétigny in 2013, causing seven deaths). The purpose is not to provide a socio-technical explanation of the accident. It is to highlight how mechanisms of knowledge and ignorance production strongly depend on experts' "social position" (Bérard et Crespin, 2015). More precisely, it shows that the extent to which certain groups of experts consider the knowledge of other groups of experts depends on their institutional and administrative base.

Four types of report are chronologically examined. They differ in their framing of expertise work:

- two technical investigations produced by the experts of the railway company (SNCF), which aims to identify the direct causes of the accident;
- two technical investigations produced by the French Transportation Land Accident Investigation Board, which aims to make recommendations to prevent future accidents;
- a report requested by the Health, Safety and Working Conditions Committee of the railway company, which aims to identify the working conditions of the employees involved in the accident;
- three judicial investigations produced by sworn engineers, based on a metallurgic investigation. Requested by the examining magistrate in charge, they aim to identify the direct causes of the accident and to determine responsibilities.

Whereas the railway company management tries to impose a purely technical definition of the accident, other experts (working for the employees, the Transport Department, and the examining magistrate) highlight the conditions of maintenance work and the dilapidation of the railway network. The paper analyzes the explanatory processes at work in the reports, focusing on how some causal elements evolve, become more complex or disappear. Depending on the data used, the definition of the accident and of the responsibilities change.

Building upon Jouzel and Dedieu's (2015) work on the production of ignorance, the paper identifies two mechanisms of ignorance production: *ignorance by omission* and *ignorance by submersion*. In contrast with their findings, these mechanisms are not so much related to the organizational dimension of ignorance production but to the process of report writing itself. The comparison of the 4 types of reports shows that what is silenced by one group of experts becomes a resource for another one to criticize and contest previous analyses of the accident.

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Maël Goumri

When the accident moves the barrier between hypothetical and possible: the consequences of nuclear severe accidents on core meltdown risk management.

What one learns from accidents is not purely technical. Even if the nuclear severe accidents from the past gave us many technical data to improve safety, they showed at a meta level that an accident is possible and call the attention of experts for accident prevention. This talk will first present the tools designed at the very first beginning of the nuclear energy development and their evolution along the time while focusing on the risk of core meltdown. Secondly, I will show the reasons of their evolution along the nuclear energy development which are not only due to the knowledge enhancement but have also political roots. The Core meltdown is the most apprehended danger for nuclear safety. On commercial power plants, a loss of core cooling possibilities leads to a fuel overheat which melts. It produces a kind of radioactive lava (called corium) which may melt through the vessel and then the containment, disseminate into the environment and lead to a hydrogen explosion if it meets water. With concepts like "Maximum Credible accident" and "design-based accident", designers imagined what could be the maximal accidents and took the dispositions to cope it to make the nuclear disaster (and this scenario in particular) almost impossible. This talk will show that the first safety management tools have been challenged by the first nuclear accident on commercial reactor in 1979 (at Three Mile Island, PA). The approach based on the maximum credible accident has been questioned by experts and lead to a major development of knowledge production programs such as Phébus PF in France. Theses new knowledges and the accident at Chernobyl powerplant in 1986 lead to a major change in the way to apprehend the core meltdown accident. Considered first "highly hypothetical" thanks the safety margins and safeguards implemented, it is now considered possible and must be considered for new reactors which must be able to cope it. Nevertheless, this talk aims also to assess the materiality of this evolution and question if and why setting the core meltdown risk on the agenda lead to major material changes or if it participates to a purely theoretical safety that French experts call "sûreté de papier" (paper safety).