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Coping with chaos at Fukushima Daiichi: Bricolage in and through a space

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Abstract

When the Fukushima Daiichi nuclear plant was hit with unexpected force by an earthquake and a tsunami, its safety protocol did not include instructions for what to do in case of a complete loss of power. Plant personnel were forced to practice bricolage, making do with what they had, to come up with their own solutions. Existing literature on bricolage activities has until now largely focused on organizational perspective. This article uses the case of the catastrophe at Fukushima to shed light on the role played by managers and workers when doing bricolage according to their hierarchical position as it is distributed within a space.

This article claims that bricolage is made possible in and through space through movement, distance and boundaries; by creating rules for choosing not to escape, expanding the bricolage repertoire's within a space, defining objectives which are simultaneously clear and gaseous, pushing back the boundaries of a repertoire to increase the possible surface area available for bricolage, and using hierarchical power to expand resources.

Finally, our article suggests that paying closer attention to the mechanisms actors use to appropriate and create spaces might provide a new framework for analyzing crises and their management, as well as helping to identify ways to promote bricolage practices in crisis situations.

Key words: bricolage, crisis management, leadership

Introduction

On 11 March 2011 at 2:46pm, an earthquake in eastern Japan caused three of the operating nuclear reactors at the Fukushima Daiichi nuclear power plant to automatically shut off, halting the fission process. Residual heat produced by the lingering presence of decaying fission products made it necessary to continue cooling the reactors at a minimal level by using a cooling system that ran on dedicated emergency circuits, which were deployed when the earthquake hit. These functioned normally until the site was flooded by the ensuing tsunami, causing a total loss of electricity. No crisis management procedure had been designed to deal with such apocalyptic circumstances. In conditions of near total blackout, operators equipped with flashlights attempted to adapt to the situation in the darkness of the reactors' Main Control Room (MCR).

How did the plant's operators manage to stay where they were and try to mitigate the accident instead of giving in to the temptation to escape from this hazardous space? As is often the case in unexpected situations, they were forced to "make do with what they had" (da Cunha, e Cunha et al. 2000): they had few resources and little time to figure out what they needed and what to do (Baker, Miner et al. 2003), which implies they were faced with the need to divert and combine the resources they did have available to them (Baker, Miner et al. 2003; Andersen 2008). Bricolage literature largely focuses on how bricolage makes it possible to divert different resources and combine them in improvised ways to address specific needs (Duymedjian and Rüling 2010; Ansell and Boin 2019).

If it has already been highlighted that bricolage activities are highly contingent on immediate spatial context (Korsgaard, Müller et al. 2021), the bricolage approach has not really taken into account the dimension of space in crisis context. This raises the question of how space might be mobilized to improve bricolage capacities in chaotic situations. To address this question we explored an arresting case of collective bricolage – the case of the accident at the Fukushima Daiichi nuclear power plant. Our case study observed the abilities of both operators and managers to stay where they were and build a space in which they could find solutions to mitigate the accident, instead of giving in to the temptation to escape.

According to the literature (Weinfurtner and Seidl 2019), space is defined by boundaries (which brings together infrastructures and actors around the same phenomenon), distance (between actors and from the phenomenon) and movement (specifically, the possibility of moving and evolving in space). Based on these dynamic properties, this article claims that bricolage is made possible in and through space. Its findings make two contributions to the existing literature. First, they help to identify how to adapt and use space for improving bricolage activities. Second, they allow us to

understand how, beside the operators on the ground, those working acting at the managerial level in times of crisis might successfully contribute to bricolage activities in a specific way.

Finally, our article suggests that paying closer attention to mechanisms actors use to appropriate spaces – and to create them – might not only provide a new framework for analyzing crises and crisis management, but also identify ways to promote bricolage practices in crisis situations.

Background

Bricolage from an organizational perspective

On the basis of the definition made by Lévi-Straus (Levi-Strauss 1966) the literature has focused on management as an instance of rational power driven by scientific thought as a way to highlight its incompatibility with bricolage and the “savage” thought that underpins it (Duymedjian and Rüling 2010). Consequently, bricoleurs may even go so far as to hide their 'misdeeds' behind investments in forms (Thévenot 1984) or to camouflage the 'irrationality' of their arrangements from the managerial eye. One such example is "tolerating uncertainties, which may be something upper middle managers do not want to see" (Halme, Lindeman et al. 2012); another is admitting that in some cases, "traditional rationality is no longer available" (Agamben 2005 , p.489).

Despite this apparent incompatibility, research (Weick and Quinn 1999; Weick and Sutcliffe 2011) has shown that there is a need for bricolage in systems that must show resilience in the face of inevitable problems (Villemain and Lémonie 2021). Safety management must be adaptive in the course of daily operations (Reiman, Rollenhagen et al. 2015; Casareale, Marincioni et al. 2021); this is all the true in crisis situations (Antonsen, Skarholt et al. 2012). It is easy to assume that bricolage would be prohibited in high-reliability organizations (HROs), but research (LaPorte and Consolini 1991; Weick and Quinn 1999; Weick and Sutcliffe 2011; Rezaei Soufi, Esfahanipour et al. 2021) has shown that there is actually a need for bricolage when these organizations find themselves in circumstances that require resilience. It is generally accepted that managers will have to supervise crisis interventions (Mutch 2015; Croweller and Tschakert 2021) and may even in some circumstances be called to participate in them, using resources in ways other than the ones intended for them. Workers must yield control when managers must assume it (Clegg, da Cunha et al. 2002).

In times of crisis, managers, too, must improvise solutions, which means they must act deliberately and unexpectedly (Moorman and Miner 1998), playing with possibilities and using available resources to find workable solutions (Nohria and Berkley 1994 , p.133).

Since it is now generally accepted that bricolage is not a deviation from “proper” management but rather a necessary practice for organizations (Pina e Cunha 2005), what possibilities exist for cultivating it? Fostering bricolage does not rely on a single authority, but rather on the collective capability to rewrite and re-plan as needed (Becky and Okhuysen 2011). Here as in many other situations, relational resources are an asset for enabling people to work together including for incremental change (Pina e Cunha 2005).

The resource management process has long been reduced to a rational process known as Design-Precedes-Execution (Baker, Miner et al. 2003) or resource seeking (Baker and Nelson 2005). According to these processes, goals can be perfectly defined and resources ideally specified to achieve optimally rational outcomes. In the past decades, however, researchers have begun to explore this process in a more nuanced way, revealing it as more complex, dynamic and exploratory, characterized by resource mutability in a given context (Feldman 2004) – again supporting the key role of improvisation and bricolage activities (Eisenhardt and Tabrizi 1995). The resource management process, in other words, has been problematized into what Feldman has called *resourcing*: “it is the ways that things are used that makes them into particular resources (Feldman and Orlikowski 2011 , p.1246). Viewed from the perspective of resourcing, the manager’s role may be to accumulate, categorize, develop, and use organizational resources over time (Moingeon, Ramanantsoa et al. 1998), as well as to pile up, disorganize, reorganize, test, and try unorthodox ways to employ organizational resources over time (Pina e Cunha 2005).

Bricolage may also be encouraged by leaving a margin of action those involved in a given situation (Crozier and Friedberg 1977), taking care that they not be subjected to excessive control (Sewell 1998). Organizational combinations can in this way sustain extraordinary group creativity (Harvey 2014), allowing for the creation of economic value (Lawrence and Dover 2015), as well as artistic output. Indeed, bricolage-inflected praxis may be seen at play in the visual arts, architecture, fashion, computing, and many other areas of design (Hebdige 2012).

All these works apprehend dynamics that contribute to bricolage activities from an organizational context shaped by institutional, political, or economic factors. None, however, consider the role of space as a possible resource for bricolage.

Bricolage from a spatial perspective

If space is distinguished in the first instance by its socio-materiality, by infrastructures, and by the way it is used (De Vaujany and Vaast 2014), it is only one component of a surface built and bounded by manners of reciting, making, working, moving, and joining (De Certeau 1984). According to De Certeau (De Certeau 1984), a place is composed of immobile objects, such as pipes, materials, maps, or walls, whereas a space emerges as these objects are mobilized – manipulated, moved, discussed, or diverted.

The bricolage approach has not yet taken the dimension of space into account, and indeed it may be surprising and slightly counterintuitive to think of it in this context. The literature does, however, allow us to identify various aspects of space that might well foster and support bricolage activities in crisis situations. The first is to be found in the space of dwelling. For humans, space is neither an external object nor an internal experience (Heidegger 1958); instead, it is constituted by them. As a result, "only when we can inhabit can we build" (Heidegger 1958) and develop a sense of familiarity that allows a person to find their place (Casey 1993) without prior deliberation (Chia and Holt 2006). Inhabiting, therefore, frees up mental capacity for bricolage.

Second, spaces can also be understood as a frame of reference actors use to make sense of their surroundings (and their position within those surroundings) and to identify new solutions within an immediate spatial context (Korsgaard, Müller et al. 2021). Weick (Weick 1993) has described how people within an organization rely on real-time information and react when situations are highly uncertain and dangerous. Like others of its kind, his study, which describes how some firefighters quickly assessed and survived a catastrophic situation, while others perished, was an attempt to understand how space can nourish flexibility and improvisation (Eisenhardt and Tabrizi 1995) within a given space. According to this literature, certain resources are available for bricolage activities in a given space (Bechky and Okhuysen 2011) and are mobilized to make sense of the situations and adapt to it resourcefully (Lipshitz 1995).

A fundamental part of bricolage, inscribed in its most common definition in the expression "at hand," means that resources must be mobilized based on the space for uses other than the ones for which they were intended. This brings us to our third point about the importance space to bricolage: in a context of action that requires bricolage, it is often viewed as a constraint (Lave 1988; Kornberger and Clegg 2004). However, space can also *organize* a given context (Johannisson and

Nilsson 1989), thus offering possibilities of action (Anderson and McAuley 1999), innovation (Dahl and Sorenson 2009; McKeever, Jack et al. 2015), and renewal (Wombacher, Herovic et al. 2018). It remains a framework produced and reproduced by collective action (Dobers and Strannegård 2004; Hernes 2004; Clegg and Kornberger 2006). Just as space and power are inseparable in the sense that space constitutes a setting where power is (Foucault 1975; Foucault, Davidson et al. 2008), bricolage and space are indivisible in that space constitutes a setting where bricolage emerges. Finally, if space can be manipulated, it is because it is dynamic, rather than static, in that it integrates vectors of direction (De Certeau 1984). In the literature, these have usually been defined according to three categories: boundaries, distance, and movement (Weinfurtner and Seidl 2019).

The question remains of how space could be mobilized from these perspectives in order to improve actors' capabilities for bricolage in crisis situations. In particular, distinctions between how managers and workers are able to mobilize space to improve these capabilities have yet to be explored. One famous example of bricolage is the case of the Apollo 13 spacecraft (e.g. (Rerup 2001; Pina e Cunha 2005), in which engineers used bricolage to find a way to create a CO₂ filter in the Apollo capsule. They built an ad hoc heterogeneous arrangement composed of materials such as the cardboard covers of flight plan logs, a roll of duct tape, plastic bags, and tube socks, then translated the results into a procedure that the astronauts could reproduce the bricolage inside the service module.

The repurposing of resources has been closely analyzed (Pina e Cunha 2005) but never in a way that accounts for the role played by space in managing situations such as this one. At most, collective solutions such as the one created during the Apollo 13 mission have been understood as an organizational capability emerging from the combined capabilities of different individual actors carrying out bricolage activities on their own. However, it must be recalled that each individual element – the roll of duct tape, the plastic bags, etc. – must be moved (geographically and functionally) through space in order to serve as a resource for bricolage; it is this mechanism that this article proposes to investigate.

Methodology

I. Sources

Our analysis is based on field documentation, including official documents and witness statements that described the interactions between the Prime Minister and those working on the Fukushima Daiichi site during the first days of the accident, from 11 to 15 March 2011, which constituted the

heart of the crisis. Of the five official reports published in English by the Japanese authorities, we have focused on the two published in English just after the accident (between 2011 and 2012), as they provide information both on the technical aspects of the accident and the actions of those involved in it.

The first report was put together by the Japanese government and published by the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations (ICANPS Final 2012; ICANPS Interim 2012). This committee comprised ten members from various fields of expertise, including academics, and was chaired by Yotaro Hatamura (professor emeritus at the University of Tokyo and professor at Kogakuin University). Their investigation to determine the causes of the accident included interviews with 772 different subjects, including plant workers, government representatives, and evacuees; an interim report on their findings was published in December 2011 and a final report in July 2012.

The second report was issued by the National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (The National Diet of Japan 2012), a body of scientific experts that included a seismologist, a chemist, physicists, and politicians. The Diet was created by Parliamentary law to investigate the Fukushima accident, and conducted 1,167 interviews (including with plant workers, government representatives, and evacuated individuals), producing a report that was published in 2012.

Our analysis was limited to these secondary sources because it was not possible to conduct interviews with any of these people. In-depth interviews might have helped to dig deeper into the relationships between the government and the licensee as the crisis unfolded (as well as before), and, in particular, to further explore the nature of the information they exchanged, but in this case were not available to us in the scope of the study.

Secondary sources do have certain limitations. Previous researchers have highlighted that the official reports we have selected for our analysis do contain value judgments that might affect readers' interpretations of certain facts (Travadel, Guarnieri et al. 2018). However, because our goal was to retrace the bricolage activities that took place during the accident, the focus of our reading was on the actions and decisions people described to the interviewers rather than on the perceived outcomes or consequences of those actions, which are far more subject to conflicting interpretations. The information we were seeking was "raw," and the witness statements gathered from the accident's protagonists, published *in extenso* in these reports, are the most immediate record of their thoughts, feelings, and actions while the accident was occurring. We paid particular

attention to Masao Yoshida's statement, which was taken by the ICANPS investigation committee and subsequently transcribed in its entirety into separate publications (Guarnieri, Travadel et al. 2015; Asahi-Shimbun 2020).

Masao Yoshida's statement has several remarkable qualities. The first is its length – he was interviewed for twenty-eight hours – and the second is the thoroughness of the questions asked. It is part of a series of interviews conducted by the Investigation Committee on the Accident at the Fukushima Nuclear Power Stations of Tokyo Electric Power Co., which totaled over 1,479 hours and contain a wealth of information. Interestingly, the account was not intended for publication: it was published on 11 September 2014 only because of “the combined pressure of public opinion and 'leaks' – which to a certain extent were well-meaning – in the Japanese media” (Guarnieri, Travadel et al. 2015). The statements in the report, in other words, come from people who, at the time of their interviews, must have felt to some degree “protected” by the secret nature of the investigation. Finally, Masao Yoshida was frequently described as a manager who expressed himself “plainly and simply,” and as someone who was not afraid to “denounce the Prime Minister, criticizing his lack of empathy and absence of support for the workers” (Guarnieri and Travadel 2018). All of these factors indicate that he would feel comfortable describing the kinds of actions defined and described as bricolage in the sections above, making his interview an unusually rich – but also reliable – source for studying bricolage activities in a crisis situation.

II. Methodological framework

Our paper uses the Fukushima Daiichi accident as a case for grasping bricolage from a spatial perspective. Case study methodology is a relevant way to investigate complex situations and to understand the how of a phenomenon (Yin 2009). Consistent with Langley's (Langley 1999) recommendations for process research, we took a multi-dimensional approach to our data analysis, which we conducted in three stages. In the first stage, we constructed chronological lists of key events, activities, and interpretations (official reports, quotes from interviews, media reports, press releases, etc.). A trajectory of accident mitigation was then established focusing on bricolage activities (Duymedjian and Rüling, 2010) aimed at preserving the damaged space in which the actors worked.

In the second stage, we distinguished two main groups of actors involved in the types of bricolage activities previously identified: those inside the Main Control Rooms (MCRs) and those inside the Emergency Response Centers (ERCs). The first group, the shift team on duty in the MCR during the disaster, comprised the actors “closest to the system.” We were particularly interested in their

relationship with the rest of the plant's teams and workers. At the Fukushima site, there were multiple MCRs connected to different reactors; however, since Reactors 4, 5, and 6 were off-line at the time of the tsunami, we focused mainly on the MCR shift teams for Reactors 1 and 2. Each shared shift team had 11 members, including a shift supervisor and deputy shift supervisor. As the accident continued, several off-duty operators also reported to the MCR to assist. For the most part, these operators were local, long-term employees.

The second group was composed of those inside the ERC, including Masao Yoshida, who was the site superintendent of the nuclear power plant. He was an experienced, long-term TEPCO employee, had worked at several of its plants, and was "the primary decision-making authority [...] of the nuclear power plant" at the time of the accident (The National Diet of Japan, 2012).

Below, those in the first group will be referred to as the operators and those in the second group as the managers. Once we had identified the two main groups participating in bricolage activities, we turned our focus to the socio-materiality of the space in order to analyze the defining features of the bricolage activities, taking into account the ways in which the two main groups of actors on site were involved in the space, including with regard to their status and origin.

Case study

On 11 March 2011 at 2:46pm, an earthquake in eastern Japan caused three of the Fukushima Daiichi nuclear power plant's operating nuclear reactors to automatically shut off, halting the fission process. Residual heat produced by the lingering presence of decaying fission products made it necessary to continue cooling the reactors at a minimal level by using a cooling system that ran on dedicated emergency circuits, which were deployed when the earthquake hit. It functioned normally until the site was flooded by the ensuing tsunami, which caused the circuits to malfunction.

No crisis management procedure had been designed to deal with such apocalyptic circumstances. In conditions of near total blackout, operators equipped with flashlights attempted to adapt to the situation in the darkness of the reactors' Main Control Room (MCR). The plant superintendent recalled being stunned by the situation: *"At that moment, to be honest with you, I was devastated. I really was. I said to myself we were facing a terrible situation. But complaining wouldn't solve anything. Clearly, we were heading for a major accident, and we needed to prepare for it."* (Guarneri 2015, p. 106).

How did the plant's operators manage to stay where they were and try to mitigate the accident instead of giving in to the temptation to flee from this hazardous space? As is often the case in unexpected situations, they had to "make do with what they had" (da Cunha, e Cunha et al. 2000): with few resources and little time to figure out what they needed and what to do (Baker, Miner et al. 2003), they were under immense pressure to act, even if it meant diverting and combining the resources they did have available to them in unexpected ways (Baker et al., 2003; Andersen, 2008; Duymedjian and Ruling, 2010).

In this article, we will focus on Reactor 1, which was hit the hardest, and the earliest. Plant staff tried three ways in succession to cool Reactor 1 (Figure 1); these will be described in greater detail further on in the article. The first (Solution 1) was an attempt to restore power to existing emergency systems, which had been flooded by the tsunami. When it became clear this was impossible, the second response (Solution 2) was to tinker with the existing diesel-driven fire pump (DDFP) in order to try to cool the reactor directly. When this, too, failed, a third and completely innovative response (Solution 3) was to bring water directly into the reactor using fire trucks. These three attempts to secure the damaged space, which will be detailed below, are examples of the type of bricolage activities our article seeks to highlight and better understand.

Figure 1-Timeline of 3 innovative solutions implemented to try to cool Reactor 1F1

I. Solution 1: Attempts to restart the existing emergency systems

I.1 Using space as a new indicator of the situation

The total blackout that occurred in Reactor 1 triggered the Isolation Condenser (IC) to start up. The IC is an emergency system that uses a passive circuit with a closed condenser, and does not require any pump-type motors or electricity to function.^[1] It is a simple system; however, in order to function, four valves must be opened. In the first moments of the disaster, the operators in the MCR did not know if the IC was operating correctly. They had no access to any indicators, and only a limited understanding of exactly how it worked, since none of them had used it before or been trained to operate it in simulations (Nakamura and Kikuchi 2011; Funabashi 2012; Lochbaum, Lyman et

al. 2014; Ahn, Carson et al. 2015; Ahn, Guarnieri et al. 2017). They therefore had no way of knowing whether the IC contained enough water to function properly, or whether the four valves had actually been opened, since the valves are normally activated by an electronic control that was rendered inoperative by the tsunami. Two of the valves were located outside the chamber, and could be activated manually, but the two others were located on the inside, and therefore extremely difficult to access.

The operators in the MCR had no way to clearly understand what was going on in the reactor, and no idea of what effect, if any, their actions would have on it (ICANPS Interim, 2012 p.111). There was no way to directly observe water or pressure levels inside the nuclear reactor without going to the reactor building themselves, where they might have access to other gauges. The operators searched for other ways to figure out whether the IC was functioning, attempting to interpret the steam they could see or the sounds they could hear in the pipes (ICANPS Interim, 2012 p. 121). Where their control screens had failed, operators moved into the field to construct their own empirical diagnosis by probing the installation directly, looking for ways to make it speak to them. Their space was no longer an instrument for the production of electricity, in other words: they had “bricolaged” it into an instrument with which to interpret reality, to determine that the IC had failed or not.

The operators were further disabled by lack of communication and support from the rest of the organization: instead of constant, multi-channel communication and real-time access to reactor parameters, the operators were linked to the ERC by a single (one per MCR) dedicated hotline (The National Diet of Japan, 2012). This meant that any interpretations by those at the top of the hierarchy were necessarily very limited (Kadota 2014) because they did not possess the empirical knowledge required. Operators, by contrast, were accustomed to hearing and interpreting the daily noises of the pipes and observing emerging heat: they were able to engage in bricolage to deduce from the rising steam and its changing color that the IC was not working. The management at the ERC was unable to draw the same meaning from this information when it reached them. This asymmetry reminds us that operator autonomy is a necessary condition for flexibility within an organization, particularly in a crisis setting (Villemain and Godon 2017).

1.2. Creating new rules to use the space

The shift supervisor sent several different missions to the field simultaneously to assess the situation and the unfolding crisis: to figure out what equipment and systems were or were not working, which ones could be fixed, and which ones were now useless. Hirano, the usual shift supervisor of the team on duty in the MCR for reactors 1 and 2 during the disaster, was absent at the time for a routine

medical examination. He had been replaced by Izawa, the leader of a different team. The first major decision Izawa made was to organize interventions outside the MCR. Rather than continue with ordinary working procedures and rather than allow unregulated, individual decisions about what constituted safe practices as the situation developed, Izawa put in place new measures, explicitly changing the rules for “going to the field” (that is, conducting any work outside of the MCR). Missions to the field would now require permission from the shift supervisor, would need to be conducted by at least two people, and would have a strict time limit of two hours, whether or not their goals had been achieved. Rescue missions would be sent for anyone who was away from the MCR for longer than two hours (ICANPS Interim, 2012).

Sending multiple missions simultaneously demonstrates the intention to constitute the richest possible stock of indicators from which to take action as quickly as possible. By the end of the afternoon (D1), five operators – all members of senior management, including two who had not been posted to the MCR that day – had been sent to check the equipment inside the turbine building. As tsunami alerts were frequent and the alarm systems were no longer working, a young operator was sent up to the roof to keep watch and alert the team on duty if a negative surge was observed (ICANPS Interim, 2012). New rules and tasks helped operators to move in the space despite very hostile conditions (Gisquet 2021), allowing them to perform bricolage activities.

II. Solution 2: Bricolage with existing emergency equipment: the fire pump

II.1. The “gaseous” view from the managerial level

At the managerial level, as doubts rapidly emerged as to whether the IC was actually cooling the reactor, there was limited capacity to identify alternative solutions. Yoshida reported that he was unable to collect all the information necessary to figure out a course of action. Instead, he was forced to make do with the patchy information filtering back up from the site:

We are in a situation where we're being told to think about a solution without having any data or being able to see anything. So, what we want is the ability, in one way or another, to look at the key data. And from the very beginning that was what I was asking the teams to do, and they devoted all their energy to it. Despite that, the data was slow in coming, and I was in a

situation whereby it was difficult to make decisions about what to do (Guarnieri et al., 2015 p.143).

At the managerial level, actors were unable to apply all their engineering skills or to follow procedure in defining what was to be done and who ought to do it. Instead, managers were obliged to delegate to the operators their ability to perceive and appropriate the space of the reactor.

This meant that at the managerial level, actors had to work with vaguer images, from what Gilles Deleuze described as a "gaseous perspective," with choppy, constantly varying, and patched-together viewpoints, as opposed to perceptions and opinions that could be expressed in a solid, geometric manner (Deleuze, 1995). As a result, they set a goal that was both clear and vague at the same time: "to find alternative solutions for cooling down the reactor." With this directive, Masao Yoshida authorized operators to work more flexibly, opening the door to more repurposing and adapting than a directive given in more precise and technical language could have. "*We needed to figure out how we could see the water level, re-establish power in the control rooms, and inject water – any water, by any means*" (Guarnieri et al., 2015 p.110). Yoshida went so far as to confirm that "*I had instructed people to think about these things, but I myself couldn't see even the flicker of a solution*" (Guarnieri et al., 2015 p.111).

II.2. From clear and vague to practical and concrete: bricolage in the field

Setting more flexible objectives without specifying indicators of success makes it possible to manipulate a space for purposes other than those initially intended. The vagueness of Yoshida's instructions authorized operators to use bricolage, both implicitly (through the use of general terms such as "think about"), and explicitly (with the clear request to "manage by any means").

Following Yoshida's request, the operators had the presence of mind to grab car batteries and assemble them in the control rooms so that they could be used as makeshift generators (Guarnieri et al., 2015)p.115). This approach fits the most widespread definition of bricolage activities; that is, using existing resources for other purposes in order to innovate or create. Meanwhile, actors at the management level had no physical or perceptual access to the field, meaning that their bricolage occurred at a certain remove. At distance from the field, the plant's management was inspired by blueprints and crisis management manuals: "*From the point of view of the crisis management manual, the first thing we needed to do was to consider using the fire protection system*" (Guarnieri et al., 2015)p.111). They based a decision to use the diesel-driven fire pump (DDFP) instead of the IC on these manuals at around 5:00pm (D1). Although the crisis management manual had already

identified the DDFP as a potential solution, there was no practical guide for its use. Management set phases of work and tasks for themselves, and identified the people who would be responsible for these tasks.

Management asked the operators in the MCR to check that the DDFP was working and made the decision to “prepare the ground,” meaning that the DDFP, which was located in the turbine building, had to be hooked up to the reactor building’s fire protection system. In a normal situation, this would have simply required pressing buttons in the MCR, but once again, with no electricity, the valves had to be opened and closed manually. This required knowing which valves were needed and where they were located. Moreover, the valves, once located, proved difficult to open, all the more so because the operators were constrained by their protective gear, a necessity as levels of radioactivity climbed. They nevertheless managed to hook up the equipment, and the DDFP was activated at 20:50 (D1).

Using bricolage to link different resources together in out-of-the-ordinary ways to keep the system working was insufficient to implement Solution 2; environmental conditions beyond their control made it impracticable. As Yoshida had feared, the pressure inside the containment chamber was too high for the DDFPs to be able to inject any water. As the operators tried to find a way to lower the pressure in the reactor, at 1:48 am (D2) the DDFP suddenly stopped working: it had run out of fuel. The operators attempted to restart the pump, to no avail, and Solution 2 had to be abandoned. Just one solution remained: using fire engines to pump water directly into the reactor.

III. Solution 3: Last-ditch attempts: the fire trucks

III.1. Reorganizing the space

From the start, Yoshida had been skeptical about using DDFPs to cool the reactor, remembering that following an earthquake in Chuetsu-oki, the internal water pipes that supplied the fire protection system in the Kashiwazaki-Kariwa nuclear power plant buildings had been badly damaged (ICANPS Interim, 2012). Yoshida’s “bricolage” repertoire was augmented by his imagination; in this case, his knowledge of past events. He recalled that at the Kashiwazaki-Kariwa nuclear plant, fire trucks had been used to pump water from onsite water tanks into the reactor to cool it down.

Only one of the three fire trucks on the Fukushima site was still in working order. Here, Yoshida’s position in the hierarchy at the managerial level made it possible for him to enlarge “the scope of the area” of bricolage, thus increasing the material and symbolic resources available for bricolage. When

Yoshida asked TEPCO to send all available fire engines to the plant, they acceded to his request because of his position of authority, despite the reasons he gave for it being intentionally vague, in order to leave operators latitude in how to use the fire engines.

III.2. Engagement in the space

With the new option of using fire engines on the table, staff were finally able to withdraw from the reactor chamber to pursue a solution beyond its walls. The rubble and debris scattered throughout the plant made movement complicated and tricky, but their capacity to appropriate a broader space outside the MCR had been reinforced by the flexibility Yoshida had given to them in the allocation of unexpected materials and the performance of unexpected tasks. Although there had been no specific command from above, the “recovery” team (from the ERC) began clearing the roads to allow the fire engines access to the reactors.

At the same time, a reconnaissance team and firefighters from Nanmei, to whom TEPCO had subcontracted the maintenance and use of its fire engines, were consulting plant blueprints and schematics to locate the connection port where the fire engine pumps could be hooked up – to a pipe that operators had already configured in their attempts to use the diesel pump.

Finding such small and specific places within the huge plant proved difficult. It took the recovery team several hours to locate the connection port, which had been hidden by debris from the tsunami. Even once it had been located, the mission was not complete, and the level of radioactivity was increasing rapidly.

Although Nanmei had been specifically contracted to operate under emergency conditions and to prevent accidents, and although none of the TEPCO staff members or the on-site firefighting teams were qualified to operate the fire engines, the chief refused to allow his employees to continue working under these conditions. Yet, given the urgency of the situation, some members of TEPCO's management team attempted to negotiate with Nanmei. One person, the deputy manager of the local electricity production team, called a subcontractor friend to alert them of the need to use the pumps (Kobayashi 2019 p. 146). Ultimately, some Nanmei employees agreed to stay on a volunteer basis. It was decided that they would help get the water injection started and then take refuge in the earthquake-resistant building (ICANPS Interim 2012, p. 155). Here, dialogue was used to convince the subcontractors to continue to inhabit the space, thereby further increasing the organization's bricolage capabilities.

Discussion

It has been shown in the literature that organizational arrangements make it possible to identify and use resources in ways that diverge from their initial purpose in order to build new solutions. Collective and relational capacities for exchange and dialogue, the management of resources (Feldman 2004), and a low degree of control (Sewell 1998) are all organizational characteristics that make it possible to promote bricolage.

None of these factors take space into account, however. Rapid responses (commands, allocation, and information sharing) in emergencies require responders to adapt their modes of organization, which, in ordinary times, rely in large part on the partitioning of practices and workspaces (Schakel and Wolbers 2019; Gisquet 2020).

However these organizational arrangements for bricolage must be adapted to the specific features of a given space, particularly in crisis situations. How to adapt to and remain in a space that has become hostile? How is it possible to identify (geographically, functionally or experientially) resources that might be available in the space and to repurpose them? How to agree on bricolage activities in the context of an emergency, when it cannot be structured or supported by shared, formally defined strategies?

As Michel Foucault observed, space and power are inseparable in the sense that space constitutes a setting where power is (Foucault 1975; Foucault, Davidson et al. 2008); similarly, bricolage and space are indivisible in that space constitutes the setting for bricolage. If space is defined by (1) movement, (2) distance, and (3) boundaries (Weinfurtner and Seidl 2019) dimensions must be taken into account if one is to effectively promote bricolage activities and to draw lessons from the role that management can play in them.

I. Movement

Although space can be a constraint and a danger, particularly in disaster situations, it can also provide signs and representations that help actors to interpret what is going on around them, to orient collective action, and, in this way, to reconfigure the space itself. Thus, space can serve as an

instrument of social stability and security, though, as well as a tool for adaptability and change (Entrikin and Tepple 2006). Movement is embedded in and through space (Weinfurstein, Seidl, 2019), fostering adaptability. Below, we will explore what makes it possible to initiate movement in ways that support bricolage activities.

Within space

The first condition for expanding capacities for bricolage in emergency situations is fostering the possibility of remaining in a space that has become uncertain and dangerous. In the Fukushima accident, the team inside the MCR found itself in an extremely stressful and dangerous situation over a significant period of time with very little fracturing. This supports Weick's (1993) hypothesis that resilience can be fostered by *"creat[ing] an inverse relation between meaning and structure (less meaning, more structure, and vice versa). [...] When meaning becomes problematic and decreases, this is a signal for people to pay more attention to their formal and informal social ties and to reaffirm and/or reconstruct them."* How was the group successful in doing this? Is this a capability it is possible to reinforce or expand?

Our case study shows that in an unexpected and uncertain situation, creating a rule-based "structure" helps actors to remain in a space, adapting their movements and developing their capacity to navigate within in it. This can be seen in the rules front-line managers defined for moving through the site: people were only to move in pairs, and a rescue team would be sent out for anyone who did not return within an hour.

These simple rules allowed operators to gain some measure of control over the space – or at least to stay put in extraordinary hostile surroundings. In a site scattered with debris and flooded by the tsunami, echoing with alarms warning them of seismic aftershocks, where radioactivity levels were rising by the minute, only rules and social organization kept panic at bay, allowing workers to remain where they were and figure out different possible courses of action.

Through space

With the accident and the loss of electricity, a shift occurred from the normalized world of nuclear power to a world that had to allow for more movement in order to encourage bricolage. As we mentioned above, capacities for bricolage are fostered by organizational contexts in which actors are not subject to excessively strict control (Crozier, Perrow, 1996; Sewell, 1998). Taking movement within the space into account is necessary to develop this organizational dimension.

While the texture of any space is necessarily complex (Tsoukas 2017), it may be posited that this complexity exists on a spectrum. Inspired by Deleuze's formulation, we may consider mechanical texture to be at one end of the spectrum and 'gaseous' texture on the other (Deleuze 1995). The more mechanical a space's texture, the more organizational boundaries and crisis management rules and frames of reference will be respected. The more vaporous it is, the more entanglement, interaction, and adaptation it will allow among actors, and the more sidestepping of official crisis management protocol. While spaces with mechanical textures feature precise concepts that separate the world into well-defined categories, spaces with vaporous textures tend to be characterized by approximation.

In a space with a vaporous texture, it becomes possible to trace a path that is not composed of clearly defined points with specific, identified objectives; here, instead, the path is one of dotted lines, leaving room for understanding, interpretation, and activities that can be adapted to be relevant to the situation at hand (De Certeau, 1984).

Narrative in these kinds of spaces becomes a provisional and collective tool used to manipulate their texture (De Certeau, 1984, p.40). The use of vaguer and more "gaseous" notions, to employ Deleuze's parallel with physical states, modifies a space's texture in ways that make it easier to manipulate (Deleuze, 1995). As mentioned earlier, the vagueness of Yoshida's instructions authorized the use of bricolage, both implicitly and explicitly; he ordered operators to "do whatever could be done [...] to find [a direct current]" (Guarnieri et al., 2015) p.115).

Managerial language makes this kind of approximation possible, which in turn opens spaces and circumstances up to bricolage: it is managers who, by setting non-specific goals, introduce the kind of "gaseous" texture into a space that may be needed to get things to "work" in the best possible way given the circumstances.

Space becomes the vector of flexibility and improvisation needed to withstand the threats it contains (Eisenhardt and Tabrizi 1995). As a result, objects (here, successively, a fire pump and a fire truck) emerge in this now vague and gaseous space, which, previously had not been seen as a resource for bricolage.

II. Distance

The Lévi-Straussian view of bricolage tells us that it takes place with whatever is at hand and relies on the signs (Levi-Strauss 1966) that the environment offers. However, following the earthquake, in accordance with emergency procedures, Masao Yoshida, the site manager, was confined to an earthquake-proof building, along with all the crisis team members. Their distance from the site

meant that they received only fragmented and delayed information from the local crisis unit. The fragmentation was exacerbated by the loss of power to the instruments in the control rooms, and the difficulty of obtaining any information at all about what was happening onsite. The delay was caused by the time needed to transmit information to and from the local crisis unit. For Masao Yoshida and the rest of their team, most resources that might help them make sense of the situation were inaccessible.

Operators are able to engage in bricolage using what they had on hand at the present time. Its perimeter was limited to a small area around the MCR, with which they happened to be very familiar, and they physically mobilized the resources present there, moving car batteries themselves.

For those at the management level without physical or sensory access to bricolage spaces, to what extent can resources be created in and through space? It appears that those at the management level were practicing bricolage from a distance, drawing on their stock of symbolic knowledge. This type of bricolage is carried out using recycled materials that are not material, but rather of a "symbolic" nature (more precisely, they imagined or recollected relationships with material experiential objects), specific to the mythical thinking (Levi-Strauss 1966).

The material repertoire is replaced by an imaginary one, fed by the memory of past experiences. In this way, for example, Yoshida recalled the problems that occurred at the Kashiwazaki-Kariwa nuclear power plant following the Chuetsu-oki earthquake, which had led to the purchase of fire trucks and the installation of emergency water tanks on the site in case of fire. Of course, when it comes to bricolage, drawing on one's past experience is not solely in the manager's purview. Every individual, including Lévi-Strauss' engineer, searches through their own repository of knowledge. However, managerial experience, by its very nature, means that a wider, more varied set of elements are at a manager's disposal than a "field operator's."

Resources for fostering and engaging in bricolage are distributed not only along a hierarchical divide between those who supervise and those who do (Moingeon, Ramanantsoa et al. 1998; da Cunha, e Cunha et al. 2000); they also include access, even from distance or mentally.

III. Boundaries

The most prevalent definition of bricolage is simply "using whatever resources are at hand," where "at hand" describes the pre-established space (both physical and mental) in which the bricoleur will locate the resources that will allow them to conduct the bricolage. However, adaptability emerges

when boundaries move (Goldstein, Hazy et al. 2010; Reiman, Rollenhagen et al. 2015; Gisquet 2020). Our analysis shows that the role of management in bricolage is to enlarge the area “at hand,” both symbolically and literally, and in so doing to add to the material and symbolic resources available for bricolage.

In the case of Fukushima Daiichi, the material resources on site were enhanced by material sent by TEPCO to the site, in a way that falls somewhere between what the bricoleur and the engineer would do. Whereas the latter would identify precise needs and try to obtain resources “procured for the purpose of the project” (Lévi-Strauss, 1966, p.17), the former would make do with the means at hand by trying to assemble them as best they could, or even divert some of them to “make it work.” Masao Yoshida knew, for example, that he would need something specific – to deliver power onsite – without knowing exactly how the generator trucks he wished to obtain would be used.

The role of managerial power in bolstering the capacity for bricolage is evident here. Ordinarily, an organization requires that uses for a new resource be identified and justified in advance before accepting the resource as legitimate. In this, it aligns its management practices and technical rationality in the same way as Lévi-Strauss’ engineer, who subordinates each task to “the availability of raw materials and tools conceived and procured for the purpose of the project” (Levi-Strauss, 1966 , p.17). In Yoshida’s case, his authority allowed him to request power supply vehicles from TEPCO headquarters without having to provide the kind of detailed rational elements higher authorities usually require to grant such a request. His decision to ask for resources without knowing exactly how they would be used not only reveals a logic of bricolage in his own reasoning, but also gives greater freedom to teams on the ground, whose repertoire of available responses increased when vehicles, which, “*after a wait which seemed endless, arrived here and there*” (Guarnieri et al., 2015 p.115).

In fine, the managerial level possesses the ability to expand the resources at hand through a process of negotiation and dialogue. Other such resources included the staff from Nanmei, which was TEPCO’s subcontractor for the maintenance and use of the site’s fire engines. Nanmei, however, refused to send its staff back to the plant and expose them to radiation levels surpassing those specified in their work contracts, a decision aligned with the Lévi-Straussian engineer sticking to the predefined specifications of a project. It was a member of the management team, namely, the deputy manager of the local electricity production team, who called one of his subcontractor friends in a move that can be considered as network bricolage (Baker, Miner et al. 2003) to alert them of the

need to use the pumps (Kobayashi, 2019 p. 146). Subsequently, someone at the managerial level with previous connections with the subcontractor who managed to convince a few Nanmei employees to come and help, thereby further expanding options for bricolage.

The ability to persuade is a central activity within the bricolage process, to which Duymedjian & Rüling (Duymedjian and Rüling, 2010) refer as *dialogue*. Lévi-Strauss highlights the moment when the bricoleur “[engages] in a sort of dialogue [...] before choosing [...], to index the possible answers which the whole set can offer to his problem.” (Lévi-Strauss, 1966, p.18). *Engaging in dialogue* with an object is not the same as dialogue with an idea, or dialogue with people. It means creating a narrative (De Certeau, 1984) that in turn produces a link between the space where an event is taking place and what is external to that space (the uninvolved). Such narratives appear even more persuasive if their tellers hold a significant hierarchical role. A manager’s ability to create a narrative of an ongoing event means they can engage in persuasion with uncooperative human resources. Di Domenico et al. (Di Domenico, Haugh et al. 2010) have also highlighted the importance of powers of persuasion for social entrepreneurs, who use bricolage to build their business projects by successfully convincing certain stakeholders to go along with them on experiments which flirt with the limits of what is permitted by current institutional regulations.

Managerial responses in the case of Fukushima show us that the hierarchical position of an authority involved in collective bricolage may enable a team to call on certain skills of dialogue and/or persuasion to which field operators do not have access. At the end, pushing back the boundaries makes it possible to expand the repertoire of and capacity for bricolage within a given space.

IV. Using hierarchical power to expand resources

Although the work of Michel de Certeau in defining spaces has been germane to this study (De Certeau, 1984), it should be noted that he defines bricolage as a tactic of the “weak” who seek, in a time and space over which they have no control, to obtain maximum effects with minimum force. Such people are reduced to combining heterogeneous elements present here and there without achieving any intellectual synthesis in terms of objectives and strategies (De Certeau, 1984). This implies, by extension, that the “strong” would not need to rely on bricolage, in that they have access to clear and formal intellectual reasoning that it is possible to expose to others.

This categorization of bricolage activities does not seem relevant in our case study, however: everyone involved in the emergency operations at Fukushima occupied a “weak” position in the sense that the plant was literally crumbling around them. At the same time, however, everyone, by

De Certeau's definition, also occupied a "strong" position: even diverting material resources to be used in new ways – as with the use of car batteries to power the main control room – required intellectual synthesis.

Finally, and contrary to what De Certeau argues, bricolage is not exclusively an activity of the weak in the sense that power, as we have seen, bolsters the capacity to engage in it. Hierarchical authority makes it possible to call on certain skills for dialogue and persuasion that are not available to operators on the ground, as happened when Nanmei was brought on board to contribute additional resources to the bricolage. In this case, it was members of TEPCO's leadership who entered into a persuasive dialogue with Nanmei staff, during which their authority was central.

Second, hierarchical authority makes it possible to ask for outside help: in the case of Yoshida, as we have seen, it was his authority that allowed him to request generator vehicles from TEPCO headquarters without explanation. His decision to request these resources without knowing exactly how they would be used reveals not only a logic of bricolage, but his willingness to transmit this logic to teams on the ground.

Power plays a role in bricolage because of its central role in helping teams to appropriate and control spaces. In this way, it also expands the capability to engage in bricolage. Bricolage, therefore, cannot be considered to be a phenomenon that occurs only backstage: it can play an explicit role in crisis management strategy. Power is necessary to bolster bricolage effectively, specifically when it comes to defining, manipulating, and expanding the contours of the space in which a crisis unfolds.

Conclusion

This article has made it possible to identify how space might be mobilized to improve bricolage capacities in disaster situations. Taking the dynamic dimensions of a space into account (borders, movement, distance) can help to define and maintain an effective resource process for bricolage activities.

From an interventionist perspective, the lessons on bricolage we can learn from the Fukushima Daiichi accident should not be ignored: many nuclear facilities in France would benefit from mobile resources that could be integrated into existing arrangements in the event of an accident. Our work also shows that the challenge of crisis preparation cannot be met merely by allocating additional

material resources to increase bricolage capacities – resources that take into account the symbolic, hierarchical, and relational dimensions of the spaces that constitute nuclear facilities must be defined.

Bricolage as resourcing, as we have seen, does not take place in a vacuum. It is always situated, relationally and spatially. Operators and managers do not necessarily work in opposition to each other in shared spaces; moreover, the fact that they use spaces differently and develop different practices within them can function as a resource in its own right and should be anticipated in disaster preparations. Hierarchy cannot be seen as a partition alone: close attention should be paid to how and to what degree actors engaged in the space of the nuclear plant on a daily basis are able to improvise together. This includes accounting for the differences between workers and subcontractors, particularly in the way they inhabit a place. Human resource policies, in other words, can affect the ways in which people appropriate spaces in everyday work, and all the more in crisis situations. Interactions, practices, perceptions, experiences, rules, and recruitment methods all make a difference to the way actors inhabit, perceive, and interact with spaces, meaning that human resource policy is a crucial tool for building actors' capabilities to engage in bricolage when major crises occur.

Beyond human resource policies in individual plants, governmental policies and regulations for the nuclear power industry should also revise their expectations of crisis preparedness and management. Rather than placing participants in unexpected and uncertain environments, safety exercises conducted in the field of civil nuclear production in France and elsewhere tend to offer an orderly representation of crisis situations (Gisquet and Borraz 2020). Although an extensive exploration of this issue is beyond the scope of this article, it should be noted that this (mis)representation of disaster scenarios is itself a result of multiple constraints and framings weighing on the writing process; these in turn are the results of tacit agreements and power relations among the different organizations present in the civilian nuclear sector (nuclear operators, regulators, experts) and civil security forces. Policy that encourages the same kind of flexibility and imagination necessary for fostering bricolage in crisis situations would no doubt go further to foster the kind of creative writing needed for writing effective preparedness exercises.

In order to improve preparedness, governmental policies and regulations in the nuclear power industry might include exercises that help actors learn how to create and manipulate spaces they are able to inhabit and in which they are able to perform bricolage in a crisis situation. These exercises might include creating rules for movement in the field, mental and physical navigation through different spatial configurations, and learning to define degrees of stability to be sought. Such an

approach would require changing or removing performance expectations in certain circumstances as well as avoiding pushback from outside the space, both of which are mechanisms that may be used to appropriate and to modify spaces during practices of bricolage, particularly during emergencies. An approach that acknowledges the importance of bricolage during crises, including bricolage involving the space that is in crisis, and fosters practices conducive to bricolage, seems vital to providing a more effective framework for analyzing crises, improving their management, and identifying ways enhance resilience and resourcefulness in crisis situations.

[1] The IC circuit functions by venting the steam that accumulates at the top of the pressure vessel as the fuel heats, circulating into a cooling pool via a duct. There, it condenses back into water and falls into the pool by force of gravity. The residual heat turns the water into steam again, which rises once more to the top of the pressure vessel, and the circuit continues.

Références

- Agamben, G. (2005). State of exception.
- Ahn, J., C. Carson, et al. (2015). Reflections on the Fukushima Daiichi nuclear accident, Springer-Verlag GmbH.
- Ahn, J., F. Guarnieri, et al. (2017). Resilience: A New Paradigm of Nuclear Safety: From Accident Mitigation to Resilient Society Facing Extreme Situations, Springer.
- Andersen, O. J. (2008). "A bottom-up perspective on innovations: Mobilizing knowledge and social capital through innovative processes of bricolage." Administration & Society **40**(1): 54-78.
- Anderson, A. R. and A. McAuley (1999). "Marketing landscapes: the social context." Qualitative Market Research: An International Journal.
- Ansell, C. and A. Boin (2019). "Taming deep uncertainty: The potential of pragmatist principles for understanding and improving strategic crisis management." Administration & Society **51**(7): 1079-1112.
- Antonsen, S., K. Skarholt, et al. (2012). "The role of standardization in safety management – A case study of a major oil & gas company." Safety Science **50**(10): 2001-2009.
- Asahi-Shimbun (2020). "The Yoshida Testimony." http://www.asahi.com/special/yoshida_report/en/.
- Baker, T., A. S. Miner, et al. (2003). "Improvising firms: Bricolage, account giving and improvisational competencies in the founding process." Research policy **32**(2): 255-276.

- Baker, T. and R. E. Nelson (2005). "Creating something from nothing: Resource construction through entrepreneurial bricolage." Administrative science quarterly **50**(3): 329-366.
- Bechky, B. A. and G. A. Okhuysen (2011). "Expecting the unexpected? How SWAT officers and film crews handle surprises." Academy of Management Journal **54**(2): 239-261.
- Becky, B. and G. Okhuysen (2011). "Expecting the unexpected? How SWAT officers and film crews handles surprises." Academy of Management Journal **54**: 233-261.
- Casareale, C., F. Marincioni, et al. (2021). "Smoothing the corners of hierarchy: Integrating shared leadership to mitigate maritime disasters." International Journal of Disaster Risk Reduction **64**: 102471.
- Casey, E. S. (1993). Getting back into place: Toward a renewed understanding of the place-world, Indiana University Press.
- Chia, R. and R. Holt (2006). "Strategy as practical coping: A Heideggerian perspective." Organization Studies **27**(5): 635-655.
- Clegg, S. and M. Kornberger (2006). Space, organizations and management theory, Liber Oslo.
- Clegg, S. R., J. V. da Cunha, et al. (2002). "Management paradoxes: A relational view." Human Relations **55**(5): 483-503.
- Croweller, M. and P. Tschakert (2021). "Disaster management and the need for a reinstated social contract of shared responsibility." International Journal of Disaster Risk Reduction **63**: 102440.
- Crozier, M. and E. Friedberg (1977). L'acteur et le système, Seuil.
- da Cunha, J. V., M. P. e Cunha, et al. (2000). Improvisation and learning: soulmates or just friends? in Vartiainen, M., Avallone, F. and Anderson, N. (Eds), Innovative Theories, Tools, and Practices in Work and Organizational Psychology, Hogrefe & Huber, Goettingen.
- Dahl, M. S. and O. Sorenson (2009). "The embedded entrepreneur." European management review **6**(3): 172-181.
- De Certeau, M. (1984). The Practice of Everyday Life. translated by Steven Rendall, Berkeley:University of California Press (Original French Edition 1980).
- De Vaujany, F.-X. and E. Vaast (2014). "If these walls could talk: The mutual construction of organizational space and legitimacy." Organization science **25**(3): 713-731.
- Deleuze, G. (1995). Negotiations, 1972-1990, Columbia University Press.
- Di Domenico, M., H. Haugh, et al. (2010). "Social bricolage: Theorizing social value creation in social enterprises." Entrepreneurship theory and practice **34**(4): 681-703.
- Dobers, P. and L. Strannegård (2004). "The cocoon—a traveling space." Organization **11**(6): 825-848.
- Duymedjian, R. and C.-C. Rüling (2010). "Towards a foundation of bricolage in organization and management theory." Organization Studies **31**(2): 133-151.
- Eisenhardt, K. M. and B. N. Tabrizi (1995). "Accelerating adaptive processes: Product innovation in the global computer industry." Administrative science quarterly: 84-110.
- Feldman, M. S. (2004). "Resources in emerging structures and processes of change." Organization science **15**(3): 295-309.
- Feldman, M. S. and W. J. Orlikowski (2011). "Theorizing practice and practicing theory." Organization science **22**(5): 1240-1253.
- Foucault, M. (1975). Surveiller et punir. Paris, Gallimard.
- Foucault, M., A. I. Davidson, et al. (2008). The birth of biopolitics: lectures at the Collège de France, 1978-1979, Springer.
- Funabashi, H. (2012). "Why the Fukushima nuclear disaster is a man-made calamity." International Journal of Japanese Sociology **21**(1): 65-75.
- Gisquet, E. (2020). "Impossibility of Narrative Bridges across Boundaries: Case Study of Fukushima-Daiichi Accident." Natural Hazards Review **21**(4): 05020010.
- Gisquet, E. (2021). "Tragic Choices at Fukushima Daiichi Nuclear Power Plant." Natural Hazards Review **22**(3): 05021008.

- Gisquet, E. and O. Borraz (2020). "Simuler une crise : La construction de la réalité dans les exercices d'accident nucléaire." Sociologie **11(4)**: 385-398.
- Goldstein, J., J. Hazy, et al. (2010). Complexity and the nexus of leadership: Leveraging nonlinear science to create ecologies of innovation, Springer.
- Guarnieri, F. and S. Travadel (2018). Un récit de Fukushima. Le directeur parle, Presses Universitaires de France.
- Guarnieri, F., S. Travadel, et al. (2015). L'accident de Fukushima Dai Ichi-Le récit du directeur de la centrale. Volume 1: L'anéantissement, Presses des Mines.
- Halme, M., S. Lindeman, et al. (2012). "Innovation for inclusive business: Intrapreneurial bricolage in multinational corporations." Journal of Management Studies **49(4)**: 743-784.
- Harvey, S. (2014). "Creative synthesis: Exploring the process of extraordinary group creativity." Academy of management review **39(3)**: 324-343.
- Hebdige, D. (2012). Subculture: The meaning of style, Routledge.
- Heidegger, M. (1958). "Bâtir habiter penser." Essais et conférences: 170-193.
- Hernes, T. (2004). The spatial construction of organization, John Benjamins Publishing.
- ICANPS Final (2012). Final Reports, Investigation Committee on the Accident at the Fukushima Nuclear Power Stations.
- ICANPS Interim (2012). Interim Reports, Investigation Committee on the Accident at the Fukushima Nuclear Power Stations.
- Johannisson, B. and A. Nilsson (1989). "Community entrepreneurs: networking for local development." Entrepreneurship & regional development **1(1)**: 3-19.
- Kadota, R. (2014). On the Brink: The Inside Story of Fukushima Daiichi, Kurodahan Press.
- Kobayashi, Y. (2019). Etude de la relation entre les leaders politiques et techniques dans la gestion de l'accident de Fukushima Daiichi entre le 11 et le 15 mars 2011. Phd, Mines ParisTech.
- Kornberger, M. and S. R. Clegg (2004). "Bringing space back in: Organizing the generative building." Organization Studies **25(7)**: 1095-1114.
- Korsgaard, S., S. Müller, et al. (2021). "It's right nearby: how entrepreneurs use spatial bricolage to overcome resource constraints." Entrepreneurship & regional development **33(1-2)**: 147-173.
- Langley, A. (1999). "Strategies for theorizing from process data." Academy of management review **24(4)**: 691-710.
- LaPorte, T. R. and P. M. Consolini (1991). "Working in practice but not in theory: theoretical challenges of" high-reliability organizations"." Journal of Public Administration Research and Theory: J-PART: 19-48.
- Lave, J. (1988). Cognition in practice: Mind, mathematics and culture in everyday life, Cambridge University Press.
- Lawrence, T. B. and G. Dover (2015). "Place and institutional work: Creating housing for the hard-to-house." Administrative science quarterly **60(3)**: 371-410.
- Levi-Strauss, C. (1966). The savage mind, University of Chicago Press.
- Lipshitz, R. (1995). "The road to desert storm." Organization Studies **16(2)**: 243-264.
- Lochbaum, D., E. Lyman, et al. (2014). Fukushima: The story of a nuclear disaster. New York, The New Press.
- McKeever, E., S. Jack, et al. (2015). "Embedded entrepreneurship in the creative re-construction of place." Journal of Business Venturing **30(1)**: 50-65.
- Moingeon, B., B. Ramanantsoa, et al. (1998). "Another look at strategy-Structure relationships:: The resource-Based view." European Management Journal **16(3)**: 297-305.
- Moorman, C. and A. S. Miner (1998). "Organizational improvisation and organizational memory." Academy of management review **23(4)**: 698-723.
- Mutch, C. (2015). "Leadership in times of crisis: Dispositional, relational and contextual factors influencing school principals' actions." International Journal of Disaster Risk Reduction **14**: 186-194.

- Nakamura, A. and M. Kikuchi (2011). "What we know, and what we have not yet learned: Triple disasters and the Fukushima nuclear fiasco in Japan." Public Administration Review **71**(6): 893-899.
- Nohria, N. and J. D. Berkley (1994). "An action perspective: The crux of the new management." California Management Review **36**(4): 70-92.
- Pina e Cunha, M. (2005). "Bricolage in organizations."
- Reiman, T., C. Rollenhagen, et al. (2015). "Principles of adaptive management in complex safety-critical organizations." Safety Science **71**: 80-92.
- Rerup, C. (2001). "Houston, we have a problem": Anticipation and improvisation as sources of organizational resilience, Snider Entrepreneurial Center, Wharton School.
- Rezaei Soufi, H., A. Esfahanipour, et al. (2021). "Risk reduction through enhancing risk management by resilience." International Journal of Disaster Risk Reduction **64**: 102497.
- Schakel, J. K. and J. Wolbers (2019). "To the edge and beyond: How fast-response organizations adapt in rapidly changing crisis situations." Human Relations: 0018726719893450.
- Sewell, G. (1998). "The discipline of teams: The control of team-based industrial work through electronic and peer surveillance." Administrative science quarterly: 397-428.
- Sewell, G. (1998). "The Discipline of Teams: The Control of Team-Based Industrial Work through Electronic and Peer Surveillance." Administrative Science Quarterly **43**, no. 2: 397-428.
- The National Diet of Japan (2012). The National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC) Tokyo Japan.
- Thévenot, L. (1984). "Rules and implements: investment in forms." Information (International Social Science Council) **23**(1): 1-45.
- Travadel, S., F. Guarnieri, et al. (2018). "Industrial Safety and Utopia: Insights from the Fukushima Daiichi Accident." Risk analysis **38**(1): 56-70.
- Tsoukas, H. (2017). "Don't simplify, complexify: From disjunctive to conjunctive theorizing in organization and management studies." Journal of Management Studies **54**(2): 132-153.
- Villemain, A. and P. Godon (2017). "Toward a resilient organization: The management of unexpected hazard on the polar traverse." Safety Science **95**: 210-218.
- Villemain, A. and Y. Lémonie (2021). "Collective activation of enacted resilience in managing unthought-of situations: An examination of the reconstruction of a critical situation on the polar traverse." Journal of Contingencies and Crisis Management.
- Weick, K. E. (1993). "The collapse of sensemaking in organizations: The Mann Gulch disaster." Administrative science quarterly: 628-652.
- Weick, K. E. and R. E. Quinn (1999). "Organizational change and development." Annual review of psychology **50**(1): 361-386.
- Weick, K. E. and K. M. Sutcliffe (2011). Managing the unexpected: Resilient performance in an age of uncertainty, John Wiley & Sons.
- Weinfurter, T. and D. Seidl (2019). "Towards a spatial perspective: An integrative review of research on organisational space." Scandinavian Journal of Management **35**(2): 101009.
- Wombacher, K., E. Herovic, et al. (2018). "The complexities of place in crisis renewal discourse: A case study of the Sandy Hook Elementary School shooting." Journal of Contingencies and Crisis Management **26**(1): 164-172.
- Yin, R. K. (2009). Case study research: Design and methods, sage.