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## **Management of transboundary risks in a low-volume industry: the role of boundary objects and boundary spanners**

**Valérie Fiegenwald<sup>(1)</sup>, Celine Cholez<sup>(2)</sup>, Thomas Reverdy<sup>(2)</sup>**

<sup>(1)</sup>Grenoble-INP, Laboratoire G-SCOP

46 avenue Felix Viallet

38031 Grenoble – France

[valerie.fiegenwald@grenoble-inp.fr](mailto:valerie.fiegenwald@grenoble-inp.fr)

<sup>(2)</sup>UMR Pacte

Le Patio- Domaine Universitaire

BP 48

38040 Grenoble cedex 9 – France

[celine.cholez@upmf-grenoble.fr](mailto:celine.cholez@upmf-grenoble.fr)

[thomas.reverdy@upmf-grenoble.fr](mailto:thomas.reverdy@upmf-grenoble.fr)

### ***Introduction***

Today's industrial companies face a paradox: they must be innovative in order to hold onto their markets and at the same time perform from an operational point of view. This requirement sees them embarking on improvement approaches such as Lean management to reduce organizational slacks. The organization becomes leaner in its processes but routines are less and less present in their standard operations, meaning that day-to-day uncertainties increase. This situation exposes them to industrial crises.

This article looks at the management of **industrial crises** in a company making bespoke equipment for the energy sector (low volumes, high customisation) and which has for a year now faced a series of serious quality incidents resulting in production stoppages which

potentially impact the functioning of the equipment. These incidents have generated a feeling of uncertainty internally as to control and the reliability of the production process.

Analysis of these incidents reveals failures in the articulation of the different stages of the process which are segmented into major, relatively partitioned, functional sectors. This article therefore contributes to thinking on transboundary risks, taking into account internal boundaries in an organization.

We can talk about “transboundary risks” because of the diversity of venues where deviations occur which contribute in the end to a failure, the possible propagation of failures throughout the process and finally, the necessary work of re-articulation carried out by those involved to rectify such incidents.

### ***Purpose of the paper***

Recent theories on risks (Schulman 1993; Barton and Sutcliffe 2009; Carroll, Hatakenaka, and Rudolph 2006), and resilience (Tillement, Reverdy, and Cholez 2008; Hollnagel 2008), present flexibility, “DIY” and improvisation (Weick 1993) as conditions which allow organizations to better face up to risks and unforeseen events. In the case of transboundary risks, this improvisation requires the intervention of “astute individuals” who are able to promote the circulation of information, and “fruitful interactions” between organizationally distant actors (Kapucu 2006; Adrot and Garreau 2010). The roles of boundary spanners and boundary objects are discussed here, in the causes behind and rectification of incidents. In the case presented here, coordination breakdowns between departments have for a long time been compensated for by boundary spanners who repair deviations, retrieve information and facilitate the circulation of information, drawings and objects to enable production continuity. They act as an interface between disjointed universes. It is they who detect a large number of errors and incoherencies. In this sense they are a strong pillar of the organization’s resilience. However, the case that we present questions the limits of resilience based only on the flexibility of those actors: we show that when studied in accidental situations in particular, this flexibility can lead, in crisis cases linked to an accumulation of incidents, to the actors involved losing control. A disorganised environment that has too many “cognitive attractors<sup>1</sup>” wears actors down through a series of minor urgent tasks. This phenomenon is described by (Lahlou 2000) about intellectual workers (R&D). In this paper we focus on the

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<sup>1</sup> An attractor is a set of material and immaterial elements which potentially participate in a given activity and which are simultaneously present from the subject's point of view.

cognitive overflows to which boundary spanners are subjected when trying to resolve transboundary unexpected disruptions.

### ***Theoretical background***

Our paper fits into a systemic approach of risks (Perrow 1994), linked to the organizational complexity. According to this framework, the organization is both a source of risks and of reliability; it is an “open system” whose functioning is based on the exchanges between its different components.

#### *1. The division of work creates uncertainties, disruptions and unforeseen events*

The problems of coordination and partitioning between activities are conventional problems addressed by organization theory. Many studies have focused on the sharing of knowledge (Nonaka 1994) and have demonstrated that specialisation linked to the division of labour implies the development of different perspectives on the organization of operational modes (Bechky 2003). Other studies have looked at the power struggles (Crozier and Friedberg 1977, vol. 436) between functional departments. Finally, authors such as (Strauss 1985) have looked at discontinuity problems linked to the division of labour. Activities are segmented, which can create disruption, incoherence and loss of information but also uncertainty as to task-related responsibilities.

#### *2. Disruptions are components of the organizations' daily life, reliability is to cope with them*

Disruptions and their informal arrangements have for a long time been seen as a problem to be eliminated. More recently, new approaches of risks present irregular variations and degradation of expected working conditions as a component of the organizations' daily life. This theoretical change is partly due to the works developed within the framework of the studies about the organizational resilience (Weick 2004; Barton and Sutcliffe 2009; Hollnagel and Woods 2006). It can be seen as a reversal of the classical perspectives about the control of risks because it means that reliability is not the absence of unforeseen events and variations, but the ability for an organization to take in charge “the irregular variations, disruptions and degradation of expected working conditions” (Hollnagel and Woods 2006) and to cope with unanticipated dangers and uncertainties (Douglas and Wildavsky 1983).

This means it is necessary to study the daily work activity and the way the different members of the organization take in charge problems they meet in the course of their normal operations; to identify the mechanism they are able to develop to rebuild some order to avoid

the accident. The comparison between the observation of the “normally disturbed activity” and the analysis of situations of completely unforeseen events, when sensemaking breaks down (Weick and Roberts 1993) is particularly interesting to identify conditions of organizational resilience (Tillement 2011). The question arises as to the way people hold on to foreseen or unforeseen events.

### *3. This approach suggests paying attention to collective learning processes and highlighting the importance of flexibility*

According to (Weick and Sutcliffe 2001), two factors can ensure a relative reliability:

- a collective vigilance defined as the ability for a group to detect and anticipate errors thanks to a relative reluctance to simplification and an operational matter;
- a resilience ability that presupposes a sense of DIY and wisdom in actions and interactions.

Flexibility, ability to interpret weak signals and to immediately correct errors and to learn from these errors are the keys of reliability. In crisis situations, actors have to rapidly adapt and improvise (Weick 1993). Improvisation corresponds to an adaptation process (Vera and Crossan 2005) during which individuals must “make with” available resources (e Cunha, da Cunha, and Kamoche 1999), and combine them in an innovative manner (Rerup 2001) in a quasi simultaneousness of decision and action (Moorman and Miner 1998). Improvisation is often associated with the concept of “DIY”. It is, however, different from “DIY” because of the very short timelines between decision and action. Improvisation can raise several problems: it can create complexity, subject actors to emotionally strong pressures (Chédotel 2005) and not necessarily produce a coherent, collective action. Thus (Adrot and Garreau 2010) look at “how to improvise together in a crisis event” within an organization.

### *4. Crossing boundaries to re-articulate work and build a multi-situated viewpoint*

In the course of normal activity as facing unforeseen events, organization break-downs always need to be reduced. According to Strauss, alignment is always necessary to ensure business continuity and what Strauss calls the work of articulation, which must accommodate the different actors whilst the action is underway. Articulation requires negotiations and arrangements. Actors will align their definitions of the situation, or at least make them compatible around a shared objective. This articulation work can be the responsibility of individuals (boundary spanners) or objects (boundary objects) which allow meaning and

language to be shared, along with the alignment of practices, learning and people's understanding of other actors' roles.

(Star and Griesemer 1989) developed the concept of boundary object to analyse the nature of cooperative work in the absence of a consensus. Boundary objects are the ingredients of action, a mean of "representing, learning about and transforming knowledge to resolve the consequences that exist at a given boundary" (Carlile 2002; Carlile 2004). Adaptability of the object and its relative interpretative flexibility promotes various buy-ins, transformations and adaptations by social groups who are prepared to cooperate in a permanent to-ing and fro-ing between the consensual form and its deviations. They "provide a lingua franca for exchanges" and facilitate cooperation (Star and Griesemer 1989).

The notion of boundary spanning individual was developed by (Tushman and Scanlan 1981) as part of development projects. These individuals are described as an effective resource for collecting and transferring information between organizational boundaries. The phenomenon of boundary-crossing is often informal and confers power and status upon the boundary spanner. The role of the boundary spanner is to (re)construct alignment (Cholez, Tillement, and Reverdy 2009). Its activities of rectification and informal coordination have been identified by crisis specialists as factors of resilience. According to (Adrot and Garreau 2010), in a highly uncertain situation, the boundary spanner contributes to coherence between parties of the organization through generation of fruitful interactions between actors giving them both an action framework and room for manoeuvre.

Boundary spanners and boundary objects could organize the emergence and the achievement of a multi-situated attention that guarantees a better understanding of the complexity of the situations. Opposing to Perrow who associates complexity with increase of the risks, Weick asserts that to reduce risks, the organizations should complicate themselves to encourage redundancies. Multi-disciplinary groups, cross-department teams should be encouraged to get people used to interact and communicate (Brion 2005).

### ***The approach taken***

The field study was carried out within a plant of a global powerhouse in electronics and electrical engineering employing around 500 persons including 200 operators. The plant works to order, manufacturing customised equipment meeting the needs of each customer. This means great variation in terms of design and assembly. Production operations involve manual assembly. There is very little automatic equipment involved in the production process (handcraft industry).

There are two distinct production lines which assemble their own products. Each line has its own quality team which is responsible for the final control and validation of products before shipment. In addition, the plant has a centralised quality team responsible for employees' training and respect of assembly procedures throughout the process for both lines.

Our research is based first of all on operational immersion in the company under study. Through 40 training sessions in Lean Manufacturing and running different workgroups on assembly errors and assembly documents, we noted and analysed data concerning both quality problems and dysfunctions regarding articulations between departments. We went deeper into this data collection through semi-directive interviews on the roles of different actors in the management of quality problems and interactions with other departments in crisis situations. We questioned key actors from the different departments in problem solving and crisis management (Technical, Design Office, industrial, logistics, production and quality) who occupy different levels in the hierarchy.

We also experienced 3 weeks' total immersion on a production line to identify in detail all the barriers to control, redundancies and control breakdowns which can lead to quality errors. The data collected within this framework come from our own observations and interviews with assembly operators and team leaders.

In parallel, we also performed detailed analyses of fifty or so formal quality reports, describing quality incidents which had occurred in 2009 and 2010.

## Main findings

We should first of all note that the equipments manufactured in the studied plant are extremely complex and sensitive what entails numerous constraints for assembly operators. The least speck of dust can, for example, damage the product. An assembly error can have serious implications in terms of safety.

The studied company works in project mode. It develops and produces an entirely customised piece of equipment at the customer's request which requires specific design before manufacture can begin.

This process is described in the following diagram:

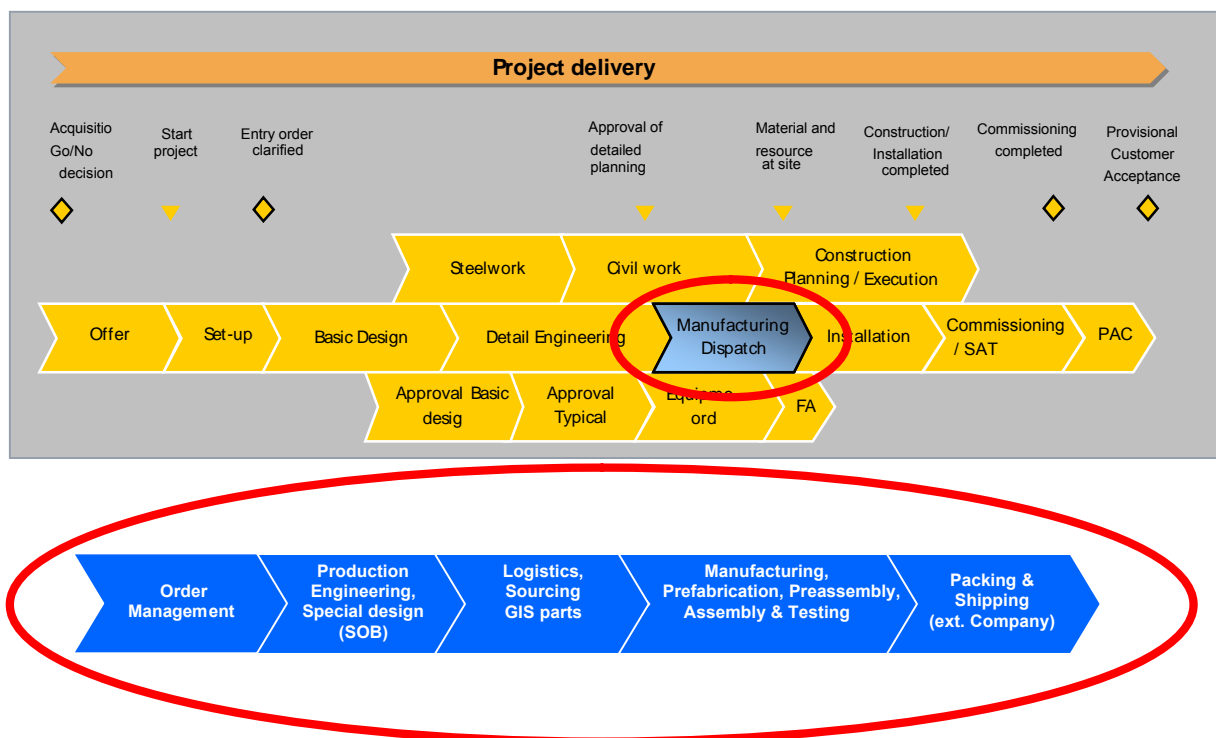


Figure 1: Project delivery process

The different steps in the process correspond to different teams, located at the same production site. A project manager for each order follows the project from the offer to the on site installation and is the official customer interlocutor. He is also in charge of the coordination between the different teams but this coordination is essentially done via documents (offer, customer specifications, minutes of meetings, drawings, etc.). The project manager is thus more focused on external coordination.

The complexity of the product and the high level of customisation for each customer bring new uncertainties for each activity of the process for each project. Actually, customer



requirements induce design specificities for each project. These specificities lead to specific assembly drawings, that means little standard assembly procedures and little routine for the operators. Customer requirements can also concern components' quality, for example use of specific screws which can easily be confused.

## **I- FACTUAL FINDINGS**

### **A- Generation of incidents**

The operational immersion and the analysis of quality reports show that the company is regularly confronted to disruptions that alter the process flow. We can say that the company has a “normally disturbed activity”; disruptions are actually components of its daily life.

We can talk about “transboundary risks” first of all because of the diversity of venues where deviations occur which contribute in the end to a failure. Each process (offer, design, logistics, manufacturing, installation) is a potential non-conformity generator. This phenomenon is amplified by the singularity of customer specificities for each project. For example, errors can occur in the offer and be detected during the specific design phase. Design errors can also occur and be detected during the manufacturing phase.

Secondly, we talk about transboundary risks because of the possible propagation of failures throughout the process. These defects may actually propagate beyond the borders of the stages because they are not systematically detected. There are control checkpoints but they seem to be somewhat porous. Errors are detected when they become blocking for a department. Thus it is during the assembly phase that many errors are identified. Indeed, an analysis of quality reports showed that 70% of problems detected during assembly were generated beforehand, and were therefore detected outside the department they stemmed from. Of the remaining 30%, cause analysis shows that half may be due to incomplete or unclear information, in particular in assembly documents.

Finally, the term transboundary refers to the necessary work of re-articulation carried out by those involved to rectify such incidents.

## **B- Their management throughout the process: late detection and rectification**

Like in every organization rectifications occur and avoid accident and crisis. When analyzing the management of failures and disruptions we observe two steps in the solving process: local and transboundary.

The local solving is undertaken by the operator/team leader pairing. This occurs upstream from the standard process for dealing with non-conformities and is an exercise to qualify the problem to determine whether it can be rectified or not, i.e. whether they are going to be able to manage it on their own.

The second step in the solving process is a transboundary management of the incident. The team leader will then manage the problem by contacting other actors, but not necessarily the Quality team, although a fault detected by an assembly operator is supposed to be passed on to Quality via the team leader.

The team leader has different action possibilities which result in different types of interventions. Table 1 shows the action range of the team leader who will for example do informal searches for missing information especially concerning misunderstanding or unclearness of documents. In this case he will address directly to the technical support, design teams or industrial teams. Another intervention is the pressure on upstream departments to rectify the failure. For example in case of missing parts, he will urge the prefabrication line to solve the problem as quickly as possible.

Actually, the team leader will attempt to reduce the number of incidents which have to be reported to the Quality department.

<b>Intervention types</b>	<b>Examples</b>
Search for missing information in other departments (design team, technical service, etc)	Drawings misunderstanding
Information interpretation	Information translation for the team, informal drawing or nomenclature correction
Pressure on upstream departments	Pressure on the prefabrication line in case of missing parts
Replacement from an actor	Parts self-service in case of unavailability of the delivery person
Request to an upstream department	Anticipation request to the upstream assembly team

*Table 1 : Intervention of the Team Leader*

Team leaders act by their permanent involvement as fire-fighters at the heart of the de re-articulation work which is necessary to the process. Why, then, do these actors not pass on all the information? First of all, the team leader does not have a global overview of the project and may sometimes underestimate the potential impacts of the problem on the organization, as well as the consequences of his isolated corrective action. Then, he may hesitate to report a problem because he fears delays to processing or even a production stoppage.

### **C- Incidents that are not rectified**

In spite of all the filters put in place by the organization and the permanent involvement of team leaders, certain problems are not rectified.

Consequences for the company can be serious with regards to costs, lead times and corporate image. An incident that has not been rectified can correspond to an incident that stops production, an incident detected during on site installation or material in use, or to a personal accident.

#### *1. These incidents are not much different from those that are rectified*

Of course some non-conformities could not have been rectified, because they are undetectable before on site installation. A conception error in the global station architecture for example will be blocking only for on site assembly. But when we look at them, we realise that most are not different from those that are rectified (constituent defects, documentary defects, assembly errors, unavailable or unsuitable tools), the only difference being that they have not been detected. Indeed, we observe that detection of non-conformities is often a “chance” discovery, i.e. outside the framework of formalised controls. The company is therefore relying on the vigilance of actors.

#### *2. These incidents can be due to rectifications*

Furthermore, informal corrections are local and occasional adjustments which do not guarantee fundamental resolution of the problem and may even lead to undesirable consequences or deviations in practices because of the application of a new method with local but not transversally effective solutions. This can occur for example when a team leader requests an isolated technical derogation on a constituent or method. The technical services involved may accept the derogation for the particular case. Generalizing this principle may not be suited for other cases and applying it could lead to a series of other incidents.

### *3. Incidents can lead to a disaster when propagating to the customer*

A crisis will emerge through an accumulation of these incidents which propagate along the process: the long period between the generation of a defect and its detection may mean that several products have been assembled and therefore potentially impacted. The response of the company is then to send experts on site to repair the defective material, analyze the root causes and the origin of the failure to identify potential risks on materials assembled in the meantime between generation and detection, in order to finally verify this material.

#### **D- Faced with a crisis, mobilisation of Manufacturing Quality Assurance**

In an attempt to resolve the crisis the company is experiencing, the Manufacturing Quality Assurance department was asked to construct collective and transversal mechanisms for incident analysis. It coordinates the implementation of corrective and preventative actions by creating areas of exchange between actors from different departments who work directly on the shopfloor, around a board.

The department also developed transversal working groups to make people from different department exchange around major transboundary issues. Another exchange area is the technical trainings for operators and especially for non-operators who can here experience the assembly constraints and stakes. The department also conducts Quality and Lean trainings for all employees. These massive training campaigns were privileged exchange moments between people with different backgrounds and helped aligning them around common objectives. All these multi-disciplinary methods and tools are set up by the Quality department in order to rebuild the multi-situated view necessary to understand complex situations and to achieve organizational reliability.

## **II- ANALYSIS**

#### **A- Boundary objects are not reliable and do not frame the actions of actors**

We saw above that documents should ensure work continuity and articulation. However they often do not and can even be a trap. Actually the multiplicity of documents which emanate from different sources and whose update procedures are complex and less reliable often trigger errors. Assembly documents actually lack harmonisation and coherence.

They could be boundary objects. They are issued by different departments for the use of the production department and are distributed via several channels. Examples of boundary objects are given in table 2.

<b>Boundary objects</b>	<b>Update issuing department</b>	<b>Update channel</b>	<b>Shopfloor update</b>
Technical drawings	Technical support	Line 1 : email to the line supervisors, industrials, document preparation assistant Line 2 : document management software	Line 1: Document preparation assistant Line 2: Line supervisors
Primary engineering drawings	Primary engineering	Project folder + email	Line 1: Document preparation assistant Line 2 : Line supervisors + Document preparation assistant
Part lists	Technical support +Primary engineering	ERP + email	Line 1: Document preparation assistant Line 2: Line supervisors
Working procedures	Industrial support	Oral information to the operators (unsystematic)	Industrial support
Control procedures	Product Quality Assurance	email from the Product AQ to the System AQ, and from the System AQ to the line supervisors	Line 1: Document preparation assistant Line 2: Line supervisors
Following sheets	Product Quality Assurance	email from the Product AQ to the System AQ, and from the System AQ to the line supervisors	Line 1: Document preparation assistant Line 2: Line supervisors
Standard preparation manual	Product Quality Assurance	email from the Product AQ to the System AQ, and from the System AQ to the line supervisors	Line 1: Document preparation assistant Line 2: Line supervisors
Picking lists (assembly kits)	Production, Logistics	Not followed	Not followed

*Table 2: Boundary objects*

However, they do not facilitate the transfer of information between departments. Indeed, the large number of assembly documents and their different origins create problems of coherence for final users. The documents are issued at different points in time during the product life cycle, also from different departments, what compromises overall coherence. Furthermore, document updating is not handled effectively by the organization because of the diversity of modification channels. Attempts at simplifying assembly documents have for the moment proved unproductive. The Quality department actually tried to conduct working groups on documents harmonization and simplification. Each department is convinced of the usefulness of the documents it issues and is not prepared to discuss the issue. The tendency actually seems to be the creation of even more documents (kit list, safety data sheet, etc.).

### **B – The boundary spanner is overflowed in work which makes him less vigilant**

In our case study, the team leader plays the role of boundary spanner. It is he who literally crosses interfaces to manage day-to-day problems in production. His role is that of a fire-fighter who is in fact always reacting to emergency situations. He is extremely flexible and adaptable: he is a “DIY” specialist. The responsibility scope of the team leader is wide-ranging. He supervises an average team of twenty operators. This is four times more than recommended by Lean theories. Three team leaders cover the whole assembly of one product.

He is permanently solicited from all sides and is therefore completely overrun with work, which of course reduces his vigilance and increases his fatigue and stress. He also has pressures in terms of deadlines because it is he who manages the production schedule of his workshop and is the guarantor of deadlines being respected. Thus, as described by (e Cunha, da Cunha, and Kamoche 1999), the management of unforeseen situations with severe time constraints can be a strong source of anxiety for those involved. The flexibility of those actors can lead to their becoming submerged. This situation also results in a general feeling of fatigue. However, it is in their day-to-day management of unforeseen circumstances and improvisation that they find their legitimacy. They have a certain power coming from their “undercover” problem solving capacities. But they are also acting alone because they lack legitimacy when facing the different support services. Indeed, their requests are often qualified by these latter as comfort modifications and refused.

### **C- The boundary spanner does not necessarily have the capacities to detect all deviations**

He can only imagine failure scenarios according to past experience, which by definition is limited. His capacity to represent failure scenarios and maintain his vigilance is limited. His capacities of anticipation are also limited.

The team leader acts mainly in emergency situation, coping with the daily failures of its workshop. Solving urgent problems does however remain primarily superficial because the team leader has neither the time to analyse the problems to find the deep root causes, nor the necessary legitimacy to put in place long term solutions to transboundary problems at an organizational level. As described by (PINA and CUNHA 2003) he can fall in an “opportunity trap” meaning that he does not manage to reuse knowledge acquired during the exploratory process of organizational improvisation. Analysis and implementation of long term actions is not his job, but that of Quality and Manufacturing Quality Assurance team leaders. The boundary spanners do not have the legitimacy or the negotiating capacity to make their voices heard in terms of their perception of risks, and in particular when it comes to asking another department to reduce discrepancies relating to “risk-free” operations. The qualifier “comfort modification” by the designer of the modification requests from the production shows this different perception of risks and responsibilities, and the associated negotiated relationship.

However, the isolated management of dysfunctions stops information on those problems getting back to the appropriate departments. As a result, the dysfunction is very likely to recur. Thus, the team leader, who is an essential part of the organizational resilience can also limit organizational learning.

### **D- How to re-establish order and coherence in crisis management – use of third parties to ensure more stabilised coordination**

Flexibility is an essential component of crisis management. However, as above-mentioned, flexibility can also be counterproductive and does not allow sustainable problem solving. That means that a minimal formalisation, as well as coherent and centralized articulation work are necessary.

Manufacturing Quality Assurance is well placed to play a role in the articulation work. The department has the posture of an outside party with a global and objective view of the situation, as well as the required legitimacy to coordinate action. It organises confrontations of points of view, creates negotiation and arrangement platforms between actors through

crisis meetings or workgroups and tables long-term solutions through the creation of transboundary objects such as the unforeseen situation management board. The success of these methods is due to the transversal approach coordinated and animated by a neutral actor, the Quality department. Through its third party position, the department has the legitimacy to bring all actors together in order to find solutions. Moreover it coordinates actions and follows their executions. Doing this, the department has really become a boundary spanner.

### ***Discussion***

Flexibility and “DIY” are presented in recent theories on risks as essential components of resilience. The case we have presented in this paper shows that the cleverness of the team leader, his ability to cross the boundaries to find information and to negotiate arrangements allow to solve many problems in the short term. Most of the daily degradations of the productive activity are corrected; the team leaders and their teams achieve the recovery of a relative order in the process and avoid most of the products’ accident that could occur. The team leaders gains power and a relative legitimacy for this and are considered as fire-fighters vital for the productive process.

But, this case also shows that an excess of flexibility can be counter-productive and mean that problem solving cannot be made long term. We discuss here the limits of this type of resilience in the case of crises resulting from a succession of incidents which occur over a long period of time. It would therefore appear that a minimum of formalisation is required, as well as coherent and unified articulation, which is recognised by all. Even though the definition of strict standards may not seem suitable, an action framework and legitimate coordination seem to be necessary to find long-term solutions to crises. As described by (Adrot and Garreau 2010), individual improvisation is not desirable in the management of transboundary crises. Organizational improvisation requires coordination between all actors involved.

This case also allows examining the hypothesis which considers that the observation of the good recovery of the disruption, performed by the teams in the daily activity, can predict the resilience of the organization. Here, an observation focused on the daily work of the productive teams could conclude to their relative resilience. But the study of the incidents suggests that this resilience is limited and can be a cause of disruptions and unawareness within the organization. Then, it shows the importance to have a scale of observation



(temporally and organizationally) large enough to be able to identify some distinctions between local and transboundary resolutions, short term and long term learning.

When we study the scale of the interactions between the productive teams and the other departments of the organization, we meet some other limitations of the resilience of the existing system based on boundary spanners individuals: limitations linked to their ability to run beyond the competitions between what can be named some organizational territories or organizational jurisdictions (Bechky 2003). Indeed, the notion of boundary evokes coordination problems and breakdowns in understanding that can occur inside and outside the organization. A negotiation exercise is therefore required to effectively accomplish collective activities. This articulation work is crucial, in particular during crisis periods. The question of who takes responsibility for it however is to do with issues linked to legitimacy.

The analysis of the overflow of the documentary process and of the team leaders reintroduces the issues of legitimacy as a condition of their effective action through boundaries (Strauss 1985). The literature has focused on the skills of communication of the boundary spanning individual who should speak several languages to facilitate the circulation of information across boundaries. In the case that we have presented, the team leaders also try to re-articulate the activities with many actions that can consist in a re-alignment of the tasks of the different services involved. But if the emergency of the situation allows these temporary arrangements, it does not mean that the team-leaders are legitimate enough to be heard when they ask for permanent improvements linked to the infrastructure of the process (Star 2002; Star 1989) . Comparing the responses of the team leaders and of the Manufacturing Quality Assurance, we suggest a new dimension of the boundary spanner's activity, i.e. the creation of negotiation zones.

Finally, we consider that this case suggests the fertility to associate an approach based on the observation of daily activity and situations (Weick and Sutcliffe 2001) and a study of the interactions between the different groups that compose the system that is studied (Tillement 2011).

## ***Conclusion***

The notion of boundary evokes coordination problems and breakdowns in understanding that can occur inside and outside the organization.

A negotiation exercise is therefore required to effectively accomplish collective activities. This articulation work is crucial, in particular during crisis periods. The question of who takes responsibility for it however is to do with issues linked to legitimacy.

Flexibility and DIY are presented in recent theories on risks as essential components of resilience. We have shown the limits of this type of resilience in the case of crises resulting from a succession of incidents which occur over a long period of time. Thus, flexibility can result in actors who play the boundary spanner role becoming submerged, making it counter-productive. Even though the definition of strict standards may not seem suitable, an action framework and legitimate coordination seem to be necessary to find long-term solutions to crises.

Management of this form of “accumulative” crisis seems to be an interesting avenue of exploration for future research on resilience in distributed action situations.

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