

Role of cognitive representations in the safety of complex organizations

Stéphane GRES & Jean-François VAUTIER

Stéphane GRES, AFSCET 100 Rue Claude Decaen 75012 PARIS, France,
e-mail : <s.gres@magic.fr>

Jean-François VAUTIER, DSNQ, CEA/SACLAY 91 191 GIF sur YVETTE Cedex, FRANCE, e-mail : <jean-francois.vautier@cea.fr>

Abstract:

In this communication, we propose to examine the role of cognitive representations for the safety of organizations from the description of an accident. We will consider both the characteristics of cognitive representations and the process of elaboration in order to propose some solutions to avoid a new accident. In other words, we will show that a double approach of representations is necessary to manage the risks of a technical system.

Key words: safety, organizations, cognitive representations, mental representations

Résumé :

Dans cette contribution, nous proposons d'examiner le rôle des représentations cognitives dans la sécurité des organisations en partant de la description d'un accident. Nous considérerons à la fois les caractéristiques des représentations cognitives et leur processus de construction afin de proposer des solutions pour éviter l'apparition d'un nouvel accident. En d'autres termes, nous montrerons qu'une approche double de la problématique des représentations est nécessaire pour mieux maîtriser les risques d'un système technique.

Mots clefs : sécurité, organisations, représentations cognitives, représentations mentales

1. Introduction

Our objective is to design ways of thinking which provide a connection between the occurrence of an accident (in this case, the explosion of a vat) and the cognitive representations of workers who have to manage the system.

First, we are going to present an example which was imagined from very common work situations in industrial plants. Next, we will show the limits of a lonely examination of cognitive representations based on their description [DURAND (2000); LE MOIGNE (1990); MORIN (1995); VAUTIER (1999 a and b)]. Finally, we will propose a more complete approach which takes into account the process of elaboration of these representations.

2. Description of the example

The accident is fiction but this example has been used in many training sessions. People reactions which are presented in this communication are the most commonly observed in these training sessions [VAUTIER (2001)].

2.1. The work situation

In this plant, two workers manage the process of transformation of a fluid. They use a display and control board (cf. figure 1) which includes a lot of indicators of level and speed of fluid.

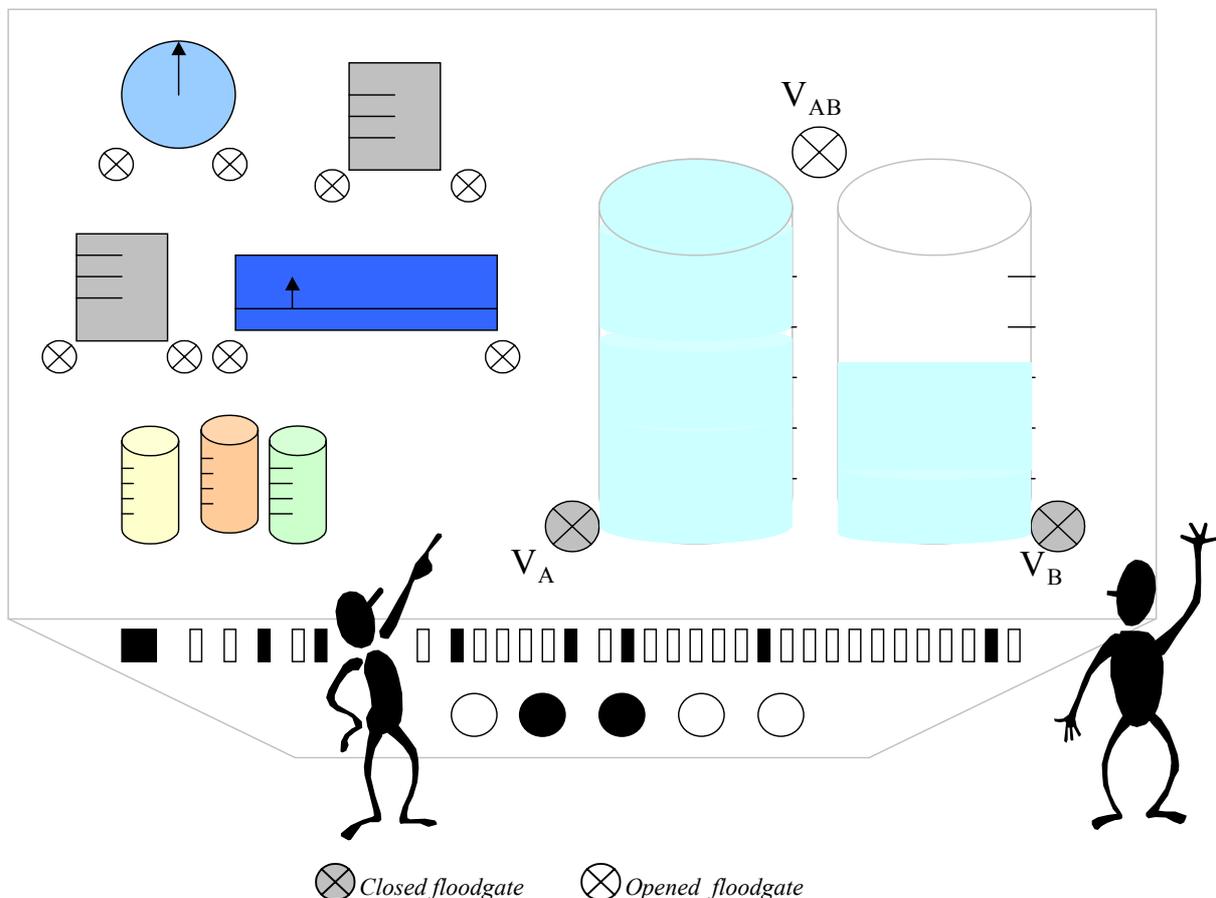


Figure 1 : The work situation

Worker 1 is located in front of the left hand side of the display and control board. He manages the left part of the board which controls the left part of the plant. On the other side of the board, worker 2 controls many devices and especially the level of two vats (A and B called respectively “CUVE A” and “CUVE B”).

After having heard worker 1 indicates worker 2 that the fluid was sent towards the two vats, the filling up step of these vats begins. During this period, a connecting floodgate located between A vat and B vat (the AB floodgate [called V_{AB}]) is opened. The floodgates that permit the draining of the vats (A floodgate [called V_A] and B floodgate [called V_B]) are closed during this step. Worker 2 always sees the same sequence on the board: the level of A vat increases up to its maximal level and afterwards the level of B vat increases up to its medium level (cf. figure 1). After some minutes of transformation of the fluids, worker 2 begins the draining step of the two vats. First of all, he closes the AB floodgate for safety reasons. Next he opens A gate and B gate and then he can see the levels of A vat and B vat decrease down to their 0 level. It indicates that the vats are empty.

When the draining step is finished, worker 2 closes the A and B gates and then opens the AB gate. Worker 1 indicates to worker 2 that he sends again the fluid and then the process starts all over again.

The most commonly cognitive representation of vats, gates and pipes of supplying, connecting and draining is presented in figure 2. This representation is the most obvious. Let us consider now that the worker 2 has this representation in mind.

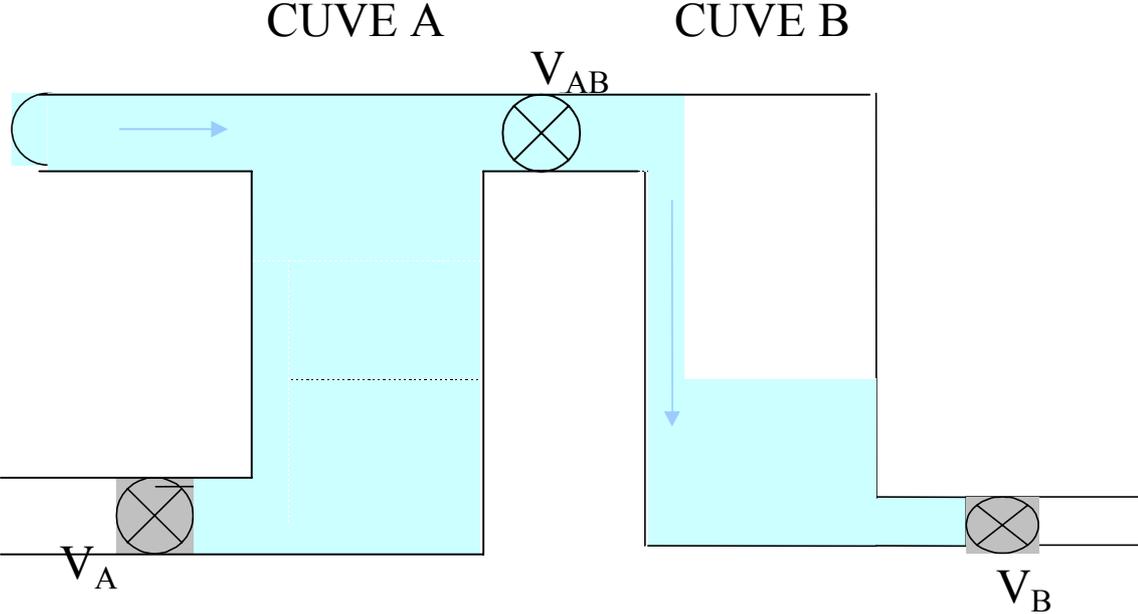


Figure 2: Disposition of vats from worker 2 point of view

2.2. The occurring of accident

Plant works also during the night even if the process is not realized entirely. The two vats are activated during the night. The number of workers decreases for the night and then there is not two persons in front of the board anymore. Worker 1 is replaced by an automaton which just indicates that the fluid is effectively sent. During the night, worker 2 is always an apprentice with little experience in managing this part of plant with the board. Indeed, this work is not considered as a difficult one to be realized and night work does not appeal more senior workers.

One day at 3 o'clock in the morning, during a filling up step, a warning light [called "ALARME"] starts up and beeps. It indicates that a crack is detected in the wall of the B vat meaning that if the level of B vat increases up to this critical level an explosion of this vat is to be induced (cf. figure 3).

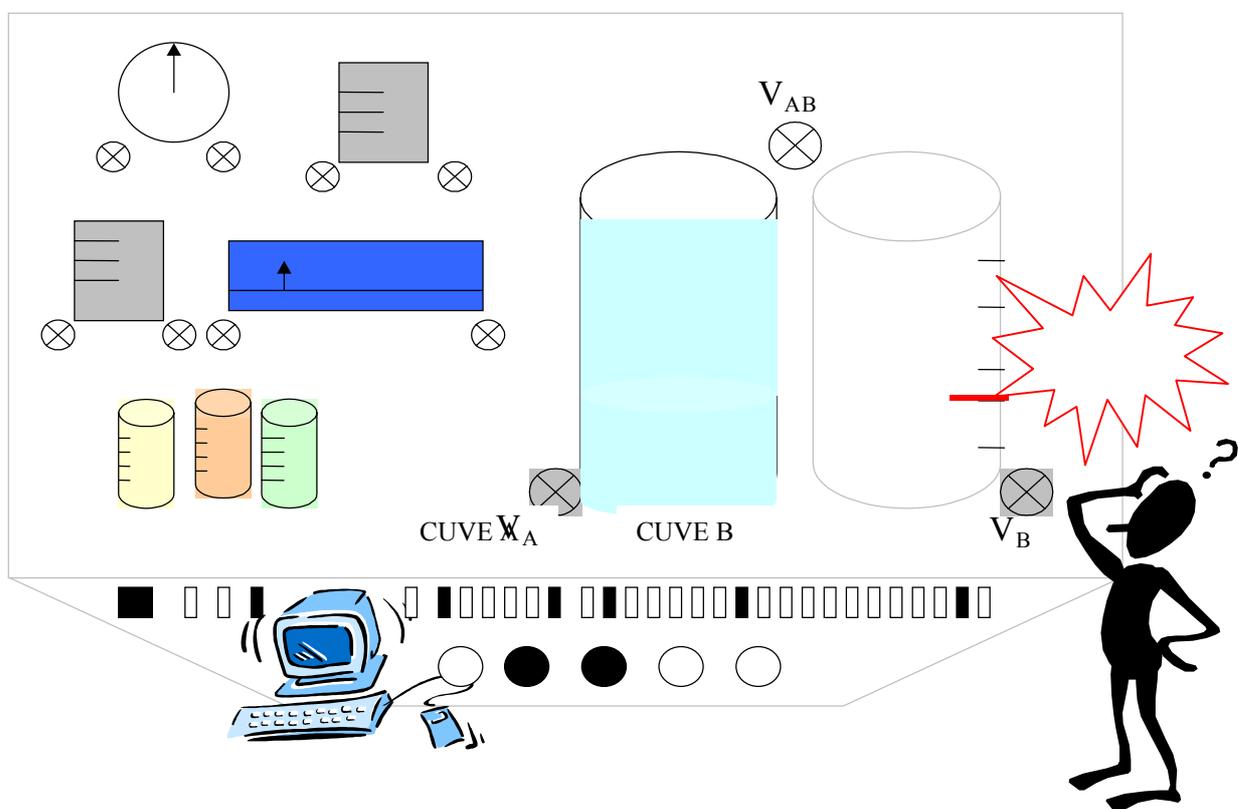


Figure 3: Warning light at 3 o'clock

Confronted with this situation, most common reactions are to close AB gate in order to avoid that fluid goes to B vat.

And this action is going to inducethe stop of the filling up of A vat whose the level steadies and the beginning of filling up in B vat ! ? ?

Usually, one does not think of opening again the AB gate even if it was the only means to avoid the occurrence of the accident. Indeed this action is not logical if we take into account

the cognitive representation (cf. figure 2). It is why people who were examined do not this action.

In fact the representation is presented in the figure 4. It is more complicated but it permits to see obviously what one has to have to do to avoid the accident. Indeed, when one keeps all floodgates opened, fluid cannot reach the crack.

Problem : the cognitive representation which is in mind of worker 2 was too different from the adequate representation presented in figure 4.

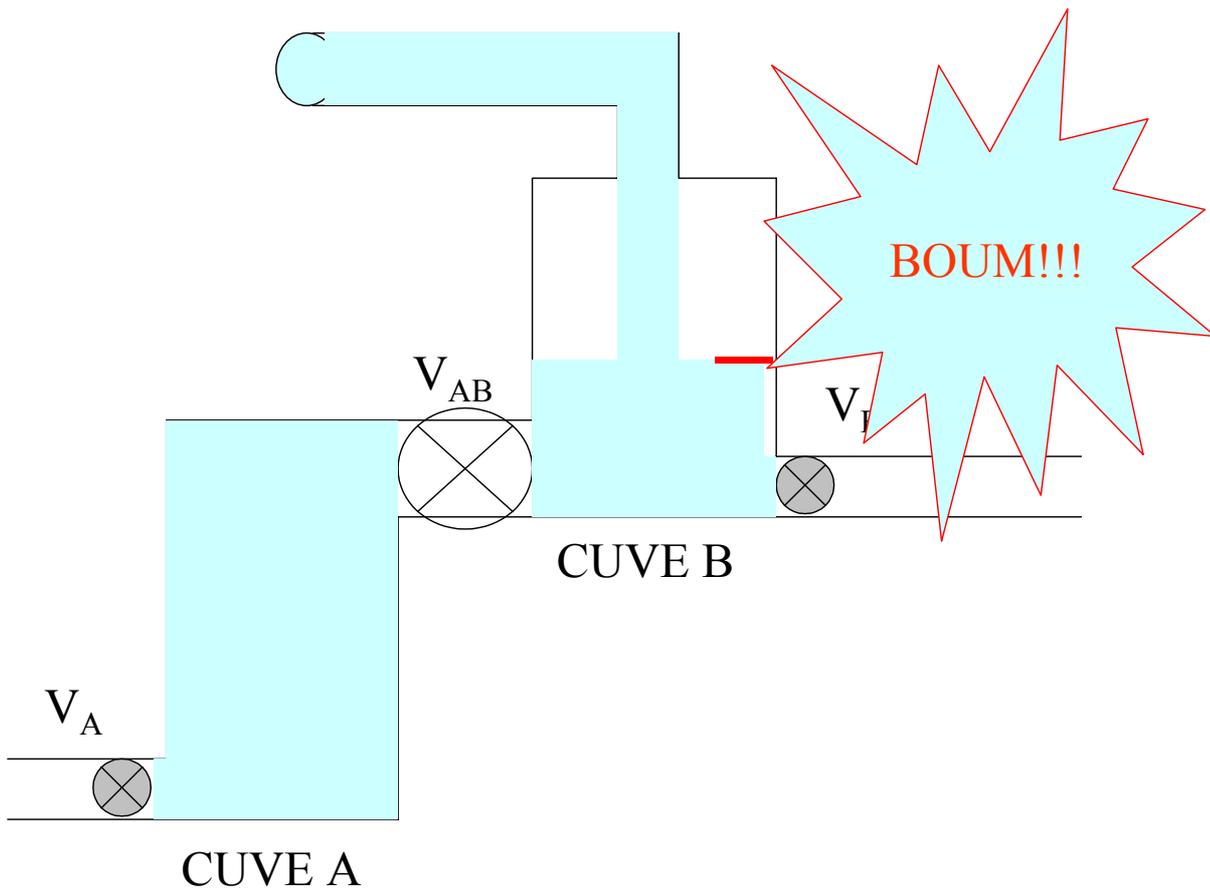


Figure 4: Real vats configuration

3. The analysis of the accident

The previous description of the accident shows the succession of operations which is coming to an end : the occurrence of this accident. From this point of view, the accident comes from a succession of inadequate operations which results from a cognitive representation that is not well matched with the work situation we study [CALVEZ (1990)]. Usually, this kind of analysis leads to propose a training session for the actor in order to modify its cognitive representation and sometimes to change the board in connection with the actor.

To go further with this previous analysis, a second one can be done. It focuses on the process of elaboration of this representation which is built from a learning process. This one results

from a set of interactions between the actor we consider, the technical system (which consists of devices and especially the two vats) and the social system (the other human actors who work in the plant).

With this new point of view, accident results from a lack of connection between the technical and human actors [GRES (1998)]. It is this lack of connection which has induced the settle of a wrong cognitive representation in the mind of actor. Consequently, doing this kind of analysis takes us to propose otherwise than training sessions as we are going to see.

3.1. The process of elaboration of cognitive representations

Elaboration of representations occurs at two basic period of the working life of the plant :

- during the design and building of the plant and especially the two vats,
- all along the functioning of the plant.

As we said before, in order to elaborate well matched representations, a lot of interactions should exist between all the actors of the plant [LE CARDINAL (1997)]. It is interactions between :

- technical system and the display and control board. The question is to know how to represent the parameters of the functioning of the technical system on the board without too big simplifications;
- technical system and the human actor we consider. This connection focuses on the level of knowledge that has really the actor about the physical operations he controls with the board;
- technical system and social system (the other human actors of the plant). The question is to know how these actors are connected, for example how information moves between them.

3.2. Some ways of improvement

The classical point of view focuses on the training and the characteristics of the board. The board is the device which is between the technical system and the actor we study. We try to present the functioning of the technical system with a board built the most logically as it is possible from a technical point of view. Then for example we present the succession of the physical operations in order to facilitate the work of anticipation of the evolution of the parameters which has to be done by the workers.

The second point of view focuses on the elaboration of the cognitive representations [GRES (2002)].

It consists in:

- integrating the actor inside the design team of the board for example in order to facilitate the understanding of the functioning of the process by the actor,
- facilitating the settle of interactions between the human actors in order to have a general point of view of all the aspects of the functioning of the plant.

Thus, we propose to complete the current ways of improvement of a work situation by some others which are more focused on the confrontation between :

- the cognitive representations of people (operators, designers) and the reality,
- the representations of the different previous human actors.

And then it means to be able:

- to know how managing the design process in the plant [GRES (2002)] and especially who is member of the design team,
- to manage better the interactions between the actors of the social system in the plant [TOSELLO (2001)].

Conclusion

This communication was focused on the cognitive representations [BARSOTTI (2001)]. We do not say that it is the only way to avoid this kind of accident we discuss about. Indeed, an improvement of the quality of the vats and the quality controls are also ways which are very important.

Finally, further than the process of elaboration of the cognitive representations, we have also to consider the process of conservation of these representations if we want to get a sufficient safety. Then we enter the process of experience analysis in the firm.

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