Contributions and limitations of "drift into failure" and "safety boundaries" identification and management in accident investigations

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Abstract. This paper explains how aviation accident investigators understand system's drifts, their main contributing factors and the way safe boundaries can be restored through concrete actions. We believe their experience can improve our knowledge about drifts into failure mechanisms and about action models to manage these drifts. After analyzing 70 french airforce accident reports and having noticed the total absence of violation's written trace, we interviewed 8 accident investigators and confronted them to the analysis of an accident report in order to assess if they have managed the risks related to violations. Our results show they know the difference between "work as imagined" and "work as actually done", they detect the reasons of drifts, establish the boundaries not to be crossed, and give guidelines based on their judgment of the drift validity. When assessing operator's interpretation of rule acceptability and flexibility, and violation's validity, accident investigators judgments are naive or too tolerant, depending on the "distance" between the analyst and the analyzed situation. What blocks violation management is the fragile analysis of operator's intention and of the socially accepted rules to which behaviour should be compared. Proactive work analysis in safety-emergent "normal" conditions and professional reflective activities about drifts into failure and safety boundaries should improve safety.

1 INTRODUCTION

When resilience engineering community points out, even confusedly, the need "*to get smarter at predicting the next accident*" [1] mainly through an increased sensitivity to "*the pressures of normal work, by normal people, in normal organizations*", it is inviting us to follow an only partly unexplored area. Ergonomics has indeed, with her "cousins" sociology and work psychology, provided lots of field work –even if it remained very often unpublished – that adresses these issues [2-6]. These disciplines have also been studying the drift of practices phenomenon and it's links to safety, health and performance. Ergonomics has always postulated it was possible to "*detect drifts into failure before breakdowns occur*" : it is possible to integrate the knowledge derived from work analysis concerning the way breakdowns are prevented during real work into the organizational (rules, structure, timetables, …) and technical (machines, computer displays, etc.) artifacts design [7].

But is this as easy as imagined ? How can we contribute to maintain alive and develop the necessary discussions of risk between peers ? What is it exactly that has to be im-

proved concerning the drift of practices management ? Does the methafor of drift and safe boundaries help stakeholders discuss and build the conditions of futur safety and system resilience?

2   RATIONALE OF THE RESEARCH

2.1 Answering to field issues and learning from field experience

Our research intends to answer to practical problems as emerging in accident analysts (AA) needs: they don't feel comfortable when analyzing human causes of accidents, mainly when they have to apply human factors concepts to the construction of causality. Among the technical limitations, they also have problems to name the human causes, especially the ones related to violations in accident reports, because it is likely that the latters will be used by the judicial and hierarchical actors to assign responsabilities and sanctions. This happens even if the organization is trained to human factors since 1994, and if the organizational conditions for independence of AA have evolved since 2003.

Even though these external factors are affecting AA causal attribution activity, we can also postulate that the quality of their analysis is good enough to be worth learning from to to their expierience as investigators. Almost all of AA are indeed former pilots who know very well the work to be assessed and the organizational features that shape it.
Therefore, we assume we can learn many lessons from the way these important actors learn themselves from human causes accidents, especially the ones related to violations, which will give us a direct access to their representation about the links made between accident occurence, violations - as system's resilience symptoms- and accident prediction. We will particularly focus on the way drifts into failure and boundaries of safe operations are detected by analysts, as a means to modelize or validate existing models [8] and also try to infer what the added value of "normal" situation analysis – with an ethnomethodological or ergonomic approach - would be [9].

2.2 Framework to understand drifts in practices and their safety boundaries

Our framework considers a drift of practices from *a priori* safe designed envelope of possible actions [10] to a higher risk zone, with a transition middle zone were practices are "normally" deviating from rules, but still under individual and social control [11]. Figure 1 shows all the different levels of legal and normal practices and their proximity to safe boundaries.

We postulate AA will detect different violations and their related risks and determining factors, according to their knowledge of the field work, the informal rules that govern drifts, and the representation of the violation itself (definition) and it's related percieved risk and acceptability. We also postulate they manage violations through judging

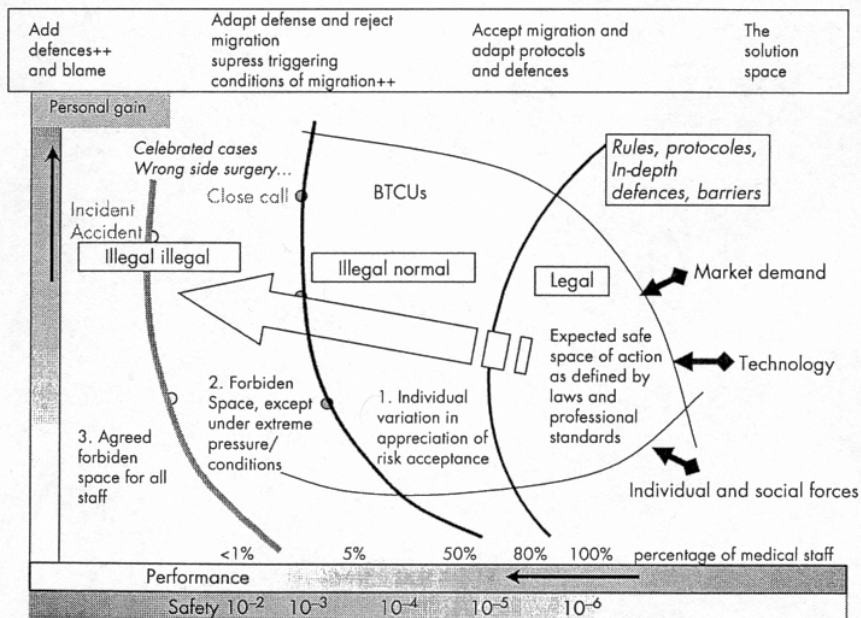the acceptability of drifts and boundaries flexibility.

Figure 1 : Migration through safety boundaries [12]

3 OBJECTIVES

This study is part of a wider approach to management violation in the french military aviation. We started with a first quantitative and qualitative analysis of accident reports from 1992 to 2002, that brought the following point : distribution of the explicit information about violations as causes of accidents accross the organization is totally absent [13]. After this first analysis, we tried to understand what was hiding behind this absence byinterviewing 8 accident analysts who explained that there is an antinomy between, on the one hand, being explicit and using the word "violation" or even "error" in the written reports, and on the other hand, preventing next accident to happen through violation detection. The main risk remains not being able to obtain information from shop floor operators in future enquiries, mainly because the reports are also used by judicial and hierarchical actors to establish responsabilities and sanctions. It is important to mention that this happens even after a Human factors plan and a human factors eductation was launched in 1994, which means management accepts the rules of new safety policies, and also gives the means to accident analysts to develop their activity in a more independent way than they use to do before. The problem of the judicial and hierarchical logics invading preventive actions remain present despite this organizational evolution.

Despite the fact violations were not mentionned in the reports, we wanted to know how they were detected and managed, since AA insisted on the fact they actually manage them. Therefore, we analyzed their view on drifts into failure and safety boundaries.

4 METHODOLOGY

We interviewed AA we could still contact in french airfoce who had done the reports from 1992 to 2002. We could only interview AA who worked during the secon period, this is from 1998 to 2002, since most of the former AA are no longuer investigating accidents, and work in different cities or even left the french airforce. We decided to contact the ones who where more likely to answer to our questions, including AA who left the institution (25%) and the ones who still work for it in different units (25%) and in the BEAD-air (50%). The latter is the french accident investigations agency in charge of aviation accident investigations including defense and flights under the responsibility of public institutions (civil security, president or government members flights, etc.).

We interviewed 8 AA through individual meetings of about 4 hours each, guided by a set of 30 questions. Their aim was to understand their global approach to violations analysis and management. In a second time, we asked more specific questions related to a situated case, confronting the AA to a report he has worked on. The specific questions referred to our goal for this paper (drift and boundary analysis) were the following :

1. **About the violation analysis:**
   a. Did you carry out an analysis of violations in this investigation?
   b. Why did you analyze them?
   c. What do you use this information for during the investigation?
   d. What does the violation detection add to the value of your work?

2. **About the intention analysis :**
   a. Did you look for the intention that originated the violation?
   b. how did you proceed?
   c. Do you think the intention is difficult to analyze in these contexts?
   d. Did you obtain the operator's point of view about his intention?

3. **About the consequences of violations analysis :**
   a. Did you assess the consequences of this violation?
   b. Do you think the detected violation was itself risky?
   c. Do you think the operator estimated well the risk related to the violation?
   d. What did you do to assess the risk taken by the operator?
   e. Did you agree with the operator' s point of view about violation's validity? Why?

4. **About violation's acceptability judgment :**
   a. Did the operator have the right/the need/the choice to violate according to the formal rules ? What about according the informal rules ?
   b. During the investigation did you find yourself in situations where you didn't agree with the operators/colleagues about normal, justificated, valid violations?
   c. Do you feel sometimes your knowledge about the operator's activity is not enough?
   d. Do you check the links you make between violations and context are realistic?

5 RESULTS

Our results will be presented in two sections :

1. A framework of violation management mechanisms, valid for all AA

2. The violation management performances, focusing on their main features

5.1 Framework of violation management mechanisms

Violation management have shown to be determined by the following invariants :

1) Detection of the violation:
   a) Identification of the deviation from a prescribed normative reference
   b) Identification of normative reference violated
   c) Identification of the existence of an intention

2) Analysis of the operator's intention
   a) Interpretation of the meaning of the violation for the concerned operators
   b) Identification of the violation with a psychological corresponding category
   c) Determining if reference is formal or informal
   d) Individual and collective debates between AA about the rule definition

3) Judgments referred to the rule and to the violation
   a) Acceptability of the rule
   b) Violation's justification
   c) Debates (differences and agreements) on the former judgments :
      i) between AA
      ii) between AA and operators
      iii) between AA and other actor of system (management, design, etc)
   d) Individual decision about the management measures related to violations

4) Actions:
   a) Writing the cause related to violation in the report/ratio (adaptation to avoid judicial and hierarchical intrumentalization for responsibility attribution)
   b) Organisational measures for preventing the violations related risks to occur again

5.2 Violation management performances :

1) Violation detection:
   - AA say they detect the violations easily, but when they are in the situated excercice, they evoke the problems they encounter when having to detect them :
      i) through more or less important inférences depending on the survival of the members of the crew and the confidence they can make to the operator's testimony

ii) Sometimes it is difficult to detect them because pilots fear sanctions : this guides the way detection of the violations is carried out since AA try to convince the actors of the benefit to trust them, by privileging the idea that the more they will understand the real causes of the event, the more their analyzes will make it possible to prevent others to happen in the futur.

- Besides these problems, AA notice that operators are often the first ones to speak about violations, which facilitates the detection process. Trust is an essential dimension of the detection process, and depends on the AA knowledge of the operator himself, his activity and his professional culture.

2) Analysis of the operator's intention
- the intention is often infered, even if the crew survives, considering the legal stakes and the fear of speaking : in situated analysis, the observations show that important inferences intervene in almost all the analyzed cases, but especially in cases of death, of suspicion about an operator's lie, or if the president of the investigation and the operator are geographically far away and need mediators to communicate
- it is hard for them to classify violations, as well as error, in the psychological categories, mainly because of the feeling of lack of human factors knowledge.
- very often, violation are associated with a category called "indiscipline" which introduces the idea of risk taking for pilot's or crew's pleasure, contradictory with the profesional expected profile of pilots and crews nowadays.

3) Judgments referred to the rule and to the violation :
- the judgment on the validity doesn't seem easy to make.
- Several zones of shade prevent a reliable identification of the intention of the operator and the reference rule to which the deviant behaviour should be compared.
- The pleasure is totally inacceptable for some of the AA, while it is something to integrate for others. Generally the ones who accept it are former pilots, and the others flight or mechanical engineers.
- The debate relates to the validity of the standards or to the violation. The opinions differ between investigators who have various experiences of the studied situation, the safety boundary decision being often taken without a consensus between all the investigators. This depends also on the kind of violation.
- The desirable debate on the validity of the standards/the violation takes place :
  - it concerns the operator's intention, the identification of a reference rule and the judgment of the violation's validity and justification.
  - AA have therefore many occasions to be confronted and to disagree.
- The difficulties for consensus are related to the objects of debate, the validity of the standard/violation and they are due to the differences between investigators on their mode of analysis:
  i) of the production-safety trade-off, which underlies the intention (ones being more compromise-prone that others),
  ii) of the standard of reference which is used as guide with the action

        iii) of the properties of the standard : does it guide or not the action correctly? Is it possible to find the answers to the problem arising in the standard ?

        iv) of the events which could take place in the context which explains the intention to deviate

- These differences in the "styles of judgment of the violation participation in causality" depend:

        i) on the distance between the analyst with the analyzed situation (pilot-pilot or nonpilot-pilot),

        ii) but overall on a difference in "causality analysis styles", on what is justified to require from an operator or from the management staff.

- These different styles create sometimes difficult confrontations between the AA who are for Human factors apporach – more systemic analysis-prone and those who think that causality shouldn't always be configured on the basis of systemic model".

- The decision concerning the tolerance of violation is often subject to discussion, but finally it is taken by the AA in charge for the investigation, even if his decision doesn't make consensus among his colleagues.

4) Actions:

- the result of the interpretation of the validity of the violations, even if it is not explicit in the reports, is translated into preventive and corrective measures

- some of the measures taken exceed the framework of the report, as AA develop an informal intervention activity in order to dis

- Certain AA maintain their piloting skills since they are asked to flight even if they are no longer military fighter or transportation pilots. At those moments, that they have the necessary contact with the shop floor to start the discussions about the violations having occurred, and intervene through direct contact and not only through the simple guideline included in the report.

- AA only recommend solutions to problems that find realistic solutions and that they can prove with solid and objective arguments they have caused the accident.

6 CONCLUSION

The collected data shows that this type of retrospective approach is rich enough to still enable safety improvements without thinking about changing the retrospective analysis tools. In fact, what's really problematic in these contexts is not the ability to detect the drifts and boundaries of safe practices, but to convince managers to make "*sacrifice decisions*" [1, 14] based on these analysis. The limited distribution of the dignosis on a written form is on the one hand favouring the adoption of little investment demanding solutions, but also preventing more expensive ones to take place. The influence of judicial and hierarchical logic should immediately be avoided through alternative violation management structures.

Which are the limitations and benefits of these retrospective analysis? The short available time, the judicial and hierarchical stakes, and the limited variety of profesionals debating about rules and behavior in these difficult contexts, lead to a risk of naive (against violations, normative, infantilisant), or indulgent (violation-prone, difficulty of seeing the limit of the safe envelope) violation assesment attitudes. On the other hand, we showed the advantages to count on experts who analyze these situations thoroughly because of the huge influence of the technical aspects of work that have to be deciphered.

We believe an alternative or complementary way for managing these dynamic and difficult to grab behaviors could be twofold :
- detecting the ways these rule deviations take place in non-incidental or "normal" situations, starting from proactive approach based on a "normal work situation" ananlysis, and on a reflective and collective work.
- improving the already emergent debates concerning rule deviation. The debate concerning validity of drifts and their boundaries should be encouraged, enlightened and "calibrated" by the activity analysis in normal situations.

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