

Cultural and Organizational Factors in System Safety: Good People in Bad Systems

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Abstract

Systems for ensuring safety and reliability in aircraft maintenance organisations do not work as they are supposed to do. This does not necessarily mean that these organisations are not safe, because unofficial and informal mechanisms compensate for these organisational deficiencies. Organisations find it difficult to manage these unofficial patterns of normal behaviour when they occur in incidents. This leads to 'cycles of stability', in which important lessons for prevention are not learned. Similar underlying patterns of culture and action may explain three things: why such systems are highly resilient, reliable and comparatively safe despite their systemic deficiencies; why they are also vulnerable to occasional failure; and why they are highly resistant to change, even following failure.

The Logic of Discourse About Safety

As the technology of complex systems whose operation carries the risk of accidental disaster has become more reliable, attention has steadily shifted towards the "human factor". For approximately the last 30 years, the "human factor" has been seen to be a critical element to explain and control. Broadly, explanations which have emerged are of four types. Each of these explanations has its own logic, but each is also deficient as a satisfactory explanation of complex accidents and disasters in a socio-technical system.

Models of the human operator seek to explain the factors within, and acting on, the individual, which lead to actions which have unintended/unwanted consequences (human error). These models often give a rather simplistic or narrow account of the situation and circumstances which influence the commission of 'unsafe' acts. It has also been argued that the way in which people understand that situation is critical to understanding how they act - this has given rise to the "new view" of human error. However the implications of this "new view" are that an exhaustive description of the normative understanding of people acting out their professional roles is available.

Secondly, derivations of these models seek to trace back from an event along a complex chain of reconstructed causality to identify factors which, although remote from the event nevertheless can be shown to have had a deter-

mining influence on the unrolling sequence. The increasing breadth and scope of major accident investigations and disaster enquiries have provided an enormously rich source of material for models, such as Reason's, which provide a framework for reconstructing the sequence of actions and events leading to disaster. However the tracing back process requires post-hoc explanations. These may be highly plausible but their validity and generalisability are not easily testable.

Thirdly, system theories provide a normative description of how the system functions in terms of the formal or explicit characteristics of the system. However when activity deviates from these functional norms (as it so often routinely does) this requires another level of explanation which can account for the regularities and irregularities of everyday patterns of behaviour.

Finally, theories of culture provide interpretive accounts of stable and pervasive characteristics of organisations. Culture is based on collective meanings, with the logical consequence that cultural explanations can account for semantic relationships but not causal ones. In other words cultural accounts can provide rich interpretations which are not testable. These interpretations would seem to be necessary if there is to be a complete account of safety events. The difficulty is to relate cultural explanations systematically to any of the other sorts of explanation.

If the contradictions inherent in these different approaches are to be resolved then there are perhaps three questions which require to be addressed.

1. How do organisational systems normally function in practice and how do people commonly behave within them?

2. What is the collective understanding and experience of such systems and of the normative roles of those within them (i.e. the culture)?

3. What is the relationship between abnormal sequences of events which lead to undesirable consequences (incidents and accidents), and normal patterns of activity?

This implies that, before we can build an understanding of how complex socio-technical systems fail, we need a better account of the normal patterns of understanding and action of people in such systems. Only when this task is underway can we begin to pose a fourth question, which is perhaps the most critical of all:

4. How can we influence such systems and cultures to change to improve safety?

We have been able to address some of these questions in a series of research projects concerning human factors in the aircraft maintenance industry (McDonald 1999, McDonald 2001, McDonald et al 2000). There may be lessons from this research for other parts of the aviation system and, indeed, for other industrial systems.

Organisational Systems – Normal Functioning and Common Behavior

One of the starkest conclusions from this research is that in fundamentally important respects the systems for ensuring safety and reliability in aircraft maintenance do not work as they are supposed to do. In so far as they do work as effective systems, this appears to be because of unofficial and informal mechanisms which are neither recognised nor valued in the way in which the systems are commonly understood by those responsible for them. In many ways these informal mechanisms run directly counter to the expressed goals and values of such systems. To summarise some of this evidence very briefly:

Violations of the formal procedures of work are admitted to occur in a large proportion (one third) of maintenance tasks. While it is possible to show that violations of procedures are involved in many safety events, many violations of procedures are not, and indeed some violations (strictly interpreted) appear to represent more effective ways of working.

Illegal, unofficial documentation is possessed and used by virtually all operational staff. Official documentation is not made available in a way which facilitates and optimises use by operational staff.

The planning and organising of operations lacks the flexibility to address the fluctuating pressures and requirements of production. Although initiatives to address the problems of co-ordination of production are common, their success is often only partial.

A wide range of human factors problems is common in operational situations. However, quality systems, whose job it is to assure that work is carried out to the required standard, and to ensure any deficiencies are corrected, fail to carry out these functions in relation to non-technical aspects of operations. Thus, operational performance is not directly monitored in any systematic way; and feedback systems, for identifying problems which require correction, manifestly fail to demonstrate the achievement of successful resolution to these problems.

Feedback systems to manufacturers do not deal systematically with human factor issues. Formal mechanisms for addressing human needs of users in design are not well developed.

Civil aviation, including the maintenance side of the business, is a safe and reliable industry. To this extent, the system is achieving its goals. How is this compatible with the statement given above? What we have to explain is a little paradoxical: on the one hand the system appears to malfunction in several important respects, yet this malfunctioning, being often a normal and routine fact of life in

maintenance organisations does not in itself imply that the system is not safe. On the other hand, it does indicate important vulnerabilities of the system which have been demonstrated in several well investigated incidents. Can the same set of principles explain at the same time how safety is normally preserved within a system and how it is compromised? Analysing the way the system is understood and the professional role of individuals within it can begin to provide an explanation.

Professional Culture

The deficiencies of the organisational systems which deliver the basic elements of the maintenance production system are well perceived by those most closely involved in maintenance operations. Thus in a typical company front line managers and skilled technicians are routinely less than satisfied with the provision of adequate personnel, tools, parts, technology, work environment, and time to do the job safely and well.

There is evidence for a professional culture in maintenance which includes a strong sense of responsibility for the overall safety of the system, going beyond simply performing a technical task to a set standard. There is a belief in professional judgement – that it is the role of the technician to use his or her own judgement, based on experience, knowledge and skill in carrying out the work, rather than blindly following a set of procedures. There is a fundamental ambivalence about the role of procedures amongst the aircraft maintenance community. Everyone agrees that safety and airworthiness must be ensured and that the job must be done, but what this means in terms of procedural compliance is the subject of completely divergent views. Some, but not all, of this disagreement reflects differences between occupational roles. Thus, there is very little difference between technicians and line management concerning the importance of avoiding delays rather than following the procedure in every respect - though these groups differ from engineering and quality personnel. Many more technicians than engineering and quality personnel believe that the primary role of documentation is simply for signing-off completed work, rather than a guide to task performance.

The overwhelming evidence from surveys of maintenance personnel points towards a common set of values, and that the importance of safety and of teamwork and collaboration are central dimensions of these values. There is a widespread confidence (perhaps overconfidence) in one's ability to manage oneself, in not being susceptible to stress, in coping with error and solving the problems of production. On the other hand, command responsibility is not shared, and there is a lack of assertiveness (by those at operational levels) about safety and about decisions that have been taken. Confidence, in the operational maintenance areas, in their own group's abilities to solve problems is not matched by a similar confidence that senior management or engineering personnel can solve these problems.

The maintenance technician thus has to reconcile the technical requirements, which have to be fulfilled, with the demands of production – getting the job done on time. Sometimes this requires compromise and it is up to the technician and front line management to compensate for the deficiencies in the organisational system in delivering what is necessary to do the job well and safely. Those who manage this compromise best are highly valued by the company as being people on whom one can rely to get the job done. However the nature of the compromise is never explicit or acknowledged.

Abnormal Events and Normal Activity

A common anecdote, well documented in incident investigations, is when one of these so-called ‘best technicians’ is implicated in a serious incident in which the nature of the compromise is laid bare to inspection. This is normally a surprise to management. The professionalism of a technician can easily lead to actions to compensate for deficiencies in the management system, particularly where the planning and organisation of work is not subject to routine validation for its adequacy in practice. Such violations can be frequent and routine; they are deliberate, intentional acts not intended to be harmful in any way. Unfortunately the role of such unofficial action is often subject to a distorted understanding after the event.

Case studies of several series of incidents drive the conclusion that incident investigation is an ineffectual method for uncovering the informal and unofficial patterns of behaviour and action which may have been associated with the incident. The interpretation of the possible causal role of such informal activities tends to be distorted by the political factors which govern the management of such incidents. These include reluctance to incriminate oneself, desire to minimise exposure to liability, need to reassure stakeholders that the situation is being well-managed, and the requirement to restore the production system to normal without too much disruption. These factors (and others) will tend to prevent the normal operational realities that may have contributed to the incident from being fully revealed and effectively investigated. The interpretation of what happened may then be distorted by naturalistic biases to overestimate the possible causal role of unofficial action or procedural violation. It thus becomes unlikely that recommendations will be developed which have a chance of addressing critical safety issues in these informal patterns of behaviour. This lack of understanding of the underlying reality then gives rise to what may be called ‘cycles of stability’ in which the process of incident management reinforces the status quo, satisfies the major stakeholders, and effectively avoids anything other than relatively superficial change.

Even when accident and incident investigations appear to be good at diagnosing what went wrong in the sequence which led to the incident, they do not necessarily (or even often) lead to actions which are effective in preventing similar incidents happening again. This second ‘cycle of stability’ may be most acute where the solution to a techni-

cal problem requires complex and difficult human action. Without first-hand knowledge of the practical requirements of getting the job done on a day-to-day basis, and the difficulties which are routinely encountered, it may not be possible to formulate an effective solution.

The lack of valid and effective monitoring and feedback mechanisms in many, if not most, organisations means that the re-occurrence of incidents becomes the dominant factor forcing change in understanding of what is necessary in terms of preventive action. Many organisations thus must be condemned to repetitive series of incidents that reproduce the same underlying causal and contributory factors. The rhetorical question - how many accidents does it take before the problem is really understood and solved? - takes on a serious practical dimension when those with responsibility for safety investigation realise that, in fact, it may take three, or more, serious incidents or accidents in order to achieve effective preventive action. This conclusion is derived from an organisation which had an independent and trained investigation team dedicated to developing preventive action. Where such an investigation team is not in place, it is less likely that the repetition of similar incidents will lead to effective learning.

Perhaps, therefore, it is not surprising that the normative outcome of incident investigation is a cycle of stability, which reinforces the status quo and does not disturb the ‘official’ understanding of how the system works. There is a failure to understand and to change the complex and difficult human and social factors which underlie safe and effective performance. There is thus a chasm between understanding what happened on the occasion of the incident and understanding what needs to change in the normal pattern of activity to prevent such outcomes occurring again.

Conclusion

The extensive field research that has supported this analysis suggests a dominant pattern characterised by well-intentioned people with a strong professional culture in relatively dysfunctional organisations. Similar underlying patterns of culture and action appear to explain why such systems are highly resilient, reliable and comparatively safe despite their systemic deficiencies, but why they are also vulnerable to occasional failure, and are highly resistant to change, even following failure. Such systems may be particularly vulnerable during times of forced organisational change.

The professional culture of maintenance personnel appears to complement the key deficiencies of the organisational system. Thus, the system’s inability to provide routinely the basic requirements for task performance, the lack of monitoring of what is actually happening, and inability to change, even in the face of serious safety evidence is matched by a strong professional commitment to safety and teamwork, confidence in one’s own abilities to solve problems (and lack of confidence in others’), a tendency to underestimate one’s vulnerability, and a lack of assertiveness against decisions made higher up (because they are

not susceptible to influence from the shop floor). The role of unofficial action is often to compensate for organisational deficiencies (there are better, quicker ways to do the job). What may appear to be routine 'violations' of procedures come out of a professional culture in which judgement and effective outcomes are more important than following documentation. In any case, such documentation is neither relied on nor normally available in a way which supports a close relationship to action. The inability of organisations to understand or manage the role of these patterns of normal behaviour in incidents leads to 'cycles of stability', characterised by a lack of learning of important lessons for prevention.

The implications of this confirm the conceptual limitations of the dominant models of human and social factors of safety in complex systems. Behaviour (whether 'violation' or error) can only be understood in its context. But this context is (at least partly) set by the organisational system and its functional deficiencies. These throw up problems and situations which need to be dealt with, but permit only certain avenues of action to resolve them. The professional culture mediates this, providing a normative understanding of how it is appropriate to behave in the context of what the system requires.

Much of this is hidden from official scrutiny or superficial observation. When the informal system breaks down and an incident occurs, the everyday pattern of normal action retreats from formal scrutiny. It is very difficult for investigators to conceptualise how this normal pattern of activity might be effectively influenced to prevent such incidents from reoccurring. Thus, culture and organisational system are intertwined in a pattern of normal activity. Only when the pattern as a whole is appreciated can abnormal events be understood. One important issue which emerges from this research concerns the inability of organisations to change. Only through analysing the nature of this resistance can we address the fourth question posed above and start to develop an adequate theory of how to intervene to effect change.

References

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