SAFETY SCIENCE Monitor

Issue 2 2009

Article 7 VOL 13

SAFETY FIRST!? ORGANIZATIONAL EFFICIENCY TRENDS AND THEIR INFLUENCE ON SAFETY

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ABSTRACT

This paper questions the "Safety first!" argument that is commonly used in organizational work life by exploring the realities and consequences of balancing efficiency and safety. The relation between organizational efficiency efforts and safety has so far been difficult to identify, focusing on measurable indicators such as accident rates. This paper focuses on the less countable effects of efficiency trends observed in local work practices. We have conducted multiple case studies within two different sectors: healthcare and civil aviation. Specific change initiatives (e.g. national reforms, implementation of new systems and practices, harmonization, and restructuring) related to efficiency processes at different system levels (ranging from government to work operation) have been identified in the two sectors, together with consequences for conducting safe and efficient work practices. Results show that it is possible to identify efficiency-safety asymmetry in local work practices at different system levels. The examples we give from the healthcare and aviation sector show that organizational efficiency trends alter the framework conditions for safety, and in some cases reduce safety to a secondary goal. Top-down implemented reforms and restructuring efforts creating new organizational interfaces should according to our findings induce warning signals in order to uphold the "Safety first!" consensus.

1. INTRODUCTION

It is an incontestable argument in organizational work life in general, and in organizational change processes in specific, that safety comes first (e.g. La Porte & Consolini, 1991; Sagan, 1993; Reason, 1997; Hale & Baram, 1998; West, 2000; Roberts et al., 2005). This paper questions the "Safety first!" argument by exploring realities and consequences of balancing efficiency and safety in two different sectors. Organizational efficiency trends such as mergers, de-mergers, downsizing, and outsourcing are rationalization efforts in order to create leaner work processes or avoid business closure. The driving forces behind the rationalization efforts might be deregulation, market mechanisms, profit, or merely societal trends (Hale & Baram, 1998; Wilpert & Fahlbruch, 1998; Gallos, 2006). The relation between such organizational efficiency efforts and safety has so far been difficult to identify, focusing on measurable indicators such as accident rates (Cook et al., 2000; Hollnagel et al.,

2006; Woods & Hollnagel, 2006). This paper focuses on the less countable effects of efficiency trends observed in local work practices within the two sectors of healthcare and civil aviation.

2. THEORETICAL FRAMEWORK

Our theoretical framework is based on theories of organizational safety (e.g. Perrow, 1984, 2006; Sagan, 1993; Reason, 1997; Roberts et al., 2005; Roberts, 2006) and theories of resilience (e.g. Cook & Rasmussen, 2005; Flin, 2006; Hollnagel et al., 2006; Leveson et al., 2006; Woods, 2006). The focus has been on difficulties with balancing goals of safety and efficiency in dynamic environments.

2.1 Safety and efficiency

In our perspective safety is not viewed as a static property of systems, but is seen as a dynamic process and a characteristic of how a system performs (Rasmussen, 1997; Cook & Rasmussen, 2005; Hollnagel & Woods, 2006; Wiig & Aase, 2007). Safety research has identified four primary organizational characteristics as vital contributors for organizations to perform safely (Marais et al., 2004): 1) prioritization of both safety and performance and consensus about the goals across the organization (La Porte & Consolini, 1991), 2) promotion of a "culture of reliability" in simultaneously decentralized and centralized operations (Weick, 1987), 3) use of organizational learning that maximizes learning from accidents, incidents and near-misses (La Porte & Consolini, 1991), and 4) extensive use of redundancy (Rochlin et al., 1987). Marais et al. (2004) argue that it is impossible to prioritize both safety and performance goals and gain consensus on these. Safety goals often do not coincide with performance and efficiency goals and in fact they most often conflict. While organizations often verbalize consensus about safety goals (e.g. "Safety is a number one priority"), performance and decision making often departs from these public pronouncements. Safety is not the primary goal of most organizations. Usually the mission of the organization is something else than safety, such as producing and selling products or services. It is often a fact that non-safety goals (efficiency and/or performance) are best achieved in ways that are not consistent with designing and operating for the lowest possible risk (Perrow, 1984; 2006; Marais et al., 2004). In Table 1 we summarize the asymmetry of signals of safety versus signals of efficiency (based on Gaba, 2000: 87).

Table 1. Asymmetry of signals (Gaba, 2000)

Efficiency	Safety
Feedback about efficiency is easy to measure reliably and nearly continuously ("revenue", "earnings" , "expenses") and indicates success in a positive fashion.	Traditional measures of "safety" are indirect and discontinuous, making them noisy and difficult to interpret or even deceptive.
Success is indicated "positively" (e.g. increasing earnings) is obviously reinforcing, and has high salience (the bottom line is the "bottom line" for a firm).	The feedback is provided "negatively" (fewer accidents or incidents), and has little reinforcement value of itself, making it achieve high salience only after an accident or a scary near-miss.
The relationship between the application of resources (money, effort, time) and efficiency goals is relatively certain, making it easy to utilize feedback.	Even when interpreted correctly the relationship between application of resources and safety goals is relatively uncertain, making it hard to utilize feedback.

Taking the healthcare sector as an example, most healthcare delivery systems were in the past loosely coupled, in which allowed the system to buffer many conditions such as short term surges in demand. However modern management techniques, organizational trends, and information systems have introduced changes allowing healthcare institutions to reduce inefficiencies in operations. This development causes conditions of tight couplings reducing the operational slack that can buffer consequences of high workload. This shift from loosely to tightly coupled operations is referred to as "going solid"[1] by Cook & Rasmussen (2005). "Going solid" in a hospital creates a series of critical relationships, tightly coupling the units of the hospital together so that events in one place have direct implications for the operations of all the others. The economic payoff by "going solid" can be high, but it has a potential of creating a myriad of problems and side effects such as management or practitioner conflicts, and problems to foresee and defend the organization against accidents. "Going solid" increases the pressure to discharge patients, encourages practitioners to speed the completion of care, and increases the performance pressure from managers that are depending on the entire facility rather than a single unit (Cook & Rasmussen, 2005; Woods, 2006).

Previous research not only limited to the healthcare sector demonstrates that "going solid" creates new organizational interfaces implying that the system becomes brittle and difficult to manage (Cook & Rasmussen, 2005; Wiig, 2008; Høyland & Aase, 2009).

2.2 Resilient organizations

Resilience describes the characteristics of managing the organization's activities to anticipate and circumvent threats to its existence and primary goals (Woods & Hollnagel, 2006). This is shown in particular in an ability to manage severe pressures and conflicts between safety and the primary production and efficiency goals of the organization (Flin, 2006; Hale & Heijer, 2006). According to Dekker (2006) it is critical to capture the relational dynamics and longer-term socio-organizational trends behind system failure, by some denoted as "drift" (Snook, 2000). One vital ingredient in drift is sacrificing decisions (Dekker, 2006; Woods, 2006), where goals of safety and efficiency are weighted against each other, and managers make local decisions based on criteria from their situated context. But establishing a connection between individual micro-level managerial trade-offs and macro-level drift is challenging both practically and theoretically (Dekker, 2006). Woods (2006) argue that there is need for research to understand the sacrifice judgment process of individuals and organizations. Such judgments are especially difficult because a hindsight view could indicate that the sacrifice may have been unnecessary because nothing happened. This implies that it is important to assess how managers and supervisors act and react to such decisions (Flin, 2006; Woods, 2006).

2.3 Research questions

Based on the theoretical framework, our main objective of the study has been to explore the asymmetry of efficiency-safety signals within the different sectors of healthcare and civil aviation, and at different levels within the two sectors. The main questions that have guided our study have been as follows:

1. *Is it possible to identify direct consequences of efficiency-safety asymmetry on local work practices?*
2. *And if possible, do the consequences differ between different system levels and between different sectors?*

3. METHODOLOGY

The paper is based on multiple case studies conducted at multiple levels within two different sectors, aviation and healthcare, involving qualitative method triangulation (Patton, 1990; 1999; Miles & Huberman, 1994). The case studies of the two sectors have been conducted by several safety researchers in the period between 2004 and 2008, and with slightly different research objectives (see Aase et al, 2007; Tjørhom & Aase, 2007; Wiig & Aase, 2007; Pettersen, 2008; Pettersen & Aase, 2008; Wiig, 2008; Høyland & Aase, 2008; Høyland & Aase, 2009). Empirical data concerning the relationship between safety and efficiency was extracted from the different case studies and formed the basis for analysis in this paper. The case studies covered the levels of government, regulator, company, management, staff, and work operations according to a socio-technical system perspective (Rasmussen, 1997).

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[1] "Going solid" is a nuclear power slang term used to describe a difficult to manage technical situation (US Nuclear Regulatory Commission in Cook & Rasmussen, 2005).

3.1 Data collection within healthcare

A total of 94 tape-recorded interviews were performed within a regional Norwegian hospital with belonging regulatory bodies using different structured interview guides. 17 interviews were conducted at the regulatory and hospital top management level covering topics such as legislation, error reporting, learning, risk perception, and prevention. Informants included inspectors, patient representative associations, and hospital management. 48 interviews were conducted at the middle management, staff, and work operation levels covering topics such as amount and categorization of errors, human and organizational factors, learning, power issues, and the regulators role. Informants included middle managers (division and department managers) and staff (senior and junior nurses, senior and junior physicians) at four hospital divisions. 23 interviews were conducted at staff and work operation level covering the topic of implementation of new and more efficient nursing shift handover practices. Informants included staff (senior and junior nurses) at two hospital wards. 6 interviews were conducted at management level covering the topic of implementation of an electronic error reporting system.

Moreover, observational data has been gathered related to the implementation of new nursing shift handover practices (a total of 11 shift handovers were observed). Observation was done by participating at existing (oral handovers) and new (written) shift handovers for nurses, using field notes as basis for the immediate succeeding interviews. Document analysis was carried out at the governmental level to describe vital changes within the Norwegian healthcare sector (legislation, Krogstad 2005, White Papers, etc.). In addition, extensive document analysis was carried out at company level (policy documents, inspection reports, annual reports, safety documents and regulations, handover reports, evaluation cards, etc.) to provide contextual information about the current hospital.

3.2 Data collection within aviation

The empirical data from the aviation sector was gathered in three single case studies at different levels of the Norwegian civil aviation system. 1) *The civil aviation authority case* consists of 26 tape-recorded in-depth interviews with inspectors, advisors and managers covering the topics of safety perceptions, safety practices, and change perceptions. 2) *The air traffic control/airport operation case* consists of 126 interviews with managers, middle-managers, employees and sub-contractor employees at five airports covering the topics of safety perception, safety priorities, competence, collaboration, attitudes towards procedures and sanctions, and learning. The case also includes qualitative free text data concerning change perception and safety perception from a questionnaire survey (n=847, N=3981) with 231 respondents (managers, planners, engineers, air traffic controllers). 3) *The maintenance case* consists of participant observation (two one-month periods) in a line maintenance department, 15 tape-recorded in-depth interviews, and numerous informal discussions. Topics covered in the data collection were safety practices at individual and group level, framework conditions and change, ownership, and organisation. The case also includes qualitative free text data concerning change perception and safety perception from a questionnaire survey with 283 respondents within maintenance (managers, planners, engineers, aviation technicians).

3.3 Data analysis

Out of the different case studies conducted in the two sectors, the analysis in this paper is narrowed down to focusing on the relationship between efficiency and safety. Efficiency has been mapped by choosing different change processes with the aim of improving efficiency at different system levels in the two sectors. The following change processes were identified as vital in the case studies, and therefore formed the basis for our analysis: (1) The introduction of national reforms at a governmental level of healthcare, (2) the introduction of an electronic error reporting at hospital level of healthcare, (3) the introduction of new handover practices at work operation level of healthcare, (4) the global harmonization trend of aviation, (5) the restructuring of air traffic control and airport operation, and (6) geographic separation of units within airline maintenance.

In analyzing data related to the efficiency processes listed above, safety has been mapped by identifying possible consequences for local work practices. For a more detailed presentation of the analysis of the different case studies, we refer to Aase et al (2007), Tjørhom & Aase (2007), Wiig & Aase (2007), Pettersen (2008), Pettersen & Aase (2008), Wiig (2008), Høyland & Aase (2008), and Høyland & Aase (2009).

4. RESULTS

The results are presented by giving examples and descriptions of specific change initiatives or efficiency trends and their possible consequences for local work practices in both sectors.

4.1 The healthcare sector

The Norwegian healthcare sector has undergone several changes during the last decade. New public management (e.g. Hood, 1991; Power, 1999; Osborne & McLaughlin, 2002) and its characteristics of cost control and effectiveness form a backdrop for major changes at the governmental level (Krogstad, 2005) with implications for lower levels of the healthcare system.

4.1.1 National reforms

Three structural reforms have been essential within the Norwegian healthcare system (Krogstad, 2005): 1) *A change in hospital financing* with a central purpose of reducing patient waiting lists, was implemented in 1997. The reform included a transition in state financing of hospitals from lump sum to reimbursement per patient. 2) *A change in institutional management* was introduced in 1999 followed by a new law (Specialized Health Service Act) with the intention to strengthen leadership as a response to a growing complexity in hospital organizations. The reform represented an explicit desire for increased efficiency and an implicit shift from clinical to managerial rationality. 3) *A change in hospital ownership and central management* was implemented in 2002 involving a transfer of hospital ownership from counties to central government.

Case study results showed that the changes in hospital financing and demands to reduce waiting lists caused several changes at the managerial level, and that the focus on economy, production and competition influenced decisions affecting medical personnel. The effects of the national reforms were also considered to have the potential of creating new emerging risks:

> *"It is one of the greatest challenges, I won't call it a risk, but it can turn out to be one. It is a challenge to deal with a yearly increase in patient volume within the same buildings and with no increase in overall resources"* (HSE manager)

To implement the structural changes at an organizational level were perceived as challenging causing internal conflicts. The hospital management encouraged all divisions to report errors and prioritize patient safety, yet simultaneously expressed the importance of cost savings and budget balance. Department managers referred to the pressure for budget balance and expressed feelings of powerlessness and worried about understaffing and "corridor patients" due to lack of space:

> *…there is a higher focus on deviation from budget, than on deviation from safety…(*middle manager)

In other words, the hospital organization had limited resource slack (time, personnel, economy), and in practice, patient safety lost against budget balance. The hospital was organized to manage normal work operations, but the organizational efficiency changes contributed to a reduction in reserve capacity for managing activities outside the short-term production perspective, such as error reporting, feedback, and training.

In sum, the structural reforms concerning hospital financing and institutional management implemented to increase efficiency altered important framework conditions at all levels of the healthcare system. Identified effects have been time pressure, stress, increased workload, and understaffing. Similarly, studies of the UK National Health Service (NHS) have shown that although the UK government had given clear messages that safety should take priority over other goals, this goal was simultaneously subverted by the inadequacy of funding provided for the NHS (West, 2000; Bone, 2002).

4.1.2 Electronic error reporting

At hospital level, several change efforts were introduced to make patient care both safer and more efficient. One of the improvement measures was the introduction of an electronic error reporting system with the objective of avoiding repetitive errors, learning from errors, and implementing preventive measures based on reported events. Implementing the system has met resistance in the organization, and underreporting is referred to as common:

> *"I do not report incidents unless it is extremely serious and has consequences for the patient. I rather discuss it informally with my colleagues"* (chief physician)

> *"If a near-miss occurs it's an eye-opener for yourself, but it does not get reported"* (chief physician)

Data reveals that one of the reasons for underreporting and low priority of the electronic error reporting system is the health care employees' desire to spend time on patient contact and treatment instead of on time-consuming reporting procedures. Even though managers in the case hospital encourage employees to report errors and have prioritised the implementation of the electronic reporting system, the fact that these efforts coincide with

a continuous emphasis on retrenchment measures and patient treatment efficiency creates difficulties. Informants refer to this cross pressure between reporting of undesired events and the focus on economy as a limitation for their time and motivation to report (see also Høyland & Aase, 2008).

4.1.3 New handover practices

At work operation level of the hospital, one of the efforts to improve the efficiency of patient care was to introduce new handover practices. Handover practices at hospitals are considered a critical stage where important patient information may get lost. The way experience, knowledge, and documentation are being transferred from one shift to another is crucial for the safety of the patients. At the current hospital an expressed need for changes and new handover routines was stated by the board of directors. This was further reinforced by the documentation demands in the Health Personnel Act (1999) requiring care providers to document their efforts. It was pointed out that the planned changes at the hospital should maintain a sound professional patient care and at the same time increase efficiency in the handover phase. A decision was made to introduce written handover reports, replacing the previous oral handover reporting at 90% of the wards in the course of a one-year period.

Again, the concurrence in time with health reforms and structural changes may have led to more resistance in the organization than necessary due to the comprehensive understanding among employees that implementation of new handover practices was an efficiency demand launched by the top management. This resulted in the fact that only a minority of the wards at the hospital had implemented written handover reports two years after the planned implementation period.

In our study of factors influencing handover practices at the hospital we found that external conditions such as handover time frame, interruptions, and ward size/ patient capacity were reported as the most common reasons for poor handover quality, thus affecting the delivery of safe patient care (see also Aase et al, 2007).

4.2 The civil aviation sector

Similar to the Norwegian health care sector, different parts of the Norwegian aviation system, ranging from governmental and regulatory level to work operation level have experienced a number of changes that affect their respective work practices.

4.2.1 Global harmonization trends

The civil aviation authority (CAA) case documents a recent focus on risk based inspections (identifying and addressing system weaknesses and risks instead of detailed technical and organizational inspections), the change from single provider (monopolist) market to deregulated market, and a transition to EASA (European Aviation Safety Agency) regulations. In addition, as part of the current Government's regional policy, a geographic relocation of CAA coincided in time with these structural changes. In sum, these changes were symptoms of efficiency and global harmonization trends, reflecting an interest in achieving a more efficient way of keeping market overview and control. The change processes have challenged the established structure of the CAA organization. Specifically, the risk based inspection approach requires cooperation and clearly defined responsibilities, while the traditionally focus has been on individual practice and tacit knowledge:

> *"There exists a high individual consciousness, but no collective coordination"* (consultant)

> *"The organization lacks an overall inspection practice that is standardized rather than dependent of individuals"* (consultant)

Adding to the already existing dependence on individual practice, CAA experienced a loss of competency and a lack of proper knowledge transfer as a result of the relocation process.

In sum, the CAA context consisted of specialized individual practices and a lack of consciousness concerning overall organizational goals. As a result, the organization demonstrated low adaptability when confronted with restructuring, international trends, and new methods for regulatory practice.

4.2.2 Restructuring

As in the CAA case, a number of changes have affected work practices within air traffic control and airport operation in recent years. Many of them come under the heading restructuring and include privatization processes, efficiency programs (downsizing, cost-cutting), merging of airlines, and reduction of air traffic control stations. A common finding within air traffic control and airport operation is that changes resulting from restructuring processes are perceived negatively by employees in terms of introducing insecurity, unrest, malcontent and stress.

Many informants refer to an increased focus on efficiency, shifting the everyday priorities in direction of economy. This creates a general conflict between economy and safety:

> *"There is an extreme focus on economy and a lack off will to invest in necessary equipment to keep up with the increase in traffic"* (air traffic controller)

> *"Managers signal 'we promote safety' implicit that it doesn't cost anything"* (air traffic controller)

The data material reveals local differences in how these conflicting objectives are handled. When handled positively, resources are made available by managers, decisions are made so that employees know safe work practices are given priority over efficient work operations, and practical organizing of work tasks is prioritized. When handled negatively decisions and management prioritization follow efficient flight traffic completion solely, and the desire to uphold turnaround time results in procedure violations.

In sum, the organizational context within air traffic control and airport operation showed difficulties in handling the effects of restructuring efforts, as demonstrated by physiological and psychological reactions (insecurity, stress, etc) and in some parts of the organization poor management of expressed conflicts between safety and economy.

4.2.3 Separation of units

The line maintenance case shows a high degree of built in resilience through the use of a common competency base (with access to experience, knowledge and resources) and through the use of specialized coordinating units (managing the information flow). These resilience traits created high flexibility, coordination and in return safe and efficient work practices. An example is the way line technicians handled the conflict of keeping an aircraft safe from technical faults and getting it operational within the time limit of its planned schedule. We identified a strong predominance to safety resulting in "delays due to technical reasons" where technicians created extended performance spaces to make sure that the airplane was technically airworthy.

As a result of restructuring processes, the maintenance organization went from being an integrated technical division in an airline to sale and merger with a competing airline as a result of falling income and increased competition. The maintenance organization was subsequently integrated in a large independent technical unit separated from the airline. As a consequence communication and experience transfer between the line maintenance organization and the maintenance control center of the airline was altered. Reduced communication in turn affected the competency base of the line maintenance organization, reducing access to experience, knowledge and resources that were crucial elements in the technicians' local work practices. According to several informants, fewer refresher courses also followed the restructuring processes, reducing technicians' knowledge of both technological developments and of new failure types and solutions. Finally, the restructuring process also meant that the line maintenance base was relocated away from the airport itself (three minute drive). The physical detachment between line technicians and operative personnel (e.g. pilots) further reduced their ability to exchange knowledge and experience.

In sum, the restructuring efforts within line maintenance altered the local work practices in several ways, creating new organizational interfaces and subsequently introducing barriers for information and knowledge flow. This resulted in restricted access to the experience and knowledge necessary for creating safe work practices by maintenance technicians (see also Pettersen & Aase, 2008; Pettersen, 2008).

5. DISCUSSION

This study has shown that organizations operating in complex systems providing services depending on multiple actors at different levels have to adapt to changes and make trade-offs, sacrificing decisions between conflicting goals at both an organizational level and in local work practices (Marais et al., 2004; Dekker, 2006; Flin, 2006; Woods, 2006; Marais & Saleh, 2008).

Characteristics of the organizational efficiency trends within the aviation sector were the simultaneity of changes at all levels of the transport system with more or less uncoordinated change processes within all actors of the system. Different parts of the aviation system displayed different organizational mechanisms for coping with the changes, of which some were more successful than others in maintaining the balance between safety and efficiency. The line maintenance case showed a collective work practice nurturing flexibility in collecting specialized knowledge for the best possible solution to work tasks, and prioritizing safety before operation through the creation of performance spaces. The work practice was influenced negatively by separation of units

creating new organizational interfaces (see also Pettersen & Aase, 2008; Høyland & Aase, 2009). The civil aviation authority case showed an organization characterized by individual specialization and tacit knowledge. The work practice was influenced negatively by the simultaneity of changes concerning restructuring, international trends, and new methods (see also Tjørhom & Aase, 2007; Høyland & Aase, 2009). The air traffic control and airport operation case showed variability in the way conflicting objectives were handled, and displayed physiological and psychological reactions to restructuring efforts. All examples from the aviation sector demonstrated how managerial resilience (Flin, 2006) at the local level was important for successfully handling the efficiency-safety asymmetry.

Characteristics of the organizational efficiency trends within the healthcare sector were structural reforms implemented top-down from governmental level placing efficiency-safety cross pressures at lower levels of the healthcare system. The effects of the cross pressures were most dominant at division and department level as a result of safety measures being delegated to middle-managers at these levels. Compared to aviation, the safety work within healthcare was less mature and the value of resilience received little attention. This was exemplified by a strong focus on introducing systems rather than maintaining and improving them (electronic error reporting and handover practices). This implies that the current healthcare organization is vulnerable to both "normal" changes and variations in operations, such as increased patient flows and budget shifts, and to more fundamental changes such as national reforms and restructuring. The healthcare examples display an urgent need for emphasizing managerial resilience (Flin, 2006) at division and department level to promote safe work practices.

What we see in examples from both the healthcare and the civil aviation sector is that most organizational efficiency trends are influenced by national and international societal characteristics such as reforms and global harmonization efforts. As Dekker (2006) points out, to establish a connection between individual micro-level managerial trade-offs and macro-level drift is challenging both practically and theoretically. Our examples from both sectors have shown that micro-level trade-offs occur as a result of macro-level drift.

6. CONCLUSION

By describing organizational efficiency trends and their effects on local work practices, we have documented that performance and decisions in some cases within both aviation and healthcare depart from the "Safety first!" consensus thereby reducing safety to a secondary goal (Gaba, 2000; Marais et al, 2004). To summarize our cross-sector study, let us return to the two research questions posed earlier in the paper:

1. *Is it possible to identify direct consequences of efficiency-safety asymmetry on local work practices?*

By giving examples of changes at several levels within the two sectors healthcare and aviation we find that organizational efficiency trends challenge local work practices by the introduction of new framework conditions. Within healthcare, efficiency trends based on national reforms have resulted in higher work pressure to treat more patients, and effects of micro-level managerial trade-off can be seen in for example the difficulties in introducing new safety measures such as electronic error reporting. Within civil aviation, efficiency trends such as restructuring (privatization, relocation, merging, separation of units) have resulted in new interfaces within and between organizational units, and effects can be seen in for example reduced flexibility and knowledge flow, and in the prioritization of efficient air traffic completion.

2. *And if possible, do the consequences differ between different levels of complex socio-technical systems and between different sectors?*

What we see in both sectors is that the effects of the efficiency-safety asymmetry are more pressing at the management and staff level, causing multiple sacrificing decisions and difficulties for local managers and employees in providing safe work practices. In the aviation sector, the simultaneity of changes also creates difficulties in upholding a sound regulatory practice. Differences between sectors include the level of maturity in prioritizing safe work practices, making healthcare more prone to "going solid" operating closer to safety limits (Cook & Rasmussen, 2005) and thus being more vulnerable to both normal variations (patient flow, budget shifts) and fundamental changes (reforms, restructuring). Within the aviation sector we see that restructuring efforts resulting in new organizational interfaces challenge the creation and maintenance of safe work practices.

The results of this study should be interpreted with some caution because of the difficulty in studying direct effects of efficiency-safety asymmetry on local work practices. It could be many reasons for why it was difficult to introduce safety measures such as electronic error reporting and new handover practices in healthcare, besides the aim of improving efficiency. Likewise, other reasons than improving efficiency through restructuring could be

the explanation for reduced flexibility and knowledge flow within aviation. Further research is needed to address these issues. A follow-up study on whether or not new local work practices following efficiency processes (electronic error reporting, new shift handovers) are in fact safer would be beneficiary.

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