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ORGANIZATIONAL FACTORS IN COMMERCIAL AVIATION ACCIDENTS 1990-2000

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Recently several major transportation accidents have brought significant attention to the role of organizational factors in supporting safety within high-risk critical systems. However, little is essentially known about the types of organizational factors that contribute to these accidents, as there has yet to be a comprehensive analysis of these factors. This paper elaborates on the types of organizational factors that have contributed to pilot-error related aviation accidents in U.S. commercial aviation. Specifically, we analyzed 60 accidents with organizational cause factors from 1990-2000. Results from this analysis indicate that the type and frequency of organizational factors that contribute to accidents varies across type and size of aviation operations. However, the data also argue for a more thorough analysis of organizational factors during an investigation so that a clearer understanding of the actual contributing factors to an accident involving pilot error can be discerned.

Introduction

Organizational factors play a significant role in the foundation of safety in high-risk systems. Several high profile accidents in the late twentieth century brought considerable attention to the role of organizational factors in accident causation. One of the first instances was the nuclear accident at Chernobyl in 1986. The International Atomic Energy Agency identified a “poor safety culture” as a factor contributing to this disaster (IAEA, 1986, as cited in Cox & Flin, 1998; Pidgeon, 1998). Since that time, organizational factors have been discussed in other major accident enquiries and analyses of system failures such as the King’s Cross underground subway fire in London and the Piper Alpha oil platform explosion in the North Sea (Cox & Flin, 1998; Pidgeon, 1998). Organizational factors also began to appear in the discussions of several high profile aviation/aerospace accidents such as the Challenger disaster (Vaughan, 1996).

The turning point for the analysis of organizational factors within commercial aviation accidents came with the National Transportation Safety Board’s (NTSB) report of the in-flight structural breakup and crash of Continental Express Flight 2574 near Eagle Lake, Texas, on September 11, 1991 (Meshkati, 1997). One Board member, in a dissenting opinion, suggested that the probable cause of this accident included, “The failure of Continental Express management to establish a corporate culture which encouraged and enforced adherence to approved maintenance and quality assurance procedures” (NTSB, 1992, p.54). Since then, the focus on organizational factors in aviation and aerospace

accidents has continued to expand to include the recent analysis of the organizational failures within NASA that contributed to the Columbia Space Shuttle tragedy (CAIB, 2003).

The role organizational factors play in the etiology of accidents has been acknowledged prior to the aforementioned accidents. For example, March and Simon (1958), in their influential work *Organizations*, describe organizations as complex systems whose failings are more often directed at administrative factors, rather than at operator (worker) behavior. Likewise, Heinrich, Peterson, and Roos (1959), discuss organizational opportunities for accident prevention efforts in their work *Industrial Accident Prevention*. Bird’s (1974) Domino Theory fundamentally traces the root causes of all accidents to failures in organizational loss control and has been a standard model of accident causation within industrial and manufacturing settings for decades. More recent theories of organizational accidents build on these and other foundations, including works by Reason (1990; 1997), Weick and Roberts (1993), Klein, Bigely, and Roberts (1995), and Zhuravlyov (1997).

But what is actually known about the types of organizational factors that contribute directly to accidents, namely commercial aviation “pilot error” type accidents? There is a growing body of knowledge in relation to the role that aircrew or pilot error plays in the cause of aviation accidents. For years, the unsafe actions on the part of the pilots as accident causal factors have hovered around 80% (Dismukes, Young, & Sumwalt, 1999; Wiegmann & Shappell, 2003). This is not surprising since pilots’ actions are more easily tied to the occurrence of an

accident, whereas organizational factors are generally far removed in time and space from an accident, making them difficult to link to an accident during an investigation (Wiegmann & Shappell, 2001). In addition, accident investigators are often highly knowledgeable of the tasks and duties of the accident aircrew that may have gone awry, but may be generally uninformed as to the types of organizational issues that they should specifically examine during an investigation.

Accordingly, there is debate that despite a growing awareness of the importance of organizational factors, they have been often overlooked or unidentified by aviation accident investigators in the field (Yacavone, 1993; Maurino, Reason, Johnston, & Lee, 1995). That is, most field investigations refer to the pilot's erroneous decision or action with little understanding of the contributing factors committed by those within the organizational chain of command. This is not to say that aviation accidents may be completely devoid of causal factors on the part of the pilot(s), but rather to note that the emphasis most often has been placed on the frontline operators, rather than tracing back up the organizational chain.

This paper elaborates on the types of organizational factors that have contributed to commercial aviation accidents in the U.S. Specifically, we analyzed 60 accidents with organizational cause factors from 1990-2000.

Method

We analyzed the NTSB's commercial aviation accident data for the ten-year period from 1990-2000. This set of accidents includes Federal Aviation Regulation (FAR) Part 121 scheduled and non-scheduled operations and FAR Part 135 scheduled and non-scheduled operations. From the original set of 1322 commercial aviation accidents, 781 were identified as having human factors causes using the Human Factors Analysis and Classification System (HFACS) (Wiegmann & Shappell, 2003). Sixty of these accidents attributable at least in part to pilot error contained 70 organizational cause factors. A comprehensive analysis of these accidents was performed using the NTSB's assigned findings. (Note: accidents relating to organizational factors associated with maintenance facilities and maintenance issues were not included in this analysis.)

Results

Of the 60 identified accidents, 73% produced some type of injury or fatality, while only 27% resulted in no injuries to crew or passengers (Table 1).

Table 1. Degree of injury sustained from 60 commercial aviation accidents with organizational cause factors, 1990-2000.

| | Frequency | Percent |
|----------------|-----------|---------|
| None | 16 | 27% |
| Minor | 8 | 13% |
| Serious | 7 | 12% |
| Fatal | 29 | 48% |
| Total | 60 | 100% |

Within these accidents, 17 occurred in FAR Part 121 aviation operations, while 43 occurred in FAR Part 135 aviation operations. When broken down into type of hauling operation these accidents represent under each certificate of operation, passenger-only operations make up the largest category of accidents, followed by cargo-only operations and then passenger-cargo combined operations. A comparison of the type of hauling operation these accidents represent under each certificate of operation is presented in Table 2.

Table 2. Comparison of type of hauling operation in 60 organizational accidents, 1990-2000.

| | | Passenger Only | Cargo Only | Passenger/Cargo |
|-----------------|---------------|----------------|------------|-----------------|
| <u>Part 121</u> | Scheduled | 7 | 2 | 5 |
| | Non-scheduled | | 3 | |
| <u>Part 135</u> | Scheduled | 8 | | 2 |
| | Non-scheduled | 21 | 11 | 1 |

Assessing Organizational Factors

Assessing the assigned findings for the accident sequence of events provided a more complete analysis of the 70 organizational factors associated with the 60 accidents. We used the NTSB identified accident sequence of events identified during the original investigation. Based both on the descriptors provided by the NTSB and a review of the narratives associated with each of the factors, we were able to cluster these organizational factors around 10 broad categories which include procedures, training, surveillance, standards, information, supervision, pressure, documentation, substantiation, and facilities. A brief description of these factors appears in Table 3.

Table 3. Organizational contributing factors of 60 U.S. commercial aviation accidents 1990-2000 (clustered).

| <u>Category</u> | <u>Description</u> |
|--|---|
| Inadequate procedures or directives | Ill-defined or conflicting policies Formal oversight of operation |
| Inadequate initial, upgrade, or emergency training/transition | Opportunities for pilot training not implemented or made available to pilots (e.g., human resource problem) |
| Inadequate surveillance of operations | Organizational climate issues Chain-of-command Quality assurance and trend information |
| Insufficient standards/requirements | Clearly defined organizational objectives Adherence to policy |
| Inadequate information sharing (untimely or insufficient) | Logbooks, updates, and weather reports on the part of the organization |
| Inadequate supervision of operations (management level) | Failure to provide guidance, oversight, and leadership to flight operations |
| Company/management induced pressure | Threats to pilot job status and/or pay |
| Faulty documentation | Inaccurate checklists, signoffs, and company record keeping that effects flight operations |
| Inadequate substantiation process | Well-defined, verified process Accountability Standards of operation Regulation Recording/reporting process |
| Inadequate facilities | Failure to provide adequate environmental controls, lighting, clearance, etc. for flight operations |

When these organizational cause factors are considered in relation to operational category (Table 4), a clearer picture of the elements related to aviation operations emerges.

Accident factors related to inadequate organizational procedures emerge prominently in both Part 121 and Part 135 operations, with 7 instances (9.5%) in Part 121 and 8 instances (11.5%) in Part 135 operations. The factors associated with inadequate training are significantly higher in Part 135 operations (16%), than in Part 121 operations (3%). Inadequate surveillance of operations also ranks higher in Part 135 operations (10.5%) than in Part 121 operations (3%), as do inadequate standards/requirements at 9% and 3%, respectively. Inadequate information sharing ranks higher in Part 121 accidents (7%), than in Part 135 operations (4.5%). Accident factors associated with inadequate supervision, which includes management oversight, are present in Part 135 operations (10.5%) but not in Part 121 operations, as

are factors associated with company-induced pressure (6%) and inadequate facilities (1.5%).

Discussion

A strong reason for the discrepancy of accident distribution between the operative categories could lie in the range of pilot non-flight duties, which depends on the employment setting. Part 121 airline pilots have the services of large support staffs, and consequently perform few non-flight duties. Pilots employed in other settings, such as Part 135 operations have duties other than flight responsibilities. They may load the aircraft, handle passenger baggage, supervise refueling, arrange for major maintenance, or perform minor aircraft maintenance and repair work.

This leads to a blurring of the supervisory chain of command and can put one person in charge of numerous supervisory issues, devoid of checks and

Table 4. Cross-tabulated breakdown of 70 organizational contributing factors to 60 commercial aviation accidents 1990-2000.

| | Part 121 Scheduled | Part 121 Non-scheduled | Part 135 Scheduled | Part 135 Non-scheduled | TOTAL |
|-----------------------|---------------------------|-------------------------------|---------------------------|-------------------------------|--------------|
| Procedural | 8% (6) | 1.5% (1) | 1.5% (1) | 10% (7) | 21% (15) |
| Training | 3% (2) | | 12% (8) | 4% (3) | 18% (13) |
| Surveillance | 1.5% (1) | 1.5% (1) | 1.5% (1) | 9% (6) | 13% (9) |
| Standards | 3% (2) | | 3% (2) | 6% (4) | 12% (8) |
| Information | 4% (3) | 3% (2) | 1.5% (1) | 3% (2) | 12% (8) |
| Supervision | | | 1.5% (1) | 9% (6) | 10% (7) |
| Pressure | | | | 6% (4) | 6% (4) |
| Documentation | 3% (2) | | | 1.5% (1) | 4% (3) |
| Substantiation | 1.5% (1) | | 1.5% (1) | | 3% (2) |
| Facilities | | | | 1.5% (1) | 1.5% (1) |

Percentages are approximate due to rounding.

balances, which they are not adequately equipped to handle. This may also serve as a contributing factor to the higher rate of inadequate supervisory and surveillance accident factors at the Part 135 operations than at the Part 121 operations.

As airlines grow larger, the problems appear to display tendencies shifting from those of direct supervisory and pressure, to those of a procedural, informational, documentary nature. What this may represent is a drift in the practical application of safety concepts. Normal rote operations may shift from time to time based on the accepted way work is performed. These shifts may also become part of organizational doctrine, as the safety rules for the original procedure become lost in the presence of the current context of work. This conceptual drift appears to contribute to the organizational factors experienced in the larger air carriers where procedural departures from routine become routine in practice in the absence of documentation and information sharing. This may be due to the hierarchical distance between the front line operators and the upper level management where the procedure is substantiated.

An abundance of factors occur toward the top of the organizational chain. Indeed, problems with the organization's procedures were cited in a majority of the accidents studied. The overarching organizational process set by those in charge of establishing the organization's directives and procedures may come into play that those in charge of setting policy are too far removed from the actual job to adequately address the issues involved. Perhaps it behooves those in charge, in the policy area specifically, to be sure a more bottom-up organizational approach is utilized to incorporate the expertise of those who actually

perform the work with that of those who preside over it.

Conclusion

This research provides an overview of the concept of organizational safety as related to the human factors perspective. We introduce a framework to objectively identify organizational factors as related to pilot error accidents. Once organizational factors are identified, interventions aimed at the supervisory and organizational levels of an establishment have the potential to improve the entire system when compared to issues at the operator level, which may focus on alleviating just one error. Valuable resources are better spent on prevention and control at the organizational level, rather than on trying to fix, after-the-fact, the inexhaustible ways people fail at the operational level. With this, we have the potential to eliminate a myriad of errors as opposed to the proverbial Dutch boy putting his finger in the dam, only to find numerous leaks exploding all around.

It bears mention that the accidents presented here are assessed according to the NTSB's findings of probable cause. Other accidents may meet the criteria of containing organizational cause factors, yet organizational factors in accident investigations have been historically overlooked and thusly not directly traceable as such in any findings. As a result, we have not included them here, thus the number of organizational accidents in commercial aviation may be higher than reported here.

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