Organizational Safety in Airline Operations

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Organizational accidents is a category of accidents caused by organizational factors. They are rare but have widespread consequences, many defenses and multiple causes, they are associated with judging and deciding, and have a long "history". Organizational accidents are also associated with highly regulated industries, such as aviation. There are several other constructs related to organizational factors undermining safety. Aviation is unfortunately closely associated with the traditional "Safety I" thinking, where adverse outcomes can be found at the end of causal chain and treating, and preferably eliminating, the causes will increase safety by preventing future accidents. An alternative view is "Safety II", where the focus is on what goes right rather than on what goes wrong. Safety II is thus defined as the ability to succeed under expected and unexpected conditions alike. Yet another viewpoint is Work-As-Imagined vs. Work-As-Done. In the former case, the focus is on accident and incident investigation and elimination of non-compliance errors ("name, blame, train"). In contrast, the latter perspective does away with both well-defined functions and malfunctions and accepts that performance is variable as a matter of fact and that the same variability can result in both success and failure. Because performance variability allows for adjustment to changing situations, it is the reason why everyday work is safe and effective.

Commercial aviation is an immensely large and complex system but also one with an unparalleled safety record. One can fairly claim that it is just that complexity that may be credited for the safety of the system. After all, the aviation industry has a relatively short history of just under 120 years (counted from the Wright brothers' first flight) and the rapid development of bigger and faster aircraft has been accompanied with equally rapid development of safety procedures and regulations. Yet, we know that complexity presents its own, inherent, hazards to safety.

Another hazard to safety comes from the distance of aviation managers and regulators from the operations. Through the years the focus of management of aviation companies has migrated from technical/operations oriented to legal/process oriented. In small companies talented workers can still develop management skills and move up to the management level, retaining their good understanding of operational processes. In larger companies managers often originate from management schools or other, sometimes not aviation related, companies. Their focus is to manage the processes within the company with guidance from legal requirements rather than from technical and operational expertise. This development has had a detrimental effect on safety in aviation.

In this paper we examine several concepts related to systemic complexity, poor communications, and management attitude and their impact on aviation safety. Examples are given from operational experience of the second author.

Organizational Factors

Scientific Management is a theory formulated in the late 19th and early 20th century to increase efficiency of work and decrease waste (Taylor, 1914). It introduced empirical methods to study work as it actually took place (i.e., Work-As-Done, WAD), with the intention to prescribe the “one best way” of doing it (i.e., Work As-Imagined, WAI). The principles of scientific management were to analyze tasks to determine most efficient performance, select people to achieve best match between task requirements and capabilities, train people to ensure specified performance, and ensure compliance by economic incentives. The WAI vs. WAD juxtaposition is also evident in behavioral sciences as well. For example, compare the idea of a homo economicus (Mill, 1848) and its assumptions of man completely informed, with infinite sensitivity, and thoroughly rational, and a decision theory that assumes that all options, outcomes and preferences are known and amenable to evaluation (i.e., WAI), to the Naturalistic Decision Making (NDM) properties that include people “muddling through” decisions and satisficing, with a decision theory that recognizes that most situations have incomplete, dynamically changing conditions and competing goal structures (i.e., WAD; Klein, Calderwood, & Clinton-Cirocco, 1985; Klein, 1999). The most recent WAI vs. WAD formulation seems to have appeared first about 10 years ago and it is mentioned by at least 3 authors (Sidney Dekker, David Woods, and Erik Hollnagel) in an edited book (Hollnagel, Woods, & Leveson, 2007). Hollnagel has further developed the WAI and WAD constructs in the healthcare domain (Hollnagel, Braithwaite, & Wears, 2013; Braithwaite, Wears, & Hollnagel, 2015).

Another useful dichotomy, or rather a continuum, is between what are known as “The Sharp End” and “The Blunt End” in an organization. The operators, or people who do the actual work (e.g., pilots), are in The Sharp End, the authorities and regulators in The Blunt End, and the management somewhere in between. In The Blunt End work is being managed by schedules and norms, which describe and prepare work for others, and managing how others do their work (quality controls, productivity standards). Production planning (e.g., “lean” optimization) also takes place here, as does monitoring and managing actions (sampling, level of detail) and investigations and auditing (errors, compliance). People in The Blunt End are regulators and arbiters of right or wrong, but have limited exposure to the actual work.

As organizations operate in time, the gap between The Sharp End and The Blunt End has serious consequences to the information flow between the ends, and the people along the continuum. Two important temporal variables within this model are the time for people to find out what is happening, and the “half-life" of information as it becomes obsolete. A gap between The Sharp End and The Blunt End results in reciprocal (mis)understanding: WAD is what I/we do, whereas WAI is what they (should) do. This creates an “Us” vs. “Them” dynamic in the organization, which is detrimental to safety.

Organizational impact to safety has a relatively short history. The term organizational accidents was coined by Reason (1997) in a book with the same title. Two kinds of accidents may be identified. Individual accidents are frequent, have limited consequences, have few or no defenses, have limited causes, consist of slips, trips and lapses, and have short “history” (i.e., the cause precedes the accident within a very short time frame). Organizational accidents, on the other hand, are rare, have widespread consequences, have many defenses and multiple causes, are associated with judging and deciding, and have a long “history”. As such, organizational accidents are much harder to investigate than individual accidents. Consequently, many accidents with organizational “roots” are not investigated as such, but as individual accidents. Unfortunately, such blaming of the flight crew members has a long and fruitless history in aviation safety.

Another type of accidents associated with systems is so-called “normal accidents”, also from a book with the same title (Perrow, 1984). These accidents result from multiple and unexpected failures that are built into society’s complex and tightly-coupled systems. Tightness of coupling indicates how fast cause and effect propagate through the system. Systems with loose coupling have slack along one or more dimensions such as time or space. Complexity indicates not only how many interactions there are but how hard they are for the operators of the system to see and understand. The tight-complex systems present fast-moving events to operators who may be too overwhelmed by them and react too slowly to rapidly propagating events. Automatic systems installed to react faster may be unreliable or give confusing signals (Whitney, 2003).

A Novel Approach to Safety

Traditional approaches to safety have followed the “causality credo”, or a reasoning that adverse outcomes (accidents, incidents, etc.) happen when something goes wrong; adverse outcomes therefore have causes, which can be found; treating or eliminating the causes will increase safety by preventing future accidents. Such reasoning is known as “Safety I” thinking (Hollnagel, 2018). It relies on manifestations, that is, observable adverse outcomes, mechanisms such as assumptions (e.g., the “causality credo” above), and that a root cause for every accident can be determined (e.g., Root Cause Analysis; RCA). Its theoretical foundations lie in the notion that systems are decomposable and accident investigation methods that are based on decomposition of the system to elemental parts.

An alternative approach is to view safety as a “dynamic non-event”, where reliability is achieved by constant compensation for changes in system components (Weick, 1987). It is invisible because people often do not know how many mistakes they could have made but did not and have only a vague idea of what produces reliability and how reliable they are. Reliable outcomes are constant, which means there is nothing to pay attention to. Operators see nothing, and seeing nothing, presume that nothing is happening. If nothing is happening and if they continue to act the way they have been, nothing will continue to happen (if it ain’t broke, don’t fix it). But this diagnosis is deceptive and misleading because it is dynamic inputs that create stable outcomes (Weick, 1987). A possible solution to this problem is to define safety as “a dynamic lack of failures”, which is also labeled “Safety-II” (Hollnagel, 2017, 2018). According to this thinking, the focus is on what goes right rather than on what goes wrong. Definition of safety is changed from “to avoid or prevent that something goes wrong” to “to ensure that everything, or as much as possible, goes right”. Safety II is thus defined as the ability to succeed under expected and unexpected conditions alike, so that the number of intended and acceptable outcomes (i.e., everyday activities) is as high as possible.

Consider the different perspectives of WAI and WAD to accident and incidents. The “normal” operation, where well-defined work functions, supported by barriers, regulations, procedures, and compliance result in success and acceptable outcomes. Malfunction is viewed as a non-compliance error, that results in accidents, incidents, and unacceptable outcomes. In the WAI case, the focus is on accident and incident investigation and elimination of non-compliance errors (“name, blame, train”). In contrast, the WAD perspective does away with both well-defined functions and malfunctions. Instead, the WAD perspective accepts that performance is variable as a matter of fact and that the same variability can result in both success and failure. Performance variability is inevitable, ubiquitous, and necessary, and because of resource limitations, performance adjustments will always be approximate. Because performance variability allows for adjustment to changing situations, it is the reason why everyday work is safe and effective.

A New Triad

In airline operations, the flying personnel in The Sharp End are not only dealing with airline management in The Blunt End but also aviation regulators and, as is increasingly the case, with aircraft manufacturers, which form a new triad, adding to the complexity of the air transportation system. Certification of aircraft and equipment, and the coupling or aircraft manufacturing and authorities certifying aircraft, was designed to check compliance with legal regulations and to see if possible errors may be overlooked after a manufacturer has developed an aircraft or aircraft system.

However, when certification becomes a goal rather than a check the process becomes counterproductive. If adapting an existing system simplifies the certification process compared to developing a new system, design goals may shift from delivering a safe system to squeezing them into an existing format. For example, Boeing's desire to market the 737 Max aircraft as requiring no additional training for flight crews because its identical handling with the previous generation 737 NG, albeit with the help of sophisticated automation known as Maneuvering Characteristics Augmentation System (MCAS), resulted in two unfortunate accidents (Lion Air Flight 610 on October 29, 2018, and Ethiopian Airlines Flight 302 on March 10, 2019), costly grounding of the aircraft, and redesign of its control laws software (Wendel, 2019).

The blurring of the roles of manufacturers and regulators (certifying agents) further contribute to distancing The Sharp End from The Blunt End. Manufacturers' expertise used for certification introduces a bias to speed up the certification process. Certifying agents often lack expertise and manpower to fulfill their role in the process. Once certification is acquired it may become a barrier to system improvement. Legally-oriented managers may ignore concerns from technical and operational experts so as not to jeopardize the system's certification status. For liability reasons most operators want their crews to follow manufacturers' procedures exactly. This Safety-I thinking. The assumed operational knowledge of a manufacturer is often overestimated. A manufacturer is not an operator and it is the responsibility of an operator to have procedures to be tailored to fit into their operation. Good guidance can be found on how to design flightdeck procedures (Barshi, Mauro, Degani, & Loukopoulou, 2016) and over time changes in common practices, systems, and materials may require adaptation of procedures and regulations. This is Safety-II thinking.

Technical and operational experts, that is, people in The Sharp End, can sometimes foresee operational problems and invest in systems or design procedures that can prevent them. Legally-oriented managers in the Blunt End must be prompted by regulations or operational/safety related incidents to take action. When a company is divided in departments with their own financial responsibility it is even more important that management oversees the consequences such savings in individual departments have on other departments and safety.

Examples

(1) When new aircraft were added to a fleet, a line pilot was consulted about what modifications were needed for making the aircraft operational. This pilot advised the airline management to install a system needed for dispatch in certain environmental conditions. However, the management sought a "second opinion" from another pilot who did not see this need based on his experience in another company abroad. The system was not installed. Only after several flight cancellations the system was installed at higher costs than initially required.

(2) A service bulletin for sealing of electrical connectors was rated as "highly recommended" instead of "mandatory" by the manufacturer of an aircraft. Only after an emergency return of one of the aircraft with a short circuit and smoke in the passenger cabin sealing of electrical connectors was performed.

(3) When remote de-icing started to replace gate de-icing manufacturers' procedures had to be adapted to cover the new situation.

(4) When computer performance calculations replaced "paper" calculations safety margins were diminished resulting in lower safety levels for some take-off procedures. Although the risk is now recognized by authorities, regulations are yet to change to cover the situation (Huijbrechts, Koolstra, & Mulder, 2019). It is difficult to convince management to change procedures just for the benefit of flight safety, even if the cost of change is marginal.

(5) The introduction of Type-4 de-icing fluid (thixotropic) resulted in clogging of drain-holes. Freezing of trapped water on subsequent flight resulted in incidents with jammed flight controls and gears. Extra maintenance procedures had to be introduced to prevent this.

Conclusion

There is a widening gap between the triad of airline management, aircraft manufacturers, and aviation authorities and technical and operational experts, driven by increased role of manufacturers in the certification of aircraft and system. Airline management often side with manufacturers and regulators in enforcing procedures without always adequately understanding the operational processes and consequences of such decisions. Incidents or even accidents have to occur first before procedures and systems are re-evaluated and corrected. Yet, accident investigations do not always reveal the real cause of an accident. Although organizational factors are increasingly recognized in investigations, manufacturers and air- lines usually are part of the investigation team. If a system or procedure fault plays a role in the cause of the accident this can result in liability claims. Investigation teams hence tend to focus on errors made by the individual crew members to avoid such responsibility. To improve flight safety at manufacturer and airline level, a mechanism has to be found to make managers feel a responsibility for the quality and safety of their product that goes beyond just fulfilling legal requirements and following processes correctly. A first step is to improve communication between management and technical and operational experts.

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