INFORMATION EMPOWERMENT OF OPERATION CONTROL CENTERS AND THE CENTRALIZATION OF AVIATION DECISION-MAKING

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The advancements of communication and information technologies (ICT) in aviation is contributing to a better information access at Operation Control Centers (OCC). This seems to be increasing their influence over crews and the quality of decision-making, empowering the OCCs and changing the decision-making balance between the sharp end (Crews) and blunt end (Operations management). Creating a centralization tendency in aviation. As a qualitative exploratory research, we’ve made a set of five interviews with airline pilots, mainly captains, and a OCC chief manager to verify how the decision-making of the pilots is being affected by the information availability to the corresponding OCC, and what are the possible outcomes of this process. We’ve concluded that the decision-making is likely being affected. Pilots may be sharing a greater portion of their decision-making so that the OCC and company can operate more efficiently. This phenomenon might change our approach to both safety and management in this industry. This study is important to improve OCC and pilot’s integration and develop better management solutions for
aviation and possibly other high reliability organizations, which operate in complex and tightly coupled systems, with abundant information, and an ever-growing need for cost reduction and increased efficiency and safety.

Palavras-chave: Aviation; Decision Making; Operation Control Centers; Operations Management; Information Empowerment;
1. Introduction

Aviation is an industry that integrates several specialties and requires countless interactions between systems and components. According to Charles Perrow (1984), such highly complex and tightly coupled sociotechnical systems, must be centralized and decentralized at the same time to operate properly. With the advancements in communications and information technologies (ICT), some industries are being flooded by enormous amounts of information that can, and are, being used to achieve better management and efficiency. This avalanche of available data, in some industries, may be changing the need of a centralized decentralized organization, allowing these systems, throughout the integration of the operations by the OCC, to be progressively operated in a more centralized way.

This paper explores the decision-making process in highly complex and tightly coupled systems, and high-reliability organizations (HROs - LAPORTE & CONSOLINI, 1991), like nuclear and petrochemical industries, since this change may also be taking place in them as well. The results could be used to improve OCC managers and crews training and integration; enhance decision-making efficiency; develop better management solutions in an era of information and data abundancy, thus reducing costs and accidents.

Systems considered complex have so many interactions that fully modelling the functioning of such systems is impractical (CILLIERS, 1998). In the context of an airline, it is possible to divide these interactions in two groups: micromanagement (sharp end), and macromanagement (blunt end). In the sharp end, we have pilots interacting with cargo handling, catering, maintenance, refueling, air traffic controllers, among other variables. In the blunt end, we have the Operation Control Centers (OCC), which are organizational structures responsible for the execution of flight planning, flight monitoring, crew rosters, etc. (FOGAÇA, 2015; CLAUSEN et al. 2010; KOHL et al. 2007). In this context, it is important to have both micromanagement and macromanagement working harmoniously.

The relation between the need to centralize decisions and accident susceptibility was studied by Charles Perrow (1984). He divided human activities in four quadrants in terms of coupling
(tight and loose) and complexity (complex and linear). Complexity is related to the number of interactions a system has. Coupling relates to the speed of propagation of a failure throughout the system, being that tight coupling requires faster response times, i.e. failures will happen in a cascade effect. Perrow argued that highly coupled and complex human activities are inevitably prone to accidents (Normal Accidents Theory – NAT).

Each of Perrow’s quadrants represents a different approach to management, requiring specific organization qualities to work properly and safe. Highly interactive systems are difficult to control, not only because of the variety of components but mainly because the interactions between the components may be non-linear (PERROW, 1984). In these interactive complex systems, abnormal states are difficult to diagnose since the cause is hidden by the controls that where meant to maintain the system operating normally. Therefore, an interactively complex system could only be controlled by a decentralized organization, where sharp end personnel have autonomy and are encouraged to interact with others. Tightly coupled systems, could only be controlled by a centralized organization, where activities must be strictly coordinated to avoid conflicts that could lead to an accident.

Table 1 - Interactions and Coupling Chart
<table>
<thead>
<tr>
<th>Linear</th>
<th>Interactions</th>
<th>Complex</th>
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<tbody>
<tr>
<td>Tight</td>
<td>Centralize to deal with tight coupling</td>
<td>Centralize to deal with tight coupling &amp; Decentralize to deal with unexpected interactions</td>
</tr>
<tr>
<td>Loose</td>
<td>Both Centralization and Decentralization work</td>
<td>Decentralize to deal with unexpected interactions</td>
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Source: Adapted from Morud et al. (2004)

HROs accept the fact that it is impossible to achieve zero accidents, thus try to develop organizational skills and culture to detect errors and quickly recover when they happen – using a notion of “mindfulness” (WEICK & SUTCLIFFE, 2001). In opposition NAT, Weick (1987) argued that culture can substitute centralization, hence creating centralized and decentralized organizations, which are able to reconfigure themselves during crisis (ROSNESS et al., 2000).

Aviation, being in the highly complex and tightly couple quadrant, must deal with this paradox. In the sharp end, pilots deal with a context of conflicting goals, scarce resources and incomplete information (FOGAÇA, 2015), and depending on the situation e.g. an emergency, do not have enough time to contact the OCC asking for assistance. Their training is heavily focused on error management, aiming aspects like leadership, effective coordination and communication, teamwork, situational awareness, stress management, etc. (HELMREICH et
al. 1999). Furthermore, they are prepared to deal with problems and emergencies locally, mitigating human error as much as possible. Their training focuses on autonomy, backed up by law (INTERNATIONAL CIVIL AVIATION ORGANIZATION, 2005). On the other side, the OCC integrates solutions, optimizes available resources, managing the big picture and supporting pilots as needed.

As mentioned before, both sharp and blunt ends are essential to make this type of system work. The sharp end is unable to completely understand the context of operations as a whole. The same occurs with the blunt end, where it is impractical to the OCC managers to micromanage each and every operation in the front lines. In this context, information, empowers decision-making, and consequently, the management of the system (WYNER & MALONE, 1996). This happens in aircraft with highly advanced systems and in the OCC. The abundant information available helps decision-making processes by making it more rational, reducing the uncertainty, enabling the evaluation of more decision alternatives, increasing the efficiency and empowering the decision maker (CITROEN, 2011).

Sundnes (2014) state that OCCs have three requirements to effectively coordinate and control: mandate – political authorization to provide management; power – autonomy and authority to implement interventions and make decisions; and resources – what is required to perform its functions. In aviation, this could mean that empowering the OCCs would enable them to coordinate more efficiently, thus increasing the centralization.

In contrast, the OCC research in the space travel industry (FRANK et al., 2013; KANAS et al., 2010, 2011; KRIKALEV et al., 2010; LOVE & HARVEY, 2014) is arguing that crews are the ones that must have autonomy – which we define as freedom to make decisions, and authority – which we define as power to enforce. This change is happening mainly due to the communications delay during very long-haul space flights e.g. mars missions, where a message can take several minutes to arrive (LOVE & HARVEY, 2014). In aviation, instead, limited communication is not a problem, but the context of centralization or decentralization is related to the discussion of this article.
In a context of complex and tightly coupled systems and abundant information, it is possible that the decision-making balance between the sharp and blunt ends is changing. Pilots may progressively lose some of their decision autonomy so that the OCC could perform better in macro scale management. These changes could mean an increase of centralization, consequently a possible drift towards the boundaries of the Perrow’s centralized decentralized quadrant. Therefore, we explore the perception of the balance of centralized and decentralized decision-making on aviation, and the relation between pilots and OCCs, to answer the following question: How does the decision-making of the pilots is being affected by the information availability to the OCCs, and what are the possible outcomes of this process.

2. Method
This is a qualitative exploratory research using semi-structured interviews (FLICK, 2009). To study the subject, we’ve made a literature review and five independent interviews. The first two interviews were made in face-to-face meeting, and the other three via Skype. The interviews lasted an average of forty-five minutes.

A small adjustment was made in the interview protocol after the first two interviews to better focus the answers on the research question. We have used the two first responses as well, because it is our understanding that the scope of the study remained unharmed.

Interviewee A was an airline pilot for more than thirty years and a captain for more than twenty years. He was a chief pilot and chief instructor of a Brazilian airline. He is an Aeronautical Science professor for twenty-two years. Although he does not fly anymore, he has an extensive knowledge about aviation in the past and the relation between pilots and OCCs. Since he started his career on a pre-digital era, he brings to the discussion a very interesting perception.

Interviewee B is an active first officer with nine years of airline experience and an Aeronautical Science degree, and also an aeronautical science professor for four years.
However, as a first officer, he may have a different perspective of the issue (as decisions are ultimately a Captain’s responsibility). His contribution is important though, because of his familiarity with operations engineering in his company (closer to the blunt end) and also as a pilot with close to 10,000 flight hours’ experience.

Interviewee C is an airline captain, instructor and flight safety manager, with seven years of experience and an Aeronautical Science degree on a major Brazilian airline.

Interviewee D is an airline captain in a major middle eastern company, with six years of experience and an Aeronautical Science degree.

Interviewee E is a OCC chief manager for more than three years and has more than twenty years of experience working at major airlines’ OCC. We’ve chosen to also interview a OCC manager so that we can analyze not only the pilot’s perspective but also have a contrast in the discussion.

The interviews’ audio was recorded and then analyzed, seeking identify the perception of pilots and OCC manager about their decision-making balance, if they perceive any change in it, and what is the role of information in this issue. We also tried to identify if there were any changes in this balance throughout time (i.e. perceived difference along their careers).

3. Results

All of the interviewees agreed that the information has a major role on decision-making and that it is crucial to be grounded on it when making a decision. It seems that the more information is available, the greater the ability to make a better decision and support it afterwards – corroborating with Citroen (2011). They also show that information has a big role on influencing both OCC and flight crew, so that the one who has more information can better support its point of view, possibly making the other side change opinion or give way. It seems that in some situations it is easier for the OCC, with its abundant information, to ground their decision then it is for the captain. According to the interviews, there is also an
increasing world trend of making the company aware of what is happening on the flight, keeping them in the feedback loop as much as possible.

The interviews showed that, nowadays it is not only easier and faster obtain information, but also that it comes with a higher quality. One example is the OCC agent that Brazilian airlines now has at the CGNA (Centro de Gerenciamento da Navegação Aérea), which is an Air Navigation Management Center responsible for the air traffic flow management, regarding mainly airports infrastructure. This representative collects real time data that was not available in the past, effectively connecting the airline and the national air traffic management system.

It was pointed by all pilots interviewed, that they perceive a captain’s loss of authority over time and that the company is having a bigger share and influence on pilot’s decision-making, always inducing pilots to make a decision in favor of the company. Consequently, pilots must be always filtering OCC’s decision and, if they want to make a different one, must be really certain of it before confronting the company. One interviewee said that if the pilot’s decision result in bad consequences, they will not have company’s support and will have to account by the action. The pilot’s autonomy seems to be somewhat preserved in emergency scenarios, with the OCCs typically stepping out (but remaining available for suggestions at pilot discretion).

On paper, captains have final authority to decide, but in many practical situations, the increased information available to the companies and therefore the inherent ability to contest pilot’s decision shows as an important factor leading pilots to sometimes avoid decision making or at least feeling pressure to validate as many decisions as possible with an OCC. This tendency, fueled by fear of losing employment, peer pressure and sometimes lack of experience, may be making their decision more vulnerable and biased towards the company, even if that could lead to a deterioration of flight safety. Over time, pilots feel this is generating a tendency for captains to stick with the company decisions, or always look for company’s endorsement, trying to implicitly share responsibility for the decisions sharing (or even trying to delegate accountability).
The OCC empowerment is less evident in emergency situations because there is little macro management to be done. In these scenarios, the management is always directly related to aircraft operation: e.g. piloting the aircraft. The search for efficiency and profitability is greatly reduced, since the main goal becomes safety; and, depending on the scenario there is little, if any, communication between pilots and OCCs due to the high pilot’s workload. The OCC role becomes one of support to the crew and making the necessary coordination and management of the resources needed for safe landing, and any “after mitigation” or recovery, even though they may advise on possible preferred airports or courses of action in some situations.

It was pointed unanimously by the interviewees that some pilots are not fully aware of how the OCC works, as well as some OCC managers are not fully aware of how the aircraft operation works. Some pilots seem to be promoted to captain without being duly acquainted, and don’t completely understand neither the role of the OCC nor the operation’s complexity.

Some airlines have training programs to get crew familiar with the OCC and other airline departments. The same applies to OCC managers. Even with these programs, it seems that there is still a lack of familiarity and understanding that could be making pilots decision-making more vulnerable to the OCC.

The interviews suggested that the decision-making is not entirely made by the crew. It is a composition between pilots and OCC decision. This probably happens because when making a decision, it is good practice to try to find what is better for the company and for the crew, and because one of the sides can have an information that the other one is not aware.

Decision grounding is understood as paramount. This is reported to be done through information, experience or knowledge. So, even without all the information availability that OCC has, using experience and knowledge is one way that pilots can sustain their share in decision-making from OCC’s heavily information grounded decision. By doing this, pilots can make use the OCC in their favor as an adequate support.
All pilots interviewed said that the “decision scales” must weigh towards the pilots, despite the increasing influence of the OCC. That’s because the pilots are the ones at the front lines, directly responsible for the safety of the flight, and with training focused on safety and decision-making.

The OCC manager, on the other hand, said that the scale weighs towards the OCC due to the amounts of information it possesses. It was reiterated that the information possessed by the pilots is crucial, but they will always have less information than the OCC, and that they can better solve the problems directly related to the flight but not the ones related to the macromanagement. Therefore, for the manager, the OCC has a bigger share at the decision-making.

In the past, as some interviewees pointed out, the weight over the captain was heavier than it is today. This occurred, according to the interviewees, because captain’s authority over the flight was bigger since he was a central figure of decision-making. It was common for captains to make decisions in matters that were not of his competence, like delaying a flight for reasons other than safety (e.g. delay a flight to wait for passengers nowadays an OCC matter).

It is interesting to note the different perceptions between pilots and OCC about the same issue. This probably happens due to the different contexts they are inserted and also different training. Even though the goals are similar, the different local objectives exist, and although a safe operation is the base of an airline sustainability, OCC’s might be biased towards production, while pilots must provide a counter gradient towards safety. Furthermore, it seems that pilots are better equipped to think locally – solving problems directly related to their flight, while OCC’s decisions typically have the bigger picture in sight.

The analysis of the interviews shows a clear progressive tendency of empowerment of the OCC through the years, and therefore a tendency of centralization in this industry.

This shift in balance shows that aviation could be moving inside Perrow’s centralized decentralized quadrant and, eventually, across the boundary. It is intriguing that, on aviation,
information is possibly leading to a centralization, whereas in general it has a natural trend to decentralize (WYNER & MALONE, 1996). However, this shift towards centralization could mean a different approach to safety and management, since the legal training standards and requirements may not work as they used to. Even if aviation never crosses the line, we may need to fine tune the industry to these changes, to keep it running efficiently and safe.

4. Conclusion
This exploratory research, sought to look into the technology advancements that are enabling OCCs to have better information access, and its effects on the decision-making balance between OCCs and pilots. These systems appear to be progressively more centralized due to an information empowerment phenomenon.

We’ve found very few studies on this subject. A central limitation of this research is the short number of interviews that were made, due difficulties to access OCCs and pilots. Future developments require a greater number of interviews with both pilots and OCC managers, including other similar HRO settings (e.g. in hospitals and petrochemical industries) which could help confirm some of the findings. Due to the small sample, we cannot state that the empowerment is happening universally, even though it seems to be a trend, thus the results must be interpreted carefully.

There is a need to further discuss what are the possible implications of increased centralization on aviation and other industries and how that can change our theories of safety management and general management. On top of that, it is our understanding that a new focus is needed on how we can better train both sides of these systems, so that there is better convergence and integration.

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