Prospectus

Establishing a Benefit Case for New Airport Traffic Control Towers
(Technical Topic)

Safety Culture and Complacency in Air Traffic Control Systems
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Sociotechnical Problem

As of the Federal Aviation Administration (FAA) *Air Traffic by the Numbers* (FAA, 2019a) and *Aerospace Forecast* (FAA, 2019c) reports, there are 518 air traffic control towers (ATCTs) in operation, and activity at these towers is forecasted to increase at an average rate of 0.9 percent through 2039. ATCTs are crucial in an airport's ability to handle a large volume of activity, providing runway and taxiway organization, offering weather and terrain guidance, and handling unusual or emergency situations. They serve as a symbol of safety for passengers and pilots, and provide benefits to airports – small, medium, and large.

When an airport determines the need for an ATCT, it must follow the FAA guidelines for establishment of a tower. Although the guidelines are generally comprehensive, they tend to be biased towards larger airports and have not been revised since 1990. With the changes in aviation since then, the criteria are vastly outdated. This is a pressing safety concern, as airports that would benefit immensely from an ATCT may be overlooked using the current procedures. To address this, the technical project will propose a model formulation that will serve as an updated method of quantifying ATCT benefits, focusing on smaller airports. However, a benefit model with potential ATCT establishments will not be sufficient to accomplish the goal of aviation safety. Looking at the Air Canada Flight 759 near-miss accident at a towered airport, it is clear that there are also social factors that influence the safety of flying. Despite having an ATCT and an active controller on duty, the incident flight nearly crashed into four aircraft carriers on the taxiway of its destination. There is no single reason for the incident, but the safety culture and growing issues of complacency surrounding air traffic control (ATC) systems undoubtedly played a part. If this continues, there is only so much an ATCT can do, and sooner or later a near-miss accident will simply become an accident.

To address the problem of improving aviation safety, I will explore both technical and social factors. Without understanding both factors, it is not possible to have a comprehensive approach to aviation safety. This paper provides a further explanation of the purposes of an ATC system, and of the need for an updated benefit model. In addition, I will use actor-network theory to analyze network formation at the San Francisco airport and how human and non-human actors are undermining the capabilities of an ATC system.

Technical Problem

In the United States, national airspace is divided into four categories, one of which is controlled airspace, a generic term that covers the different classifications of airspace (A-E) in which Air Traffic Control (ATC) services are provided (FAA, 2017, Section 3-1-1). The ATC system primarily serves to prevent collisions between aircrafts and other hazards. It includes ATCTs, which are established to provide for “safe, orderly, and expeditious flow of traffic on and in the vicinity of an airport;” they are responsible for taxiway and runway movement, providing advisories and safety alerts, and for managing emergencies (FAA, 2019b, Section 2-1-1). In conjunction with a new ATCT, Class D airspace is usually established. This airspace sees low to medium volumes of traffic, and is predominantly general aviation, business jets, and flight training. Establishing a tower at an airport changes the operating environment and procedures for pilots flying to and from the airport (“Air Traffic Services Process Brief,” 2005). Because air traffic operations are not the only factor to consider when establishing a tower, there are often questions about how the FAA makes its decision.

The FAA has several criteria in determining whether to establish towers or to discontinue tower services, the most important of which is a benefit-cost (BC) ratio detailed in FAA-APO-90-7. The BC ratio considers traffic density, terrain, weather, and aircraft operating efficiencies;

it indicates that a tower should be built if an airport has a BC ratio greater than one, and that a tower should not be built or should be decommissioned otherwise. It is still possible for an airport to build a tower if its BC ratio is less than one; however, in most cases, the community is required the pay 20 percent towards the total construction and operational costs of the contract tower through the FAA's cost share program (U.S. G.P.O., 2009, pg. 117 STAT.2513). This means that whether an ATCT is approved and funded by the FAA is determined solely using the FAA-APO-90-7, a document that was last updated in 1990. As with most other technological fields, aviation has changed extensively since 1990, and the current establishment criteria are considerably outdated. In addition, upon examination, the Department of Transportation (DOT) found that certain towers were consistently efficient, while other towers frequently ranked among the least efficient. The performance gap between the relatively efficient towers and least efficient towers was substantial, and the least efficient towers were estimated to use as much as 42 to 66 percent more resources than their efficient counterparts (OIG, 2005). This demonstrates that the current model for tower establishment is not effective. If the criteria are not updated to reflect the changes among aviation, then the FAA will continue to incur costs for inefficient towers. There will not be a clear method of determining whether an ATCT should be established or discontinued, and the total risk mitigation capabilities will be inhibited.

The goal of the technical project is to develop a model that quantifies the benefits of ATCTs; it will be targeted towards airports serving Class D airspace, and will use airport specific data to aid in the decision to establish a tower. The team will not be proposing any changes in the design of the tower, airplanes, or technology. Rather, the initial focus will be on formulating a system to consider whether it is beneficial for Class D airports to build an ATCT. Areas of focus will be on safety, economics, customer experience, and environmental benefits. The majority of the project timeline is anticipated to be spent looking at benefits, but the final model will include costs as a user input.

STS Problem

As the field of aviation continues to develop, and the number of commercial flights increases, aviation safety becomes increasingly important. An essential part of aviation safety involves the ATC system, such as that in San Francisco, California, where what could have been the worst accident in aviation history was closely avoided (Koenig, 2018). On July 7th, 2017, "Air Canada flight 759 was cleared to land on runway 28R at the San Francisco International Airport (SFO), but instead lined up with parallel taxiway C where four air carrier airplanes were awaiting clearance to take off from runway 28R" (NTSB, 2018, p.1). The incident airplane reached a minimum altitude of about 60 ft. above ground, a mere 13.5 ft. above the PAL115 airplane on the taxiway, before starting to climb (NTSB, 2018).

The National Transportation Safety Board (NTSB) identified causes of the near-miss accident in its incident report, the first of which was the first officer's failure to tune the instrument landing system (ILS) frequency for runway 28R. Having previously flown into SFO at night, the crewmembers expected to see two parallel runways; their lack of awareness about the runway 28L closure led to the incorrect identification of taxiway C instead of 28R as the intended landing runway (NTSB, 2018). Without having tuned the ILS, the crewmembers could not take advantage of its lateral guidance capabilities to ensure proper alignment, and the cues indicating misalignment were not sufficient to overcome their belief, as a result of expectation bias, that the taxiway was the intended landing runway (NTSB, 2018). Expectation bias is defined as "having a strong belief or mindset towards a particular outcome" (FAASTeam, 2012). In addition, as current Canadian regulations sometimes do not allow for sufficient rest for pilots, the captain and the first officer were fatigued during the flight due to the number of hours that they had been continuously awake. Due to thunderstorms during the first half of the flight, the crewmembers were prevented from taking advantage of controlled rest during the flight (NTSB, 2018).

While the above are all viable causes, the report failed to recognize the safety culture and growing issue of complacency in ATC; as aviation continues to become safer, it has become harder to avoid complacency (Sullenberger & DeSaulnier, 2019). Traditionally, air travel safety improvements are made after devastating circumstances, and the safety culture leads to the assumption that, because there have been few accidents, everything is being done correctly (Sullenberger & DeSaulnier, 2019). If "year after year, pilots and traffic controllers encounter few threats, and few genuine emergency situations, the temptation to ease up and deviate from the standard operating procedures is understandable" (Johnston & McDonald, 2017, p.57). This mindset, evidenced through expectation bias in the Air Canada near-miss, points to the need to recognize and identify safety risks from human error and nature.

If the safety culture and issue of complacency continues to be overlooked, then the FAA along with its stakeholders will not be able to gather a comprehensive understanding of the Air Canada incident, which will inhibit future investigations and accident prevention efforts. The analysis of the Air Canada incident will utilize the science, technology, and society (STS) concept of actor-network theory, which explores the technology-society relationship that examines power dynamics in heterogeneous networks. Heterogeneous networks are those comprised of human and nonhuman actors and include a network builder and a goal. In particular, I will use Michel Callon's concept of translation, which describes the process of forming and maintaining an actor network, to understand how human and nonhuman actors played a role in undermining the goal of the San Francisco ATC system to ensure safety within and surrounding the area of the airport (Callon, 1987).

Conclusion

The technical report will deliver a new model that quantifies the benefits of establishing an ATCT at a small airport and the STS research paper will provide a better understanding of the social factors that may undermine ATC safety. The new benefits model will overcome biases against smaller airports and will account for changes in aviation since the current model was created in 1990. This will ensure that the FAA has a clear method of determining whether it should establish or discontinue a tower at a smaller airport. Having this new model effectively mitigates risks within the vicinity of an airport; however, as will be discovered in the STS research paper, there are many actors associated with the ATC system and the existence of a tower is not the definitive solution to safe air traffic. Using the Air Canada near-miss that occurred at the towered San Francisco airport, I will explore safety culture and the growing issue of complacency to provide a different angle on the current vulnerabilities in the ATC system. The technical report and STS research paper will work together then, to present a more comprehensive understanding of aviation safety.

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