AIRLINE OPERATIONS MANAGERS: AN INTRODUCTION TO THE THIRD LEG OF THE NATIONAL AIR TRANSPORTATION SYSTEM

Karen M. Feigh, Amy R. Pritchett; Georgia Institute of Technology, kfeigh@isye.gatech.edu, Atlanta, Georgia

Abstract

US airlines play a large role in the efficient operation of the national air transportation system. Little, however has been written about how airline operations management decisions are made. This paper presents the results of contextual inquiries conducted on three Sector Operational Managers at a major flag carrier. Sector Operational Managers were found to play a key role at both minimizing disruptions to the NAS and in speeding the recovery at the airline level of air traffic following the conclusion of disruptions.

Introduction

US airlines play a much larger role in the efficient operation of the national air transportation system, than their European counterparts. Most US airports and airspace sectors operate on a first-come, first-served basis and as such the decisions of individual airlines have a huge impact on certain sectors of the NAS. For example airline actions at Chicago's O'Hare airport recently caused such gridlock at the airport that a special meeting had to be convened between the FAA, airport officials and the airlines to address peak period congestion [2].

The national air transportation system is however not only subject to strategic decisions made by airlines, but is also dependent on the daily implementation of these strategic decisions. The safe and efficient management of an airline is a complex cognitive task, involving many individuals working in close coordination. Airlines develop optimized schedules months in advance to maximize profit and aircraft utilization, and then implement these schedules for several months according to strategic corporate plans.

However these optimal schedules are often disrupted during the course of normal operations. Just as flow control happens at many levels, so too disruptions impact the NAS at many levels. At the national level disruptions due to convective weather often call for the implementation of a ground delay program, a ground stop, or playbook reroute. At a lower level, airline responses to these same disruptions or a higher level disruption response, include flight delays, flight cancellations, the addition of new flight segments, and new flights.

Considering the number of deviations and their impact on the NAS, it is of interest then to determine not only how airlines make strategic decisions about fleeting and scheduling, but also how airlines make daily operational decisions. The decisions about how to cope with deviations and how to return to the normal operating schedule are made and executed by a team of individuals at each airline. At one major carrier these teams are centered around Sector Operational Managers who have the complex task of maintaining the overall schedule while minimizing disruptions to passengers, maximizing aircraft utilization, minimizing revenue impact while complying with all federal regulations and contractual obligations for staff and crew.

To date the job and role of both pilots and air traffic controllers has been well documented [3-8]. Less, however, has been written about the aspect of the air transportation system impacted by individual airlines [9;10]. Optimization software packages have been designed and implemented to help these Sector Operations Managers to improve airline schedule recovery performance. However these operations research decision support tools have been developed without proper consideration for the work that Sector Operations Managers perform. As a result the decision support tools are rarely used. The tools are often inappropriate for routine tasks. Disuse and lack of understanding of how the tools work, causes their results for the tasks which they are used to be disregarded.

In this paper we use contextual inquiry to look specifically at the work performed by Sector Operational Managers. Contextual inquiry allows an examination of how the system operates while taking into account not only the users but also everyone actively dependent upon the work. Specifically, this paper will discuss the role of Sector Operational Managers, the information and tools they use to make their decisions and how these decisions impact the NAS. In addition this paper will discuss some preliminary insights derived from the contextual inquiries.

Methodology

A set of contextual inquiries was conducted on three Sector Operational Managers at a major carrier over the course of seven months (February to August 2004) for a total of over twenty hours of direct observations.

A contextual inquiry is an interviewing technique described by Beyer & Hotzblatt which is centered on four guiding principles: context, partnership, interpretation and focus [1]. The first principle, context, implies that the interview must take place where the work is being conducted. Conducting the interview in context allows the interviewee's actions and their answers to questions to be much more accurate. The second principle, partnership, requires that the traditional role of interviewer-interviewee is replaced with the familiar role of mentor-mentee. This relationship enables the interviewee to take more control in the interview and thus impart the knowledge that they feel is important instead of simply answering questions specifically asked of them.

The third principle, interpretation, signifies that a shared understanding must be developed about all aspects of work that matter. To accomplish this, the data collected must be transformed into meaningful information before it is useful. Contextual Inquiries use a set of models to bring about this transformation. The fourth principle of focus implies that unlike pure observation, contextual inquiry allows the interviewer to steer the conversation gently, to remain on task and to capitalize on unexpected insights.

Job Description and Duties

The following job description has been derived directly from the contextual inquiry, and provides a summary of the work models which are described in subsequent sections. The primary task of a Sector Operational Manager (SOM) is to maintain the airline's published schedule by ensuring that the on-time arrival and departure rates are within acceptable limits for the prevalent external conditions. Normally external conditions include weather related difficulties and air traffic control restrictions, but can also include random issues like inoperable equipment at airports. The SOMs maintain the flight schedule by making decisions about how to deal with deviations from the published flight schedule. Often these decisions are non-time critical with a look-a-head between 30 minutes to 6 hours. However sometimes the decisions are very time critical such as the rescheduling of flights after an emergency shut-down of a runway or the unanticipated depletion of fuel or de-icing fluid at an airport.

Airline Sector Operational Managers are highly knowledgeable, often having risen through the ranks. Correspondingly, they know all aspects of the airline industry. They understand what it is like for a crew to be stuck somewhere, or for a gate agent to deal with angry customers after a flight has been cancelled. SOMs spend a lot of time developing and maintaining interpersonal relationships, and as such verbal communication is very important to the work culture. SOMs can be deeply suspicious of upper management and management in general. They are highly loyal and truly wish to see their airline be the best airline it can be.

Airline Sector Operations Managers do not work in isolation. Rather they function as part of a larger operations team in which they often play the coordinating role. The Sector Operations Managers observed in this study were organized into three daily shifts. Each shift consisted of six SOMs each with responsibility for different sectors of the country: Eastern, Central, Western, International, Main Hub and ATC Liaison. It is important to note that one SOM serves as an interface between ATC and the airline.

Tools

The information required by the SOMs is readily available through a variety of (sometimes redundant) sources. The primary source of information is a text-based interface into the primary scheduling computer system. This computer system contains data about aircraft and crew schedules as well as weather information, notices to airmen (NOTAMS), information about the facilities at all of the airline's serviced airports, and the current duty roster of all operations staff.

The SOMs are highly skilled at using this system to find the information they require. They are often only one text command away from their intended information. SOMs are also aware of what information cannot be found in the computer system and are highly adept at finding the required information from the correct person. The one aspect that slowed down the Sector Operational Managers interviewed for this project was a high number of typographical errors made while entering commands into the system. As some of these commands were upwards of 20-30 characters in length, these errors were understandable.

Cognitive Models

The data collected during the Contextual Inquiry was incorporated into a series of models to facilitate understanding and to look at the role of a Sector Operational Manager from a variety of angles. The models presented here include a flow model to examine information flow, a physical model to examine physical context on work, artifact models to illustrate sources and stores of information used by SOMs, a cultural model to illustrate cultural forces and pressures which impact the work of SOMs, and sequence models to examine the procedures and motivations behind some of the SOMs' actions and decisions.

Flow Model

The purpose of a flow model is to show the flow of information between individuals and artifacts within the system and to note any breakdowns in information flow. The flow model for the Sector Operational Managers involved both individuals and computer systems. Individuals are represented by ovals. Artifacts (tangible pieces of information) are represented by small rectangular boxes, and areas of information storage are represented by shaded boxes. The flow of information between these elements is illustrated by arrows. Breakdowns in information flow are represented by lightning bolts.

A flow model for airline Sector Operational Managers is shown in Figure 1. The SOM is depicted at the center of the figure. His major sources of information are his computer terminal, telephone system, television displays and printer.

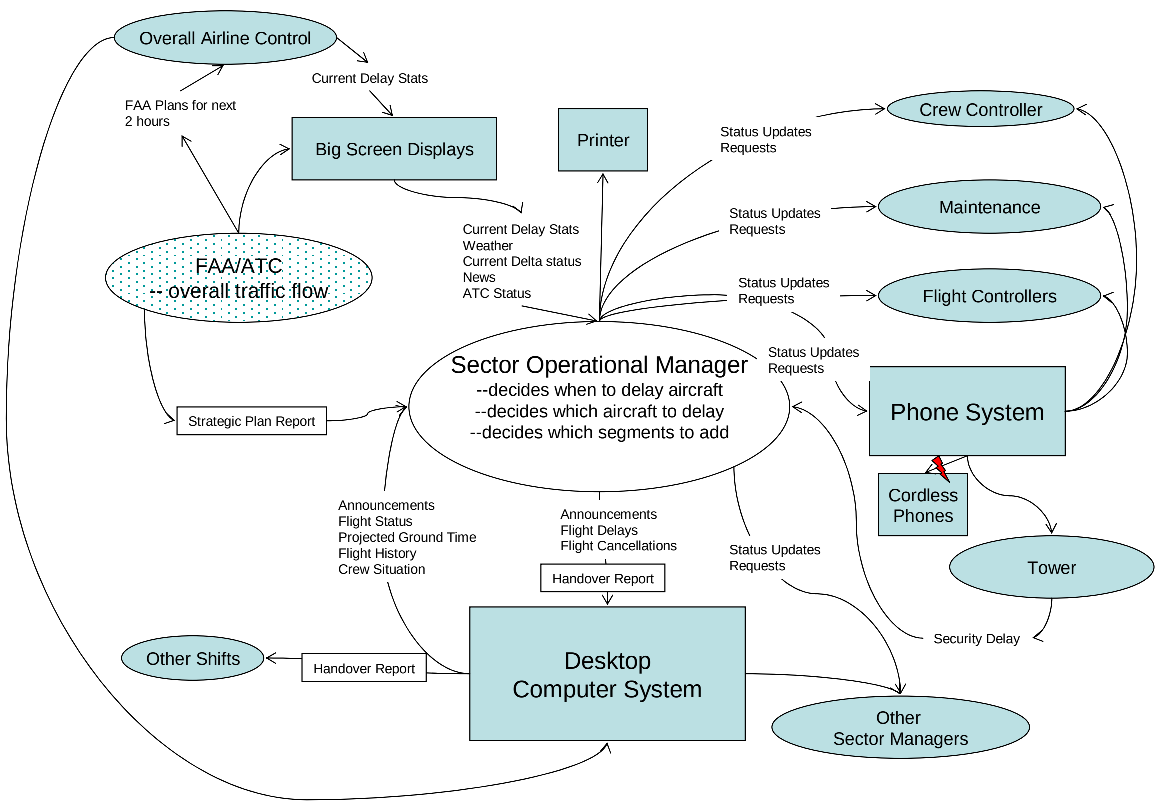

Figure 1: Flow Model for an Airline Sector Operational Manager

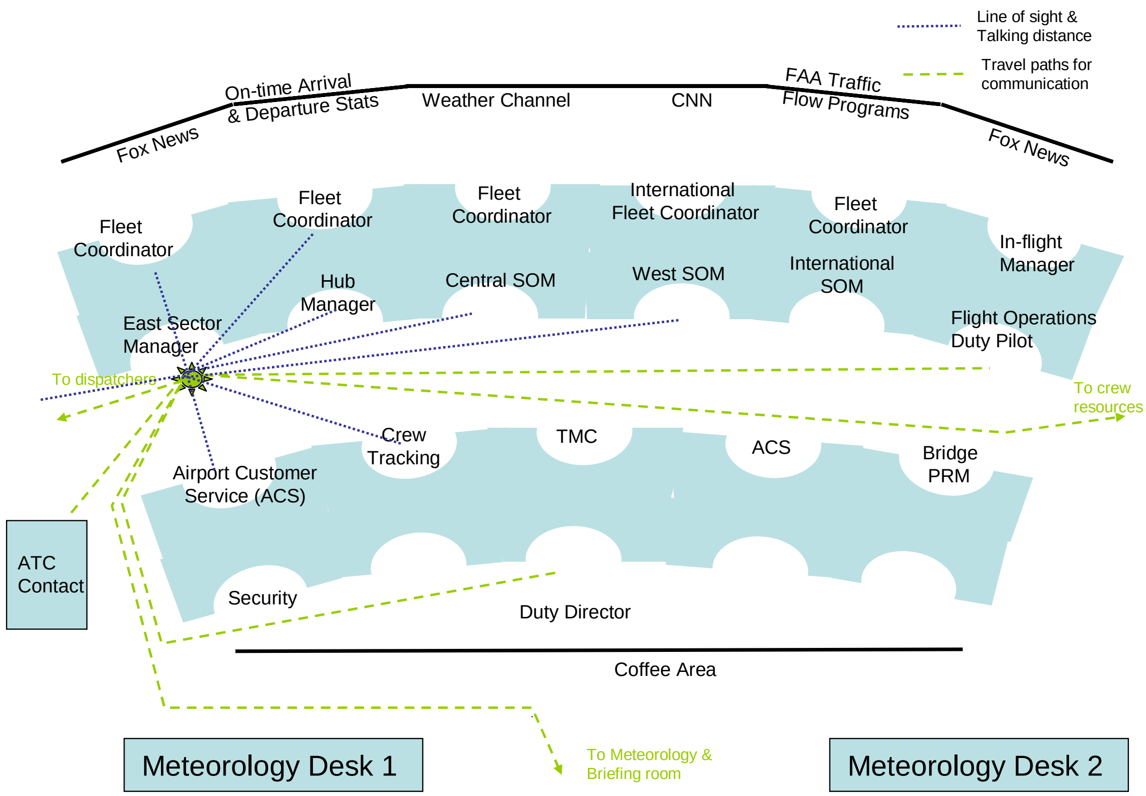

Figure 2: Physical Model for an Airline Sector Operational Manager

Only one potential breakdown was identified. Although the SOMs are provided with a cordless phone so that they may be mobile while using their phones, in reality, many do not use them. They prefer instead just to tell another SOM where they are going. In this way SOMs cover for one another, transferring tasks back and forth readily.

Physical Models

The purpose of the physical model is to depict the physical environment in which the work takes place and to detect any physical barriers to productive work. The physical model for the Sector Operational Manager is shown in Figure 2. As the figure illustrates, all of the SOMs are within view, and most are within speaking distance. In addition to the SOMs, the fleet managers, crew coordinators, customer service representatives and the duty director are all co-located.

Artifact Models

The purpose of the artifact models is to determine how artifacts help or hinder work. Sector Operational Managers use a variety of aids to help them with their work; however, few of them are physically tangible. The two physical artifacts are their workstations and their computer screens, see Figure 3. The workstation is organized such that the SOM has a computer display consisting of three 17 inch computer monitors interconnected so as to display a single computer desktop. This large computer display area enables SOMs to simultaneously display many of their software tools, such as radar tracks, weather radar and DOS-based text interface windows. Each workstation is also equipped with a continuous feed printer, which enables SOMs to print out any information displayed on the computer terminal. In addition, each work station is equipped with a touch-screen telephone system, a cordless phone, a keyboard and a mouse.

The vast majority of the aids used by Sector Operational Managers are software-based. These electronic artifacts serve two functions: information presentation and storage. Figures 4, 5, 6 all illustrate different software programs which present information to the SOMs.

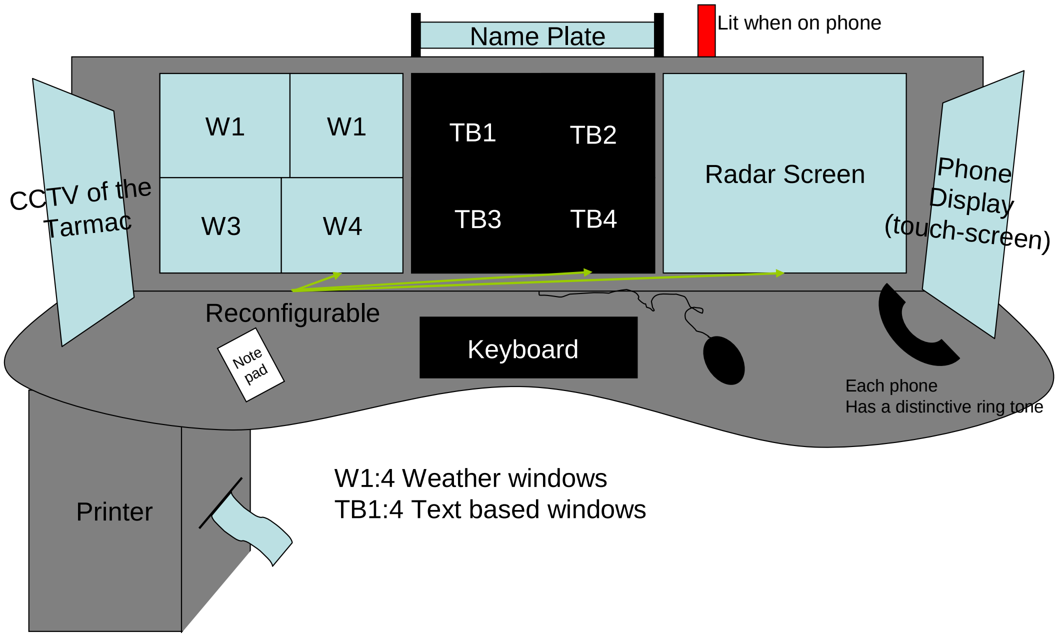

Figure 3: Artifact Model – SOM Workstation

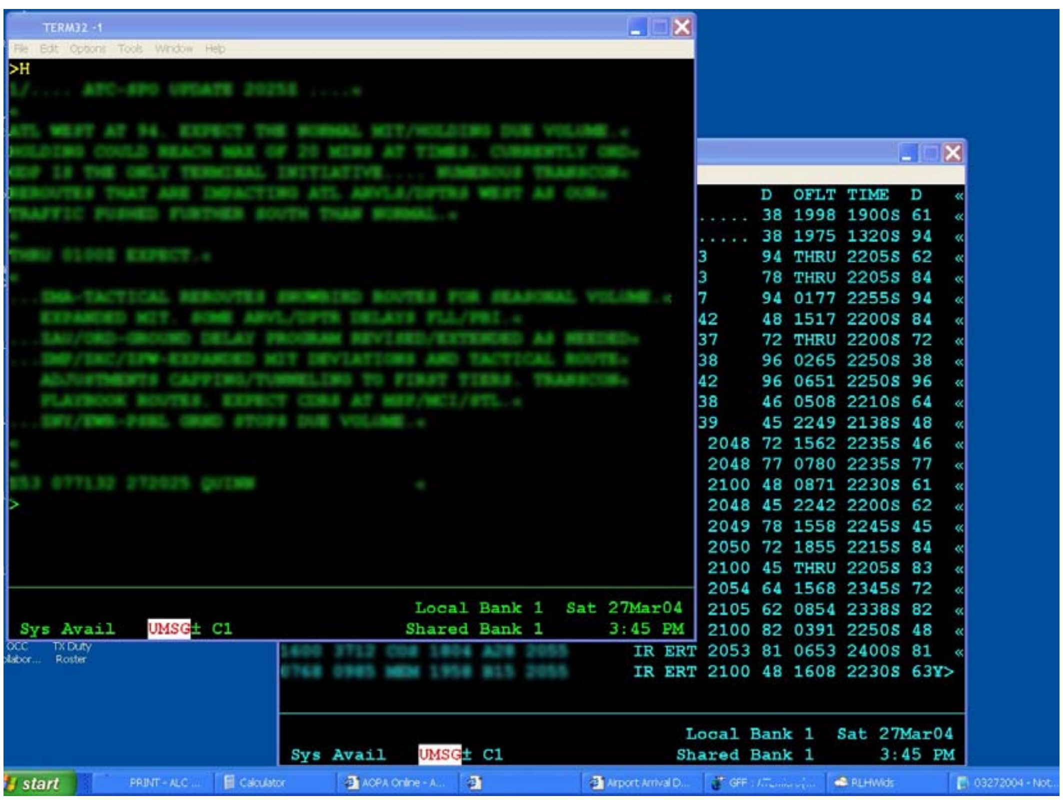

Figure 4: Artifact Model -- TERM32 Software Interface

(Some areas were intentionally blurred to protect proprietary information.)

Figure 4 shows the primary interface used by the SOMs: a DOS terminal from which the SOMs can interface with the airline's main scheduling database. For the purposes of this paper the DOS terminal will be called TERM32. This interface allows SOMs direct access to the scheduling database and is thus extremely powerful.

Figure 5 shows a new graphical user interface for the scheduling database, called ODT. This interface does not have all of the capabilities of the TERM32, but is more useful in monitoring the progress of arriving and departing aircraft, as aircraft predicted to arrive or depart significantly behind schedule can be highlighted automatically by the computer program.

Figure 6 shows another tool used by SOMs to determine future air traffic loads. This tool is provided directly by the FAA and accessed via the internet. It allows SOMs to assess the future airport arrival or departure load, and to adjust their tactics accordingly. For example, if the arrival rate exceeds the runway capacity for a single time block, then no drastic actions need be taken. However, if the runway capacity is exceeded for several time blocks in a row, then action needs to be taken to determine how these delays will affect the rest of the airline's schedule, or if the capacity has been lowered due to weather it is an indication that the FAA will decide to implement ground delay and ground stop programs. This tool allows the airlines to anticipate ATC flow control actions which will be implemented at a higher level and potentially impact them. In this way they may decided to initiate a departure push over an arrival push to keep their aircraft from being caught on the ground.

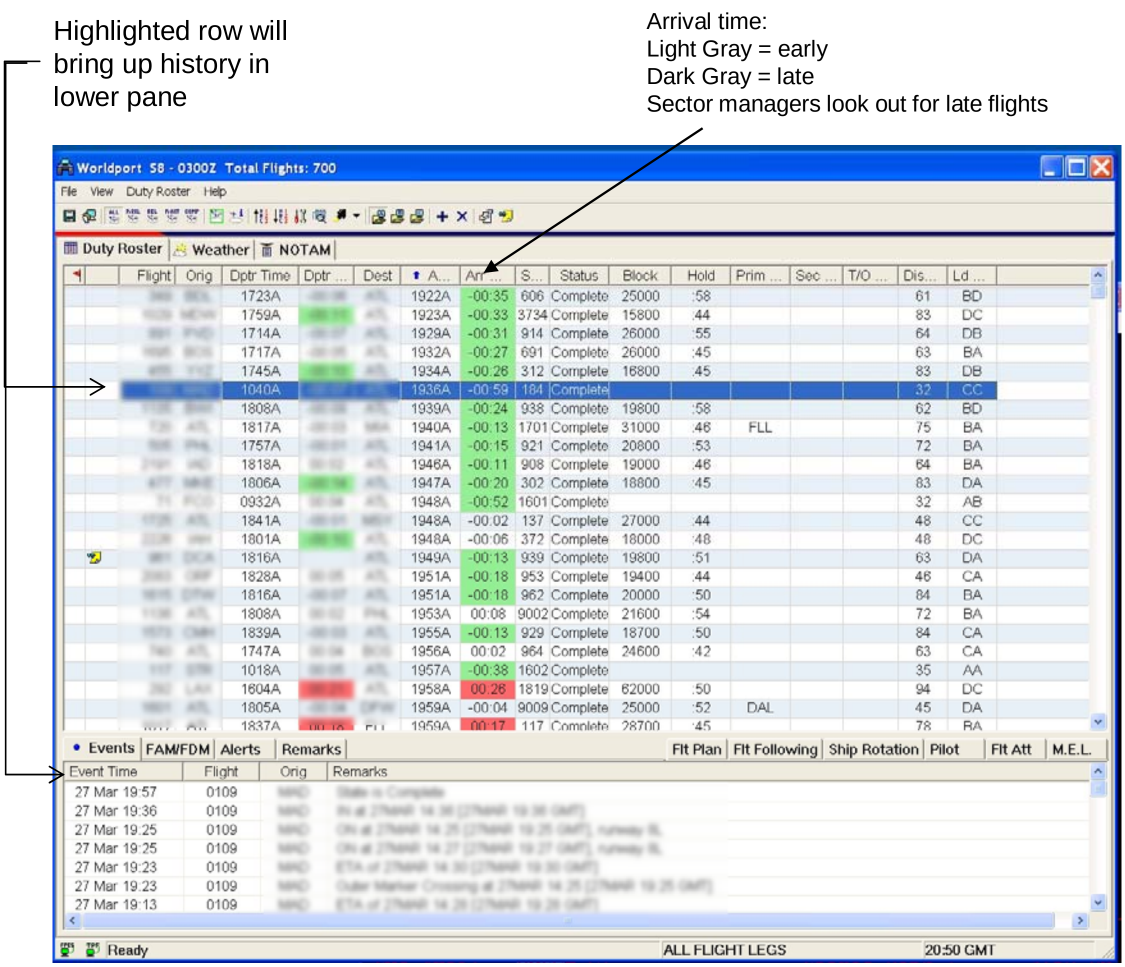

Figure 5: Artifact Model -- ODT Software Interface

(Some areas were intentionally blurred to protect proprietary information.)

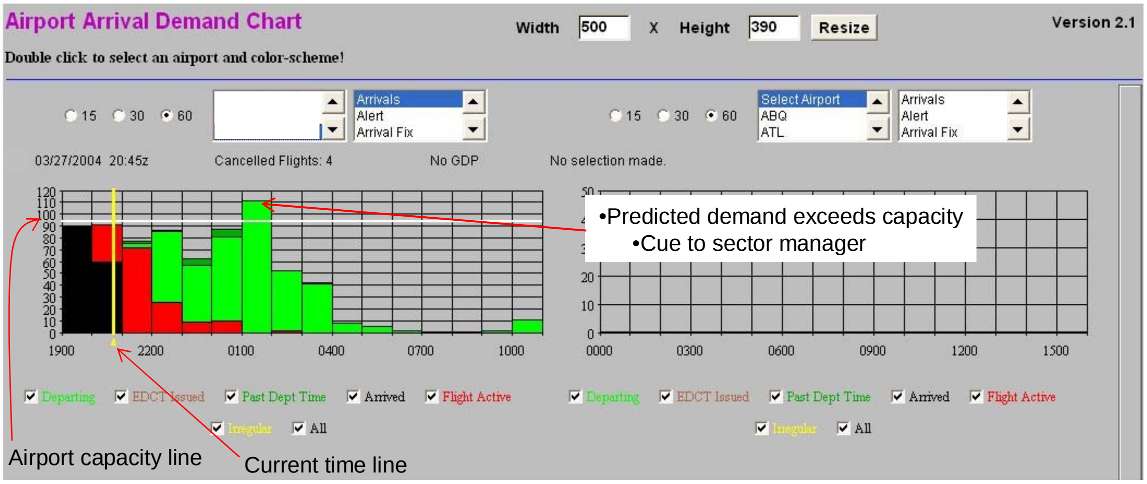

Figure 6: Artifact Model -- FAA Software Interface

Cultural Model

The purpose of a cultural model is to understand the cultural forces which impact both the work environment and the work itself. In a cultural model the main influencers on a position are represented, be they people, policies, values, preferences, or points of pride. In addition, the specific topic of influence and direction of that influence are shown. The cultural model for Sector Operational Managers is illustrated in Figure 7.

The only real tension found in this study was between the air traffic managers and the SOMs in terms of the perceived amount of traffic the air traffic controllers should be able to handle. SOMs often expressed their frustration at limitations imposed by the FAA and the belief that the limitations were excessive to the point of sometimes being motivated by a desire to "share the pain." (That is, to make sure that all airlines suffered equally regardless of whether the situation warranted it.)

Sequence Model

The purpose of the sequence model is to examine procedures used by individuals to complete their work and to examine the motivations behind the actions taken, similar to many forms of task analysis. As the work of the Sector Operational Managers is more goal-driven than procedure-driven, sequence models provide limited utility in understanding the pattern of work done by SOMs. However, sequence models can help begin to explain the tasks and the motivations and intentions behind the SOMs' actions.

Two sequence models are presented below in Figure 8 and Figure 9 to provide a broad overview of the types of tasks that SOMs perform. The sequence model is arranged in chronological order from top to bottom. The left hand column describes the motivations and intentions for the actions described in the right hand column.

The first sequence model, as seen in Figure 8, describes a task in which the aircraft arriving into the hub airport were re-sequenced by the air traffic controllers at the request of the Sector Operational Manager. This sequence of actions was triggered by a call from the airline station manager pointing out that one of the arriving aircraft was significantly behind its scheduled arrival time and that, unless action was taken, most of the passengers onboard would miss their connections in the next departure push. The sector manager coordinated the re-scheduling of the airline's flights (including all associated commuter airlines) to get this aircraft into the airport in time to allow the passengers to make their connections. (This meant moving this particular aircraft to the front of this airline's queue of airplanes to land.) This sequence is a primary example of how SOMs and air traffic control often work together to maintain the efficient flow of people and goods through the NAS.

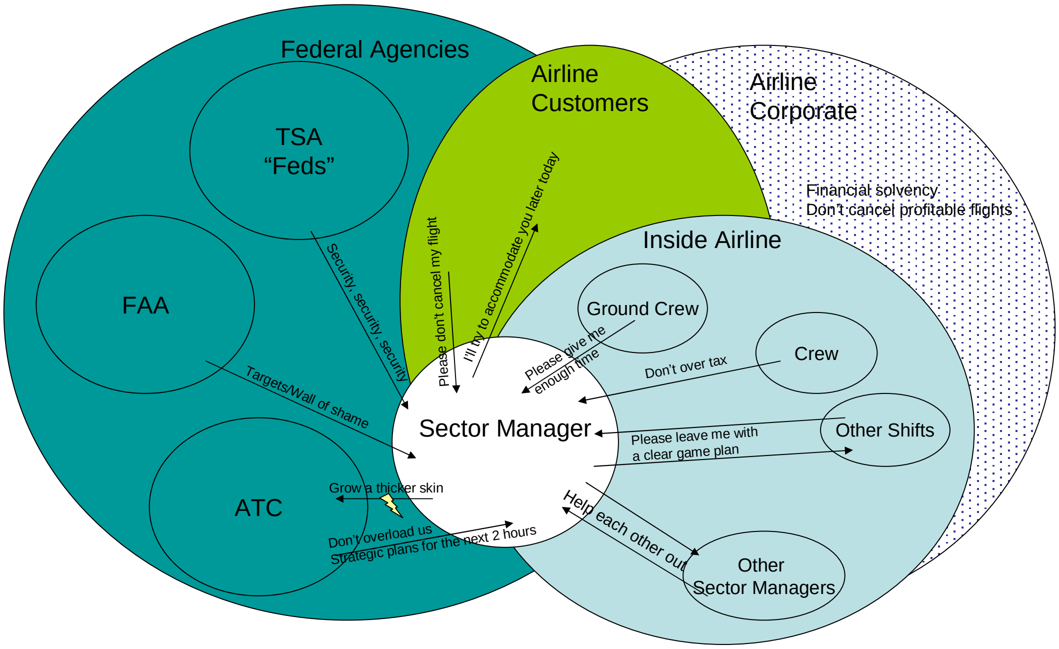

Figure 7: Cultural Model for an Airline Sector Operational Manager

• Trigger: Airline Tower Call – Indicated that an aircraft was significantly behind its scheduled arrival time • Intent: Verify that aircraft is behind lots of other traffic & if so plot solution	• Checked graphical location of aircraft on radar display • Pulled up info on aircraft on the text-based window
• Intent: Aircraft will be OK if it can be brought in ahead of all other Airline traffic	• Got up and went to talk to the FAA SOM to ask if the aircraft can have priority • FAA contact will talk to his counterpart with the commuter airline
• Intent: Make sure that the passengers make their connections even if it means holding other aircraft for a few minutes	• Calls dispatcher to tell them about connections so dispatch might hold the planes and allow the connections to be made
• Intent: Keep the Airline Tower up to date	• Calls Airline Tower back and updates him of current status
• Intent: Make sure that the plane has a place to go when it gets down	• Checks the gate availability

Figure 8: Sequence Model -- Bring Plane in Ahead of Other Traffic

• Trigger: Using the ODT, East SOM noticed that a plane out of Raleigh was late for no apparent reason	
• Intent: find out what might be causing the delay	• E-SOM used TERM32 to review aircraft's history and found that something had happened at Raleigh when he was not on duty. • Called a Raleigh to find out what was holding the plane up – Found out that an F-18 had crashed by the fuel farm and the wreckage was blocking the road to get fuel trucks to and from the terminal, causing delays – Asked to tanker at Hub for the weekend
• Intent: ask for tankering out of Hub to minimize overall system delays caused by Raleigh	• Walked to the Duty Director to see if it would be possible to tanker out of Hub for the weekend – No, Hub has a fuel shortage problem
• Intent: to inform Raleigh that the request had been denied and why	• Called Raleigh back to tell bad news that they will just have to take the delays
• Intent: to inform his fellow sector managers and to find out if any of them knew, and how he managed not to know about the fuel shortage	• Shouted over to Hub & Central SOM stations to tell about Hub fuel shortage
• Intent: to inform follow on crews about the fuel shortage and Raleigh delay issues.	• Wrote down the Hub fuel shortage and the Raleigh tanker delay problems in the SM activity report

Figure 9: Sequence Model -- Uncovering Sources of Delay

The second sequence model, as seen in Figure 9, describes a task where a partially obstructed access road leading to the fuel farm was discovered to be the cause of delays, which because of the circumstances could not be avoided. In both of these sequences the goal of the SOM was to minimized disruption to the schedule by coordinating the actions of the airline operational personnel.

Impact on National Air Space

The airline Sector Operational Managers keep both small and large disturbances in the air transportation system from becoming large problems requiring the intervention of federal regulatory agencies. For example, during the first hurricane to hit Florida in 2004, the airline SOMs acted without direct FAA guidance to re-route flights and change the entire airline schedule to avoid affected airports. This re-scheduling was enacted by a SOM over a four hour period.

In addition to helping to minimize the impact disturbances have on the NAS, SOMs are also key to the quick recovery of airlines to disruptions caused by weather and air traffic control disruptions. The speed of these recoveries is heavily dependent upon the skill of airline Sector Operational Managers. SOMs are the individuals who must make changes to the airline schedules when strategic traffic management programs are initiated at the national level such as ground delay and ground stop programs. Their decisions of whether to reroute, delay or cancel flights will impact the degree to which the effects of these actions will propagate through the NAS after the disruptions have passed.

Airline Sector Operational Managers, although not often consulted by civil aviation authorities drafting new policies and procedures, may impact such policies in unanticipated ways. Thus, they may play a large role in their successful or unsuccessful implementation. Understanding the role that SOMs play in the NAS is vital to properly predict the outcome of many new ATM policies.

Conclusions

The national air transportation system has three main players: air traffic controllers, pilots and the airlines that employ them. Up to now most of the advances in air traffic management have focused on the interaction of controllers and pilots as well as technology to aid both of these roles. However the role airlines and their operational personnel play in the smooth running and recovery of the air transportation system has been largely overlooked.

Research and investment are needed to aid the airlines to enable speedier recoveries to disruptions. First, however a better understanding of the role airline Sector Operational Managers play is required.

This paper has endeavored to begin to fill just such a requirement.

Preliminary insights found by this research have indicated that SOMs perform ill defined tasks which they accomplish successfully aided by years of experience. The problems that they solve are diverse in nature and are often one-off occurrences which, although similar in nature to previous incidents are dissimilar enough to preclude the explicit execution of detailed preset procedures. Often these problems are unique because of the uniqueness of their context, i.e. a plane has mechanical trouble on a Tuesday night in Cleveland on the Winter Schedule for 2004. Even if the same plane had presented with the same mechanical problem on the following Tuesday night in Cleveland, many of the incident recovery parameters would be different, e.g., the number of reserve crew, weather conditions, number and location of reserve aircraft, etc.

Additionally SOMs work on a variety of problems, each with a separate time scales. Some problems will present hours in advance and will be worked on, on and off for hours. During these situations, multiple solutions will be formulated, information will be gathered, and possible solutions and scenarios will be discussed. Other problems will only be noticed at the last minute and will require very quick decisions to be made with little time for information retrieval.

These preliminary findings suggest that any decision tool designed to assist SOMs will need to be flexible both in terms of the types of situations that is designed to assist with and in the amount of time and information that it will require to provide useful assistance.

References

[1] Beyer, H. and K. Holtzblatt, 1998, *Contextual Design*, San Diego, CA, Academic Press.

[2] Bond, David. *New ORDer at O'Hare*, Aviation Week & Space Technology, McGraw -Hill; 2004;161: 8:48.

[3] Cardosi, K. M., March 1993, *An Analysis of En Route Controller-Pilot Voice Communications*, DOT/FAA/RD-93/11; DOT-VNTSC-FAA-93-2.

[4] Corker, K., K. Flemming, and J. Lane, 1999, *Measuring Controller Reactions to Free Flight in a Complex Transition Sector*, Journal of ATC, October - December.

[5] Fan, T. P. and J. K. Kuchar, *Evaluation of Interfaces for Pilot-Air Traffic Control Data Link Communications*, IEEE Digital Avionics Systems Conference, Philadelphia, PA, 19th Proceedings, pp. 4A5-1-4A5/8.

[6] Grimaud, I., E. Hoffman, and K. Zeghal, 2000, Evaluation of Delegation of Sequencing Operations to the Flight Crew from a Controller Perspective -- Preliminary Results, SAE/AIAA World Aviation Congress, San Diego, CA.

[7] Lozito, S., S. Verma, L. Martin, M. Dunbar, and A. McGann, 2003, *The Impact of Voice, Data Link and Mixed Air Traffic Control Environments on Flight Deck Procedures*, 5th USA/Europe ATM R&D Seminar, Budapest, Hungary.

[8] Nichools, D. B. P., P. Marti, and S. Pozzi, 2003, *Presenting Uncertainty to Controllers and Pilots*, 5th USA/Europe ATM R&D Seminar, Budapest, Hungary.

[9] Pujet, N. and E. Feron, 1998, *Modeling an Airline's Operation Control*, 2nd USA/Europe ATM R&D Seminar, Orlando, FL.

[10] Smith, P. J. , C. E. McCoy, and C. Layton, 1997, *Brittleness of the Design of Cooperative Problem-Solving Systems*, IEEE Transactions on Systems, Man and Cybernetics, 27(pp. 360-371.

Key words

Contextual Inquiry, Airline Operations, Schedule Recovery

Biographies

Karen Feigh is a Ph.D. student in the School of Industrial and Systems Engineering at Georgia Tech. She holds a B.S. in Aerospace Engineering from Georgia Tech (2001) and an MPhil in Aeronautics from Cranfield University, UK (2003). Presently she is working on decision support tools to more closely match the dynamic needs of Flight Operations Managers.

Amy Pritchett is an associate professor in Aerospace Engineering at the Georgia Institute of Technology. Dr. Pritchett earned her S.B., S.M., and Sci.D. in Aeronautics and Astronautics from the Massachusetts Institute Of Technology in 1992, 1994 and 1997, respectively. Her research involves cockpit design, including alerting systems and advanced decision aids. Simulation of complex systems with hybrid (discrete and continuous) dynamics as a mechanism to model, prototype and test changes in emergent system behavior in response to implementation of new information technology.