2005

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THE USE OF INTEGRATED HISTORICAL AND PREDICTIVE DATA TO SUPPORT FLIGHT PLANNING BY AIRLINE DISPATCHERS

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Airline dispatchers play a critical role in the National Airspace System (NAS), as their flight planning decisions have a direct impact on the efficiency and safety of the resultant traffic flows and on contingency plans to deal with possible events that could arise while enroute. Their decisions also have an important impact on the operating costs for an airline. This paper first discusses the results of two focus groups with airline and military dispatchers that served to identify potential uses by dispatchers of the functionality contained in NASA's Future ATC Concept Evaluation Tool (FACET). This tool uses trajectory modeling to generate predictions of ATC sector loadings and to generate and evaluate alternative routes for an aircraft in terms of potential traffic congestion concerns. The paper then discusses follow-up work based on one of these findings: The potential value of combining data from FACET with historical data about a flight's past performance in order to improve pre-flight planning and flight-following while an aircraft is enroute.

Study 1

An initial study was conducted to identify potential uses of the functions embedded in the Future ATM Concepts Evaluation Tool (FACET) for Airline Operations Centers (AOCs). In addition, the study sought to determine potential enhancements of FACET that might better support the needs of dispatchers and air traffic control coordinators at AOCs.

As part of the study, a total of 19 dispatchers were interviewed. All of them had at least 8 years of dispatch experience. Eight of them also had at least 4 years of experience as an airline ATC coordinator. These dispatchers and ATC coordinators represented experience with dispatching at 5 different airlines. Another of them was a dispatcher for the US Air Force. The participants were introduced to the current capabilities of FACET and asked to consider potential uses and extensions of the functionality contained in FACET for AOCs and the interface design features associated with these functions. Key findings are summarized below.

AOC Tasks that Could Make Use of FACET

FACET was originally designed to support decision-making by FAA traffic flow managers. The dispatchers interviewed identified a number of potential areas where it could be of value to AOCs, however:

- Evaluate traffic constraints along alternative routes for a single flight during preflight planning.
- Identify modifications to a flight plan (route, altitude profile, departure time, speed) that would avoid a traffic constraint.
- Evaluate alternative reroutes contained in ATCSCC reroute advisories in terms of traffic constraints.
- Alert the dispatcher if a flight with an already filed flight plan (whether still pre-departure or enroute) is now predicted to encounter traffic constraints.
- Allow an ATC Coordinator or dispatcher to look at the predicted traffic congestion for specific airspace regions (such as the arrival sectors for an airport).

Predicting Which Flights Will be Moved

One of the key features of FACET is its predictions of air traffic congestion in a sector. Although this type of metric is of use to AOC staff, in many cases the question they really want to answer is how likely it is that this particular flight will be rerouted because of traffic congestion, and if so, what the resultant reroute and airtime is likely to be. Such information would help the dispatcher decide whether to plan a different route or just plan for contingencies if the flight is likely to be tactically moved by ATC (adding extra fuel, etc.).

Incorporating Other Data into FACET

Philosophically, the dispatchers recommended a human-centered approach that treats FACET as one source of data to help the dispatcher make judgments:

"Show them the data and let the person do the probabilistic reasoning."

The dispatchers interviewed indicated that to improve prediction accuracy and help the dispatcher make better judgments, three kinds of data could be integrated into FACET:

- Complete 4-D trajectories based on airline flight plans
- Weather data
- Historical data about the performance of a flight (such as its history of reroutes).

In terms of the use of historical data, the dispatchers noted:

"If you had the ability to show what that specific flight had done on previous days, that could be used in your decision making processing by saying 'okay, this is what happened to me in the last four to five days.'"

"If you had the previous history as to what that flight has done, it would go a long way toward helping you make a decision as to what you are going to do with that flight today. Because if you know if this airplane gets moved 40% of the time, then maybe you would be better off just moving it."

"The first flight is a good predictor of what is going to happen for the rest of the day if nothing major changes. You tend to do the same thing the rest of the day."

Study 2

Based on the recommendation to integrate FACET predictive displays with historical data on flight performance, a set of designs were prepared and then evaluated using a questionnaire. The results are summarized below.

Biographical Data

Fifteen dispatchers were sent a questionnaire about the integrated displays shown in Figures 2-5. All 15 responded. These dispatchers worked for 6 different airlines. Their years of experience dispatching ranged from 8-29 years, with a mean of 17.7 years. All but 3 of them also had experience as ATC Coordinators. These 12 dispatchers had 1-15 years of experience as ATC Coordinators, with a mean of 7.5 years of experience.

Preferred Form of Access

Before discussing details of the design, the dispatchers were asked the following question: Would you prefer to have this information displayed to you for every flight, or only for those flights where the predicted or historical data indicates a potential problem (as an alert)? Please indicate your reasons.

The responses emphasized the need to consider the time pressure often faced by dispatchers when preparing a flight release. Generally speaking, the dispatchers indicated that, although the dispatcher should be able to call up such information about an individual flight, these displays should not be shown for every flight. Instead, the dispatcher should be able to set some parameter(s) that determines when an alert would be generated for a flight, which would then allow the dispatcher to look at the combined predictive/historical data displays for that flight. This conclusion is supported by responses such as the following:

"As a dispatcher, I believe in the 'managing by exception' principle whereby I am shown issues that require my attention, whereas routine items are not dirrectly displayed to me, but are available for call up when I choose to do so."

"We have between 40-90 releases in a shift, so an alert would work best for our group."

Additional Information Needs

After answering the first question regarding form of access (alert vs. always present display), the dispatchers were asked about additional information that they might want to see incorporated into these screens. For Figure 2, the suggestions for possible types of information to add included:

- ATC preferred route
- Time and burn calculations for today's flight
- A traffic congestion index such as # of congested sectors transited
- Cost/time enroute and fuel requirements for alternative routings
- Out to off delays
- Reason for the route change
- Percentage of routes filed and flown successfully without ATC reroute

In addition to providing suggestions for including the information summarized above, more specific comments included:

"I think that screen has all the information I need for a quick and dirty risk assessment. … If I am working a DTW ATL flight, Figure 2 gives me an instantaneous assessment of which route I need to fuel for with a 99% probability (provided some other conditions are not a factor)."

"Out to off delays. … Seeing average out-off delays, assuming they are excessive, may make me look for other options (and why the out-off delays are consistently high)."

"I think you would need both planned speeds/altitudes along with altitude changes to filed routes/speeds/altitudes."

"Access to the previous few days' enroute weather."

The dispatchers were also asked whether they saw any problems with the content or design of specific screens.

Figure 2. Most of the dispatchers indicated they were happy with Figure 2, except for adding some of the additional information discussed earlier, making comments like

"In itself it doesn't contain much useful data. It should be incorporated into another screen."

"Simple and easy to read. It indicates your chance of being moved and the route to which you will be moved."

"Add the ability to break down by time. Sometimes flights are only consistently rerouted certain times of the day (i.e. due to crossing arrival/departure traffic at another airport)."

"It would be nice to show a mileage figure next to the route."

Figure 3. Most (but not all) of the dispatchers felt that Figure 3 required too much thought to use, emphasizing that they want to make decisions at a glance as much as possible:

"Too much info on charts. Difficult to understand in a short time. Dispatcher needs to see a trend or pattern, not raw data."

"I am not sure if we need EDCT's or Planned/Actual minutes when we have the difference. Rest is good."

"Historical table with EDCT, Dept. fix, holding, arrival fix info is confusing. The map with potentially overloaded sectors is good."

"This is great stuff. The information on this page would be very useful to me. I have no suggested changes."

"Good presentation. Table initially takes some study but once you get used to seeing it can focus in on important numbers."

Figure 4. The response was much more positive for most (but not all) dispatchers to the use of bar and scatter charts rather than tables to display data, but some dispatchers still had concerns about the specifics of these particular charts:

"Liked the charts. Easy/quick way to see trend. Also, good info and lots of info in small space. Desktop real estate is at a premium."

"This screen is more useful because I can gather much information at a quick glance. Bar graphs more useful than verbal statistical data."

"The screen is complex but easier to use than the tables. The bar graphs for off time delay and airborne delay indicate that regardless of what the flight planning computer says, your taxi out time and enroute time will not be as planned. We have one flight in particular where the actual enroute time exceeds the planned enroute time by 50% on an almost daily basis."

Figure 5. There was some disagreement about how much information to present about predicted sector loads. There was, however, general agreement that information on predicted sector loadings could be useful, assuming that it was reasonably accurate in the timeframe needed by dispatchers. There were also some suggestions for improving the details of this screen.

"Looks good. The ability to list flights in overloaded sectors would be useful."

"This is best screen for presenting all necessary info in a concise presentaion. No problems.

"I'm not sure that such detailed info regarding ATC sector in/out, duration, count, capacity is pertinent to a dispatcher. More basic info like 'will the sector I'm routing through be overloaded?' would be adequate."

"This table tells me that 3 ATC sectors are predicted to be saturated, but not how they will handle it. Will they delay or reroute UAL or USAIR and let my flight through or will I get the delay?"

"I have never been a big fan of predictive arrival information because of all the variables which impact a flight's actual arrival times at its destination. Whether it is a mechanical delay, flight attendants needing more ice, the boarding of additional meals, or whatever else may pop up, the statistical accuracy of any tool which predicts when a flight will get to its destination (or any other point along the route of flight) calculated before the actual gate departure is suspect. On the other hand, I can see where it could be useful to know something about the expected demand at an airport at the approximate time of my planned arrival. I would incorporate these estimates into my flight planning."

Likert Scale Questions

In addition to the open-ended questions summarized above, a number of Likert scale questions were asked. Figure 1 provides results for two very broad questions. In general, the more detailed questions were very consistent with the answers provided to the open-ended questions as summarized above.

Conclusions

The goal of these two studies was to gain insights into how predictions of air traffic activity as provided by FACET can be made useful and usable for airline dispatchers. Overall, there was a strong belief by the dispatchers studied that predictive data could be of substantial value to airline staff in making a variety of decisions, including decisions about:

- Fueling aircraft.
- Changing the routes or altitudes for flights, either preflight or while enroute.
- Expediting or delaying departure times.
- Negotiating with TFM to adjust traffic flows.
- Rebooking passengers.

The relevant time horizons require predictions ranging from 2 hours before departure to 10 minutes before departure to decisions made while a flight is enroute. Furthermore, while many of these decisions could be implemented effectively in the current NAS, new TFM procedures are likely to be needed to take full advantage of such predictive data.

The dispatchers emphasized the need not only to provide data regarding potential bottlenecks due to air traffic congestion, but also to provide insights into how these bottlenecks are likely to affect a particular flight. At present, the most effective way to accomplish this latter goal is to integrate predictive data with historical data.

In terms of usability, the dispatchers strongly emphasized the need to provide access to such information by exception (as alerts), and to provide it in a form that can usually be processed at a glance, but with additional details easily accessible for those cases where they are needed. A tool that requires substantial navigation through and analysis of the data is likely to be impractical for many of the tasks faced by dispatchers because of their high workload.

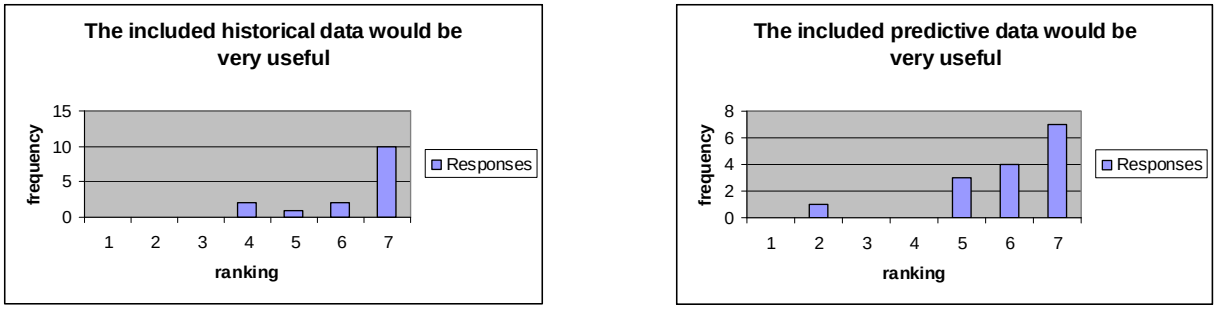

Figure 1. *Sample Likert Scale responses.*

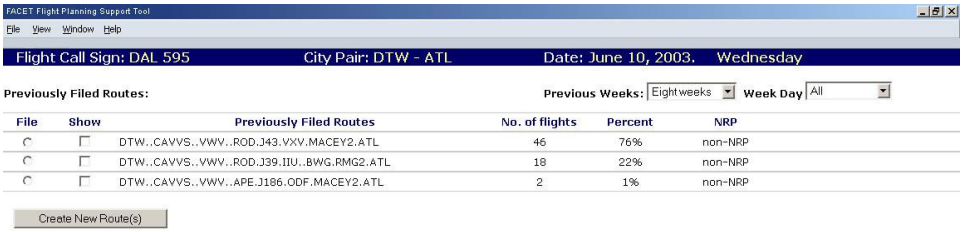

Figure 2. *Initial information on a specific flight.*

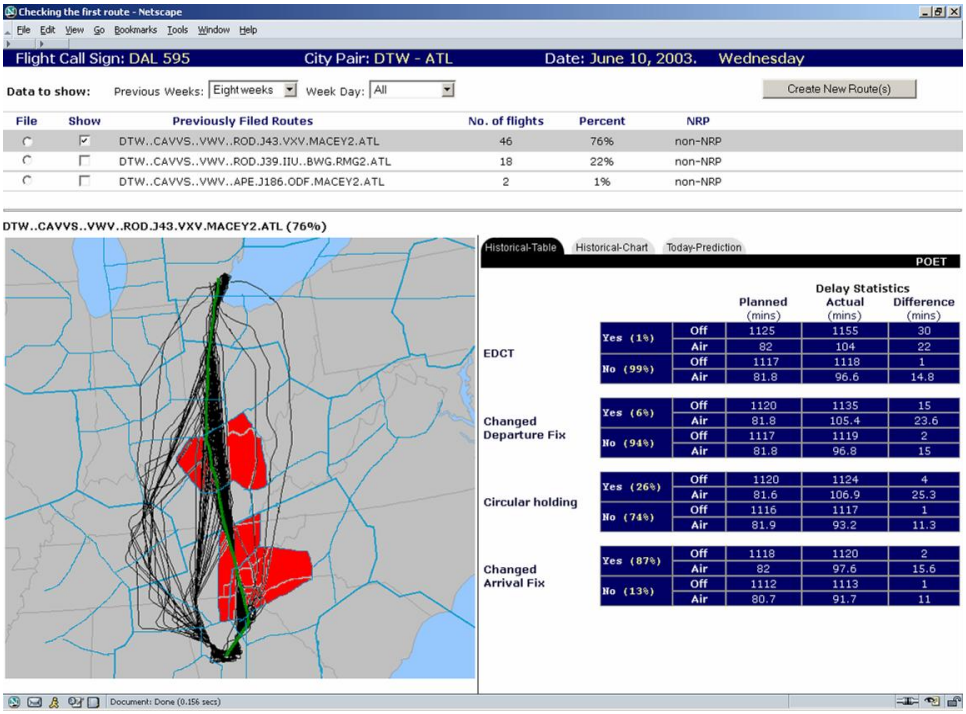

Figure 3. *Tabular presentation of historical flight performance data along with map display of FACET data and filed (green) vs. flown (black) routes. (The red sectors on the map represent sectors with "high" traffic volume.)*

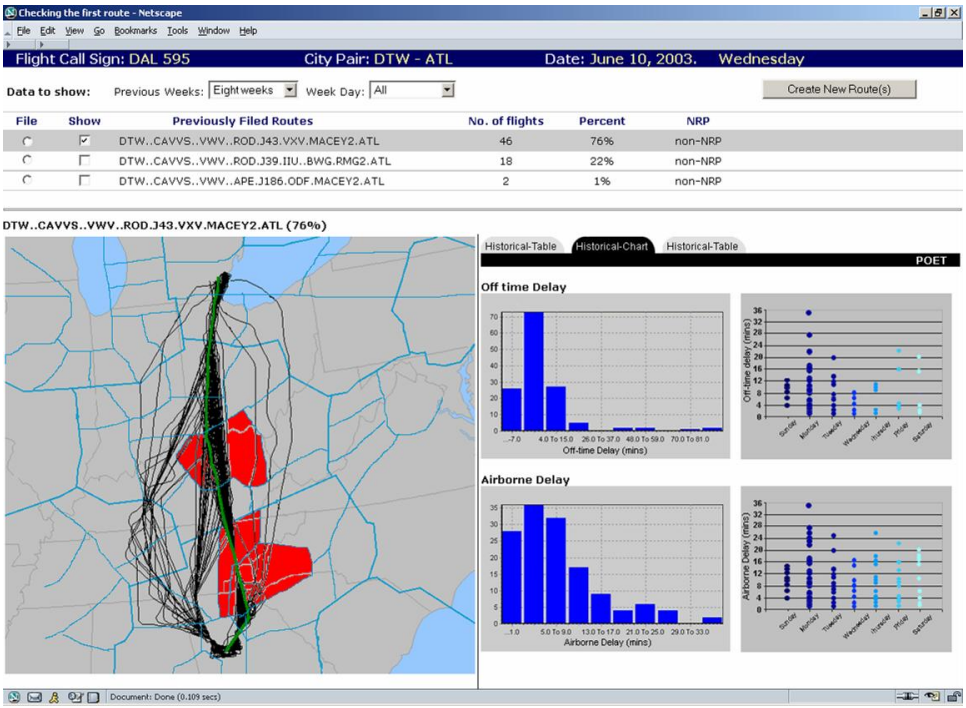

Figure 4. *Graphical presentation of historical flight performance data along with map display of FACET data and filed (green) vs. flown (black) routes. (The red sectors on the map represent sectors with "high" traffic volume.)*

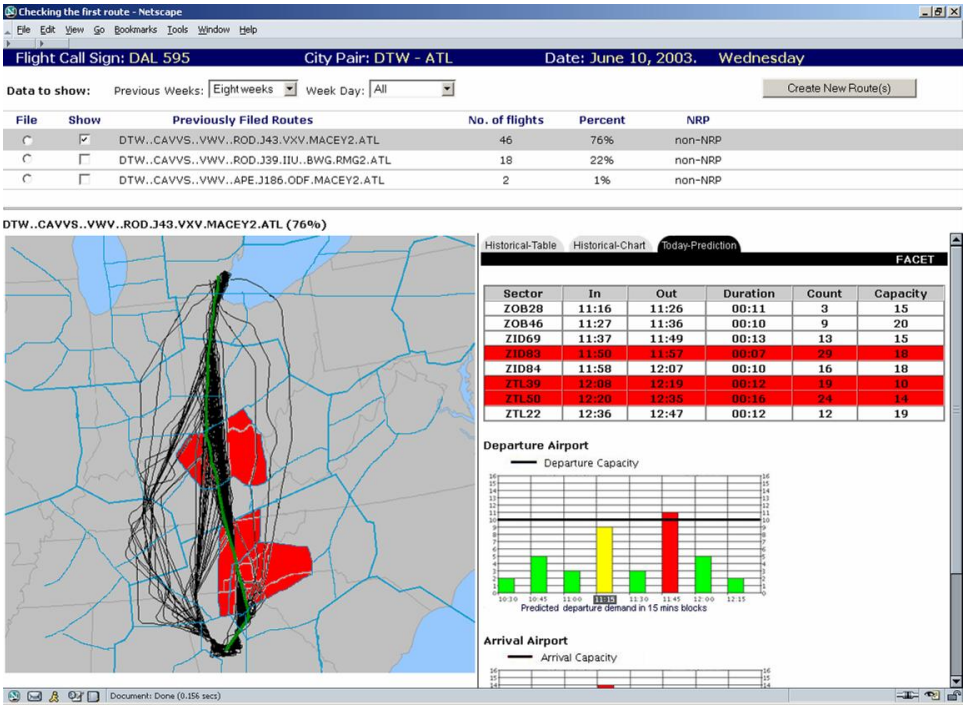

Figure 5. *Tabular presentation of FACET sector data, graphical display of FACET data on traffic demand at arrival and departure airports, and map display of FACET data and filed (green) vs. flown (black) routes. (The red sectors on the map represent sectors with "high" traffic volume.)*