Learning early about late flights

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A new study published in the Articles in Advance section of *Transportation Science*, a journal of the Institute for Operations Research and the Management Sciences (INFORMS), improves how air traffic managers cope with unexpected delays and provides them with more predictable ways to manage arrival traffic at airports with adverse weather.

The study, Incorporating Predictability into Cost Optimization for Ground Delay Programs, is by Yi Liu and Mark Hansen of the University of California, Berkeley. Ms. Liu received honorable mention for her research in the 2013 INFORMS Aviation Applications Best Student Presentation Competition.

The paper's key takeaway is that it is good to know early how late a flight will be. Ground Delay Program (GDP) decisions that recognize this are superior to those that do not, substantially reducing the cost of GDPs to flight operators. In a case study based on San Francisco International Airport, the authors reduced the cost of delays by 13 percent.

The model results can guide traffic managers on when to be optimistic, pessimistic, or neutral in their assumptions about when arrival capacity at an airport will recover.

Bad weather forces the FAA and air traffic controllers to implement GDPs. When there are delays, officials avoid asking pilots to circle their destination, which can increase fuel-related and others costs—and endanger passengers. Instead, they delay planes on the ground until it is safe to fly, and until backups in traffic to destination airports are reduced.

In 2011, 1,065 GDPs were issued in the U.S., imposing delays totaling 26.8 million minutes to 519,940 flights. At high volume airports like San Francisco International and Newark Liberty International, GDPs are implemented as often as every other day.

The novelty of the new research is its recognition that airlines and their passengers benefit when they have accurate knowledge of flight delays ahead of time. GDP decisions are based on weather forecasts, which carry great uncertainty. The authors sought to minimize the expected cost of delay, given the information that is available when the decision is made, assigning a cost to changes in the initial plan's delay.

Ideally, for the amount of delay incurred by a GDP, the cost is least if the entire delay is predicted up front; if there are subsequent modifications, the cost increases. Previous research into reducing delay cost focused on two factors, delays that take place on the ground and those that occur in the air. This is the first research that incorporates a new factor, predictability, into reducing the cost of GDP.

Initial GDP decisions are revised if there are changes in conditions. The most common revisions are extending delays and early resumptions of flights. Prior research did not consider how changes to the initial plan affect the cost of a GDP. And previous research considered the same unit cost of ground delay regardless of whether it was part of the initial GDP plan or imposed due to an extension. In reality, unexpected extra delays require more flight operator dispatcher effort and reduce air traffic controllers' choices, which can result in greater costs compared to those in the initial plan.

To study the relationship between these GDP problems and decisions, the authors formulated the problem based on a technique known as "continuous approximation modeling." This is the first time that this class of models, though widely used in other areas of transport analysis, has been applied to this kind of problem. The models are based on a small number of parameters, highlighting the problem's essence without the distraction of extraneous details.

The analysis also highlights the interplay of GDP scope—the geographical area where originating flights are assigned ground delays and the importance of unpredictability in determining the right "risk posture" to take in planning GDPs. The model is the first to systematically explore how the scope decision affects the optimal planned duration of a GDP.

The insights from this analysis could be used to develop a decision support tool that air traffic managers use to design more predictable GDPs.

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