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A decision support system for airport strategic planning

Miltiadis A. Stamatopoulos [a,*], Konstantinos G. Zografos [b], Amedeo R. Odoni [c]

[a] *Athens International Airport, Athens, Greece*
[b] *Department of Management Science and Technology, Athens University of Economics and Business, Athens, Greece*
[c] *Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, MA, USA*

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Abstract

This paper describes an integrated set of models for the estimation of the capacity of an airfield and the associated delays. The aim is to develop a decision support tool suitable for airport planning at the strategic level. Thus, the emphasis is on obtaining reliable approximations to the quantities of interest quickly and with a limited set of inputs. The models account for the dynamic characteristics of airfield capacity and demand, as well as for some stochastic aspects of airfield operations. They are sensitive to airfield geometry, the operational characteristics of the airfield and of the local air traffic control system, and the characteristics of the local air traffic demand for airport access and services. Through its integrated structure, the decision support tool can account for interactions among operations at different parts of the airfield.

Keywords: Aerodrome; Airport; Airside; Apron; Capacity; Decision support system; Delays; Runway; Sequencing

1. Motivation and objectives

The demand for air transport has been increasing rapidly over the years and all forecasts suggest that this trend will continue. In response, airports worldwide are making large investments aimed at increasing capacity and operating efficiency and controlling congestion. The busiest commercial airports in the United States spent $7.2 billion on capital investments in 2000 and had

* Corresponding author. Present address: Athens International Airport, 190 19 Spata, Greece. Fax: +30-210-361-6919.
E-mail addresses: stamatopoulosm@aia.gr (M.A. Stamatopoulos), kostas.zografos@aueb.gr (K.G. Zografos), arodoni@mit.edu (A.R. Odoni).

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already committed another $24 billion between 2001 and 2006 (ACI-NA, 2001). The corresponding figures for the whole world are probably at least twice as large.

Expansion planning at airports must typically adopt a long-term perspective with time horizons of 15–50 years. In this paper, we present an integrated set of models that has been developed to assist airport operators and managers in planning strategically for expanding and optimizing the airfield (runways, taxiways, aprons) and for improving operating procedures or managing demand (''slot control and allocation''). Planning at the strategic level requires the ability to examine approximately the implications for the level of service at the airport of a wide range of different scenarios and hypotheses about future conditions. The goal of MACAD (MANTEA Airfield Capacity And Delays model), the decision support system described in this paper, is to provide such a tool for performing this type of analysis quickly, reliably and with limited effort.

A number of existing simulation models (e.g., SIMMOD, TAAM and the Airport Machine) aim at providing assistance in the detailed design of the airfield. However, such microscopic models are not well suited to serve as strategic decision-support tools because their use requires a great amount of time, effort and expense. They also have a steep learning curve, requiring well-trained, expert users. It may take several person-months of effort to set up the simulation of an airport using these tools. Significant modifications to some of the original assumptions or airport configuration may also take much additional time to implement. Moreover, these models suffer from the somewhat paradoxical disadvantage of often providing too much detail for the needs of a strategic planning exercise, instead of focusing on the aggregate characteristics of interest (Odoni, 1991). A detailed discussion of these issues, as well as descriptions of existing models, can be found in Odoni et al. (1997).

On the opposite side, numerous analytical, macroscopic (low level of detail) models also exist for computing approximate capacities and/or delays associated with each of the individual elements of the airfield, i.e., the runways, taxiways and apron areas (Odoni et al., 1997). However, these models have been used in a stand-alone mode to date, e.g., for runway capacity studies or for apron capacity studies. They have not been integrated in a fashion that would permit examination of the airfield as a whole, including possible interactions among the various elements of the airfield. The approach described here is an attempt to provide such a macroscopic, integrated tool.

In what follows we first provide a brief overview of the integrated system, and then describe some of the individual models that its main module, the Airside Module, is composed of. The reader is referred to Stamatopoulos (2000) for a far more detailed description.

2. Overview of the decision support system

MACAD integrates macroscopic airside models to provide approximate estimates of the capacity and delays associated with every element of the airfield. Its primary advantages are that it is fast, flexible and easy to use, and thus suitable to support strategic decision-making. In recognition of the fact that the availability of data and the statistics of interest differ widely from case to case, the user is offered several options in this respect. For example, MACAD will accept as an input a detailed daily schedule of arrivals and departures at the airport of interest or will assist the