# A system approach to airport control

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*In questo articolo è presentato un approccio sistemico per l'operatività ed il controllo del traffico aereo, approccio nell'ambito del quale l'aeroporto costituisce un sistema tecnologico ed organizzativo.*

## 1 Introduction

Traffic systems are generally quite complex. For this reason, in creating their theoretical mathematical model, we would have to take into account an extremely large number of variables and their interrelationships. However, with methods of logical and methodological decomposition, a traffic system may be divided into a finite set of simpler subsystems which are then studied and analysed separately [8]. Each of the subsystems represents an independent system while other subsystems represent its more or less relevant environment. Such a scientific approach is based on the axiomatic principle of describing a traffic system with the set of elementary statements which are true on the basis of evidence of the traffic science theory. In this way consistency, completeness and minimality of the traffic system structure are guaranteed while scientific precision and generality are maintained.

Air traffic can be defined as an undivided and extremely complex dynamic system. When referring to air traffic as a system, we understand its inner structure, i. e. the set of subsystems, elements and their interrelationships as well as their relationships with the environment. An air traffic system is divided and interrelated in vertical and horizontal directions [9]. In vertical analysis five strata are found. They behave as technical, technological, organizational, economic and legal subsystems. In the horizontal direction, the system of air traffic is a synthesis of three subsystems of activities: transport, disembarkation/embarkation and flight control. In this part we are interested in the airport subsystem within the framework of the air traffic system. We are going to deal with it as a system of aircraft, passenger, cargo, luggage and post operations. All the necessary and relevant activities are carried out by airports, which are organized as business companies.

Rapid development of air traffic has emphasized the importance of airports, which have in many places become the bottleneck in the process of air traffic dynamics. In most cases this bottleneck is felt as lack of capacity. Airports have become complex technological and organizational structures which follow the laws of dynamic systems. Therefore technical and technological modernization alone cannot provide satisfying results in optimal exploitation of existing capacities and planning the new ones. For this reason we have to adopt a scientific approach to managing airports as complex dynamic systems.

## 2 The properties of an airport system

All real systems refer directly to their environment and consist of separate closely linked subsystems. Strict boundaries between the subsystems, the system itself and the environment are not accurately defined, but they depend on the concrete approach to the problem regarding the desired aim.

When speaking about the airport system, its technology, i. e. the organization of technological activities at the airport, is its technological subsystem. In this context the relative environment is the whole air traffic system. The air traffic system acts upon the characteristics of traffic flows taking place at airports as well as technological processes that enable these flows. Apart from the structure of the system itself its operation also depends on how the environment is structured and on the intensity with which its elements influence the components of the system. The system environment are all the elements which are not a constituent part of the system but are nevertheless directly linked with its elements.

Typical of airport systems is a numerous set of influential elements from the environment. These can be divided into the following groups [2]:

- normative elements,
- economic elements,
- technical elements,
- market elements,
- geographical - climatic elements,
- ecological - social elements.

In the airport system, each group exerts influence on separate subsystems with different intensity.

Traffic systems (and all their subsystems) are stochastic, as there are always random variables in their operation. Stochasticity of technological subsystems of a traffic system is conditioned by the very nature of traffic. Traffic system controllers' interest is to study these random processes intensely, and to make them - to a certain degree of accuracy - statistically predictable. In an air traffic system the airport as its subsystem has known infrastructure and terminal capacity, but traffic flow in this system is stochastic. Stochasticity of passenger and aircraft flows causes periodical overloading of facilities, and here a basic question arises of how to solve this problem as on average the capacities are not surpassed by demand. Optimal control has to depend on a clearly defined function of the goal which will be defined in structuring the mathematical model of control.