Preface

The air transportation system is a key element in the global economy. It makes people and goods move round the world and, for many geographical places for which the surface connections to the world are precarious, it may be the only economically feasible transportation. Where it competes with ground and water modals, it usually provides the shortest travelling time. Its success has been such that the demand for it has increased spectacularly in the past decades. However, the capacity to accommodate more and more aircraft in the airspace and in the airports has not met this demand growth. Infrastructure expansion is difficult and lengthy, mainly because land for airport runways and dependencies is increasingly scarce, among many other reasons. Besides, noise restrictions have brought limited operating times and more difficult flight profiles. Therefore, to accommodate the future demand pressure, the air transportation users need some breakthroughs, thus keeping the existing set of supporting technologies for the air transportation system is not an option.

To extract more capacity from the same basic resources, it is necessary to develop new technologies and, not surprisingly, to apply already existing ones, but in such a way that it keeps or improves safety levels, not to suddenly exclude less equipped or trained users, and that global interoperation continues to be harmonic. Several nations are promoting this evolution, but two modernization programs, with strong implications in most of the world's air traffic, are taking the lead: NextGen (*Next Generation Air Transportation System*), in the U.S., and SESAR (*Single European Sky Air traffic management Research*), in Europe. They are progressing at a fast pace and, because of them, in a few years, we will see quite a different picture in air transportation from the one we see today. Other countries, although not directly participating in these programs, are also seriously engaged with the evolution of their air transportation systems, and ambitious local programs have been laid out. In or around all these modernization programs, thousands of scientists, engineers, economists, pilots, air traffic controllers, business persons and many other sorts of professionals are producing knowledge and technologies to enable safer, more efficient and environmentally friendly air transportation.

In this context, it is very important to bring together renowned researchers and professionals from the industry, government and academia as contributors in a publication to disseminate and stimulate ideas to improve efficiency, safety and quality in air transportation. The background theme chosen for this book is Information Technology in Air Transportation, and along the chapters we have it inserted and exploited in several distinct contexts. The interdependence of subjects makes it difficult to categorize the chapters in distinct sections, but despite that we have arranged them in four sections, which we want to briefly comment to the reader.

The first section deals mostly with the Complexity of Air Transportation. The first chapter of which, "*Challenges Ahead for European Air Traffic*", poses and discusses some important needs existing in the

current European air transportation, with a systemic and evolutive perspective, from authors who have unique roles in the SESAR program. Many of their challenges are applicable to the other regions of the world, and because of this, and of its systemic approach, we believe it to be a good opening for the book. After this, we have three interesting chapters presenting models and tools to deal with the complexity of managing and optimizing multiple flows of aircraft through airspace and airport resources with limited capacities. These chapters are "*The SYNCROMAX Solution for Air Traffic Flow Management in Brazil*", "*Balance Modeling and Implementation of Flow Balance for Application in Air Traffic Management*", and "*Cooperative Control for Ground Traffic at Airports*", and together bring a powerful mix of software products and mathematical models.

The second section is devoted to improving the economic and operational performance of airports and airlines: for airport planning, "*Critical Review and Analysis of Air-Travel Demand: Forecasting Models*" describes and critically analyzes several models which can be handy for dimensioning airport facilities, with respect to the expected demands; "*Using the Continuum Equilibrium Approach to Solve Airport Competition Problems: Computational and Application Issues*" unveils an innovative computational method to understand how passenger flows behave when competing airports are available in a region; "*Real-Time Non-Destructive Evaluation of Airport Pavements Using Neural Network Based Models*" reports a smart model to evaluate pavement elasticity parameters in real-time, therefore enabling more agility in decision-making depending on airport pavement conditions, which is very likely to have safety implications. For the interest of airlines, "*Advances in Data Processing for Airlines Revenue Management*" presents a sophisticated model and a computational method to forecast airline revenue based on ticket booking and cancelation events; and finishing this group, we have "*Commercial Aircraft: A Holistic and Integrated Model of the Flux of Information Regarding the Operational Support*", presenting a very comprehensive and systematic model for the process of operating commercial aircraft with Continued Airworthiness, which can help airline managers to better understand what is behind the commercially-available software they use, therefore enhancing their ability to see opportunities of process improvement.

After that, we have a section focused on safety and efficiency of aircraft operations. The first chapter of which deals with risk analysis in air traffic, considering technical advances coming into practice in the next years: "*A Case Study of Advanced Airborne Technology Impacting Air Traffic Management*", with arguments showing that some key technological advances in airborne equipment, can provide the skies with more safety. A concept explored in this chapter, airborne separation management, is also in the core of the next chapter, "*A Distributed Systems Approach to Airborne Self-Separation*", which develops a very elaborated technique to safely allow fully automatic aircraft self-separation. Afterwards, the reader will find an extremely efficient algorithm to find optimal aircraft trajectories: "*A Global Optimization Approach to Solve Multi-Aircraft Routing Problems*", which is primarily focused on military aircraft missions, but is pretty adaptable to civil aircraft operation.

Up to this point, the chapters have presented computational and mathematical models to directly solve problems in the air transportation world. However, software has its own complexity, and it is often necessary to solve problems within the software, and for this we have the fourth and last section. "*Collaborative Decision Making and Information Sharing for Air Traffic Management Operations*" visits distributed software architectures to propose an interoperation paradigm to ensure that the right information is in the right place, at the right time, helping to make the right decision in air transportation operations. Next, one finds two chapters with a correlated aim, which is to formally define and use a method to specify and verify safety properties of embedded software, which turned out to be ubiquitous in aircraft control

functions, often with highly critical roles. The chapter "*Component-Based Development of Aeronautical Software*" presents an overview of models and techniques for component-based software development, and develops a step-by-step case study on component modeling and verification for a specific function of a gas turbine controller; following this comes the chapter "*The Language Specification PEARL for Co-Designing Embedded Systems*", which explores an accurate and effective technique to specify and verify multiprocessor hardware/software co-design for embedded systems, and an application example is given of a Flight Guidance System.