1

Introduction

1.1 Advances since 2003

The principles of avionics systems are unchanged but new innovations have been introduced since the first edition of *Civil Avionics Systems* was published in 2003. Many of these advances have been incorporated into modern aircraft, and research continues to improve the aircraft and the air transportation system. Notable advances include:

- The A380 and B787 aircraft have been introduced into service.
- The use of commercial off-the-shelf (COTS)-based data bus networks have significantly increased: in particular, ARINC 664 at the aircraft level, and CANbus at the intra-system level have been widely adopted.
- The introduction of advanced (3rd generation) IMA implementations on A380, B787 and emergent on A350.
- More-electric aircraft (MEA) implementations; in part on A380 and more extensively on B787.
- The rapid growth of global navigation satellite systems (GNSSs) in addition to GPS. The Russian GLONASS has been reconstituted in recent years, and COMPASS (China) and Galileo (European Union) systems are being established.
- The introduction of the electronic flight bag (EFB), most recently with iPad implementations by some organisations.
- The introduction of improved ground-based augmentation systems (GBAS)-based approaches.
- Significant improvements in flight deck displays using COTS glass in rectangular format. The trend towards larger display surfaces has continued, indeed escalated.
- Wider adoption of head-up displays and the use of enhanced vision systems (EVS) to help mitigate reduced visibility as a limiting factor in flight operations.
- The development of synthetic vision systems (SVSs) to provide an aid for location of runways and other objects.

Civil Avionics Systems, Second Edition. Ian Moir, Allan Seabridge and Malcolm Jukes.

Table 1.1 Comparison of Boeing and Airbus solutions

Implementation	Boeing approach	Airbus approach
IMA implementation (Chapter 6)	B777: First generation – AIMS/ELMS B787: Third generation using cabinets and supplier-furnished RIUs	A380: CPIOMs and subsystem supplier-furnished RDCs A350: CPIOMs and generic cRDCs
Onboard maintenance (Chapter 7)	Embedded maintenance display and PMAT options	Dedicated hardware in CMC
More-electric technology (Chapter 7)	B787: 500 kVA/channel at 230 VAC No bleed air off-take from engine. Electric ECS, engine starting and anti-icing	A380: 150 kVA/channel at 115 VAC 2 'H' + 2 'E' architecture – blue hydraulics channel subsumed into electrical implementation Use of EBHAs
Data bus wiring (Chapter 7)	Twinax wiring	Quadrax wiring
Aircraft wiring (Chapter 7)	Not < 22 AWG	Not < 24 AWG
Fly-by-wire (Chapter 10)	Conventional control yoke for pitch and roll inputs Trio-triplex computing using dissimilar hardware Similar software	Sidestick controller for pitch and roll inputs Multiple dual COM/MON computing Dissimilar hardware and software
Electronic flight bag (Chapter 11)	Class I/Class II Fixed or docked	Class III Laptop/iPad/Tablet
FANS embodiment (Chapter 11)	[B737;B747;B757;B767;B777] Fixed hardware with software upgrades/increments	Additional hardware: ATSU/DCDU

1.2 Comparison of Boeing and Airbus Solutions

While the avionics technologies are applied in general to provide solutions to the same problem statement, there are a range of alternative philosophies and architectures that will provide safe and certifiable solutions for an aircraft. Boeing and Airbus adopt different approaches for a number of different system implementations; that is not to say that one solution is any better than another. The different approaches merely reflect the design cultures that exist within the respective manufacturers.

Table 1.1 lists a number of areas where the Boeing and Airbus approaches differ and which are described more fully in the body of the text.

1.3 Outline of Book Content

The contents of this book are aimed mainly at commercial transport aircraft, but the principles described are also applicable to military types. This particularly applies to large military aircraft

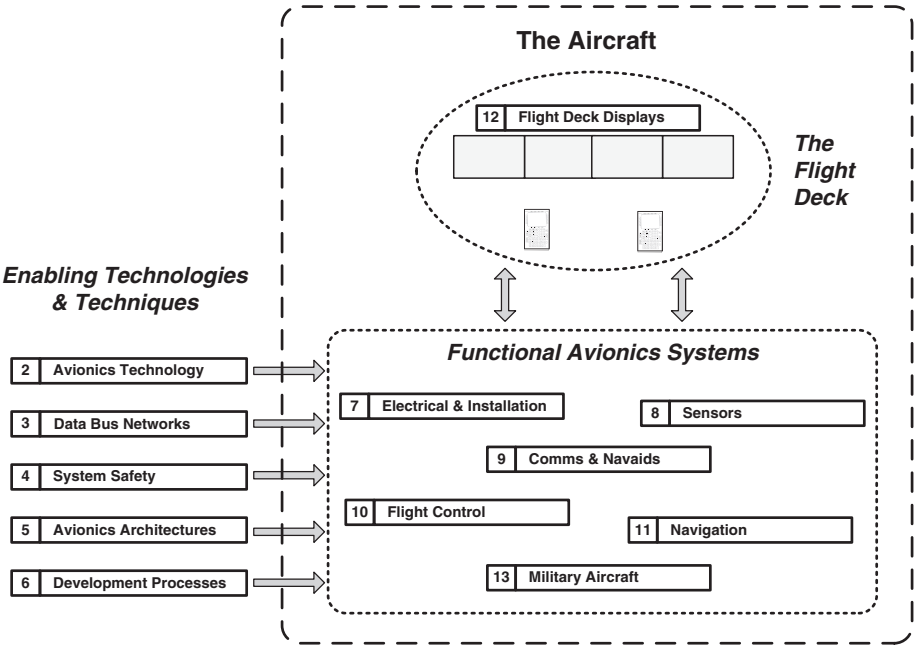

Figure 1.1 Interrelationship of enabling technologies and aircraft system

that are conversions of commercial aircraft in which the platform avionics will generally remain, with mechanisms for connecting it to military system additions. The description of avionics systems may be subdivided into three areas which together provide the total aircraft function (see Figure 1.1). The chapters that describe these functional areas are listed below under the headings:

- Enabling technologies and techniques (1.3.1).
- Functional avionics systems (1.3.2).
- The flight deck (1.3.3).

1.3.1 Enabling Technologies and Techniques

The enabling technologies described have a history that is interesting because it shows a comparison of modern implementations with their improvements in performance, mass, availability and safety. It is interesting also because it demonstrates how technology in the consumer market is being applied successfully into what was once thought to be a very specific and 'high end' market of aerospace. What is clear today is that many 'off the shelf' products can be used to advantage. Technology is still advancing and the following chapters try to point to the direction in which is it going:

- Chapter 2 – Avionics Technology
- Chapter 3 – Data Bus Networks

- Chapter 4 – System Safety
- Chapter 5 – Avionics Architectures
- Chapter 6 – Development Processes.

1.3.2 Functional Avionics Systems

The chapters in this section provide description of the functional systems of the aircraft and should be used in conjunction with companion books in the Wiley Aerospace Series to gain a complete picture of the modern aircraft and the aerospace environment. As far as possible, given the constraints of security and commercial sensitivities, there are descriptions of the latest aircraft to enter service, sufficient at least to gain an appreciation of avionic systems.

- Chapter 7 – Electrical Systems and Installation
- Chapter 8 – Sensors
- Chapter 9 – Communications and Navigation Aids
- Chapter 10 – Flight Control Systems
- Chapter 11 – Navigation Systems and PBN
- Chapter 13 – Military Aircraft Adaptations.

1.3.3 The Flight Deck

The flight deck is an amalgam of avionics technology and human–machine interface in a secure and comfortable environment to allow the flight crew to operate effectively during short haul and very long haul flights. This is an area that has seen great advances in the ability to provide information about the progress of the flight and the status of the aircraft and its systems. Advances are still being made which predict radical changes in the future, which is why this subject enjoys its own chapter.

- Chapter 12 – Flight Deck Displays.

Each of the chapters listed above contain both introductory and detailed descriptions of the respective subject matter. Given the integrated and interrelated nature of avionics technology and functions, cross-references have been made where appropriate in the main body of the text to help the reader to make the necessary links.

1.4 The Appendices

To assist the reader in understanding how some of the analytical tools such as dependency diagrams, fault tree analysis (FTA) and Markov analysis may be applied to typical systems, four appendices have included. These appendices address the following systems:

- Appendix A: Safety Analysis – Flight Control System
- Appendix B: Safety Analysis – Electronic Flight Instrument System
- Appendix C: Safety Analysis – Electrical System
- Appendix D: Safety Analysis – Engine Control System

The analyses in the Appendices are presented in a simple mathematical fashion to provide the reader with purely advisory and illustrative material: they should not be considered as definitive analyses of the standard that would be demanded during formal aircraft system design. Nevertheless, it is hoped that they will aid the reader in appreciating some of the design issues that need to be considered early on in the design process. (During formal design, engineers utilise dedicated design tools that undertake the appropriate analysis in a rigorous fashion. At the same time, these tools provide the required documentation to the standard necessary to convince the certification authorities that the design is safe.)