Chapter 2
Displays and Man–Machine Interaction

2.1 Introduction

The cockpit display systems provide a visual presentation of the information and data from the aircraft sensors and systems to the pilot (and crew) to enable the pilot to fly the aircraft safely and carry out the mission. They are thus vital to the operation of any aircraft as they provide the pilot, whether civil or military, with:

- Primary flight information,
- Navigation information,
- Engine data,
- Airframe data,
- Warning information.

The military pilot has also a wide array of additional information to view, such as:

- Infrared imaging sensors,
- Radar,
- Tactical mission data,
- Weapon aiming,
- Threat warnings.

The pilot is able to rapidly absorb and process substantial amounts of visual information but it is clear that the information must be displayed in a way which can be readily assimilated, and unnecessary information must be eliminated to ease the pilot’s task in high work load situations. A number of developments have taken place to improve the pilot–display interaction and this is a continuing activity as new technology and components become available. Examples of these developments are:

- Head up displays,
- Helmet mounted displays,
- Multi-function colour displays,
- Digitally generated colour moving map displays,
- Synthetic pictorial imagery,
• Displays management using intelligent knowledge based system (IKBS) technology,
• Improved understanding of human factors and involvement of human factors specialists from the initial cockpit design stage.

Equally important and complementary to the cockpit display systems in the ‘man–machine interaction’ are the means provided for the pilot to control the operation of the avionic systems and to enter data. Again, this is a field where continual development is taking place. Multi-function keyboards and multi-function touch panel displays are now widely used. Speech recognition technology has now reached sufficient maturity for ‘direct voice input’ control to be installed in the new generation of military aircraft. Audio warning systems are now well established in both military and civil aircraft. The integration and management of all the display surfaces by audio/tactile inputs enables a very significant reduction in the pilot’s workload to be achieved in the new generation of single seat fighter/strike aircraft. Other methods of data entry which are being evaluated include the use of eye trackers.

It is not possible in the space of one chapter to cover all aspects of this subject which can readily fill several books. Attention has, therefore, been concentrated on providing an overview and explanation of the basic principles involved in the following topics:

• Head up displays (Section 2.2)
• Helmet mounted displays (Section 2.3)
• Computer aided optical design (Section 2.4)
• Discussion of HUDs versus HMDs (Section 2.5)
• Head down displays (Section 2.6)
• Data fusion (Section 2.7)
• Intelligent displays management (Section 2.8)
• Display technology (Section 2.9)
• Control and data entry (Section 2.10)

2.2 Head Up Displays

2.2.1 Introduction

Without doubt the most important advance to date in the visual presentation of data to the pilot has been the introduction and progressive development of the Head Up Display or HUD. (The first production HUDs, in fact, went into service in 1962 in the Buccaneer strike aircraft in the UK.)

The HUD has enabled a major improvement in man–machine interaction (MMI) to be achieved as the pilot is able to view and assimilate the essential flight data generated by the sensors and systems in the aircraft whilst head up and maintaining full visual concentration on the outside world scene.