Precis

Introduction

The Head Up Display was developed to present flight data overlaid on the pilots view through the windshield ideally at the same focal distance as his normal vision. So, how is it different from the Gunsights that preceded it? Those devices also used a collimating optics with a combining glass in front of the pilot and had some sophistication in symbology. It would seem that the definition should include a fully programmable display device, such as a Cathode Ray Tube and a Waveform Generator and Computer to drive that device. This source is much more capable than the reticle of a Gunsight.

The Head Up Display is however more than a sophisticated Gunsight. Most pilots would agree that the HUD was invented around the late 50s and it is no coincidence that this was the time when there was an urgency about conveying data to the pilot in a better and faster manner. This was especially urgent in the European theatre where the new generation of combat Fighters were being introduced and high-speed terrain following was seen as the way to succeed in an attack. The issue was to understand what the pilot needed to have displayed, how this should be presented and fundamental issues like the shape and form of the symbols. How could data best be presented in an era of sophisticated weapons, high speed flight and extreme manoeuvrability? Research was underway to move away from the plethora of individual instruments and to provide a primary source available 'head-out' so that the pilot does not have to keep looking down into the cockpit to gain vital information.

So rapid was the acceptance of the head-up concept that applications spread to helicopters and both military and airline transports. The head-up concept has been extended to locate on the pilot's helmet as a Helmet Mounted Sight or Helmet Mounted Display and such devices have made the transition into the fast jet cockpit and fit naturally in the Helicopter cockpit. As the number of new military fast jets declines in favour of unmanned aerial vehicles (UAV) or unmanned combat aerial vehicle (UCAV), conversely the introduction of Head Up Displays in commercial airlines is increasing with the pressures of tight Air Traffic Control.

Those of us in the industry are aware, however, that the HUD did not burst on the scene in a variety of successful applications without some developmental groundwork being laid. Certainly, significant developments in the art took place during those years, but research of the patents existing in the field indicates that the basic concepts for most of the developments we think of as modern had been known, identified and published as far back as 1901!

This book tells the story of the different aspects that had to come together to create the need for a Head Up Display and the technologies that had to mature to allow its creation.

- The need.
- The Technologies.
- The presentation formats.
- Companies to manufacture the HUD.

The need for an aiming Sight on a Field Gun is the real start of the story but clearly since the Head Up Display is a piece of equipment to sit in an aircraft it is obvious that there was no need established before the invention of the aeroplane. Sadly it took aerial conflict to accelerate the need for a sighting system in an aircraft so perhaps the first glimmerings of the need can be said to stem from the early part of the 20th century.

The technologies required are the following **(Fig. 1.1):**

- Optics
- Display devices (CRT)
- Computing

Optical design was very mature by the early 20th Century and devices such as Telescopes were quite mature. However, the precise arrangement of optical elements needed to create even the basic Gunsight had not been configured until this time.

Display devices initially were very simple such as a light bulb illuminating a pattern etched on a glass plate. Various mechanical arrangements could be used to provide more information but essentially it took the invention of the Cathode Ray Tube to provide a programable display.

The early analogue computers were quite amazingly complex and as we shall see could provide sufficient computing power to produce a decent number of symbols on the first Head Up Displays. These first HUDs certainly could claim that they met the definition, but real progression to a fully programable task specific suite of symbology would need the advent of digital electronics; analogue computers were simply too big.

The next important element to define was to work out what the pilot wanted to know at any time. The basic aircraft instruments displayed Air Speed, Altitude and Climb or Descent and there would be a Compass and a Clock as well. Eventually weapon aiming information would be desired and the computer to calculate all the complex parameters associated with ballistics. Finally as aircraft speeds and manoeuvrability increased the pilots wanted all the flying information head up to allow flight at high speed and low level, in poor weather and at night. The comprehensive suite of symbology available to a modern pilot is exemplified by a picture from a HUD in an F-16 Fighting Falcon **(Fig. 1.2).** Having determined the function the format of the symbols need to be worked out; the shape and brightness and factors about how much to present

at any time. A lot of what we now call Human Factors needed to be explored by engineers and test pilots within a dedicated organisation such as the Royal Aircraft Establishment.

This book describes how the technologies and the requirement came together in the late 1950s with the Strike Sight Pilots Display Unit and for the Buccaneer. This is primarily the story of the development of Head Up Displays by Cintel who worked with the Royal Aircraft Establishment to develop some of the first Head Up Displays in the UK. Cintel lacked a large-scale production capability and so it was that Elliott Bros came to take over the company and its heritage of the world's first production Head Up Display. The Head Up Display has been a success story for the UK.

It is not intended to be a technical treatise however as it includes some of the stories and the key people behind the developments. The inspiration of engineers, scientists and of course pilots was required to make a success of the Head Up Display and this is just a part of that story.

The Strike Sight PDU for the Royal Navy Buccaneer. This early HUD has the large valve high voltage power supply in the box at the forward end.

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