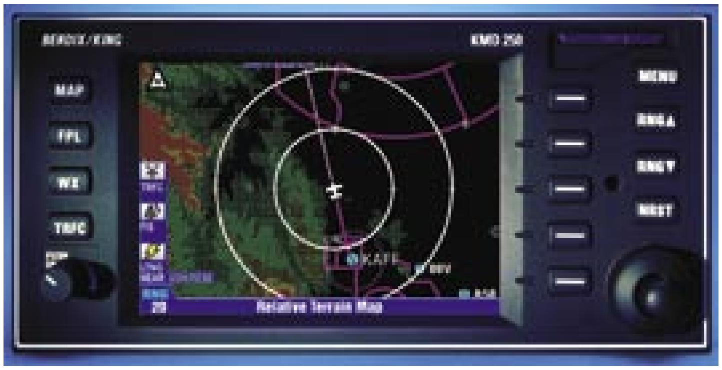
# ALL ABOUT MFDs

BY TONY BAILEY




***Moving map with relative terrain on Bendix/King's KMD 250***

Wow, I hope everyone is as impressed as I am with the evolution of avionics. It is absolutely amazing! Incredibly, one of the most amazing devices on the market today is the multi-function display (MFD). Talk about power! What was once reserved for only the most expensive aircraft, has made itself mainstream, and in a big way. But how did MFDs come about?

The current advanced displays seen in aircraft reflect over a century of development. From the Wright Brothers' piece of string used as a slip indicator to the modern electronic glass cockpits, the cockpit display has been the means of presenting information directly to the pilot. Serious attention was not given to display development until the advent of the need to fly without visual references and the subsequent development of a usable gyroscope that could be applied in the form of an artificial horizon. From this serious attention, came serious advancements. Another technological breakthrough that advanced the state of displays was the rapid development of electronics. This enabled servo-driven instruments to become possible in the 1950s and then gave the designer the freedom to locate the sensor away from the actual instrument. As digital avionics technology has continued to advance there has been an increased focus on display design. As aircraft performance was increasing, more information was made available to the pilot, and both the number and complexity of displays increased. The period from 1970 to the present has been marked by major changes in the appearance of the flight deck due to the introduction of electronic display units (EDU). In the early 1980s, the all-digital AirBus A310 and Boeing 757/767 introduced Cathode Ray Tube (CRT) flight displays in civil aviation and this marked the watershed in the evolution of the "glass cockpit," a term synonymous with MFDs. A typical glass cockpit configuration includes up to six electronic display units, backup flight instruments (liquid crystal displays (LCD) or electromechanical instruments) and a few critical system indicators on the main instrument panel.

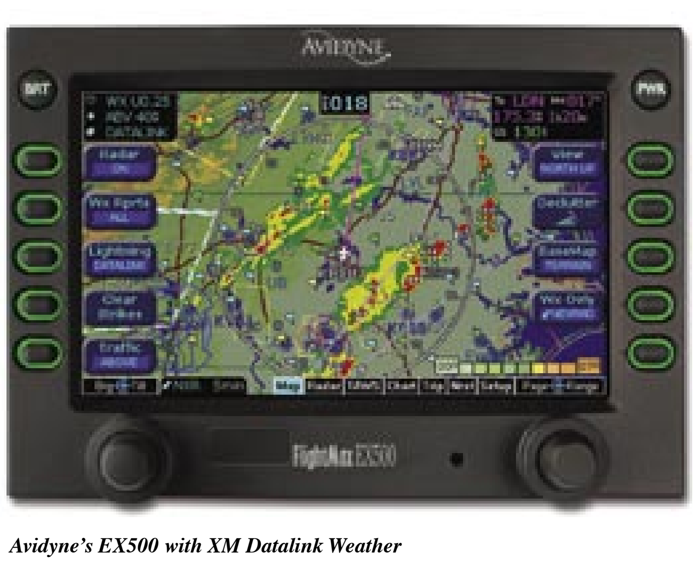
As manufactures were struggling with the type and need of the information to display, technology employed continued to evolve and although glass cockpit displays were not significantly different, they used different techniques to display information. Boeing used an electronic attitude director indicator (EADI) which was similar to those of the older electromechanical attitude directional indicator's (ADI) that it replaced. Airbus took a different approach and was able to take advantage of the flexibility of the new displays and elected to introduce a primary flight display (PFD) that integrated main airspeed, selected altitude and deviation, full flight mode annunciation and various other information. In addition to flight instrument displays, glass cockpit technology also can be applied to the presentation of systems information. This involves engine data as well as other aircraft systems. The flexibility of this time-sharing form of display enables systems information to be presented only when required, either because of the phase of operation, such as engine starting, or when a system deviates from its normal operating range.

Another use of MFD technology is for the flight management system (FMS). The FMS interfaces with the navigation system and is intended to reduce workload, compile complicated lateral and vertical profiles, and supply data for the electronic flight guidance system. In general these systems optimize operating efficiency with a primary aim of reducing fuel costs. The flexibility of glass cockpit displays has made it possible to provide information when it is needed, in new and different formats, and to modify that information in any way desired by designers to fit any need. The MFD is a display surface which, through hardware or software controlling means, is capable of displaying information from multiple sources and, potentially, in several different reference frames. The device may be capable of either displaying different groups of data (i.e., weather, traffic or terrain) one at a time or in a combined fashion. In some cases the data may be combined within a single common reference frame or within separate reference frames. The advances in technology combined with decreases in cost have led to design flexibility of the cockpit displays. As a result, MFDs have become increasingly prevalent in aviation. MFDs have been promoted as a means of "layering" information in integrated formats and of using single display surfaces to present large amounts of data which has become a major concern for the FAA and Human Factors experts. MFDs are capable of presenting data from a number of independent sources, including those from cockpit display of traffic information (CDTI) systems, enhanced navigational information systems supporting moving maps, weather information sources, traffic alert collision avoidance systems (TCAS), and terrain avoidance warning systems (TAWS). Human factors issues arise when avionics subsystems evolve independently, without consistency in the design of the user interfaces, and are brought together in the cockpit. Cockpit MFDs create the opportunity for a variety of systems to be displayed either simultaneously on adjacent display surfaces, sequentially, in layers on the same display surface, or simultaneously in "windows" on the same display surface. If MFD users are confronted with conflicting, mismatched, and inconsistent display designs, either at the level of display construction and formatting or at the level of data accession method, effective use of the displayed data is likely to be compromised.

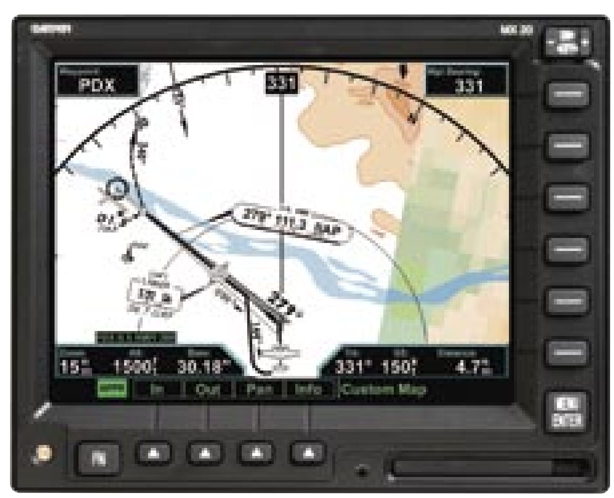
Amazingly enough, the evolution has made it from the large transport aircraft only, to the smallest of aircraft with all of the functionality you would expect from the "big guys." New features promise to add more capabilities like datalink, large-format display, graphical METARs and textual METARs. METARs is a format for reporting weather information resulting from a French abbreviation, which translates to "Aviation Routine Meteorological Report" and used to be primarily utilized by airline pilots, to learn about the weather where they're going to land, and by meteorologists, who use the information to help forecast the weather. Now this technology is becoming available to even the smallest of aircraft types and operators.

Manufacturers like Bendix/King (Honeywell), Garmin and Avidyne introduced the small aircraft industry

*Continued on following page*




***Avidyne's EX500 with XM Datalink Weather***




***Garmin's MX20***

**ALL ABOUT MFDs**

*Continued from page 59*

to MFDs that could be utilized almost anywhere with the same performance pilots would expect to see only in high priced equipment at a much lower cost. All of the sudden, everybody had to have one and the market boomed. Manufactures of higher end displays such as Universal, Rockwell Collins, and Honeywell made great strides as well by introducing Flat panel integrated displays (FPID) that incorporate the latest advancements in technology to offer superior sunlight readability along with higher resolution, greater contrast, wider viewing angles and full graphics capabilities. They also designed systems for both new aircraft and retrofit applications, allowing older systems to be integrated with the new technology without major headaches (well, in theory anyway). They also included reversionary display functions for enhanced cockpit safety as well as added advantages in weight, power, cooling and reliability.

Some of the multi-function displays are listed below by manufacturer and as you can see, just about everyone is getting involved in this ever expanding market. In fact, for everyone of the manufacturers and models I have listed, there are probably 10 I missed. It is absolutely staggering to consider the evolution of this product.

### Aspen Avionics

AT-300

### Avidyne

FlightMax EX-500 with Internal Satellite NEXRAD WEATHER RADAR Datalink

FlightMax EX-500 with Bendix RDR-130/150/160 Radar Interface

FlightMax EX-500K with Bendix/King RDR-2000/2100 or RDS-81/82/82VP/84/84VP/86/86VP Radar Interface

FlightMax EX-500C Multi Function (Radar) Display with Collins WXR-250/270/300 or Bendix/King RDR-1100/1200/1300 Radar Interface

FlightMax 650

FlightMax 740

FlightMax 850

### EVENTIDE

Argus 3000

Argus 5000

Argus 5000CE

Argus 7000

Argus 7000CE

### Garmin

Apollo 360

MX-20

### Honeywell Bendix/King

KMD 250

KMD 250 with Internal GPS

Color Skymap IIIC

KMD-150 with Internal GPS

KMD-550

KMD-850

### Honeywell

Primus Epic

Primus 2000XP

MFRD

AMLCD

### L-3 Avionics Systems

SmartDeck

### Meggitt/S-TEC Avionics

Magic System

### Northrop Grumman

SMART MFD

### Palomar Display Products

8010 MFD

### Rockwell Collins

AFD-3010

MFDS-1000

DU-9802

### SAGEM Avionics (ARNAV)

MFD-5200

### Smiths Aerospace

MCDU 2882

MCDU 2884

MCDU 2885

MCDU 2887

MCDU 2888

MCDU 2889

### True Flight

Flight Cheetah FL-250

Flight Cheetah FL-270

### Universal Avionics

MFD-640

As for the future, many different approaches from the industry are in work. NASA, for example, has been working on the AGATE (Advanced General Aviation Transport Experiment) program since the mid-1990s which has been testing various ideas for the cockpits of tomorrow. One of them is what has come to be called the "Highway in the Sky" (HITS) concept—a concept first advanced in the 1960s by California aeronautical engineer George Hoover. This involves reducing pilot workload by providing an altogether new concept in navigation technology. The pilot views a series of rectangular symbols that trail along a flight-planned route. Fly through this series of boxes and you'll navigate like a pro, from takeoff to touchdown, VFR (Visual Flight Reference) or IFR (Instrument Flight Reference).

In its highest evolution, HITS would involve a three-dimensional type of display, one that would faithfully depict the terrain around the airplane, show any conflicting traffic, and show symbols for nearby lightning or precipitation returns—all on the same screen.

To fully see how fast the MFD is evolving, you need not look any further than the military. Electronic subsystems and components for U.S. and allied combat vehicles are entering a fundamentally new and different era of inter- and intra-systems integration with a broad range of new technologies and networked communications. Primarily driving this trend are the overall emphases on "force transformation" and the Future Combat System—better known as FCS.

The new transformational era will usher in advanced technologies in aviation electronics such as nuclear/biological/chemical sensors, automatic target recognition, computer-based decision aids, ultrasonic/infrared/visible-light sensors, laser radar (LADAR), high-speed distributed computing, robotics, low-profile conformal antennas, position/navigation/tracking systems, disposable unattended sensors, battle command on-the-move systems, through-wall and through-foliage sensors, standoff mine detection, unmanned vehicles, high-speed wireless mobile networks, advanced machine navigation, sensor fusion, optoelectronic countermeasures, flexible and conformal color displays, and Charge Coupled Device (CCD) cameras. The transformational philosophy of weapon system design, acquisition, and deployment seeks to catapult the notion of an integrated architecture from a platform level literally to a global level.

Armed with such a dynamic picture, or with this kind of "situational awareness," U.S. forces theoretically could maneuver against opposing forces without making direct contact, strike in the time and place of their choosing, mass fire against opposing forces without massing their own forces, keep their eyes continually on targets, and decentralize decision making.

And what does this mean for the future of MFDs? It is quite possible that future displays for corporate aircraft will have warning "overlays" that provide threat information such as missile alerts, chemical warnings, and automatically engage counter measures in conjunction with real-time updates of satellite imagery, runway information, flight tracking and directional accuracy coupled with a great view of the passengers in the back. Some of the features the future MFDs will contain are:

• Fewer control devices will be needed to operate the system, and they will be placed within more natural reach.

Graphical management will improve the speed and accuracy of many functions (especially graphical flight planning).

• Intelligent menu management. For example, when entering a flight plan, as soon as a field is filled, the cursor will go directly to the next item.

• Checklists will have certain auto-sensing functions (e.g., flap setting checks itself off when its condition is met), and pop up automatically when requested—an important step toward the paperless cockpit.

• Threats from missiles or active radar.

• Streaming video providing real time weather updates with actual position including actual altitude triangulated between ground and satellite stations.

• Utilization of emerging Automatic Dependent Surveillance-Broadcast (ADS–B) technology to complement radar for en-route, terminal area and airport surface surveillance.

• Ability to utilize the "arrival manager" system connected to Air Traffic Control (ATC) which will allow for automated airfield taxi and Fixed Base Operation (FBO) parking instructions.

• Display of Very High Frequency (VHF) Datalink Mode 4 link technology.

The truth is clear that the MFD is probably one of the most useful tools in the pilot information toolbox. Even after pilots are long gone, the MFD will have set the stage for some of the most advanced technological achievements in avionics history! The future looks bright, clear, and cleverly encased in black! ❑