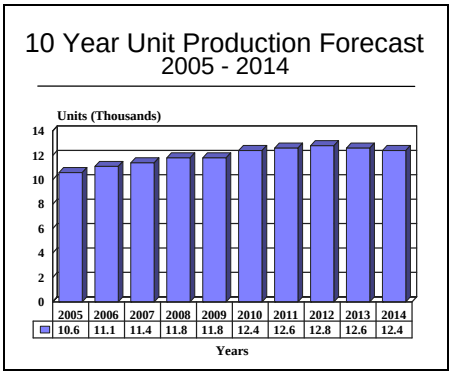
Flat Panel Displays - Archived 6/2006

Outlook

- Over 120,000 FPDs expected to be produced for major civilian and military new-build and modernization programs through 2014
- Honeywell's FPD-dependent Avionics Modernization Program (AMP) will be a key part of C-5 Galaxy, C-130 upgrades throughout the forecast period



Orientation

Description. Flat panel displays (FPDs) provide an alternative to cathode ray tubes (CRTs) for the electronic display of data.

Contractors. See the **Program Review** section of this report.

Status. In various stages of development and production.

Total Produced. It is estimated that over 4.7 million FPDs of all types had been procured by the world's military forces and commercial sectors through 2004.

Application. FPDs are used in military and commercial cockpits, on laptops, in graphics calculators, and in test units, among other applications.

Price Range. Prices for FPDs are difficult to estimate because of the manufacturers' reluctance to release pricing data. In addition, prices will span a wide range based on size and application.

Note: *This report is not meant to be a forecast of production of the total number of flat panel displays that will be produced, or of every application worldwide. Rather, it is an overview of past programs, current trends and possible directions in the years ahead. Also, it is primarily focused on the military aircraft sector.*

Contractors

Not available.

Technical Data

Design Specifications. Flat panel displays (FPDs) are advanced data displays developed to replace the cathode ray tubes (CRTs) used in older aircraft cockpits and are standard equipment on newer platforms. A wide variety of displays that might correctly be called flat panels have been in service for a number of years. For the purposes of our forecast, the FPD is intended to provide an electronic display similar to that of a cathode ray tube, but superior to the CRT in several areas. Perhaps the most important advantages for aircraft design are the FPD's relatively small size and light weight, as well as its higher reliability, longer operational life, and low-voltage/lower power demands.

The various cockpit display technologies are briefly described below:

Plasma Displays. Gas-discharged plasma displays are the next major, mature display technology for alphanumeric and graphics presentation. Monochrome plasma displays are used primarily in medium to large military command and control applications.

Light Emitting Diode (LED). The LED is a mature FPD technology that provides sunlight readability, ruggedness, and low power requirements. Its disadvantages are sub-par image resolution and screen size. Typical LED applications include data entry displays and system monitoring displays.

Electroluminescence (EL). Monochrome EL panels offer advantages in luminescence, ruggedness, viewing angle, and temperature range, along with lightweight construction. They are employed exclusively to display text and graphics.

Passive Matrix Liquid Crystal Displays (PMLCDs). The most common of all FPDs, these easy-to-fabricate systems are too slow for video programs with a repetition rate faster than 30 frames per second. Nonetheless, dual-scanning and active-addressing schemes have done much to increase speed and make this a technology worth watching.

Active Matrix Liquid Crystal Displays. AMLCD technology is considered the leading-edge display technology for new FPD applications over the near term. AMLCD offer video-quality image, sunlight readability, fast repetition speed, and wider-viewing-angle performance characteristics.

Field Emission Displays. These are solid-state vacuum displays, not unlike cathode ray tubes, based on cold emission of electrons from a matrix array of metal or semiconductor microtips.

Flexible Displays. Still in the development stage, these displays promise to offer seemingly revolutionary applications. Lighter, thinner, and made of plastic, they promise to be much more rugged than previous displays. Future applications could include helmet-mounted face shields and even flexible, disposable documents for infantrymen.

Flat Panel Rugged Displays. Produced by DRS Technologies, these systems feature AMLCD technology and are designed specifically for performance in hostile environments. These situational displays are intended for use in a variety of land, sea, and air applications.

Variants/Upgrades

See the **Technical Data** section above for the various types of flat panel displays currently in development/production.

Program Review

Note: *This section serves as an historic account of some past and future FPD programs and systems. It is not meant to serve as a full checklist of every single FPD program ever developed, produced or implemented. As such, some systems and programs may not be represented below. This section, like the entire report, is merely an overview of the FPD sector.*

Background. The various FPD applications are too numerous to fully cover in this report. To limit scope, we review only major military and civil aircraft applications. The three U.S. military services have been investigating a number of improvements in aircraft avionics displays and controls. Information to be displayed includes stores management, tactical-situation indications, engine and systems status, and attitude indication. To achieve maximum utility in a high-performance single-seat fighter, the control must both be touch-sensitive to activate specific systems and be integrated with a voice control system.

To give the U.S. a boost in the FPD industry and spur the growth of a domestic supply base, the U.S. Defense Advanced Research Projects Agency (DARPA) awarded a $50 million Flat Panel Display Initiative grant to AT&T, Xerox, and Standish in June 1994. The grant, which included $30 million from the Defense Production Act fund and $20 million from DARPA's R&D account, matched funds put up by the three companies heading up the Flat Panel Manufacturing Testbed Partnership.

USAF Display Development in the 1990s. The U.S. Air Force has sponsored a large number of programs that directly or indirectly involve display development. The following are just some of these programs.

Super Cockpit. This U.S. Air Force program has been in progress for several years, with the aim of building a new display that will offer a panoramic, 3-D color picture. Input from the Pilot's Associate program was used to develop artificial intelligence capabilities that will result in an electronic copilot. The original concept called for a three-phase approach. Phase I entailed combining a panoramic screen with a helmet-mounted display. This appears to have been accomplished under

the PCCADS program (discussed below). Phase II added a second major display to give the pilot a "God's-eye" view of the world from a point approximately 20,000 feet above the aircraft. The Phase III effort focused on the integration of the electronic copilot developed under the Pilot's Associate program, and the addition of touch controls.

Panoramic Cockpit Control and Display System (PCCADS/PCCADS 2000). McDonnell Douglas (now Boeing) was contracted by the USAF to test and validate the PCCADS concept using a customized simulator setup. The program sought to evaluate the improvements to situational awareness that could be achieved if a single, large-area color display were used to handle the clutter problem in the higher levels of sensory input likely to be found in the future combat environment.

Favorable test results led to a follow-on effort based on McDonnell Douglas's Cockpit 2000 (called PCCADS 2000) that evaluated the concept using a 100-square-inch FPD fabricated specifically for this effort.

F-16 AMLCD Radar/Electro-Optic Display Set. The Battelle Memorial Institute (Columbus, Ohio), under a USAF contract, developed an Improved Radar/Electro-Optic (REO) display set for the F-16. The display portion of the REO is a full-color AMLCD. The usable display area form-factor is 4 x4 inches, with a resolution of at least 120 full-color groups per inch.

VCANS. The Visually Coupled Attack and Navigation System (VCANS) program developed a helmet-mounted display and head-position tracker designed to operate with a head-steered forward-looking infrared (FLIR) system. The initial application is slated to be the U.S. Air Force's next-generation CAS (Close Air Support) aircraft.

VCASS. One of the primary motivators for the Visually Coupled Airborne Systems Simulator program was the trend toward supersonic aircraft, which brought with it unavoidable minuses – not the least of which are smaller cockpits and the need for the pilot to recline to tolerate high *g* forces. The reclining position made viewing cockpit instrumentation especially difficult. VCASS applied the concept of a panoramic display to the helmet itself.

In June 1999, AlliedSignal (now Honeywell) began providing new up-front control displays and integrated control panels as part of a five-year upgrade program for Lockheed Martin's U-2S spy planes. Later that year, Barco Display Systems of Belgium started supplying Honeywell Defense Avionics Systems with 200 control display units for the cockpit upgrade of USAF G-5 Galaxy aircraft.

The U.S. Air Force began installing FPDs in the Lockheed U-2S aircraft in August 2001. Cockpit conversions to the entire fleet of 31 aircraft are expected to be completed by 2007.

U.S. Navy Display Development Programs. The U.S. Navy found a way to save $500 million in the spring of 1999 when it decided to replace the service's existing cockpit display screens with flat panels on all Marine MV-22s and Air Force CV-22 variants. The service also benefited from the P-3C Block Modernization Upgrade Program launched later that year through a deal with Barco Display Systems. The Belgian company began supplying Lockheed Martin Tactical Defense Systems with RFD251 20.1 inch (510mm) rugged FPDs to aid in the overhaul.

In November 1999, Boeing was awarded a $123 million contract by the U.S. Naval Air Systems Command to modernize the cockpits of its fleet of 16 E-6 TACAMO aircraft. Under the terms of the Multifunction Display System (MDS) contract, Boeing would further adapt its next-generation 737-700 cockpit and avionics architecture to the E-6 fleet. MDS will replace over 100 aging cockpit instruments with six FPDs. All FPDs should have been installed by the end of 2004.

In October 2000, the U.S. Navy's DDG-79 became the first Arleigh Burke class (AEGIS) destroyer to be deployed with Sanders (now BAE Systems) AMLCDs. In addition, 23 further AEGIS class destroyers and several AEGIS class cruisers were due to receive the displays over the following two years, replacing the ship's older CRT displays.

Overseas FPD Activity

French Large Interactive Display Concept. The French, led by Sextant Avionique (now Thales), developed a large interactive display concept for next-generation combat aircraft. This conceptual system includes a helmet-mounted display with a large field-of-view, a head-up display, a large interactive head-down display, and a data glove to be used by the pilot to point at selected items on the display.

Sextan developed a large interactive display mockup that included a 15x20 inch LCD rear projector (440x480 definition, allowing observation under high ambient light illumination), a voice input device, and a hand input device. The image source is a Sextant-produced digital map generator. Further improvement was to follow, and eventually an aspect ratio of 16:9 was to be achieved.

Japanese Cockpit Displays. The Japanese were early leaders in developing commercial applications of FPD technology for computers, entertainment systems, and work stations. Hosiden Electronics, Japan Aviation Electronics, Sony, Tokimec, Tokyo Aircraft Instrument

Company, Toshiba, and Yokogawa Electric Company were some of the early major developers and suppliers of advanced aircraft display products.

Yokogawa Electric Company privately developed a 3-inch, 540 pixel x 540 pixel, color AMLCD instrument display arranged in parallel strips – with a half-pixel difference in alignment between successive strips to provide a red/green/blue triangle – which was proposed for the FS-X program (now known as the Mitsubishi F-2 fighter).

Japan Aviation Electronics supplied a 7.5 x 5.5 inch color AMLCD for the Japan Air Self-Defense Force's C-1 retrofit program. The display was centrally mounted on the instrument panel between the two pilots for viewing. It should be noted that several Japanese LCD and AMLCD producers have supplied the major U.S. avionics producers with display panels for use in their respective commercial and general aviation products.

Eurofighter Typhoon. The Typhoon fully incorporates advanced FPDs within its cockpit environment. Three displays are used in single-seat versions, while twin-seaters are equipped with six. The display is the AMLCD type. The Multifunction Head Down Displays (MHDDs) offer tactical situation information, attack formats, map displays, and various system status read-outs.

Commercial Cockpit Applications. The large commercial transports have been equipped with the leading edge in cockpit automation, with the latest designs incorporating advanced glass cockpits that center on the Electronic Flight Instrumentation System (EFIS). Until 2002, Boeing 747-400s featured a Rockwell Collins EFIS with six 8-inch color CRTs for the display of primary flight, navigation and powerplant information. The first aircraft equipped with their replacement – 8 x 8 inch DU-7001 AMLCDs – was delivered in October 2002.

While the majority of current-generation flight displays rely on CRT technology, major U.S. and European cockpit systems manufacturers are offering cockpit systems with advanced FPDs. These FPDs take the form of AMLCD or EL types. Rockwell Collins introduced its first AMLCD product for transport applications in 1988. This was the DLC-800, a touch-sensitive FPD with an AMLCD screen for display of engine, navigation, and wind/temperature data. Traffic Alert and Collision Avoidance Systems II (T/CAS II) terminals that incorporate color liquid crystal displays (LCDs) are now on the market.

Boeing, McDonnell Douglas, and Airbus have each sponsored research projects regarding advanced cockpit systems. State-of-the-art CRTs continue to be employed for older platforms, but, as indicated above, the display suppliers are moving into new FPDs. The transition to large color AMLCD cockpit displays is also being led by the Boeing 777, which features a Honeywell-supplied EFIS with six 8 x 8 inch AMLCDs.

Commuter and business-class jets are also incorporating EFIS and related flight display systems, although, as with their big brothers, these systems currently rely on CRTs. With smaller cockpits and tighter space requirements, their FPD transition will follow that of the large transports. These applications generally feature a four-tube layout, with an average size of 5.25 to 6 inches.

Commercial helicopter applications represent the smallest business segment for FPD applications because they have less need for instrumentation than do fixed-wing aircraft. However, this may be changing somewhat as new-generation corporate helicopters come onto the market.

FPDs into the 21st Century. In FY00, $38.2 million was budgeted by the DoD for the RDT&E phase of the Integrated Command and Control Technology program tasked with developing technologies for high-definition displays. Among the efforts conducted during the year was the development of active matrix backplanes – flexible, rugged displays based on organic electro-luminescence and zero-power reflective technology. Of the total budgeted for the program, $7 million was devoted solely to flat panel display development.

FPDs are usually a much touted component of new, advanced platforms. In the spring of 2000 it was announced that the first Sikorsky S-70A-28D Black Hawk produced for Turkey had been equipped with Rockwell Collins' glass cockpit. Sikorsky was scheduled to retrofit 20 in-service and deliver 30 new-build Black Hawks to the Turkish Land Force, all with the glass cockpit.

A cockpit display system produced by Thales Avionics was selected in July 2001 for the flight deck of the developing Airbus A380 super-jumbo jet. The system will consist of eight LCDs, with 6 x 8-inch screens that will display a wide array of information.

In February 2001, Warrior Vision, an FPD designed for armored vehicles, was installed as a key element of the workstation of the International Space Station. The FPDs were integrated into each workstation and provided images of the station's robotic arm as it performed various tasks in space.

A new glass cockpit was reportedly introduced in the summer of 2002 for the Russian Mil Mi-26 Halo heavy-lift helicopter. The aircraft's PNK-26M flight-navigation complex includes a glass cockpit with five color multifunction displays (MFDs).

In August 2002 Rockwell Collins announced that it had signed a Letter of Intent with Sikorsky for the provision of 1,200 displays for the UH-60M Black Hawk helicopter. The company said that the work could have a value of up to $225 million over the next 20 years.

In January 2003, Rockwell Collins completed FAA Supplemental Type Certification for the FPI-920 Electronic Attitude Director Indicator/Electronic Horizontal Situation Indicator (EADI/EHSI) on DC-10 and Boeing 747 Classic aircraft.

Astronautics Corporation of America was awarded a contract in July 2003 from BAE Systems for the supply of AMLCDs for U.K. Royal Air Force (RAF) Tornado GR4 aircraft. The company was to provide 5-inch Pilot Multifunction Displays (PMFDs) for a total of 160 units. These systems are based on technology developed under contract from Alenia Aerospazio and Panavia for the Tornado aircraft fleets operated by Germany and Italy.

Numerous international contracts were awarded in late 2003 to Belgium's Barco for the production of FPDs for use in U.K. RAF EH101 helicopters, Swedish armed forces NH90 helicopters, and USAF RC-135 Rivet Joint surveillance aircraft. Significantly, Barco was also chosen as the supplier of FPDs for the developing USAF/U.S. Navy X-45 Joint Unmanned Combat Air System (J-UCAS). The company's display systems will be used within the mission control station of the aircraft.

In April 2004, Barco was awarded a contract of undisclosed sum for production of Onboard Information Terminals (OITs) for the developing Airbus A380. These systems include a 12 inch, sunlight-readable LCD display. Each of the aircraft will include two of the OIT systems, which will be used for routine flight management information display.

In the same month, Thales Avionics introduced a system called the Interactive Flight Management and digital map System (IFMS), incorporating multiple FPDs. Already the system has been ordered for installation on AgustaWestland A109LUH helicopters for Malaysia, South Africa and Sweden. No timetable for this work has been released.

Barco, in May 2004, was awarded another major contract, this time from Alenia Marconi Systems (AMS) for up to 400 Modular Rugged Flat Displays (MRFDs) for naval programs in Italy and other countries.

In an advancement toward production of the avionics suite for the developing F-35, Lockheed Martin announced in May 2004 that it was close to completing the final development phase of the advanced cockpit display suite. The multi-function displays (MFD) supplied by Kaiser (which is owned by Rockwell Collins) are intended to give the pilot "information dominance" through their unique pilot-vehicle interface. The developers of this system have come up with a simple but effective format: text and symbols will be displayed in green during normal operating conditions; yellow will mean caution; and red will inform of imminent danger from enemy forces or a serious operating problem.

In June 2004 military planners announced that the U.S. and U.K. were planning to perform demonstration flights of their F-35 by sometime in 2006 with the new FPD systems. With the announcement more details emerged about them. The suite will have two side-by-side 8 x 10 inch display surfaces, for a combined 8 x 20 inch viewing area – reportedly the largest, current fighter aircraft cockpit display.

Around the same time, Lockheed Martin began installing Honeywell-produced Avionics Modernization Program (AMP) kits into the U.S. Air Force's fleet of 112 C-5 Galaxy transport aircraft. The program is expected to last several years. The AMP kits, which feature six 6 x 8 inch FPDs for the pilot and one for the flight engineer, will replace older, analog cockpit instrument. The AMP kits are also being integrated as a key part of the U.S. C-130 fleet.

It was announced in March 2005 that the Swedish Air Force had been selected as the first international customer for the C-130 AMP program. The nation's fleet consists of eight C-130E/H aircraft. The modifications and deliveries are expected to be completed by 2009.

Manufacturers and Component Suppliers

MANUFACTURER/SUPPLIER	LOCATION	DESCRIPTION
Astronautics Corp of America	Milwaukee, WI, USA	AMLCDs for U.K. Tornado GR4s
BAE Systems	U.K.	Cockpit displays
Barco	Kuurne, Belgium	FPD manufacturer
Casio	Japan	Producer of AMLCDs
General Dynamics, Canada	Ottawa, Canada	Military EL display manufacturer
DRS Technologies	Parsippany, NJ, USA	Flat Panel Rugged Displays
Epson Electronic Components	Nagoya, Japan	Color LCDs, supplies Rockwell Collins

MANUFACTURER/SUPPLIER	LOCATION	DESCRIPTION
Hitachi Displays	Tokyo, Japan	AMLCD manufacturer
Honeywell	Phoenix, AZ, USA	FPD avionics
Hosiden Electronics	Tokyo, Japan	AMLCD manufacturer
IBM Japan	Yamato, Japan	Subsidiary for LCD development
Industrial Electronic Engineers	Van Nuys, CA, USA	AMLCD Display Integration
Interstate Electronics Corp	Anaheim, CA, USA	Ruggedized AMLCDs
Kaiser Electronics (part of Rockwell Collins)	San Jose, CA, USA	Cockpit display systems for F-35
Kopin Corp	Taunton, MA, USA	Cyber displays
Krupp Atlas Elektronic	Bremen, Germany	LCD producer for military applications
L-3 Communications	Anaheim, CA, USA	Military cockpit displays
Lockheed Martin	Bethesda, MD, USA	AMLCDs
Mitsubishi	Tokyo, Japan	Color LCD for its laptop computer
Northrop Grumman, Navigation Systems Canada	Canada	AMLCD for laptops
Raytheon Co	Marlboro, MA, USA	EL and plasma FPDs
Rockwell Collins Avionics	Cedar Rapids IA, USA	Full range of cockpit displays
SAIC	San Diego, CA, USA	Various FPDs
Sanyo	Tokyo, Japan	Color LCD development
Sharp	Tokyo, Japan	Color LCD production
Smiths Aerospace	Cheltenham, U.K.	Standby 3” x 3” LCD for F-35
Sony	Tokyo, Japan	AMLCD development and production
SRI International	Princeton, NJ, USA	AMLCD technology development for USAF
Tektronix	Beaverton, OR, USA	Development of Plasma-Addressed Liquid Crystal (PALC) displays
Thales Avionics	Paris, France	FPD producer, AMLCD technology
Toshiba Yokogawa	Japan Japan	AMLCD development and production AMLCD development
Xerox Corp, Palo Alto Research Center	Palo Alto, CA, USA	AMLCD development; partner in U.S. Flat Panel Initiative

Funding

Quite a number of programs and projects of the U.S. DoD incorporate flat panel display – too many to fully list. The intra-service program, PE#0602708E Integrated Command and Control Technology, ended in 2001.

Recent Contracts

Note: These are just a *sampling* of the significant recent contracts. A listing of all the recent contracts for FPDs worldwide would be far beyond the purposes of this report. Also, in some cases the specific FPDs to be used for upcoming avionics upgrades, such as those for the C-130, have not been identified by the contractor.

Contractor	Award ($ millions)	Date/Description
Lockheed Martin	58.0	Feb 2001 – Modification to FFP contract for the production of Color Multifunction Display System (CMDS) kits for F-16 aircraft. Work is expected to be completed by December 2005. Aeronautical Systems Center, Wright-Patterson AFB, OH, is the contracting agency. (F33657-98/C-0035, PZ0008)
Rockwell	16.0	Sep 2002 – Contract by Northrop Grumman Canada to develop FPDs for

Contractor	Award ($ millions)	Date/Description
Collins		Canadian Forces (CF) and Royal Australian Air Force (RAAF) F/A-18 aircraft. Rockwell's Kaiser Electronics will develop the displays in an effort expected to last 30 months. Program will involve 71 Australian and 80 Canadian F/A-18 aircraft.
Barco	Unknown	Sep 2003 – Contract from L-3 Communications for 54 multifunction displays (MFDs) for USAF RC-135 Rivet Joint aircraft. Order follows earlier delivery of 25 units for same platform.
Rockwell Collins	14.0	Nov 2003 – USAF contract to upgrade displays for Boeing F-15Es. Contract calls for delivery of 178 5-inch Flat Panel Color Displays starting in January 2005, with deliveries to be completed by April 2006. The FPCDs will replace older CRT-based systems currently aboard the F-15E. Production could entail refitting up to 750 aircraft, both domestic and international.

Timetable

Month	Year	Major Development
	1989	U.S. selects AMLCD for several next-generation aircraft applications
	1989	DARPA promotes HDTV spin-offs for advanced FPDs
	1993	Full-color AMLCD made available for commercial/military applications
Oct	1996	Delta Air Lines selects Collins LCD as fleet standard for its 727s and 737s
Nov	1996	Collins General Aviation Division of Rockwell introduces new 7.25 AMLCD for use in aircraft flight deck upgrades and retrofits
Nov	1996	AlliedSignal introduces flat panel multipurpose displays to replace the monochrome displays in use on the Longbow Apache helicopters
Feb	1997	dpiX begins development of high-resolution reflective display technology
Oct	1998	Planar chosen to supply all FPDs for Eurofighter Typhoon
Apr	1999	U.S. Navy replaces existing cockpit display with FPDs for all Marine MV-22s and U.S. Air Force CV-22s
Jun	1999	AlliedSignal provides up-front control displays for U-2S spy plane
Nov	1999	Boeing wins $123 million contract to modernize cockpits of U.S. Navy E-6 TACAMO aircraft
Mar	2000	Lockheed Martin wins contract for common cockpit kits for U.S. Navy Sikorsky (UTX) CH-60 Vertical Replenishment helicopters
Oct	2000	U.S. Navy's DDG-79 Arleigh Burke class AEGIS destroyer deployed with Sanders (now BAE Systems) AMLCDs
	2001	Warrior Vision flat panel display installed on International Space Station
Aug	2002	Rockwell Collins announces plan with Sikorsky for the provision of 1,200 displays for the UH-60M Black Hawk helicopter
	2004	Work begins on installing Avionics Modernization Program (AMP) kits on 112 U.S. Air Force C-5 Galaxy transport aircraft
Mar	2005	Sweden enters C-130 AMP
	2006	Expected in-service date of Airbus A380
	2007	Completion of U-2S cockpit conversion with FPD, expected LRIP for F-35
	2005-2014	Continued high rate of production of FPDs for various military and civil aircraft applications

Worldwide Distribution

FPDs are distributed among military and civilian aircraft worldwide in numbers far too large to break out individually.

Forecast Rationale

Throughout 2004, major orders for a large number and variety of aircraft were placed for avionics packages that prominently feature flat panel displays (FPDs). While many of these orders were for new-build aircraft, more than a few were for critical modernization programs. The prominent aircraft involved in these installations include such important next-generation platforms as the F-35 Joint Strike Fighter, and older, workhorse, transport aircraft like the C-5 Galaxy and C-130 transport aircraft. All this activity will ensure the ongoing, steady production of a wide variety of FPDs throughout the next 10 years.

In May 2004, Lockheed Martin announced that it was close to completing the final development phase of the advanced cockpit display suite for the F-35. The multi-function displays (MFD) supplied by Kaiser (which is owned by Rockwell Collins) are intended to give the pilot "information dominance" through their unique pilot-vehicle interface. Total planned U.S. Air Force procurement of the F-35 is currently set at 1,763 aircraft. It should be cautioned, however, that, as with the F-22 Raptor, the U.S. Air Force planned buy could be reduced in the future (the projected number of F-22s has been drastically reduced). Initial Operational Capability (IOC) for the F-35A has also slipped – to FY13 from FY11.

Despite the vicissitudes of various USAF jet fighter programs, FPDs are being integrated into a vast number of other platforms, both civilian and military, all over the globe. Some of the key programs include installations for the all-important Airbus A380 civilian airliner. In April 2004, the Belgian company Barco was awarded a contract for production of Onboard Information Terminals (OITs) for the A380 which will feature a 12-inch, sunlight-readable liquid crystal display (LCD).

FPDs also feature heavily in Honeywell's Avionics Modernization Program (AMP) kits. The kits include six 6 x 8 inch FPDs for the pilot and one for the flight engineer. The USAF's fleet of 112 C-5 Galaxy transport aircraft are being fitted with these systems. The AMP kits are also due to be installed on most U.S. combat delivery and special mission C-130 aircraft to bring them up to Global Air Traffic Management (GATM) 2005 and Air Force Navigation and Safety requirements. The Swedish Air Force, in March 2005, was selected as the first international customer for the AMP program. Modifications to the nation's fleet of eight C-130E/H aircraft are expected to be completed by 2009. This work is an indication of how important equipment commonality between the U.S. Air Force and other military services is becoming. The implication is that other European C-130 operators may choose to make similar modifications.

For the purposes of this report, production numbers are based on estimates for a few of the major aircraft platforms. According to Forecast International's aircraft analysts, worldwide fighter/attack/jet trainer aircraft production is expected to total around **4,020** aircraft over the next 10 years. An estimated **922** military transports of all types and classes are expected to be produced over the same time period. Finally, approximately **5,835** large commercial transports are expected to be produced, along with **3,728** regional aircraft. If these aircraft receive the typical six to eight FPDs per plane, this production could result in the need for some 87,030 to 116,040 displays.

Given the enormous number of aircraft of all types that are expected to be built throughout the world over the next 10 years, the production numbers given in the **Ten-Year Outlook** below are certainly an underestimate. The forecast numbers are based on the figures for the platforms mentioned above but also attempt to account for the large number of new-build aircraft, such as military and civilian helicopters, that will surely be receiving FPDs. Taking these factors into account, an estimated 120,180 FPDs are expected to be produced through 2014 for both the civilian and military sectors worldwide.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level			Speculative			
Designation	**Application**	**Thru 04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**Total 05-14**
FLAT PANEL DISPLAYS	COMMERCIAL (WORLD) (VARIOUS)	3484500	7500	7700	7500	7900	7900	8000	8000	8000	8000	8000	78500
FLAT PANEL DISPLAYS	MILITARY (WORLD) (VARIOUS)	1262000	3150	3470	3970	3970	3970	4470	4670	4870	4670	4470	41680
Total Production		4746500	10650	11170	11470	11870	11870	12470	12670	12870	12670	12470	120180