

# AVIONICS PLANNING FOR FUTURE AERONAUTICAL SYSTEMS: PILOT-VEHICLE INTERFACE (PVI)

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## Abstract:

The purpose of this paper is to present the efforts of the DCS, Development Planning at Aeronautical Systems Division (ASD/XR) in the area of future system cockpit planning. Over the last three years a central group of emerging aeronautical weapon systems has been identified, and planning efforts have begun to understand the likely mission needs and requirements these systems will demand. Much of this planning is conducted horizontally, across the future systems. This facilitates the discovery of commonality between the various future systems - especially in avionics. A ripe technical area for up front definition is Pilot-Vehicle Interface (PVI). PVI will be addressed in the overall context of weapon system avionics, culminating in a future system cockpit vision.

## Future Systems:

The future systems that form the basis for avionics and PVI planning (Fig. 1) are: The Special Operations Aircraft (SOA), The Advanced Theater Transport (ATT), The Multi-Role Fighter (MRF), The Bomber Fighter Training System (BFTS), and The Joint Primary Aircraft Training System (JPATS). Although there is other planning activity in ASD/XR, these systems comprise the focus for the avionics planning.

## Functional Capability Analysis:

Once the future mission needs are embodied in a weapon system concept option, a linkage is necessary to the various emerging technologies that will compete on a performance and cost basis to implement the various subsystem functions.

A technical discipline has been established in ASD/XR that embodies that link, Functional

Capability Analysis (FCA). FCA complements the well established disciplines of Mission Analysis and Design Analysis; providing a structured methodology for assessment of MAJCOM requirements, definition and comparison of alternative system concepts (options), decomposition of system requirements to the major subsystems, and a translation of those requirements into capability requirements for each technical area of expertise (e.g. aerodynamics, propulsion, avionics, etc.).

ASD PROJECTED FUTURE SYSTEMS		
	PROGRAM DESCRIPTION	COMMENTS
ATT	• ADVANCED THEATER TRANSPORT • INTRATHEATER AIRLIFT (ALB FUTURE) • C-17 COMPANION 21ST CENTURY	• MISSION/DESIGN ANAL CONTINUING • CONCEPT DEV TEAM FORMING • KEY TECHNOLOGY DECISION - 1994
SOA	• SPECIAL OPERATIONS AIRCRAFT • LONG RANGE VERTICAL LIFT SUPPORT • CLANDESTINE INFILTRATION/RESUPPLY • SUPPORT A-TEAM & SEAL PLATOON	• JOINT MISSION AREA ANAL (USSOCOM) • TECHNOLOGY PLAN BEING DEVELOPED • DESIGN/MISSION ANALYSES CONTINUING
JPATS/ SUPT	• JOINT PRIMARY AIRCRAFT TRAINING SYS • T-37 REPLACEMENT (USAF) • T-34C REPLACEMENT (USN)	• DoD TRAINER MASTER PLAN • JOINT DEV ACO W/NAVY • NON-DEVELOPMENTAL AIRCRAFT
BFTS/ SUPT	• BOMBER FIGHTER TRAINING SYSTEM • T-38 REPLACEMENT	• DoD TRAINER MASTER PLAN • JOINT DEV ACO W/NAVY BEING EXPLORED • HIGH THRUST/WEIGHT AIRCRAFT
MRF	• MULTI-ROLE FIGHTER INTEGRATED WITH POST 2000 TACTICAL ASSETS	• ANTICIPATED FORCE STRUCTURE DEF. • COST DRIVEN DESIGN

Figure 1

This systems engineering method is being applied within the context of Integrated Product Development (IPD) to characterize the future systems. This provides a basis for investment guidance to the science and technology community, and links technology and systems investment strategy at ASD.

The top-level snap shot of this method is the Functional Capability Requirements (FCR) chart and the companion Supportability FCR chart, which consists of the ten Integrated Logistics Support

(ILS) elements. Together these charts represent a robust description of a future operational need, or a weapon system concept option.

### Selected Cockpit/PVI Perspectives:

The planning concept for these future systems is an across system, horizontal perspective. This way technology investments can be leveraged to yield higher payoffs by effecting many systems. Figure 2 is an example of this mind set.

EMERGING SYSTEMS: CRITICAL TECHNOLOGIES PILOT-VEHICLE INTERFACE		
SYSTEM APPLICATION	FUTURE SYSTEM	TAD
• REAL-TIME, ON -BOARD MISSION MANAGEMENT	JPATS	1990
• REDUCED COCKPIT COMPLEXITY	ATT	1996
• REDUCE PILOT WORKLOAD	SOA	1996
	MRF	1999
	BFTS	1999
TECHNOLOGY GOALS	PAYOFF	
• PRODUCIBLE LARGE AREA FLAT PANEL DISPLAYS	• IMPROVED SITUATIONAL AWARENESS (PERFORMANCE)	
• DECISION AIDING & DISPLAY GRAPHICS SOFTWARE	• INCREASED RELIABILITY	
• INTEGRATED HELMET SYSTEMS	• REDUCED COST	
• LEVEL OF COCKPIT AUTOMATION INCLUDING VOICE	• SAFETY OF FLIGHT	
	• IMPROVED TRAINING EFFECTIVENESS	

Figure 2

Figure 2 was excerpted and updated from the FY 1992 Program Objective Memorandum (POM) Investment Guidance Package provided to the Wright Research and Development Center (now Wright Laboratory) by the DCS, Development Planning. As can be seen, four broad technology goals were related to five future aeronautical systems.

The main focus of the planning community in PVI has been the large area flat panel display. This technology goal has the potential to yield the highest payoff in mission effectiveness in future systems. While the other three goals have significant payoffs (especially integrated helmet systems), the flat panel display has been the focus of activity.

The most stressing missions from a crew workload perspective are most likely performed from a single seat fighter. In this class of weapon system the pilot has an awesome task - maintaining situational awareness while engaging adversary aircraft and formidable anti-aircraft systems. The classic 25 square inch (or smaller) display found in the fighter aircraft of today quickly becomes cluttered in this environment. As many as sixteen

targets per square inch of display surface (assuming even distribution - the kindest case) can appear - postulating mid 1990 avionic advances.

A solution to this display clutter problem is a larger display. The difficult to manage sixteen targets per square inch corresponds to four targets per square inch on a 100 inch square display.

This size of display pushes the limits of Cathode Ray Tube (CRT) technology. The leading technology in the implementation of large area displays is Active Matrix Liquid Crystal Display (AMLCD). A cursory qualitative assessment of CRTs and FPDs is seen in figure 3.

CRT VS FLAT PANEL DISPLAYS (FPD'S)		
FPDS NEED R & D TO OVERCOME DEFICIENCIES		
ISSUE	CRT	LCD
COLOR	■	■
BRIGHTNESS	□	■
SIZE	□	▣
GROWTH POTENTIAL	□	■
VOLTAGE	□	■
RELIABILITY	□	■
POWER	□	■
YIELD	■	▣
LEGEND: ■ EXCELLENT □ UNDESIRABLE ▣ LIMITED BY TECHNOLOGY		

Figure 3

AMLCD development has had successes, and today is the aeronautical cockpit designer's technology of choice. This is seen in the large number of current and near term systems that have postulated the use of AMLCDs. They include U.S. Air Force systems (Advanced Tactical Fighter, C-130J), Navy Systems, Army Systems (Light Helicopter), and various commercial aircraft.

However to date, the major U.S. manufacturers that work with DoD in the AMLCD field are small or research oriented, and may have difficulty producing large numbers of displays (at high yield and low cost).

Asia and Europe are investing hundreds of millions of dollars in LCD technology in anticipation of the future market for High Definition Systems. Hence, offshore LCDs are being utilized in many DoD laboratory programs implementing AMLCD technology. Without some substantial investments in the United States display industry, offshore AMLCDs will dominate all markets - including DoD.

Thus an item that may have far reaching commonality and application in defense systems, may not be available from U.S. sources.

To attack the issue of Flat Panel Display producibility, efforts have begun with the Wright Laboratory's Cockpit Integration Directorate (WL/KT) and Manufacturing Technology Directorate (WL/MT) to define and structure a manufacturing program with the objective of establishing a

PVI FUNCTIONAL CAPABILITY REQUIREMENTS					
XR EMERGING SYSTEM	HUD	HMS/D	HIGH RES DISPLAY	VOICE WARNING	VOICE CONTROL
JPATS	?		✓		
ATT	✓		✓	✓	
SOA	✓		✓	✓	?
MRF	✓	✓	✓	✓	?
BFTS	✓	? ✓	✓	?	?
LEGEND: ? NEEDS ANALYSIS ✓ YES					
HUD: HEADS UP DISPLAY HMS/D: HELMET MOUNTED SIGHT/DISPLAY ASD/XRF 20 APR 90					

Figure 4.

domestic capability to cost effectively manufacture AMLCDs for Aerospace and DoD needs. Consensus has been reached with key Army and Navy display technologists and system planners, in an attempt to carry the commonality beyond one service.

#### Future System Cockpit Vision:

By considering the future systems in figure 1 as fighter class (JPATS, BFTS, MRF) and transport class (ATT and SOA), common attributes between them can be postulated. In figure 4, those systems are correlated with five PVI functions. While the "answers" are debatable, and subject to discussion; this structure allows the planners to iterate functions and requirements with the user and technology community, very early in the acquisition cycle.

Focusing on the two trainer aircraft systems, JPATS and BFTS, a vision for cockpit commonality emerges (figure 5). The future concept for pilot training (for fighters and bombers) consists of initial training in the JPATS aircraft, and subsequent training in the BFTS aircraft. From the BFTS, the pilot will fly his assigned aircraft, as seen in the right hand side of figure 5.

JPATS, BFTS, and MRF are future systems in the planning stages. By making the cockpit hardware, software, or both common (as common as possible) between them, more effective transfer of training skills could result. The cockpit concepts that result in commonality could then influence P<sup>3</sup>I decisions for the entire bomber/fighter fleet. This is not to imply that the cockpits should be identical, as mission and operational needs will dictate the configuration. But, common hardware and software "modules" for common functions (i.e. display heads, graphics generation computers and software, etc.) could prove a high payoff.

The quantitative payoff of this is subject to debate and discussion. But, by considering unconventional issues such as this trainer aircraft cockpit vision early in the acquisition cycle, potential show stoppers or high payoff concepts can be explored.

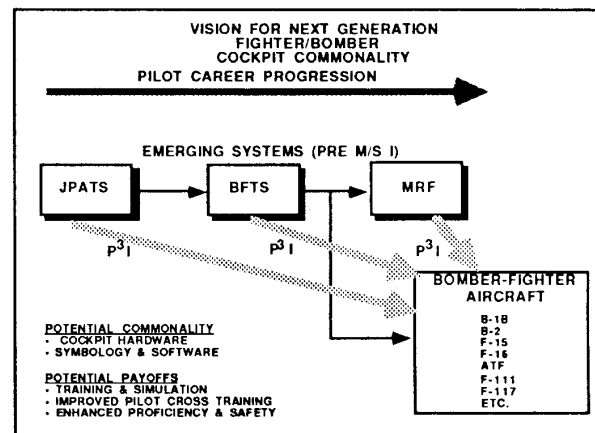


Figure 5.

Other technologies under consideration for this up front horizontal approach include: decision aiding software, display generation software, integrated helmet systems, and uses of voice.

The issues being addressed in software focus on what to present to the pilot through the display medium. Current technology programs such as the Pilot's Associate Program and Air to Air Attack Management program, both in the Wright Laboratory, are pushing the envelope of decision making software aids.

For planning purposes, it is critical to understand the level of decision aiding that maximizes the performance of the weapon system in fulfilling the mission. Then, software "modules" from these programs could impact many future

systems (although most of the effort to date has focused on fighter applications).

The payoffs for the helmet system and voice are probably highest in the fighter application. Future studies will assess these technologies and their impacts on mission performance.

### Conclusion:

The Development Planning community at Aeronautical Systems Division is responsible for the genesis of future aircraft systems. By examining these emerging systems very early in the acquisition cycle, common attributes between systems can be gleaned, especially in the system's avionics.

The avionics and cockpits of the future systems have the possibility of sharing many common aspects. By applying functional capability analysis, an initial scope of the commonality can be made. Commonality between the aircraft systems of the future promises to reduce cost (both acquisition and life cycle), and increase supportability and maintainability.

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