Mission Performance Aid for Aerial Combat

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ABSTRACT

This paper addresses the concepts, methods, apparatus, and tools used to establish the operational requirements and system architecture for an advanced mission performance aid (the smart cockpit) that targets aerial combat operations. As the complexity of our modern avionic systems increase, it is important to define operational requirements and crew station display features early in the design cycle. Many observers insist higher quality front-end work be performed to reduce the growing number of back-end mistakes and cost overruns. This paper provides a top-down orientation that treats platform, avionics, weapons, and flight crew as an integrated system. This facilitates the analysis of system-wide functional attributes that represent key design drivers. Topics include mission decomposition, critical task analysis, information requirements, function allocation, and crew station display features. This material is intended for managers, engineers, human factor professionals, and test and evaluation flight crews improving mission performance in an increasingly complex environment.

KEYWORDS


INTRODUCTION

There is general agreement among military planners that tomorrow’s air battle will pose a significant challenge to aircrews who will likely encounter sophisticated and numerically superior opponents. Future tactical aircraft designs must take into account the likely excess task and information loading experienced by aircrews. This challenge will require new concepts, tools, and methods that can achieve optimum integration of avionics and aircrew. Eggleston and Kulwicki (1984) indicated that present design methods are unable to adequately identify, evaluate, and select system-wide attributes during design and integration. He concluded that methods should and must be developed to analyze convergent technologies and must consider utility analysis to examine tradeoffs between aircrew and system functions. This would resolve tactical conflicts, maintain situational awareness, optimize decision making, and reduce pilot workload. In response to this challenge, we will discuss the use of Mission Performance Models to drive the design decisions, justify the selection of any particular design option, and assess the impact of a chosen solution on total system performance.

The Use of Models

This paper will present a number of highly structured, tightly linked predictive models useful for the definition and design of higher-ordered functionally integrated tactical systems. These models are particularly useful in evaluating system-wide attributes as part of the macro-system design and integration task and for providing a mechanism for the early assessment of system, subsystem, and component functional area operational utilities. The models presented have been applied to the specification and design of advanced tactical programs with positive results.

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Critical Mission Concerns
In current and future air battles, pilots are likely to encounter sophisticated numerically superior threat systems, and thus may encounter high task loading, high-risk situations complicated further with serious information overload. The modern tactical environment will consist of:

- More weapons choices
- Increasing number of weapons guidance choices
- A proliferation of onboard sensors
- Battle zone network demands
- Expansion of the operational environment
- Communication requirements

Designing an advanced tactical crew station will depend increasingly on the ability of the design communities, working closely with the test and evaluation communities, to achieve higher-order functional integration of all aircrew systems. In other words, by applying task, functional integration across traditional functional boundaries, it is expected that pilots will be provided with a more holistic view of the tactical situation, allowing for the concentration on critical mission activities instead of being distracted with myriad housekeeping chores that can more easily be handled by a smart cockpit. (Eggleston, 1987; Harrington, 1987).

CONCEPT DEVELOPMENT

Advanced Integrated Systems
A functionally integrated system can be defined as one that correlates input information, calculates cumulative effect across important operational dimensions, assesses the operational utility of that information, and combines this information and presents it to the crew member as a composite informational package. Importantly, it is no longer considered appropriate to present to the crew station the lowest element of information. Much work is needed to eliminate as much as possible the time-consuming, discrete activities that degrade rather than enhance mission performance.

Generally an integrated system performs the following (see Figure 1):

- Sensor management
- Information fusion and packaging
- Utility assessment
- Decision support
- Event sequencing

By effectively integrating two separate functions, say flight path control and defensive countermeasures, a pilot at the optimum range could navigate around a synthetic visually displayed obstacle superimposed on the head-up display (HUD). This composite information could depict a group of threat systems and would indicate lethal or safe zones. The pilot then could use this information to execute the optimum maneuver corresponding to the optimum countermeasures. The smart cockpit would also calculate and display to the pilot the sequence, timing, and secondary maneuvers in order to optimize mission success.
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