A SYSTEM APPROACH TO HELICOPTER UPGRADE FOR ANTI-SUBMARINE OPERATIONS

Srinivas Jonnalagadda **Arvind K. Sinha** **Peter Hoffmann**
Sir Lawrence Wackett Centre for Aerospace Design Technology
School of Aerospace, Mechanical and Manufacturing Engineering
RMIT University, GPO Box 2476V, Melbourne, Victoria, 3001, Australia.
(Tele: +61-3-9925 8091 Fax: +61-3-9925 8050)
(E-mail: arvind.sinha@rmit.edu.au)

Daniel P. Schrage
Professor and Director CERT and CASA
School of Aerospace Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0150, USA
(Tele: +1-404-894-6227 Fax: +1-404-894-2760)
(E-mail: daniel.schrage@ae.gatech.edu)

ABSTRACT

The role of maritime helicopters is now complex due to the global warfare that has shifted maritime missions from blue sea to littoral waters. The threat from submarine in littorals requires the enhancement of anti-submarine capabilities of aerial platforms; including helicopters for future global crisis and conflicts (Morgan, 1998). The vast coastline of Australia needs to be protected from such attacks. As the design of a new aircraft with advanced mission systems on-board to enhance the mission capability is a costly venture, upgrade of aircraft in-service with these advanced systems is the preferred option (Mulholland, 2000). The upgrade analysis process is complex, iterative and requires the development of software tools for speed and accuracy. This paper describes a system methodology being adopted to automate the upgrade process of maritime helicopter for anti-submarine operations through the development of ”Intelligent Decision Support System” software.

INTRODUCTION

The role of maritime helicopters has grown in complexity due to the evolving global warfare scenario that has shifted maritime missions from blue sea to littoral waters. A submarine poses the ephemeral and gravest threat in todays and future maritime missions (Morgan, 1998). Submarine detection in littoral waters is very difficult and is as challenging operation as it is in blue seas (Edmonds, 2000). Australia with its vast coastline is vulnerable to submarine attacks and needs to be protected in the present global warfare scenario. The threat from submarine in littorals requires the enhancement of anti-submarine capabilities of aerial platforms; including helicopters for future global crisis and conflicts (Morgan, 1998). As the design of a new aircraft with advanced mission systems on-board to enhance the mission capability is a costly venture, upgrade of aircraft in-service with these advanced systems is the preferred option (Mulholland, 2000). The upgrade analysis process is complex, iterative and requires the development of software tools for speed and accuracy.

To address the upgrade process for mission capability enhancement of helicopters, a system approach was adopted by Sinha et al. (1995, 1996, 2000a,b) to consider the disparate design parameters - mission capability, flight performance, reliability, maintainability and cost. The system was conceptualised in an 'input-process-output' configuration (Flood & Jackson 1991; Turban & Aronson 1998, pp, 35). A framework to automate the upgrade methodology developed by Sinha et al. (1995, 1996, 2000a,b) was addressed by Kusumo et al. (2001a, 2002), through an "Integrated Decision Support System". A timely, robust, and mission specific upgrade analysis needs a system approach for automation through an "Intelligent Decision Support System".

This paper presents a detailed helicopter upgrade system for anti-submarine mission building on the system approach adopted by Sinha et al. (1995, 1996, 2000a,b) and the automation framework by Kusumo et al. (2001a, 2002). A brief outline of the "Intelligent Decision Support system" is presented based on the system configuration.

HELICOPTER UPGRADE SYSTEM FOR ANTI-SUBMARINE OPERATIONS

The generic system methodology for upgrade process for mission capability enhancement of helicopters, developed by Sinha et al. (2000a) was configured in a conventional input-process-output configuration (Flood & Jackson 1991; Turban & Aronson 1998, pp.35), to structure the helicopter upgrade system for anti-submarine mission. The operational needs and the operational environment of maritime helicopters were investigated to identify the anti-submarine mission requirements and the mission capabilities to be derived from the helicopter upgrade system. The conceptualised helicopter upgrade system developed by the system approach is presented in (Figure 1). The structure identified the system environment, its boundary, inputs, subsystems/components, attributes of each of the components and the interfaces between various components.

The model is developed as an open system and comprises of the following:

- **System environment:** The littorals, time of operation, weather and sea state;
- **System inputs:** Provisions for the inputs by the user;
- **System components:** The components are mission systems, in-service helicopter and man-machine interface. A knowledge-base system provides the avenue for interaction of the helicopter system, mission systems and the man-machine interface to produce the upgraded helicopter system; and
- **System output:** Upgraded helicopter for anti-submarine operations.

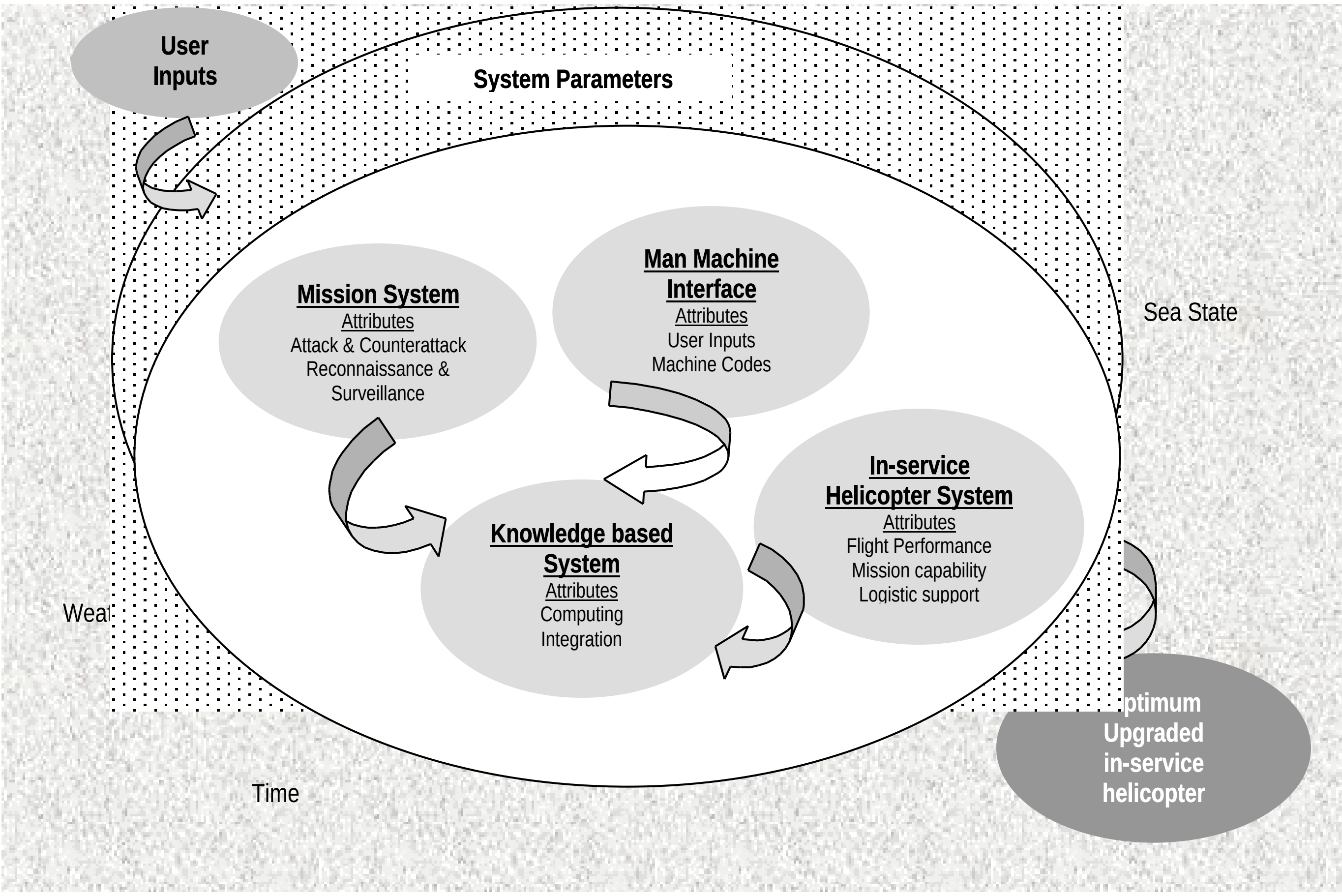

Figure 1: Helicopter Upgrade System for Anti-Submarine Operations

System Environment

The environment of the helicopter upgrade system is composed of several elements which lie out-side the system but affect its performance and consequently attain the system goals (Turban & Aronson, 1998, pp.36). The system environment analysis leads to the correct definition of the complete application and all the entities concerned by the system (Calvez, 1996). The helicopter upgrade system for anti-submarine mission being modelled as an open system is dependent on littoral water including time of operation, weather and sea state for the inputs and delivers outputs into the environment. The helicopter upgrade system may also interact with other anti-submarine warfare systems to attain its goals. This section gives the description of the Australian littoral environment and its impact on the helicopter anti-submarine mission.

Littorals are regions adjacent to shores that are with in the direct control of and vulnerable to the striking power of naval expeditionary forces (U. S. Naval Doctrine Command, 1998). These regions encompass full range of depth, from the shallow to the deep. Australia being a maritime nation due to its large maritime jurisdictional area and sharing of its borders with Indonesia, East Timor, Papua New Guinea, New Zealand, the French Territories and the Solomon Islands faces a significant challenge in controlling its littorals (Royal Australian Navy, 2001). It, along with other coalition partners and United States Navy in the lead nation role are currently working on the anti-submarine warfare mission area, with an objective to integrate and establish a shared information environment for effective command and control in a multi-national, network-centric operational framework (Defence Science and Technology

Organisation, 2002). Thus in such a highly complex and sophisticated operational framework the Navy should ‘push’ certain technology affecting various platforms including sea based aerial platforms and ‘pull’ off the shelf technology to maintain its regional superiority and strategic needs in working with maritime allies.

The challenges of the littorals, weather, time of operation and sophisticated submarine adversaries, places the requirement of anti-submarine warfare force that can respond rapidly and decisively (U. S. Naval Doctrine Command, 1998). To increase the operational effectiveness in littorals, the anti-submarine warfare helicopter needs to utilise appropriate combinations of sensors, efficient and autonomous signal processing and robust weaponry (U. S. Navy, Air ASW Vision Statement, 1998).

System inputs

The user provides the system inputs either through direct interaction with the helicopter upgrade system or by the fusion of data from a number of on-board sensors of an in-service maritime helicopter. Operational needs and the operational environment are the inputs to the system. The operational needs can be classified as a) offensive; d) defensive; and c) logistic support.

System Components

The helicopter upgrade system consists of the following three key components:

· <u>In-service helicopter</u>

The In-service helicopter system represents the maritime helicopter being considered for the upgrade process. The helicopter is characterised by the following design attributes:

➢ Flight performance

The degradation of the flight performance due to upgrading the helicopter to the anti-submarine mission capability is evaluated. The flight performance parameters are: a) maximum speed; b) rate-of-climb; c) hover ceiling; and d) endurance.

➢ Mission capability

The mission capability comprises of derived and defined mission capabilities. The derived mission capability is the capability offered by the current mission payloads and the defined mission capabilities are the capabilities required for the anti-submarine mission.

➢ Logistic support

Logistic support comprises of the repair and maintenance requirements.

· <u>Mission systems</u>

The mission systems on-board dictate the mission capabilities of the helicopter. Mission systems on-board undergo technological advancements, at a rate that outpaces the service life of aircraft. These mission systems that enhance the anti-submarine mission capability needs to be identified. The mission systems identified are then analysed for the mission payload design.

The mission systems can be characterised according to their utility. The following are the categories of anti-submarine mission systems:

- Attack & Counterattack; and
- Reconnaissance & Surveillance.

- Man-Machine Interface

The helicopter upgrade system for anti-submarine mission interacts with its environment through the man-machine interface. The man-machine interface interacts with the user to receive data and display the required information. The man-machine interface will be a Graphical-User Interface capable of displaying 2-dimensional and 3-dimensional visualisations in the form of graphs, upgraded helicopter diagrams.

- Knowledge based system

A knowledge-base system provides the avenue for interaction of the helicopter system and mission system to produce the upgraded helicopter system. Knowledge based systems are computer systems that advise on or help solve real world problems, which would normally require a human expert's interpretation (Reffat et al, 1994). By searching the knowledge base for relevant facts and relationships, the computer can reach one or more alternative solutions to the given problem (Turban & Aronson, 1998, pp. 204). Alternative mission systems can be identified for a particular in-service maritime helicopter by searching the knowledge base for the design of an optimum mission payload for anti-submarine warfare; the aim of helicopter upgrade.

System output

The helicopter upgrade system output will be an optimum upgraded in-service maritime helicopter with enhanced ant-submarine mission capabilities. The derived sub-mission capabilities are the following: a) attack and counterattack; and b) reconnaissance & surveillance.

INTELLIGENT DECISION SUPPORT SYSTEM

Modelling and simulation play a key role in the development of future submarine concepts and capabilities (Defence Science and Technology Organisation, 2003). Computational Intelligence is gaining influence in analysis, modelling and control of complex processes (Tagarev & Ivanova, 1999). The advent of multiagent systems has brought together many disciplines together in building distributed, intelligent and robust applications (Deloach, 2001). The upgrade analysis process is complex, iterative and requires timely, robust, and mission specific automation following the multiagent paradigm through an “Intelligent Decision Support System”.

Based on the system approach presented in this paper an “Intelligent Decision Support System” software will be developed to automate the helicopter upgrade process from an anti-submarine perspective. The development process follows system development life cycle with rapid prototyping. The tool will not make decisions but generate different upgrade models with speed and accuracy from sensor inputs or directly from the knowledge base. With the inputs of helicopter anti-submarine mission requirements; the software will identify state-of the-art mission systems, and produce models that enhances the anti-submarine mission capabilities in a littoral environment. The optimum model will be identified based on pre-designated operational and design benchmarks to be formulated in this research. Two-dimensional and three-dimensional visualisations of upgrade models will be generated for further detailed design analysis, towards upgrade implementation.

RESULTS & DISCUSSION

A system approach has been adopted to establish a "helicopter upgrade system" for anti-submarine operation that identifies the operational environment, its boundary, inputs, components, attributes and the interfaces (relationships) between various components. The upgrade system provides the avenue for a holistic analysis of helicopter upgrade process for anti-submarine missions. The establishment of the upgrade system resulted in the identification of the following for further design analysis:

- **System components:** The mission systems, in-service helicopter and man-machine interface are the key subsystems. The functional characteristics of the subsystems include reconnaissance, surveillance, attack, flight performance, mission capability and logistic support;

- **System environment:** It covers the littorals, which are with in the direct control offshore forces and vulnerable to the striking power of naval expeditionary forces. It also includes weather, time of operation and sea state.

CONCLUSION

System approach provides an avenue to holistically address the helicopter upgrade process. Conceptualisation of the upgrade process in an input-process-output configuration establishes the base line for detailed design analysis. The various design components and its expected functional characteristics are clearly identified including their interfaces that inter-link the components. The systems approach provides a new upgrade design philosophy for aerospace.

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