A Systems Approach to the Design & Development of a Helicopter Fleet Management System

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Abstract

This research is part of a major helicopter acquisition program including upgrade under a 20+ year strategic plan. The program aims to rationalise the number of helicopter types operated, simplify operational requirements and reduce through-life-support costs. The helicopter fleet presently comprises of nine helicopter types, to be grouped to three to four fundamental types. A coherent fleet management system (FMS) is to be developed and modelled for the rationalised number of helicopter types. The research will assess current practices in aerospace technology management of civil and military aircraft fleets and establish requirements for military rotary-wing platforms and design a specific methodology for the fundamental Multi-Role Helicopter (MRH, NH-90) of the defence forces. The outcome will be a technology management methodology, implemented for simulation and demonstration on the MRH platform.

Keywords

Systems Approach, Fleet Management, Helicopters, Rotary-Wing, Technology Support.

1. INTRODUCTION

Rotary wing technology provides major benefits to the community and the industry in the civil and military sectors. It has proven its capabilities in service for emergency and military support over the years. Rotary-wing platforms cover a variety of missions, conducting passenger and emergency transport, search & rescue tasks, heavy lift duties and military roles. Defence forces worldwide operate and maintain large fleets of rotary wing platforms that require advanced fleet management practices for efficient operation and support.

Fleet management addresses the operational and support issue for effective vehicle life-cycle management. It involves tracking & managing usage information and expenses of a vehicle from the identification of its need to disposal. It is a network of systems that monitors the vehicle's operational status and provides the stipulated support. The goal of fleet management is optimising the availability (reliability & maintainability) of the vehicle at minimum acquisition and support costs to meet the operational readiness benchmark.

Fleet management is based on commercially available tools to track the usage status of aircraft & components and manage the required support. Companies specialising in the development of softwares, customise the tools based on aircraft and fleet types, resulting in several commercially available tools. These tools assist the operators to optimise availability and enhance service life of the vehicle. The tools are limited in applicability due to the need for customisation to support a fleet effectively. A preliminary analysis on commercial off-the-shelf fleet management systems and its characteristics is as follows:

- Maintenance & Repair Operations Software: It manages the maintenance activities and associated documentation of aircraft components & parts. The software documentation generates work reports & tasks cards and tracks the parts inventory for logistic support. Regulatory compliance is addressed through airworthiness directive tracking. Commercial features include the generation of purchasing orders, and sales & invoicing.
- Scheduling & Reservation Systems: It covers the time schedule of aircraft and equipment for maintenance on missions. Flight reservation systems and ground time scheduling are applied in commercial and general aviation.
- Airline & Airport Software: It provides commercial features for airlines to enhance operational effectiveness. These include planning systems, revenue management and airline controlling. Resource management of personnel and equipment provides the base for timetable generation and flight scheduling.

- Flight Tracking Software: Flight information systems for both, military and civil applications provide data on aircraft positions, air traffic and weather.
- Aviation Manufacturing Software: In support of complex engineering tasks the software assists in the manufacturing design of aircraft & components.
- Aviation Leasing Software: Management of leasing aircraft and components is addressed through portfolio and contract management software. It covers commercial and technical documentation of leasing assets.

The analysed off-the-shelf software covers aspects of aircraft operations and support. It is limited in application for life-cycle management of the fleet (Vijayakumar, 2006). It is designed for general and commercial aviation, with limited flexibility for customisation to military applications. Military aircraft life-cycles exceed the service life of commercial aircraft due to lower usage and extended life through mid-life upgrades to enhance mission capability. This requires built-in flexibility in the technology insertion management system. The different composition of operating and support costs between fixed- & rotary-wing aviation and its support structure requires a customised alternative for military helicopter applications for overall life-cycle management and support. Research in fleet management investigates issues related to increase the average age of military aircraft fleets (Crowley and Mutzman, 2003), and the operational acquisition costs faced by operators. The research aims to extend the service life (Tiedeman et al., 2002) of the airframes to enhance operational effectiveness (Brewer, 2002) and predict fleet reliability (Meyer et al., 2001). To address issues of aircraft scheduling, performance and cost management; probabilistic approaches (Kaczor, 1999, Oore, 2005) and statistical models (Rumph, 2006) are being considered; including single or multiple type fleets to optimise maintenance and training procedures (Scott and Gaerke, 2002).

2. FLEET MANAGEMENT – SYSTEMS PERSPECTIVE

A system comprises of components, attributes, and relationships, while the components are also referred as subsystems. The attributes are the functional characteristics of the components designating the functional requirements in the design of a system. Relationships are the inter and intra relationships between components and attributes and provides the synergy. The purpose of the system is achieved by the system's process by transforming the inputs into desired outputs (Sinha et al., 1995). A system may be part of a larger system in a hierarchy, and its components may be referred as a subsystem.

The system may be referred as a total system, at any level governed by the system / component under study. The system structure comprises of the components, its attributes (Cavaleri and Krzysztof, 1993, Blanchard and Fabrycky, 2006), the inputs from the environment into the system and the output to the environment. The Fleet Management System (FMS) will be analysed in this context from a systems perspective for a holistic analysis.

2.1 System Configuration

The FMS system configuration is analysed from a typical input-process-output perspective. The FMS is to be developed for the MRH, hence the MRH systems technology, specifically the Health & Usage Monitoring Systems (HUMS) on-board and off-board needs to be considered. Furthermore the MRH platform "support needs" for the operation of the MRH fleet will form an additional critical input to the FMS process. The support needs will comprise of the "operational support needs" for the designated roles and missions of the MRH. The inputs will also comprise of the "scheduling & availability needs", providing the planning & timing of the platform and infrastructure. The "operational environmental needs" address the foreseen spectrum of conditions in which the MRH will need to operate.

The analysis of the system needs to the FMS process will stipulate the design & development requirements of the FMS. The output of the process will be a fleet management capability. The FMS in the input-process-output context from a systems perspective provides the base for a holistic analysis to develop the FMS for application on a specific technology – the MRH. The systems perspective of the FMS in an input-process-output configuration is presented in Figure 1.

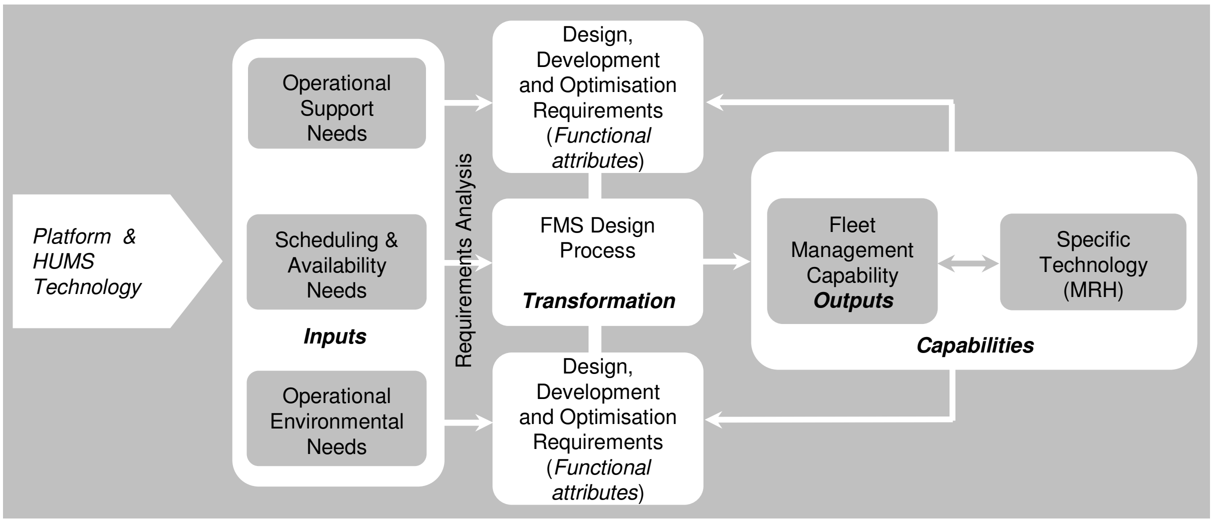

Figure 1: FMS System Configuration – Input-Process-Output

2.2 System Hierarchy

For further analysis, the system hierarchy of the FMS will need to be developed to identify its subsystems and components for the development of the system structure at each level. The system structure will stipulate the 'Inputs', 'Process' and 'Outputs' at various levels of the hierarchy, for the FMS to address in providing the required support to the MRH.

2.2.1 Hierarchy Level 0 to 1

The FMS is considered as the total system at Level '0' of the system hierarchy. The MRH Platform is a subsystem of the FMS and a component at Level 1 of the FMS hierarchy. The other subsystems needed to provide operational support will comprise of the 'Infrastructure' needed to support and the 'stipulated' schedule pattern in which the support will be provided. Thus the subsystems / components at Level 1 of the hierarchy are 'Platform', 'Infrastructure' and 'Schedule' (Figure 2).

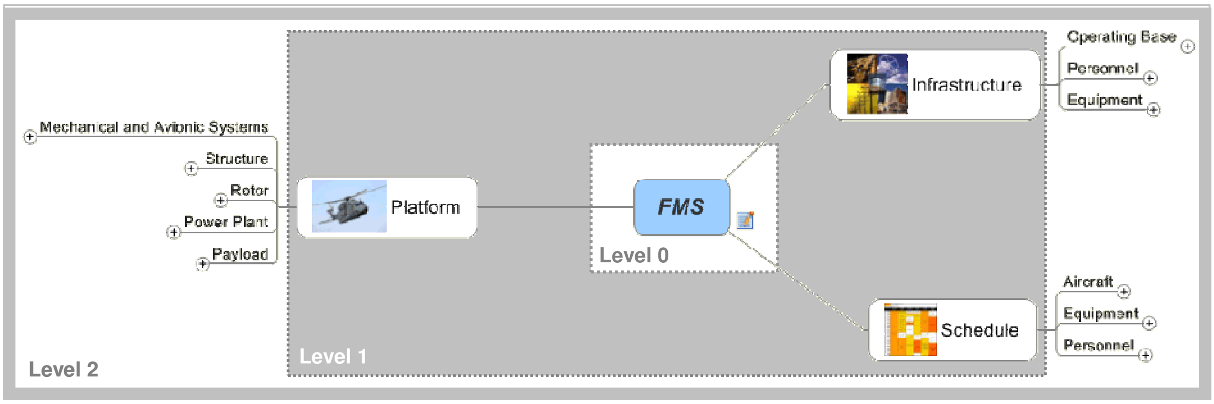

Figure 2: System Hierarchy – Levels 1 and 2

2.2.2 Hierarchy Level 2

A development of the Level 2 hierarchy requires a further detailed analysis of the Level 1 subsystems (Platform, Infrastructure and Schedule). Analysis of the Platform will need an understanding of the various key assemblies that contribute to the operation of the platform. Infrastructure components need to cover from personnel to the operating bases. The Schedule subsystems needs to be in-order to those stipulated in real-time for both personnel and platform activities.

- Platform: The platform encompasses the housing for various assemblies / components, propulsive power and components that contribute to the mission accomplishment. The housing is the airframe structure and the propulsive power is provided by the engines and the rotor system. The systems that contribute to the mission accomplishment are the mission systems payload governed by the role and mission of the platform. Thus the key components of the platform system are ‘Structure’, ‘Power Plant’, ‘Rotor’, ‘Mechanical & Avionic Systems’ and ‘Payload’ (ATA, 1999).

- Infrastructure: It comprises of the systems required for rotary-wing operations and support. The operating bases are airbases on-ground and on-ships. At each of these the personnel to operate and support the aircraft comprises of air- and maintenance crews. Equipment for operations and support include repair & maintenance, spare part supply and ground support equipment. Thus the three subsystems of Infrastructure are ‘Operating Bases’, ‘Personnel’, and ‘Equipment’.
- Schedule: Schedule comprises of the operations and support activities related to planning & timing of personnel, aircraft, and equipment. At the base, these consist of the allocation of aircraft to operations (the roles & missions) and maintenance tasks (servicings and inspections including upgrades and modifications). It also includes the planning of air & ground crews and equipment to the operational and support tasks. Thus the Level 2 components for scheduling are ‘Aircraft’, ‘Personnel’ and ‘Equipment’.

2.2.3 Hierarchy Level 3 to 5

The subcomponents of Level 1 (Platform, Infrastructure, and Schedule) were further analysed as above, for the development of Level 3 to 5 hierarchy components.

2.3 FMS Design & Development – Requirements Analysis

The FMS design & development requirements are derived from the MRH and Health & Usage Monitoring (HUMS) technology needs, operational support needs, system availability needs, and operational environment needs. The MRH & HUMS technology needs comprise of the technical requirements of the platform and its health monitoring systems from a support perspective. The operational support needs are for civil and military mission requirements. The military requirements comprise of naval and army missions off ship-based, air fields and forward air bases. The system availability needs are the stipulated manufacturer maintenance schedules and the availability targets of the fleet operators. The operational environmental needs are in natural and manmade environments, comprising of the type of terrains, weather, the operational time and the threat to the platform and personnel.

2.3.1 MRH & HUMS Technology Needs

To stipulate the design and development requirements, the MRH & HUMS technology inputs to the design process of the FMS are investigated. The technology has two versions – Tactical Transport Helicopter (TTH) and NATO Frigate Helicopter (NFH). The technology provides enhanced operational flexibility & efficiency through common operational, training & logistic systems and the capability to rotate personnel, aircraft, spare parts and equipment between troop lift, special operations and maritime support roles and missions. Thus the maritime support and training requirements are similar to both technologies.

The MRH TTH version is to be operated from sealed, prepared and unprepared surfaces and the NFH version is to operate from ships to meet tactical transport requirements. Hence the manoeuvrability & survivability requirements are similar including maintenance support requirements on ships / unprepared areas. Additionally, electromagnetic compatibility is critical while operating from ships.

The design and development of the MRH helicopter includes the implementation of HUMS technology for condition-based maintenance. The two key components of HUMS for the MRH are the ground and aerial system. These systems are referred as follows: a) Ground System - Ground Management System (GMS); and Aerial System - Diagnostic System (DS). The GMS provides the required information to initiate / perform the appropriate maintenance activities. The DS is to provide the required diagnostic & prognostic functions for maintenance.

The analysis of the MRH & HUMS technology further identifies the FMS design & development requirements. A summarised technology analysis is presented in Table 1, which systematically identifies the requirements / attributes. The identified attributes (Table 1) are the functional characteristics of the components of the system Platform, Infrastructure and Schedule. The characteristics may be attributable to either one or more components. The analysis of the attributes vis-à-vis components is presented in Table 2.

Table 1: MRH & HUMS Technology Analysis to identify Requirements / Attributes

Technology	Technology Analysis	Design & Development Requirements
MRH (TTH & NFH)	Operational Flexibility by Commonalty in Logistic Support and Training Operation from unprepared Surfaces / Ships	Maintenance & Logistic Support Training Manoeuvrability Survivability Electromagnetic Compatibility Support Equipment Scheduling Maintainability Op. Flexibility
HUMS	Health Monitoring On-Board and initiate Maintenance Activity	Prognostic & Diagnostics Maintenance Planning Repair Analysis Preventive & Corrective Scheduling Cost Effectiveness

Table 2: Components and Attributes based on Technology Needs

Components	Platform	Infrastructure	Schedule
Attributes	Survivability	Electromagnetic Compatibility	Maintenance Support
	Prognostics & Diagnostics	Training	Training
	Electro-magnetic Compatibility	Maintenance Planning	Preventive & Corrective Scheduling
	Repair Analysis	Logistic Support	Support Equipment Scheduling
	Maintainability	-	Cost Effectiveness
	Operational Flexibility	-	-

2.3.2 Operational Support Needs

The operational support needs covers the analysis of present and future rotary-wing roles and missions of the operators. It includes support to provide air mobility in support of troops, equipment and casualties. In addition to providing administrative support it also includes tactical support for special operations, communications, surveillance and limited armed support. The MRH is also to provide training to the crews on these roles. The key attributes derived from the MRH roles and missions is providing mobility to troops & equipment and medical & casualty transportation on battlefields. The MRH provides tactical and logistic support to special operations groups, conducts reconnaissance & surveillance tasks and provides intelligence. The MRH is also a training platform for both air and ground crews. Thus high manoeuvrability and situational awareness is needed to enhance the survivability on such roles. A summarised mission analysis of the roles is presented in Table 8 (Appendix), which systematically identifies the design and development requirements / attributes of the FMS.

The identified attributes (Table 8) are the functional characteristics of the components of the system – Platform, Infrastructure and Schedule. The characteristics may be attributable to either one or more components. The attribute ‘Training’ is of all three components, the platform is needed for the training, the Infrastructure is to provide the operating base and equipment and the personnel are to be scheduled for the training. The attributes are accordingly analysed vis-à-vis the components to stipulate its functional characteristics. The component attributes are based on operational support needs and are presented in Table 3.

Table 3: Components and Attributes based on Operational Support Needs

Components	Platform	Infrastructure	Schedule
Attributes	Troops / Cargo / Equipment Transportation	Training	Training
	Tactical Support	Maintenance Support	Maintenance Support
	Survivability	Mission Support	Mission Planning
	Training	Basing / Protection	Readiness
	Med / Cas Evac	Forward Deployment	-
	Armed Reconnaissance & Surveillance	-	-

2.3.3 Scheduling and Availability Needs

The analysis of schedule and availability needs covers the platform readiness parameters and aircraft & infrastructure scheduling requirements. The platform availability parameters comprise of the minimum and optimum target number of available aircraft. It also addresses the manufacturer overall mission design reliability target. The platform readiness is constrained by scheduled maintenance requirements and regulatory framework for aircraft and crews. The key attributes of platform scheduling are therefore the readiness benchmark to be met, the daily / annual rate-of-effort covered by each airframe, and the downtime for scheduled & unscheduled support, stipulated by the technical manual. It requires a level of airworthiness to be maintained during operations & support.

The personnel schedules cover the assignment of crews for missions, deployments and training / exercises. It also includes the planning of maintenance personnel for the scheduled support tasks. The equipment scheduling provides maintenance tooling assignments to scheduled and unscheduled inspections & servicings. A summarised scheduling analysis of the platform & infrastructure is presented in Table 4, which systematically identifies the design and development requirements / attributes of the FMS. The attributes of the personnel and equipment schedules therefore include the provision of maintenance & mission planning to assign assets. It also includes the infrastructure maintenance & ground support planning for platform operations and support and the training required to provide efficient operations & support.

The identified attributes (Table 4) are the functional characteristics of the components of the system – Platform and Infrastructure. The characteristics may be attributable to either one or more components. The attributes are accordingly analysed vis-à-vis the components to stipulate its functional characteristics. The attributes of the components based on scheduling & availability needs are presented in Table 5.

Table 4: Platform & Infrastructure Schedule Analysis to identify Requirements / Attributes

Schedule	Scheduling Analysis	Functional Characteristics / Attributes
Aircraft	Provide operational readiness Meet availability targets Schedule for missions & maintenance Constrained by Crew & maintenance requirements	Readiness Benchmark Rate-of-Effort Downtime Airworthiness
Personnel	Scheduling for training, missions, deployments, & exercises Maintenance scheduling	Training Mission Planning Maintenance Support
Equipment	Assignment for maintenance & repair, and ground support	Maintenance Support Ground Support

Table 5: Components and Attributes based on Scheduling & Availability Needs

Components	Platform	Infra-structure	Schedule
Attributes	Rate-of-Effort	Training	Readiness Benchmark
	Training	Maintenance Support	Mission Planning
	Downtime	Ground Support	Maintenance Support
	Airworthiness	-	Ground Support

2.3.4 Operational Environment Needs

The operational environment analysis investigates the environment in which the MRH platform is designed to operate and its impact on the technology. The environment plays an essential role in helicopter design, operations, support and safety. It affects mission accomplishment, maintenance, fatigue, crew load and costing. The MRH operational environment comprises of natural and manmade environments.

The platform operators deploy equipment on a regular basis to conduct disaster relief, peacekeeping and military operations. The system considers operations in various climates & terrains, Antarctic regions are also considered.

The analysis of the natural environment covers the types of terrain, climatic conditions, time of operation and threat to operations:

- Terrain: The major section of Australia consists of deserts or semi-arid areas with medium altitude mountains, rainforests and a large coastline. The overseas deployment terrain covers deserts, high mountains, tropical rainforest, and sea. The operational environment needs in such terrain are appropriate maintenance support in all terrains, visibility or situational awareness of own location, and manoeuvrability in restricted space. Training of crew will be needed for operation in these terrains.
- Climate: The ADF operates its rotary-wing platforms in climates of Australia and overseas. The climate around the world covers temperatures ranging from very hot to severe cold. The humidity also varies based on the terrain of operation including the snow & sand conditions and rain. In the Australian region the coastal and desert operation places the high temperature and humidity conditions. Thus, the operational environmental needs in such climatic conditions are the required maintenance support, visibility or situational awareness in the extreme weather conditions and training of the crew to operate in all weather (Defense, 2000, Sissenwine and Cormier, 1974).
- Time: The MRH operational environment covers day and night time operations. Hence, the operational environment need is round-the clock operations. The components will need to provide adequate visibility for situational awareness and the crew will need to be trained accordingly.
- Threat: The natural threats in the operational terrain include hills, mountains and trees. To avoid flight into these natural threats, visibility or situational awareness of own position and manoeuvrability is critical for survivability. Thus, the operational environment needs are situational awareness, manoeuvrability and survivability.

The manmade operational environment comprises of threat due to urban development and that from the adversary. This will need to be compensated by situational awareness of the threat, manoeuvrability and on-board weapons to counter the adversary. Additionally, the manmade environment will induce stress and accordingly will impose training needs. The environment needs are situational awareness, maintenance support, armed support or survivability, and training.

The analysis of the various environments in which the MRH will operate resulted in the identification of the FMS design and development requirements or attributes of the FMS. A summarised environment analysis is presented in Table 6 which systematically identifies the design & development requirements / attributes of the FMS.

The identified attributes are the functional characteristics of the components of the system - Platform, Infrastructure and Schedule. According to the discussion in previous analysis, the characteristics may be attributable to either one or more components. The analysis of the attributes vis-à-vis components is presented in Table 7.

Table 6: MRH Operational Environment and Analysis to identify Requirements / Attributes

Operational Environment	Environment Analysis	Design & Development Requirements / Attributes
Terrain	Operation in Deserts / Mountains / Rain Forests / Sea	Maintenance Support Situational Awareness Manoeuvrability Training
Climate / Weather	Hot and severe Cold Snow & Sand & Rain Conditions Humid Conditions	Maintenance Support Situational Awareness Training
Time	Round-the Clock Operations	Situational Awareness Training
Threat (Natural / Manmade)	Hills / Mountains / Trees Urban Built-Up Adversary	Situational Awareness Manoeuvrability Maintenance Support Armed Support / Survivability Training

Table 7: Components and Attributes based on Operational Environmental Needs

Components	Platform	Infrastructure	Schedule
Attributes	Situational Awareness	Maintenance & Logistic Support	Maintenance Support
	Manoeuvrability	Training	Training
	Maintenance Support	Basing / Protection	Mission Planning
	Armed Support / Survivability	Survivability	Rate-of-Effort
	Training	-	Readiness

2.3.5 Design & Development Requirements / Attributes

The analysis of the MRH & HUMS Technology (MHT), Operational Support Needs (OSN), Scheduling and Availability Needs (SAN), and Operational Environment Needs (OEN) and the identified the inputs to the design process of the FMS. These inputs provide the functional characteristics / attributes of the three identified subsystems / components of the FMS. The functional characteristics / attributes of the subsystems (Platform, Infrastructure and Schedule) are presented in Table 9 (Appendix).

2.4 System Structure Development

The system structure is a representation of the components & attributes (Blanchard and Fabrycky, 2006) (Cavaleri and Krzysztof, 1993) and the inputs and outputs in an 'Input-Process-Output' configuration. The analysis of the FMS from this perspective identified the components as 'Platform', 'Infrastructure' and 'Schedule' by the development of the system hierarchy (Sec. *2.2 System Hierarchy*). The attributes of these components (design & development requirements) were derived from the analysis of the MRH & HUMS technology needs, operational support needs, scheduling & availability needs, and operational environment needs (Sec. *2.3 FMS Design & Development – Requirements Analysis*).

The holistic relationships for the design process between the components and attributes are the inter and intra – component & component, component & attribute, and attributes & attribute. The system structure at Level 1 of the system hierarchy is presented in Figure 3. The Level 1 system structure is further analysed for the development of the Level 2 structure. At Level 2, the structures will need to be developed for the three subsystems (Platform, Infrastructure, and Schedule). The components of the three subsystems were previously identified on the system hierarchy Level 2 (Sec. *2.2.2 Hierarchy Level 2*). The components are the following: a) Platform - Mechanical & Avionic Systems, Structure, Rotor System, Power Plant & Payload (based on the ATA aircraft breakdown specification 100 (ATA, 1999)); b) Infrastructure - Operating Bases, Personnel & Equipment; and c) Schedule - Aircraft, Equipment & Personnel. The attributes of these components at Level 2 are studied according to previous analyses (*Sec.2.3 FMS Design & Development – Requirements Analysis*).

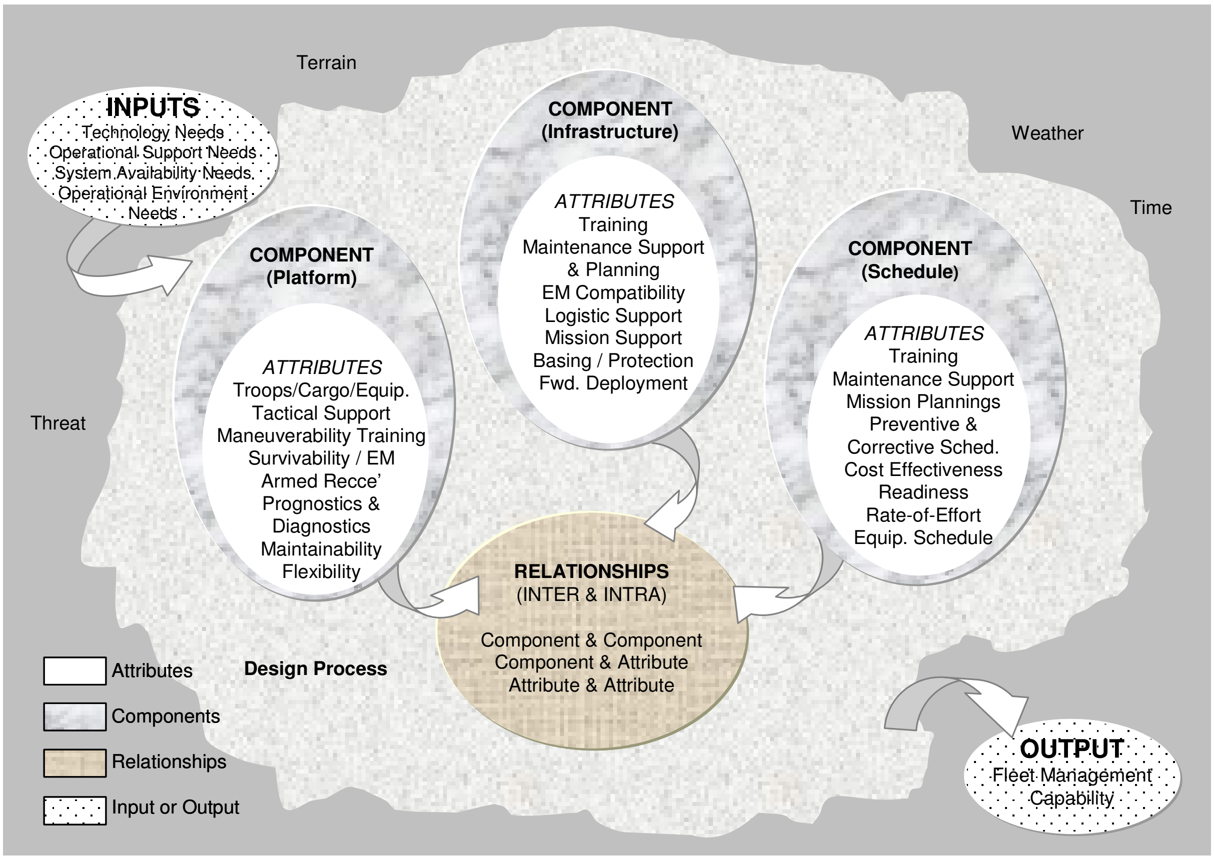

Figure 3: FMS System Structure in an Input-Process-Output Configuration – Level 1

The Level 2 inputs to the three subsystems (Platform, Infrastructure and Schedule) are analysed based on the attributes of these systems. The required inputs to the Platform remain as at Level 1, while that of the Infrastructure is governed by the support and environmental needs; and for schedule by the technical manual stipulations and operational readiness benchmark. The output of the platform is mission capability, of Infrastructure is support capability, and that of the subsystem Schedule is the system availability.

3 RESULTS & DISCUSSION

For a systems perspective of the inputs, design process and the outputs, the FMS was considered in an Input-Process-Output configuration. Results cover the development of a system hierarchy at various levels to identify the subsystems / components of the FMS. Additionally, the system structure identified the attributes / functional characteristics / design & development requirements of the subsystems / components. The four key inputs were the following: a) MRH & HUMS Technology Needs, b) Operational Support Needs, c) Scheduling & Availability Needs, and d) Operational Environment Needs. The FMS comprised of three subsystems. The 'Platform' which provided the mission capability, the 'Infrastructure' that provided the support for fleet management and the 'Schedule' for planning the fleet management. The analysis of the inputs stipulated the design & development requirements of the FMS. It covered from maintenance support to training and troops / equipment transportation to tactical support. These requirements were further analysed and designated to the subsystems for further consideration in the design & development of the FMS. The developed system is customised for demonstration and application on the MRH platform. To provide versatility, the system hierarchy, methodology and simulation model are developed on a modular basis for application on other rotorcraft platforms. The component 'platform' and its sub-components in the hierarchy are interchangeable to include other helicopter platforms and are based on the ATA aircraft breakdown specification 100 (ATA, 1999). The components 'Infrastructure' and 'Schedule' may also be considered accordingly.

4 CONCLUDING REMARKS

A system approach was applied to address the complexity of rotary-wing operations & support. The approach assists in structuring the issues & challenges faced in designing a technology support management methodology for the operators and covering the various aspects of a helicopter life-cycle. The investigations studied the present and future helicopter fleets and the fleet needs of the operators. It addressed the civil & military fleet management practices of operators worldwide to develop FMS system & software design requirements. The next phase of research will develop the FMS methodology and establish a customised simulation model for demonstration of the developed methodology.

APPENDIX

Table 8: MRH Roles and Missions Analysis to identify Requirements / Attributes

Role	Mission Analysis	Design & Development Requirement / Attributes
Airmobile Mission (AMO) – Land	Air Insertion, Air Re-Supply, and Air Extraction - Land	Troops / Equipment Transportation
AMO – Amphibious	Air Insertion, Air Re-Supply, and Air Extraction - Coastal Areas	Troops / Equipment Transportation
Artillery AMO / External Load Mission	Air Insertion, Air Re-Supply, and Air Extraction - Artillery / Sling Loads	Troops / Equipment Transportation
Air Movement	Provide and enhance Mobility of Troops and Cargo	Troops & Cargo Transportation
Ferry	Deliver / Transfer Aircraft between two Locations	Aircraft transfer
Aeromedical Evacuation	Tactical and Strategic medical Transportation	Med / Cas Evac
Command, Control, Communication, Electronic Warfare (EW)	Provide observational Information, manage Battlefield, provide Command and Control to all Assets, use of Electromagnetic Energy to confuse/disable Enemy Defensive Systems	Intelligence & EW
Support Operations	Enhance military Survivability	Survivability
Training 1- Tactical	Practice Battlefield Tactics	Training
Training 2 - Circuits	Practice Air Base Patterns	Training
Training 3 - IFR	Practice under Instrument Flight Rules	Training
Training 4 - Deck Landing Practice	Practice Landings on Ship Decks	Training
Special Operations (SO) Support	Provide Mobility and Support to SO Group	Tactical Support
Combat Search and Rescue	Aid in Search and Supplement Rescue in Battlefield	Med / Cas Evac
Logistics Support (Maritime)	Provide Naval Logistic Supplies and Equipment	Transport Cargo / Equipment
Anti-Surface Warfare	Detection and neutralisation of enemy Surface Targets	Armed Reconnaissance & Surveillance
Helicopter Visit, Board, Search and Seizure	Support maritime Boarding Actions and Tactics	Tactical Support
Aerial Mine Search and Disposal	Detection and Neutralisation of Mines	Reconnaissance & Surveillance
Maintenance Test Flight / Ground Run	Prove Serviceability before Return to Service	Maintenance Support

Comp.	**Platform**				**Infrastructure**				**Schedule**			
FMS Design Process Inputs *(Requirements Analysis)*	*MHT*	*OSN*	*SAN*	*OEN*	*MHT*	*OSN*	*SAN*	*OEN*	*MHT*	*OSN*	*SAN*	*OEN*
FMS Design & Development Reqs. *(Functional Attributes of FMS Components based on Requirements Analysis)*	Surviv-ability	Troops / Cargo / Equipment Transport	Rate-of-Effort	Situational Awareness	Electro-magnetic Compati-bility	Training	Training	Mainte-nance & Logistic Support	Mainte-nance Support	Training	Readiness Benchmark	Maintenance Support
	Prognostics & Diagnostics	Tactical Support	Training	Manoeuvra bility	Training	Mainte-nance & Logistic Support	Mainte-nance Support	Training	Training	Mainte-nance Support	Mission Planning	Training
	Electromag netic Compati-bility	Surviv-ability	Down-time	Maintenan ce Support	Mainte-nance Planning	Mission Support	Ground Support	Basing / Protection	Preventive & Corrective Scheduling	Mission Planning	Mainte-nance Support	Mission Planning
	Repair Analysis	Armed Recce & Surveill-ance	Air-worthi-ness	Armed Support / Surviva-bility	Logistic Support	Basing / Protection	-	Surviv-ability	Support Equipment Scheduling	Readi-ness	Ground Support	Rate-of-Effort
	Maintain-ability	Med / Cas Evac	-	Training	-	Forward Deploy-ment	-	-	Cost Effective-ness	-	-	Readiness
	Operational Flexibility	Training	-	-	-	-	-	-	-	-	-	-

Table 9: Summary of FMS Components and Attributes

Legend: MHT: MRH & HUMS Technology
OSN: Operational Support Needs
SAN: Scheduling & Availability Needs
OEN: Operational Environment Needs

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