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AVIONIC INTEGRATION IN FUTURE BATTLEFIELD HELICOPTERS

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ABSTRACT

The helicopter is at long last being taken seriously as a potent vehicle in the battlefield. The days of adding weapon systems to utility designed aircraft have passed and there are several purpose designed helicopters in development both in the United States and Europe. Integration is a key requirement both of system data and sensor displays, and work on these aspects has been underway at Farnborough for some time. A wire data bus system is currently being installed in a Puma, and this will be followed in the near future by a fibre optic system in a Lynx. Integration of the display of information and video pictures is also most important, and so both head down and helmet mounted systems are being developed. Colour head down monitors are now available, which allow more information to be displayed that can be easily absorbed by the crew. Tactical information overlaid on moving maps driven from accurate navigation systems will simplify the task of the helicopter crew in battle conditions. Helmet mounted displays which are monochrome at present, but could well be colour in the future can present FLIR pictures for night flying and give head up display information for low level flight. Significant steps in integration are being made possible by these developments, together with the inevitable progress in real time computing power.

INTRODUCTION

The helicopter offers a unique combination of abilities as a battlefield weapons platform that cannot be provided by either ground based forces or fixed wing aircraft. It is able to be deployed quickly to areas needing support, and then loiter for long periods to search and attack targets as they move forward. This capability has become more recognised in recent years and there are now several purpose designed battlefield helicopters in development. Such helicopters will contain significantly more sophisticated avionics and weapon system equipment than in the past, with thermal imaging systems for night operation, threat warning receivers of various kinds to increase survivability, advanced navigation systems to give accurate position, and secure communication systems to keep the front line helicopter crew up to date with the rapidly changing scenario. The future battlefield helicopter will therefore contain a number of systems which need to be integrated to provide an easily used, low weight system, at a cost that can be afforded by the Services. At Farnborough we have a number of programmes, many of which are undertaken jointly with UK Industry to develop and demonstrate the technology to provide fully integrated avionics and weapon systems.

Optimum integration will be achieved by considering two factors. Firstly common areas of the various avionics systems must be identified with a view to providing a single element to serve a number of functions. Many systems are composed of 4 primary elements.

a. Sensor systems or data stores which generate information

b. Data links, mainly wires, to transmit information within the aircraft

c. Electronic processing

d. Displays

Each of these 4 groups must be rationalised to yield the minimum weight and cost consistent with performing the tasks required with sufficient integrity. This latter requirement of maintaining high integrity must be considered when carrying out an integration exercise, and is particularly important for a battlefield helicopter that may suffer damage from hostile fire. Failures of a single element in an aircraft must not be catastrophic and alternative or back-up systems must be provided. The major elements of an integrated avionic system being currently developed at Farnborough are shown schematically in Fig 1. The data bus forms the key to integration as it allows each system in the helicopter to communicate with any other system. All systems can therefore be controlled from a central management computer which can perform processing for all the avionics systems. Integrity of the avionics and weapon systems in a production system would be ensured by providing a number of buses each of which would be dual redundant. A schematic outline of a system that would be suitable for Military Service is shown in Fig 2. Separate buses would be provided for flight control, avionics and weapon systems, and equipments such as the avionics management computer would be duplicated to provide sufficient redundancy.

The second factor to be considered in integration is the division of responsibility between the crew and the avionics system, and particularly how much information needs to be displayed. Mission Management Systems will assume more responsibility as their capability increases, and continuous display of many parameters will no longer be required. Acceptance of this will only be achieved by long term flight demonstrations to build confidence, and this is seen as a prime objective of the work at Farnborough. In the longer term single pilot operation could well become a requirement; this will only be possible in a helicopter if substantial amounts of the routine management of the avionics systems is undertaken by a computer based mission system.

SENSORS AND DATA STORES

These encompass a broad variety of equipments from measurements of engine performance parameters, through Thermal Imaging Sensors for piloting and weapon sights, to digital or film based stores to generate moving maps. Sensors in general perform independent tasks, and it is not therefore practical to eliminate much hardware. Some integration can be achieved by, for instance, using a Thermal Imaging Sensor for a number of tasks, such as night piloting, weapon aiming and threat warning. At Farnborough we have been carrying out trials in these three applications of thermal imagers for several years, following on from previous work on Low Light Television Systems. The parameters of field of view, resolution and slew rate are now well established for the piloting and weapon aiming tasks but, unfortunately, are not particularly compatible with each other. A piloting aid needs a wide field, medium resolution, and fast slewing system, whereas a weapon aiming system needs a small field of view with high resolution which is inertially stabilised. Integration of the two requirements can be achieved by providing multiple field of view telescopes, but the cost effectiveness of merging two quite different requirements is doubtful. Threat warning systems require the Thermal Imaging Sensor to be combined with an intelligent electronics system to recognise potential threats such as other helicopters or fixed wing aircraft. Integration of the thermal imaging requirements of a threat warning system with those of a weapon aiming sight are quite practical, as the resolution and slew rates are compatible. Some integration of thermal imaging systems is therefore worth considering provided the various requirements are not radically different.

Video symbol generation for display on CRT monitors is another area that can be integrated. Many systems can use such symbology, eg

Display of flight information
Display of engine and transmission parameters
Display of weapon aiming sight, graticule, etc

All this symbology could be generated by a single Waveform Generator rather than incorporating individual generators into each system. Compatibility of various video systems is easily ensured by adopting a single video standard throughout an aircraft, making integration a fairly easy procedure.

DATA BUS SYSTEMS

Data buses using screened twisted pairs of wires are now being adopted for most new military aircraft both helicopters and fixed wing. When implemented with data bus compatible equipment, considerable simplification and weight saving is achieved. Farnborough has played a leading role in the UK in establishing the use of the Mil Std 1553B data bus in avionic systems, with the development of an avionic test facility using a Buccaneer. This work is now being extended into helicopters with a similar installation in a Puma. The aim of these programmes is to demonstrate the advantages of adopting data bus systems for avionics, and to detect and solve any resulting problems that may occur prior to major aircraft development programmes. The advantages of the data bus system are fairly clear but the current 1553B wire system is unable to cope with the increasing amount of data needing to be transferred within the helicopter. Higher bandwidth systems are required and a fibre optic bus may be the answer, its bandwidth limited only by the electronics at each bus terminal. Full military specification fibre optic bus interfaces are now being developed in the UK, and we are planning to install a full 31 terminal fibre optic data bus in a Lynx helicopter at Farnborough in 1987/8. This programme follows on from a laboratory fibre optic rig built at Westland Helicopters under RAE sponsorship, which demonstrated the viability of this type of system. The bus will operate initially at the 1 MHz 1553B data rate but will be uprated to a higher rate when an agreed standard becomes available.

Fibre optic buses offer many significant advantages over wire systems in addition to the increased bandwidth. Electromagnetic interference can be a major problem in the design of a new aircraft, and wiring has to be carefully routed to ensure electromagnetic compatibility. This problem may increase in the future with the use of non-metalic materials in helicopter airframes. Fibre optics is totally immune to electromagnetic interference and permits carefree installation into the airframe. It is hoped that the demonstration of a fibre optic data bus in a Lynx at Farnborough will provide sufficient confidence for the technique to be adopted in future helicopter development programmes.

MISSION MANAGEMENT SYSTEMS

Electronic processing is the third area that is amenable to integration. Flight Management Systems are now fitted to many commercial aircraft, and their military counterpart Mission Management Systems are likely to be fitted to new battlefield helicopters. At Farnborough we recognised the need for greater sophistication in helicopter avionics some years ago, and sponsored the development of a Battlefield Mission Management System which was jointly produced by Ferranti and Decca. The equipment was fitted to an Army Lynx at Middle Wallop and trialed during 1981/82. The system provided basic mission management functions either directly controlling, or displaying advisory information for navigation, steering, radios, and encoding. This data was presented on a monochrome CRT display with selection switches located to one side. Following the successful flight evaluation of this initial system, we undertook to develop a more extensive system taking advantage of the growth in electronics technology and based on a Mil Std 1553B data bus. This system, which is being built, and jointly funded by RACAL Avionics (formerly Decca), is being installed into a Puma helicopter at Farnborough this Autumn and may be available for viewing during the Farnborough Air Show next year. The system provides 2 major facilities: a Mission Management System based on the 1553B bus to provide navigation, steering, flight plans, communications, warnings and checklist procedures, and a Colour Tactical Display to present both topographical moving maps from a remote store, together with tactical information that can be fed into the helicopter immediately prior to flight using a solid state memory. This system together with an accurate navigation system, will allow the helicopter crew to know exactly where they are at all times and also where friendly and enemy forces are situated.

The type of mission system just described plays an essentially pasive role in controlling the helicopter systems. There is however a limit to the reduction in pilot workload that can be achieved so long as the authority of the system is restricted. If single pilot battlefield helicopters are to become a reality, and there are significant advantages to be gained from such a progression, then computer based systems must assume a more active role. At Farnborough we are already planning the development of a more advanced Mission Management System that will take advantage of the growth in computer processing capability providing integrated management of both avionics and weapons systems. This will permit the task of flying a combat helicopter to be substantially simplified by using the computer systems to monitor the aircraft and weapon systems, determine data that needs to be presented to the crew, and display it in an easily understood manner on a multifunction head down, head up, or helmet mounted display. This system will use the fibre optic data bus outlined earlier and will be installed in a Lynx in 1987/8 to provide a facility for further development of integrated avionics systems.

DISPLAYS

The final major area for integration, and perhaps the one that is most familiar is displays. The crew of a helicopter do not need to view displays of all the systems simultaneously, and indeed with the development of the more advanced Mission Management Systems outlined above, information will only be displayed when faults occur or decisions need to be made by the crew. Integration of displays is therefore seen as providing a flexible system that can provide displays of flight instruments, navigation data, communications systems, threat warnings, moving maps etc, either selectable by the crew or automatically switched in when the Mission Management System decides that the crew should be given some information; threat warnings, engine failure etc. There are a variety of types of display that can be considered for the battlefield helicopter. The first and perhaps the most obvious is the head down CRT monitor which can be used as a display for most helicopter systems such as flight instruments, maps, sight displays. Colour screens are now being adopted and at Farnborough we are investigating the use of both shadow mask and penetron tubes. Shadow mask tubes are of course readily available and are currently being installed in our helicopters, but may suffer in the vibration environment, and so work on the penetron tube, which is inherently more rugged than the shadow mask is also being progressed. The use of head up displays in helicopters is also being considered though the weight and cost implications of integrating these into helicopters does not make them very attractive. The alternative to the head up display is the helmet mounted display which by necessity must be very light. We have evaluated a number of these systems in the past, and are currently engaged in the development of a biocular display which will be used to display visually coupled FLIR together with flight symbology overlay, for map of the earth night and poor weather flying. The use of such displays for other applications such as the display of sighting information which will lead to a visually coupled weapon aiming system is also being considered.

CONCLUSIONS

Helicopters are evolving as an important part of NATO's defence structure with several new purpose designed machines in development. Helicopters have several advantages over fixed wing aircraft in some roles, the ability to loiter unseen for long periods being one example. One important advantage, which should not be forgotten, is that helicopters in the past have offered considerably lower costs than fixed wing aircraft. This cost advantage must not be lost in future designs, and so integration of systems is vitally important to obtain high performance at the right price. At Farnborough we aim to demonstrate the integrated systems outlined in this paper, to show their applicability to helicopter design, and produce cost effective systems for the UK Services in the future.

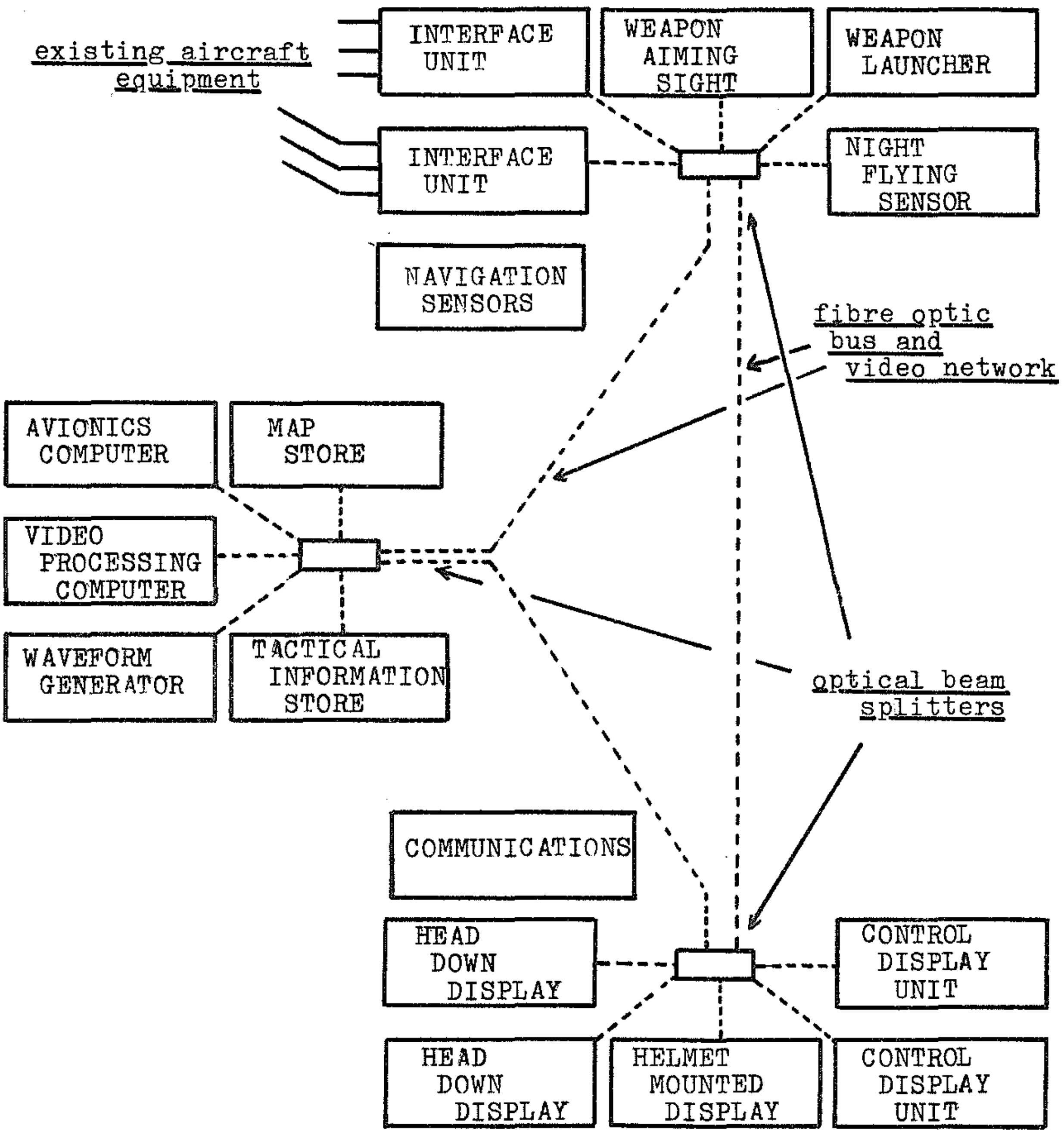

FIGURE 1 Schematic outline of the Inegrated Avionics and Weapon System to be installed in a Lynx Helicopter at Farnborough.

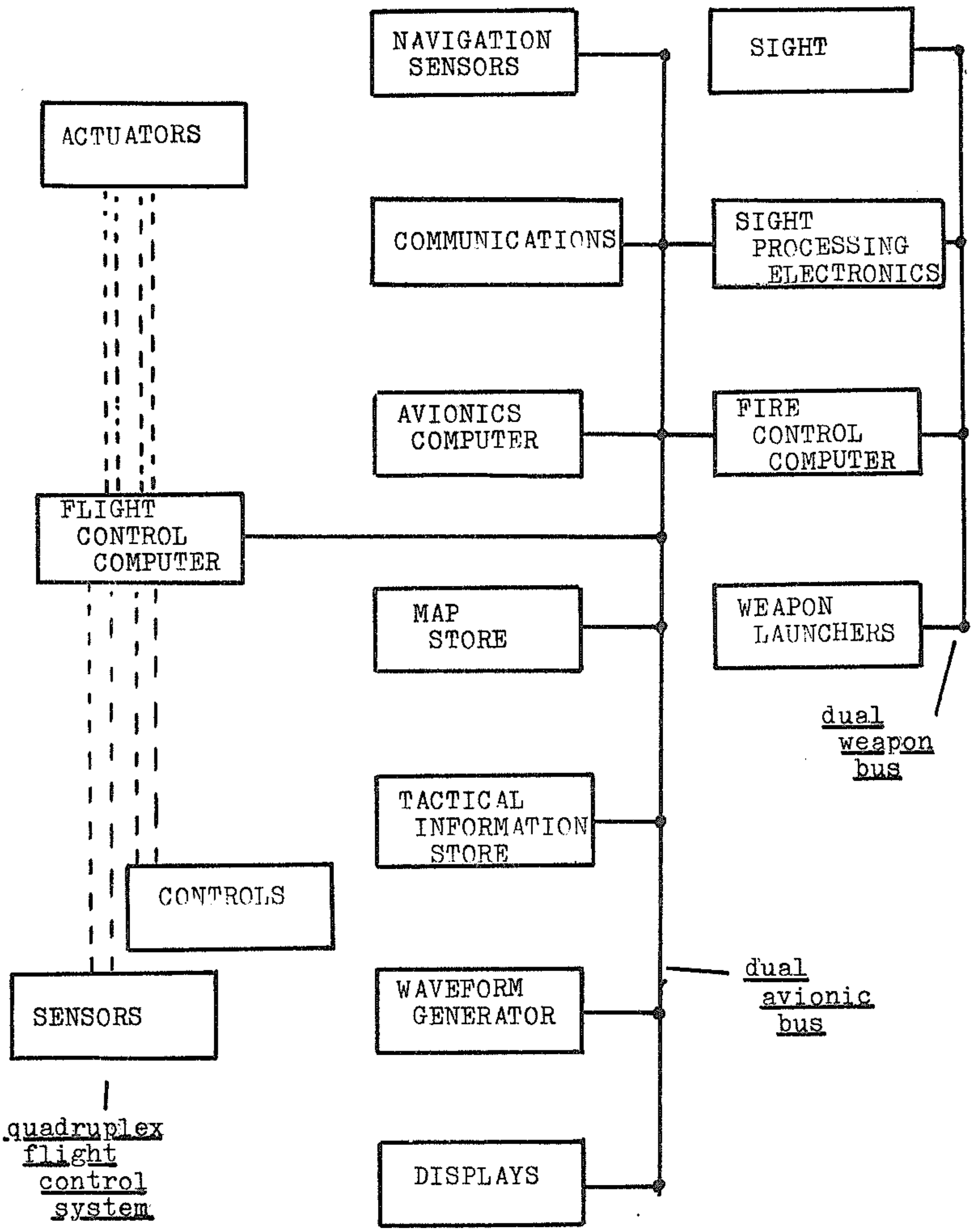

FIGURE 2 Schematic outline of a fully integrated helicopter flight control, avionic, and weapons system.