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THE PREDICTION OF HELICOPTER CREW INFORMATION REQUIREMENTS

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1. INTRODUCTION

Current helicopter crew are subjected to very high levels of information input from a variety of sources. This situation is likely to worsen rather than improve. In addition the operational effectiveness of the military helicopter in its various roles is becoming increasingly dependent on the capability of the crew to accept and process information received from sophisticated weapon systems and sensors. Pressure on panel and console space has led to the widespread adoption of electronic multimode displays and interactive techniques to present filtered and compressed data. The designer of complex new systems seeking to optimise operational effectiveness is consequently faced with a wide range of human factor problems. It was considered that the research approach adopted in this study would provide increased confidence in making complex design decisions.

A number of techniques have been developed for the analysis of tasks and crew activity levels. One of the principal objectives of this study was to produce a more satisfactory crew activity estimation technique. During previous studies WHL had used Time Line Analysis. This involves building up activity patterns for the operation of complex systems from time and motion data on simple action times. A detailed mission profile outlines the tasks that are required to be performed.

It was found to be relatively straightforward to develop detailed and comprehensive Time-Line Analysis plots which can be used to compare alternative equipment configurations. However, a major problem exists in the correct interpretation and analysis of the plot in terms of work load or effort, principally because the concept of workload is not sufficiently clear or well defined to enable overload conditions to be specified. In particular, the workload rates for individual tasks do not summate linearly. When several highly practiced and skilled tasks are carried out simultaneously the total workload rate may be lower than the sum of the individual levels. This is because skilled and experienced crew can time-share sensory inputs. It is also difficult to account for continuous control activity, visual activity and environmental factors.

Consequently it was decided not to use TLA further, and instead to devise an approach which; (i) avoids the interpretational problems of TLA, (ii) retains the scope and simplicity of an approach based on operational analysis, and (iii) may be used predictively.

The resulting technique was given the acronym "Hecate" (Helicopter Crew Activity Assessment Technique). The methodology is outlined below.

2. HECATE

A number of detailed missions are drawn up to cover likely aircraft operations. For each mission detailed specification is required of the following: flight conditions, airspeeds, aircraft performance, flight path, tactics, environment, threat data, equipment operating procedures, etc. These are based on published or proposed data and coordination inputs from experienced pilots. From these a mission event time-line is produced.

Up to this stage the approach is similar to TLA. However, the time-line may also be considered as a record of information processing requirements. Hence, as the aircraft moves from event to event, the time during which the information is made available to the crewman is closely specified. For example, a reference feature identifying a turning point may only be visible to a fast, low-flying helicopter for a few seconds, during which time at least one of the crew must be able to visually search for it. The suitability of a cockpit layout may thus be evaluated in terms of the number of occasions in a mission when the crew are unable to make a sensory input of information because their sensory capacities are committed elsewhere. This approach is made possible by the definition of the term "information" as used in this paper; it is defined as covering all the sensory inputs the crew make which enable them to complete their mission successfully. These may range from precisely specified numerical data, to "seat of the pants" sensations, of which the crewman need not be consciously aware.

In order to model the crews' ability to input information, a number of concepts have been brought together from various previous studies. The result is a model which treats the crewman as a "black box", and mimics some of the important behaviour of the man-system interface. It does not seek to model the internal cognitive processes. Information handling is therefore described in terms of the time required to input data, e.g. instrument scan times, or visual search times, etc. Important aspects of the operators' behaviour that are incorporated into the model are the following:

(i) The assignment of priorities to sources; determined by the criticality to mission success.

(ii) The ability to time share a number of inputs.

(iii) The division of inputs between members of the crew.

The ability of a skilled and experienced crew to accept information from a number of sources simultaneously is a vital part of the technique. The extent to which the inputs can be combined is described by an "interlace coefficient". This is a function of the following:

1) The sensory modalities of the information
2) The physical separation of the sources
3) Crew experience, etc.

The coefficient may be adjusted to take into account the effects of fatigue and training, motivation, experience, morale, etc.

The crew information requirements are synthesised by a computer program, modelling these features. The program is designed to schedule information sensing tasks and to produce estimates of the minimum possible time in which all the tasks can be completed. This is compared with the time available. The analysis may be reiterated with alterations to the variables in order to investigate alternative aircraft configurations, tactics, training and the effects of fatigue, stress, etc. The number of tasks shed by the crew, because of time stress, and their criticality to the mission may be minimised. Additional information sources may be included, or existing sources modified or deleted, and their value estimated.

The object is to investigate configurations which lead to optimum schedules of information handling.

The specification of a sortie requires:

1) Definition of - (a) The type of helicopter
(b) The ancillary equipment (e.g. navigation fit/weapons, etc.)
(c) The helicopter role
(d) The battle zone/enemy

2) Definition of a number of field situations based on the characteristics of the aircraft, the terrain and probable Nato/Enemy Tactics. These should cover the entire likely crew information requirements.

3) Definition of the actions of the helicopter and crew, in detail, to produce a mission "Script". (A suitable format has been developed in which to code the data).

Various sources of information were used when developing the sorties used in this study. These included tactics manuals, experienced pilots and typical mission profiles flown by current helicopters. The latter were adapted for speed and expected weapon performance.

Prior to evaluating a complete mission profile, a sensitivity analysis of the programme variables would be required in order to determine the reliability of the data assembled. To do this each variable would be manipulated separately and the effect on the entire mission profile analysed. The data base could then be refined, or due allowance made for the more sensitive variables.

Much further work is required before the system can be considered operational. This will include trials to determine interlace coefficients, and practical validation exercises.

3. CONCLUSION

The approach to activity assessment which has been outlined in this paper may be applied to any complex system for which detailed user scenarios can be prepared. It is possible to both compare entire system configurations and to assess the effects of small design changes. The level of detail to which this may be taken depends on the quality of the input data. Though the information requirements synthesised by the computer model apply to a hypothetical, "ideal" crewman, by suitable weighting of the interlace coefficients estimates can be made of the effects of fatigue, motivation, training, individual differences, etc.

The "Hecate" approach has considerable promise as a cockpit design tool usable from the earliest stages of study. It will give an early indication of information overload problems. It will also evaluate possible solutions and thus increase confidence in complex design decisions.

Considerable work remains to be done to develop the HECATE approach, and to extend the methodological basis of the technique. When complete this will provide human factor research with a valuable tool.

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