Development of Training System Requirements and Support of Simulator Acquisition Process

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Abstract. This paper describes the approach taken to analyse training needs and evaluate alternative strategies for mid-life upgrade of the RAN's S70B2 Seahawk Helicopter. Increasing reliability and reducing life-cycle costs are endorsed priorities for the Seahawk Midlife Upgrade and Life Extension program, generating a need to determine and, if possible, improve cost-effectiveness of the training system. Although only at the Project Definition Study (PDS) Phase, training system performance has been recognized as a critical component of the overall weapon system capability and a thorough training study has therefore been conducted. The training study has involved a detailed analysis of training system fidelity and instructional support feature requirements and comparison of these against the capabilities offered by alternative approaches, including conventional shore-based simulation, embedded training and embarked mission simulation. Models have been developed of the training systems under consideration and assessments made of their suitability in terms of defined cost-benefit measures. The training systems models are also expected to provide ongoing support to the acquisition authority through its processes of information gathering, tender development and evaluation. In this paper, we describe the training data acquisition process, the nature of the modelling undertaken and the mechanisms that the acquisition authority might use to develop, review and consider options through the acquisition process. While based on a study for the RAN Seahawk helicopter, this paper focuses on the broader principles of defining and assessing potential training systems as a part of major acquisition projects.

1. INTRODUCTION

Director General, Aerospace Development, Capability Systems Division, within the Australian Department of Defence is conducting a Project Definition Study for the mid-life upgrade and life extension of the RAN’s S70B2 Seahawk helicopter, in an approved program known as AIR 9000 Phase 3A. The study is looking at the whole of Seahawk system and capability it offers. An important component of that work addresses the training system performance as a component of the weapons system capability.

Options under The Seahawk Mid-life Upgrade and Life Extension include upgrading the existing Seahawk Anti-Submarine Warfare (ASW) capability to maintain its relative effectiveness against emerging modern threats and to increase its sustainability for service into the mid 2020s. Presently there is in place a system of training that is serving the needs of the Seahawk Squadron. Training coursework is complemented with a mix of instruction through flight and weapons system training simulation facilities, aircraft based instruction and more limited use of a software development rig for part-task instruction.

The simulation facilities have been in service since the early to late 1980s. These facilities address current training requirements, and are likely to require modification to meet requirements addressed under the SMULE program. Also, the current training devices are based upon older generation computing platforms that are presenting maintenance difficulties. These systems will need to be upgraded to be supportable for the lifetime of the capability.

Not only should the Seahawk capability be supported by training devices (simulators and part task trainers), but the exploitation of individual training devices
within the training system should be optimized. Training should be conducted through the most suitable platform (aircraft or synthetic training system) in order that the training conducted is as effective as possible. As well as that demands on the aircraft for training need manageable within the context of aircraft maintenance engineering and operational requirements. To this end, the scope for increased effective use of synthetic environments for training needs to be investigated.

In other places [1],[2],[3],[4],[5],[6], military training systems rely increasingly on synthetic training environments for a range of aircraft availability and training suitability reasons. Appreciating at the outset the most appropriate training environment for the full range of training tasks requires a detailed appreciation of those tasks and the characteristics that a platform and a training environment should possess.

In this paper we will address aspects of the process that has been used to review and understand the longer-term training requirements for the Seahawk capability. The objective is not so much one of looking at the pedagogical aspects of the training process, but to determine the most appropriate means of supporting instruction through a range of synthetic training devices and systems. Whilst the paper refers to the recent Seahawk study extensively, the specifics should be seen as indicative examples only.

To this end, in Section 2 of the paper we will discuss the process of Training Requirements Analysis that has been undertaken and the findings that have resulted. In Section 3 we discuss analysis of other potential training system options through use of the Tandem DSS™ training system modelling tool. In Section 4 we discuss potential support for the longer-term acquisition process that the training requirements analysis and the Tandem DSS™ tool could provide. Finally, in Section 5 we make some concluding remarks.

2. TRAINING REQUIREMENTS ANALYSIS

2.1 Aircrew TNA

The study of Seahawk aircrew training commenced with an investigation of the current context for training and that anticipated post-SMULE (Seahawk Mid-life Upgrade and Life-of-type Extension). Generally principles [7] and a skill learning model, previously applied to other ADF aircrew training studies [8] were used to investigate stages of aircrew training from initial type conversion through operational conversion and to currency, collective and mission preparation training when embarked. Conversion and currency training were scoped to be consistent with the extant aircrew curriculum. Collective and mission preparation training were scoped to maintain skills required for Australian Illustrative Planning Scenarios (AIPS) cited in project operational concept documentation. Descriptions of the current context for training and that anticipated post-SMULE were reported in the SMULE Training Analysis Report.

The scope of training identified in the SMULE Training Analysis Report led to identification of 903 pilot, observer and aircrewman training tasks. A training task analysis was conducted to identify stimuli and instructional support features required for the effective conduct of each training task. Task analysis data was recorded in a tailored version of the Tandem DSS™ training system modelling tool and reported in the SMULE Training Task Analysis Report.

Potential training environments were also analysed in terms of the same set of stimuli and instructional support features used to investigate tasks, and the results recorded in Tandem DSS™. Tandem DSS™ permitted a range of training strategies to be tested against training requirements and the results were documented in the Baseline Training System Report and training strategies discussed include:

1. all-through aircraft training,
2. use of the SMULE aircraft with existing training devices,
3. use of upgraded/new training devices and aircraft,
4. use of low-cost training devices, and
5. use of post-conversion training devices.

Despite a lack of reliable cost information, a strong case was established, in the Baseline Training System Report, for the retention of flight and tactical simulation capabilities. Modelling of these capabilities demonstrated that they could offer:

1. reduced reliance on aircraft flying hours for training;
2. reduced constraints on the effectiveness of instruction; and
3. reduced reliance on the aircraft for training tasks that are prohibited in the airborne environment for reasons of policy, practicability or safety.

An assessment of various combinations of training strategies led to recommendation of a training approach, which was described in detail in the Training Requirements Report. This recommended approach comprises:

1. minimal reliance on the Seahawk aircraft for training,
2. a Flight Simulator,
3. a Weapon Systems Trainer,
4. an Embarked Mission Training System, and
5. Ground school training that may include PC-based part-task training.

Subsequent cost-benefit analysis will be required to determine whether the Flight Simulator and Weapon Systems Trainer should be implemented as linked or fully integrated devices. The approach taken to implementation of these devices will substantially influence their precise training capability; however, the proposed general applications of these devices may be summarised as follows:

1. **Flight Simulator.** The Flight Simulator will provide a high-level flight simulation capability for Pilot and Observer training. If
operated as a standalone device, the Flight Simulator would include modelling of the tactical environment and weapon and sensor systems to the extent required for Pilot training. If operated as a device linked to, or integrated with, the Weapon Systems Trainer, the Flight Simulator would make use of the tactical environment and weapon and sensor systems modelling provided by the Weapon Systems Trainer.

2. **Weapon Systems Trainer.** The Weapon Systems Trainer will provide a high-level tactical training capability for Observer and Aircrewman training. This capability includes procedural training in weapon and sensor systems operation. If operated as a standalone device, the Weapon Systems Trainer would include aircraft systems and flight modelling to the extent required for tactical training. If operated as a device linked to, or integrated with, the Flight Simulator, the WST would make use of aircraft systems and flight modelling provided by the Flight Simulator.

The Embarked Mission Training System is proposed to provide onboard tactics refresher training for aircrew. The extent of this system functionality will be limited to part-task training in selected aspects of aircraft systems and environmental stimuli. The rationale for only employing a limited range of stimuli is that aircrew are already qualified in the physical manipulation of systems and only certain aspects of the tactical air and maritime environment are necessary for refresher training.

Groundschool training is proposed to primarily employ conventional classroom instruction; however, PC-based part-task training may be warranted for some initial and procedural training on specific Seahawk systems. Resolution of the need for such part-task training will be dependent on the complexity and operational procedures of systems selected for acquisition under SMULE.

The final SMULE Training Requirements Report delivered under this study includes a proposed concept of training and functional specifications of fidelity and instructional support features for the following training sub-systems:

1. Flight Simulator.

### 2.2 Support Personnel TNA

The study of Seahawk support personnel training commenced with an investigation of the current context for training and that anticipated post-SMULE. In addition to the obvious requirement for training in relation to new or upgraded systems, the study recognised that legacy training systems may need to be modified to ensure that a complete and coherent training solution would be achieved.

A contextual analysis identified several constraints on the efficiency and effectiveness of current training. These constraints arose from less than ideal availability, reliability and capability of current training resources. Moreover, the constraints were found to be largely attributable to the ageing nature of Seahawk support personnel training systems and a history of discrete aircraft system upgrade projects. From this assessment of the current training context, a SMULE Training Enhancements Report was prepared identifying opportunities for improvements to extant training systems. The Training Enhancements and Training Management Reports proposed strategies through which training for both new and upgraded systems, and legacy systems, that could be successfully implemented post-SMULE.

A detailed training task analysis process was undertaken to identify the functional requirements of Seahawk support personnel training tasks. In practice, the support personnel training of primary interest was that provided for Seahawk Avionics and Aircraft trades maintenance staff. A Training Task Analysis Report was then delivered detailing the stimuli and instructional support features required for the successful conduct of each of 711 maintenance training tasks.

The stimuli and instructional support features available through certain generic training environments were also examined and the data for both task requirements and candidate training environment capabilities modeled within a database tool. A tailored version of the Tandem DSS™ training system modelling tool was developed for this project and copies have been delivered for ongoing use by the Commonwealth. Tandem DSS™ permitted a range of training strategies to be tested against training requirements and the results were documented in the Baseline Training System Report. Training strategies discussed include:

1. continued use of in situ training environments,
2. variations in flight simulator capability,
3. replacement/upgrading of Synthetic Aircraft Maintenance Trainers (SAMTs),
4. airframe or cockpit mock-up dedicated to training,
5. computer-based instruction (CBI), and
6. part-task trainers.

The clearest discriminator between the capabilities of potential training strategies is the instructional functionality required for fault-find training tasks. The lack of availability of suitable environments for fault-find tasks is a key problem with current training. Without availability of suitable devices, this type of training is left to paper-based exercises in formal training and on-job-training when, and if, opportunities arise.

Modelling of potential training environments indicated that SAMT-type devices or high-end CBI is required to satisfy fault-find training tasks. In terms of instructional functionality, there is no justification for selecting one of these two approaches over the other and, indeed, an
amalgam of the two may eventually prove to be the most cost-effective solution.

SAMTs and high-end CBI specifically designed to address fault-find training tasks may be usefully augmented by low-end CBI specifically targeting those training tasks for which it is fully suitable. A clear need for other devices, such as part-task trainers and system mock-ups, is not apparent at this time, but may be worthy of consideration as part of offered suites of training systems.

The recommended approach to support personnel training is detailed in the Training Requirements Report and comprises:
1. minimal use of aircraft for personnel training,
2. Fault-Find SAMT(s) and/or High-End CBI for functional test and fault-find training,
3. use of Low-End CBI to reduce reliance on Fault-Find SAMTs and/or High-End CBI, and
4. preparatory trade instruction in classroom and general trade training environments.

The final SMULE Support Personnel Training Requirements Report delivered under this study includes a proposed concept of training and functional specifications of interaction fidelity and instructional support features for the following training sub-systems:
1. Preparatory Trade Instruction.
2. Computer-Based Instruction.

The proposed concept of training and functional specifications are intended to provide a necessary basis for the preparation of funding submissions and offer a starting point for more detailed requirement definition work in the acquisition phase of the project.

3. TRAINING DEVICE OPTIONS ANALYSIS

The notion of the Full Mission Simulator (FMS) used here is a concept of an integrated pilot, observer and aircrewman training environment where training has a clear ‘whole of mission’ focus. However, it also serves to meet the needs of individual training and can be configured in a training scenario for each classification when necessary. Implicit is the clear constraint that when individual training is being conducted the whole environment is unavailable for other training. For this reason some alternatives merit consideration.

The concept of the Flight Simulator (FS), servicing the joint and separate needs of the pilot and observer, and the separate Weapons System Trainer (WST), servicing the joint and separate needs of the observer and aircrewman, has been identified. The WST and FS can then be electronically linked into a joint training environment that is the functional equivalent of an FMS. In addition, the concept of a separate PC-based Part Task Trainer (PCPTT) has been considered. This supports the needs of the aircrewman as completely as the WST but was physically separate and electronically linkable to pilot and observer environment flight and weapons simulator to provide FMS functionality.

Accordingly the following environments have been further analysed: PC Part Task Trainer – PCPTT; Weapons System Trainer – WST; Flight Simulator – FS; Full Mission Simulator- FMS; Seahawk - S70B2. Each environment is defined as a high fidelity environment replicating the S70B2. The PCPTT, the WST and the FS are functionally defined and modelled in the Tandem DSS™ tool. The FMS is modelled as an augmented environment that combines the capabilities of the FS and the WST.

The environments were considered as elements of 3 options:
1. Suite1: PCPTT, WST, FS, FMS S70B2
2. Suite2: FMS, PCPTT, S70B2

The objective was to gain some appreciation of the relative training value of the different environments. The aircrew specialist skill categories considered were Pilot Embarked, General Instrument Flying, Tactical and Utility Phases, Observer Tactical and Utility Phases and Aircrewman Sensor Operator and Utility Phases. In total there were 321 Pilot, 309 Observer and 198 Aircrewman training tasks respectively. The Tandem DSS™ database embodies all these tasks and the stimuli and instructional support features considered necessary for effective training.

In Figure 1 the capabilities of pilot training environments are shown - the aircraft, the Level D

![Figure 1: - Comparative Capabilities of Pilot Training Environments](image-url)
Flight Simulator and the integrated FMS. It is interesting to observe that the integrated mission environment (FMS = FS+WST) is superior to both the aircraft and the flight simulator on its own in terms of the reduced number of areas of training task deficiency and the more limited extent to which it falls below a fully suitable rating when it does exhibit some weakness. It should be noted that 142 stimuli satisfied is considered fully suitable. (Clearly this diagram does not allow individual tasks to be identified exactly but Tandem DSS™ does provide clear visibility. However, trend information is clear and particular training segments can be identified.) While this figure presents a view of training task suitability for pilot training, a similar appreciation is available for observer and aircrewman training tasks.

Having developed an appreciation of the relative merits of the training environments, what are the possibilities for utilization in a system of training? It is now that the training system suite options mentioned earlier are addressed.

In Figure 2, Suite 1 comparison is made. The diamond points and arcs depict the assignment of tasks to training devices where the devices were found to fully meet requirements and the order of priority of the distribution was PCPTT, WST, FS, FMS, S70B2 (based on preferred use of least costly environments first). This leaves a considerable number of tasks for which no environment is fully suitable. At this point those unassigned tasks were assigned to equipment on the basis of the prevailing RAN practice in the existing training system. Square points and arcs represent this situation. Finally, the triangle points depict the assignment of remaining unassigned tasks to environments on the basis of best match of modelled requirement to modelled capability. This last presentation might be viewed as a possible highest utilization option. It is the position that might be achieved if, with the development of experience, device availability, and satisfaction within the training community, a judgement was formed that synthetic devices could take more of the load (assignment of additional tasks). Under these circumstances it is noted that some 300+ hours are moved to other trainers, principally the Full Mission Simulator.

4. SUPPORT TO ACQUISITION PROCESS

Having identified the training requirements having been identified how does this assist the Defence Material Organisation in the selection of the most appropriate proposal – i.e the proposal that is the most sensible compromise in terms of dollar cost and training effectiveness?

4.1 Tandem DSS™ modelling of Potential Training Platforms

Potential training platforms were functionally modeled in terms of the aircraft system and environmental stimuli that they offer as well as the instructional support features that they provide. This data was input to the Tandem DSS™ training system modelling tool which then compared training platform capability against the requirements of individual training tasks. To provide this data in tender evaluations, the potential suppliers would be requested to assess and justify the capabilities of their offerings against stimuli and instructional support feature criteria and complete an Excel spreadsheet that may then be copied into the database application as a functional specification of the proposed training platform. Space does not allow the inclusion of the spreadsheet for perusal but essentially it requires the identification of features available and the fidelity of stimuli as either abstracted, representative or authentic. A range of aircraft systems and environmental features are surveyed for requirements and a range of stimulation types, instructional support requirements and sensor system detection requirements are identified in this context.

A suite of platforms might be offered as part of a complete system of training solution. In this way comparative assessments can be made of all aspects of the different training system solutions offered by tenderers. Not only is it possible to assess the utility of a device by identifying those tasks for which modelling suggests it has appropriate suitability, it is also possible to assess how well the overall training package proposal can meet the totality of training needs that have been identified by the training authorities and practicing instructors.

A tool such as Tandem DSS™ facilitates the elicitation of knowledge about training requirements for job classification and archiving the composite data and information so that it can be used to assess different offerings for their suitability against the requirements, their cost effectiveness and the comparative capability against other contenders. It is important to note that this approach is not inconsistent with those approaches to training needs analysis defined by Australian Defence publications, including specific guidance for each of the Services, but rather supplements the overall training requirements analysis process which must still be undertaken with a detailed assessment of simulation needs.
4.2 Training Requirements Elicitation

From an acquisitions organization perspective it could be argued that this process is perhaps feasible for an upgrade in an existing capability since the extent training community will have a keen appreciation of the current requirements and system deficiencies. Clearly that community will be well placed to estimate or project the training tasks for the enhanced capability given that the community have access to data regarding the behaviour of the new system and its tactical application. When it comes to a new capability altogether the question is much less simple.

New capability is not likely to have the same degree of local training expertise, particularly if there is likely to be a major movement in the type of operational capability (say two seat to single seat or fixed wing to rotary) or a major shift in applied technology. Even so local training authorities have invaluable knowledge of the more general pedagogical, cultural and environmental issues within the service. Using that knowledge and experience in an early task analysis to gain an assessment of the training requirements will have demanded a review of the likely local tactical application and the operational concept. With that task analysis and an estimate of the stimuli and instructional support features, a tool such as Tandem DSS™ gives acquisition organizations an objective scheme for assessing training system options.

Nevertheless the analysis and assessment of such tasks is activity demanding the collaboration of local training authorities, platform and sensors system developers and integrators. Accordingly it is likely to be an expensive early acquisition program activity but it will afford a clearer appreciation of the training capability required and a clearer vision of the ongoing through life cost of the different strategies. Perhaps also the necessary processes of introspection and operational analysis required to appreciate training requirements may afford valuable earlier insight into operational and tactical issues.

The SMULE study was a collaboration between Learning System Analysis, the RAN Subject matter Experts and DSTO as part of Capability Systems Division tasking. Further analysis though is specialist work and it is probably fair to say that getting the most from the database in the acquisition office probably requires extensive training of dedicated training system analysts.

4.3 Intended Use Document

Procurement against functional specifications as opposed to engineering requirements is becoming more fashionable, but acceptability can be problematic. Simulato acquisition in these circumstances is similarly vexed although it may have access to the application of mandatory qualification requirements that cover some aspects of the device performance. Whilst the issue of qualification requirements is beyond scope of this paper, an Intended Use Document can complement qualification documents such as AC120-63. It can explicitly articulate specific training tasks that must be satisfactorily demonstrated by the training device. Detailed exposition of the training tasks through detailed TNA enables development of an appropriate Intended Use Document.

5. CONCLUSION

In this work we have discussed the approach taken to appreciate the training requirements of Seahawk Personnel in the RAN. Training Needs Analyses have been conducted that expose training tasks and importantly these analyses identify the aircraft systems and environmental stimuli and instructional support features needed in order that appropriate instruction can be provided for each task. Further modelling then enables assessments of different training platform options. Assessment is made of the extent to which an option satisfies the stimuli and instructional support feature requirements of a task and the number of tasks serviced by the device. Finally, we have discussed some ways the analysis provides for longer-term support of the training system acquisition program as a component of the SMULE program.

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