Chapter 3 – TECHNOLOGY SURVEYS

The proposed decision support tool has been designed in a distributed environment in order to facilitate hierarchical command and control and the integration of different decision models corresponding to procedural terms and information processing forms the crux of the research.

Uncertainty which arises from the existence of incomplete and imprecise information inherent in both disaster relief and military operations is another challenging technical aspect that needs to be studied in detail. Neither the task, the duration, the nature nor the multi-national context in which the operation will take place are known in advance: these factors will differ for each mission. Therefore, a versatile approach compatible with international standards should be analysed under different scenarios which encompass this uncertainty.

To achieve these purposes and optimisation requirements of the model, during the Analysis Phase of the project, technology surveys were carried out on modelling, computer and software engineering and data collection technologies; geographical information systems, digital maps, mission data compilation systems; model, data, and knowledge management repositories in NATO nations. This process was identified by the Program of Work (POW). Then, the technology mapping and capability matrix has to be developed using the identified current needs and capability gaps. This chapter presents a comprehensive summary of these investigations.

3.1 DECISION SUPPORT TOOL TECHNOLOGIES

Before going into detail in the conception of a mathematical tool, the group decided to make a survey of the mathematical techniques available for the solution of the model.

It is figured out that many decision problems can be modelled using mathematical programs, which seek to maximize or minimize some objective which is a function of the decisions. The possible decisions are constrained by limits in resources, minimum requirements, etc.

The survey includes a detailed analysis of linear, non-linear, stochastic, constraint satisfaction problem which can be used for the design of decision support model for helicopter mission planning in disaster relief and military operations. Furthermore, it includes simulation, data analysis and mining and artificial intelligence.

Artificial intelligence has specially retained the attention of the group, since many Artificial Intelligence problems are not well defined initially. The process of developing and testing software helps to clarify the problem. Artificial Intelligence problems often require different kinds of knowledge to be represented and different kinds of inference mechanisms to be used and intelligent systems may need to modify themselves dynamically over time.

Deeper researches were engaged, and the techniques of Artificial Intelligence were subject of examination: Expert Systems (ES), Neural Networks, Fuzzy Logic and Genetic Algorithms.

For each of these mathematical techniques of optimisation, simulation, data analysis and mining and artificial intelligence, the group has investigated the related software systems available in the market.

3.2 INFORMATION TECHNOLOGIES

An information system, with its very broad definition is a –computer– system that is used for the storage and retrieval of any type of information – text, numerical, graphical, video, and sound. Before designing an information system, an analysis is to be done to find out the requirements. For decision support systems, a mathematical model should also be considered in the analysis phase. Then, in the design phase, focus is directed towards the realization of the system to meet these requirements.

The group accomplished a significant research on data management issues to be considered for RTG SAS-045 on "Computer Based Decision Support Tool for Helicopter Mission Planning in Disaster Relief and Military Operations." The topics covered include data management approaches, data interaction strategies, Database Management System (DBMS) paradigms and DBMS providers.

This research concludes that the following criteria may be the basis for designing data management architecture for RTG SAS-045:

Performance and Accessibility: Data management should address the time requirements of the decision support algorithm to promote its robustness. Thus the desired system proposed by RTG SAS-045 should respond quickly to an emergency situation.

Interoperability with other NATO models and repositories: Based on another technology survey within analysis phase of RTG SAS-045 [SMI03], most common data repositories in NATO organizations including Integrated Command and Control & Air Command and Control System (ICC and ACC) and Allied Deployment and Movement System (ADAMS), Tool for Operational Planning, Force Activation and Simulation (TOPFAS) have been implemented by using relational database models. In order to generate practical and flexible plans for missions supported by helicopters during a crisis situation, the decision support system should have rapid access to reliable information in a standard format. The system should also be able to distribute its results in a standard format to the related users.

Distribution and Crash Recovery: In disaster-relief operations it is probable that some parts of an information network might be damaged or inaccessible. The data management architecture to be proposed should consider data distribution and crash recovery by planning redundancy and back up system.

3.3 GEOGRAPHICAL INFORMATION SYSTEMS, DIGITAL MAPS AND MISSION DATA COMPILATION TECHNOLOGIES

A Geographical Information System (GIS) is a "computer system for capturing, managing, integrating, manipulating, analyzing and displaying data which is spatially referenced to the Earth." (McDonnell and Kemp, 1995). GIS is an information system that is composed of hardware, software, data and personnel. The current generation of GIS products support data integration and manipulation, query, thematic and overlay analysis, and visualization in two and three dimensions. Geographic information technology has emerged as an important operations research tool for exploiting increasingly available amounts of valuable geographic data in a form easily comprehended by analysts and decision makers (Hanigan, 1989).

What distinguishes GIS from other forms of information systems, such as databases and spreadsheets, is that GIS deals with spatial information. GIS has the capability to relate layers of data for the same points in space, combining, analyzing and, finally, mapping out the results. Spatial information uses location, within a coordinate system, as its reference base. The most common representation of spatial information is a map on which the location of any point could be given using latitude and longitude, or other grid references.

An extensive work on digital map format and co-ordinate reference system was performed. The applicable STANAGs were considered, and automatic data capture, remote sensing and tactical data link systems have also been investigated.

The group stated that a generic Decision Support System (DSS) should interact with the analyst and the decision maker for exploiting different course of actions and present the current status and the results of the actions in a form easily comprehended by analysts and decision makers. Geographic information systems and mission data compilation systems can help to fulfill this requirement.

3.4 MODELS, DATA AND KNOWLEDGE MANAGEMENT REPOSITORIES AND PLANNING PROCESS IN NATO ORGANISATIONS

Since several models are known to exist to support an operation inside NATO, the group has investigated to perceive if the possible application of the model in support of the helicopter planning that will be developed within this study could be achieved successfully in NATO nations.

The group observes that NATO nations developed several models for planning purposes, but none of them has specifically been developed to support helicopter operations. However, it seems to be sensible that the helicopter model that will be developed within RTG SAS-045 scope will need to use similar software platforms and compatible database systems used in NATO models like ADAMS.

The group concludes that some planning models have been developed within the nations; however, most of the models are developed to support the planning of aircraft. So far only The Netherlands have developed a model called FELPATH to support the operational planning of helicopters. FELPATH, however, supports only a limited number of the functionalities that are required for the new NATO helicopter planning model. On the other hand it was rational to use the lessons learnt from The Netherlands, while developing the model, and probably use FELPATH as a starting point for developing the decision support tool for planning helicopter operations.