A TRAINING NEEDS ANALYSIS INTO MAP USE IN A MILITARY CONTEXT

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

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ABSTRACT

The primary objective of the South African National Defence force is the protection of its citizens against external threats. The nature of the work, especially in operational situations, very often causes members of the SANDF to work in remote and unknown territory. The SANDF is composed of different units such as the army, air force and navy. All of these units typically control a specific aspect of the environment, especially in operational situations, and is very often also geographically spread over a large area. The battle commander would typically be in charge of all these units and must direct and control them efficiently towards achieving their assigned mission.

In order to be an effective battle commander, the commander must thus be able to understand the terrain that his/her units are operating in, and maps are often the only information to base such understanding on. Map use is thus a critical success factor in effective battle command, and also for every member of the units navigating the often unknown terrain.

The aim of the study is to conduct an investigation into the status quo of map use proficiency in the military, and specifically the South African National Army. The investigation comprises the following:

- To conducting a detailed task analysis into map use in a military context, in order to establish specific map use functions and related skills regarded as critical in the military context.

- The development of a proficiency test, taking the form of a questionnaire, based on the skills identified in the task analysis.

- Comparing the results of the questionnaire with map use skills identified in the task analysis, to determine the level of map use proficiency in military context.

The secondary aims of the study comprise the following:

- To investigate the level of map use training and determine if a need exists in term of additional map use training in the military, based on subjective opinions.

- To investigate the level of computer literacy and the need for formal computer training in the military context.

The key conclusions of the study are the following:

- A gap between optimal and actual performance has been identified in terms of map use in the military context.

- This gap can largely be attributed to insufficient structures and processes within the military context to facilitate effective map use.

OPSOMMING

Die primêre doel van die Suid-Afrikaanse Nasionale Weermag is om die burgers van die land te beskerm teen eksterne gevare. Die aard van die werk veroorsaak dat soldate, tydens operasionele toestande, dikwels na onbekende en vreemde areas verplaas ten einde bogenoemde primêre doel te bereik. Die weermag bestaan tipies uit verskillende eenhede, wat elk gefokus is op die verrigting van spesifieke funksies, en dikwels geografies wyd versprei is. In gesamentlike operasies, is die operasie bevelvoerder tipies in beheer van die verskillende eenhede en moet hy toesien dat hul bewegings gekoordineer is ter bereiking van hul doel.

Die operasie bevelvoerder, ten einde die doelwit effektief te bereik, moet in staat wees om die terrein waar die verskillende eenhede beweeg te ontleed, en effektief tot doelbereiking kan benut. Kaarte is een van die primêre bronne van inligting, ten einde die terrein te ontleed om dit sodoende tot voordeel te kan gebruik. Effektiewe gebruik van kaarte is dus 'n kritieke faktor wat bydra tot die sukses van die operasie bevelvoerder, asook vir feitlik elke lid binne die verskillende eenhede wat deur dikwels onbekende terrein moet navigeer.

Die doelwitte van die studie is om 'n ondersoek in te stel na die status quo met betrekking tot kaart-gebruiksvaardigheid in die Suid Afrikaanse Nasionale Weermag. Die studie behels die volgende:

- 'n Omvattende taak-analise ten opsigte van die gebruik van kaarte in die militêre konteks, om sodoende spesifieke funksies en verwante vaardighede te identifiseer wat as kritiek vir die militêr beskou word.

- Om 'n vaardigheidstoets in 'n vraelys te inkorporeer, gebaseer op bogenoemde geïdentifiseerde kaart-gebruiksvaardighede.

- Om die resultate van die vaardigheids-toets te vergelyk met dié geïdentifiseer in die taak-analise, om sodoende die vlak van kaart-gebruiksvaardighede te bepaal in die militêre konteks.

Die sekondêre doelwitte behels die volgende:

- 'n Ondersoek na die vlak van kaart-gebruiksopleiding en om te bepaal of 'n behoefte bestaan na verdere kaart-gebruiksopleiding, gebaseer op subjektiewe opinies.

- 'n Ondersoek na die vlak van rekenaargeletterdheid, en die behoefte aan rekenaar-opleiding.

Die afleidings wat uit die studie gemaak kan word is die volgende:

- daar bestaan 'n prestasie-gaping tussen optimale and werklike prestasie met betrekking tot die gebruik van kaarte in die militêre konteks, en

- hierdie gaping kan grootliks toegeskryf word aan onvoldoende strukture binne die militêre konteks, wat nie kaart-gebruiksvaardighede fasiliteer nie.

DECLARATION

The financial assistance of the National Research Foundation (NRF), as well as Sub-committee A from the faculty Economic and Management Science, towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at are those of the author and are not necessarily to be attributed to the NRF or Sub-committee A.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

This purpose of this chapter is to provide detailed background information on the issues that will be dealt with in the study. This includes theory regarding the training needs analysis process, as well as the relevant aspects of the SANDF as related to the study. This chapter further aims to provide an ouline of the problem the study seeks to address as well as a break-down of the chapters and the issues to be discussed.

The field of Training and Development aims to develop skills, attitudes, knowledge and capabilities in order to enhance an individual's performance, thereby improving the overall effectiveness of organisations. Organisations each year spend large amounts of money in training their employees, and "of all human resource development (HRD) programs, training is one of the most expensive" (Haskell, 1998, p1). Despite this, "too often training and development programs get their start in an organisation simply because the program was well advertised or marketed" (Wexley & Latham, 1981, p.28). This makes little sense, especially if training is to be viewed as a strategic aspect of the organisation.

The role of the training department has drastically changed over the last years, and increasingly, trainers are called upon to justify training activities and the time and costs it requires. "In most organisations today, resources are scarce and have to be used carefully, time is of the essence, and trainers of all kinds are required to justify their position and account for their activities" (Boydell & Leary, 1996, p.1). By identifying specific needs or problems in the organisation at which training is directed, the time and money spend on these interventions can thus be adequately

justified, not only to the organisation, but also to the learner. "Performance initiatives should begin with a systematic assessment of training needs to ensure that training programs have relevance to the people being trained" (Gupta, 1999, p.4).

The systematic planning and execution of training has become an increasingly important aspect within the training department, especially in South Africa, due to the Skills Development Act. The Skills Development Act of 1998 aims to develop and improve the skills of the South African workforce by not only establishing standards against which training interventions can be measured, but by encouraging employees to participate in such training interventions, and encouraging employers to create active learning environments within their organisations (RSA, 1998). Employers are also obliged to pay a skills development levy of up to 1% of the total amount of remuneration paid to their employees. A certain percentage of this money could however be paid back to a specific organisation if they comply with certain conditions as outlined in the Skills Development Levies Act of 1998. This could force employers to train their employees in order to recover a certain percentage of the levy paid (RSA, 1998).

Viewed in this light, it thus becomes increasingly important for organisations to be able to ensure that training targets specific needs in the organisation, that it is systematic and thus contributes to organisational performance. By doing this, active measures are thus taken to ensure that money spent on training is not wasted.

Because training is mostly expensive and time-consuming it is important that training is planned and directed towards solving organisational problems/needs, as stated previously. "Training that is ill directed and inadequately focused does not serve the purposes of the trainers, the learner, or the organisation" (Boydell & Leary, 1996, p.1). Training needs analysis, very broadly, is a study conducted to determine the exact nature of an organizational problem and how it can be solved (Kossek & Block, 2000). This process also serves to identify when training should occur, as well as who should attend (McNamara, 1999). The analysis phase is the

foundation of a training program. This forms the basis for decisions about who must be trained, what must be trained, when training will occur, and where the training will take place (Boydell & Leary, 1996).

The product of this phase is the foundation for all subsequent development activities. The training needs analysis thus allows you to identify the specific targets for training as well as the means for reaching your target (Sparhawk, 1994). "In this way, organisations will use training and development interventions only for the people and the situations where needed" (Wexley & Latham, 1981, p.28).

1.1.1 Models of Training Needs Analysis

Gupta (1999) identifies four models cited in the literature, of training needs analysis. A brief overview of the human competence-, organisational elements-, analysing performance problems- and training needs assessment models are discussed below.

Human Competence Model

This model was developed by Thomas Gilbert, and proposes that human performance is affected by six factors, namely: information, resources, incentives, knowledge, capacity and motives.

These factors need to be investigated before training is conducted.

Organisational Elements Model (OEM)

This model was proposed by Kaufman, and includes the following:

- inputs (resources of organisation);
- processes (methods, procedures, etc. used to achieve desired results);
- products (building blocks achieved to achieve desired results);
- outputs (end results delivered outside organisation); and
- outcomes (effects as a result of the process).

Analysing Performance Problems

This model was developed by Mager, in the form of a flow chart that can be used to uncover performance problems and solutions. The five main areas in Mager's model is:

- describe the problem;
- explore fast fixes;
- check consequences;
- enhance competence; and
- develop solutions.

Training Needs Assessment

Rossett's model are applied to purposefully gather information regarding:

- optimal performance;
- actual performance;
- causes of performance problems;
- feelings of relevant parties; and
- solutions to the problems.

The above models all explore diverse aspects of the organisation that needs to be investigated, as well as focusing on diverse information that needs to be gathered in order to effectively conduct a training needs analysis, but all are geared towards uncovering the nature of organisational problems and finding possible solutions.

1.1.2 Relevant aspects of the SANDF as related to this study

"The primary object of the Defence Force is to defend and protect the Republic, its territorial integrity and its people in accordance with the Constitution and the principles of international law regulating the use of force" (RSA, 1996).

According to Odiorne and Rummler (1988, p.iv) the military could be seen as the largest training and development organisation. This stems from the fact that armies, navies and air forces not only have to train their members to fight wars, but to also ensure that their members remain ready to fight. "Well trained and led, quality soldiers have proven capable of adapting to any situation, against any opponent, anywhere in the world…The army has one standard: tough realistic, battle-focused training".

Even though the South African National Defence Force (SANDF) is not in currently in an operational situation, its members still need to be ready to face any potential situations that may arise at any time. It is imperative that "the SANDF has to maintain a core defence capability because of the inherent unpredictability of the future" (RSA, 1996, p.1).

According to Joe Modise, former Minister of Defence (1997), the SANDF faces the following realities:

- a dwindling supply of experienced officers;
- ageing equipment;
- a drastically reduced budget, resulting in reduced maintenance and training; with a myriad of negative effects on morale, equipment and standards; and
- the reality of rationalisation, downsizing and rightsizing.

Despite facing the above realities, the Draft White Paper on National Defence provides that all members of the SANDF shall be properly trained in order to comply with international standards of competency (RSA, 1996). The future battlefield with integrated technology has:

- a larger battlespace at a higher tempo
- increased lethality through precision munitions
- massing of effects versus massing of forces

- increased ability to visualize a battlefield consisting of both friendly and threat forces (Zimmerman, 2000).

Technology has become increasingly important in modern warfare, a fact recognised by the South African government, as reflected in the recent international arms deal. The SANDF considers technology as 'strategically essential', which refers to "technologies which can provide an operational winning edge, or which ensure self-sufficiency in areas for which high-priority operational requirements exist" (RSA, 1999, p. 34). Modern command and control systems are considered as strategically important by the military, since such systems typically receive, classify, and integrate data from many sources to produce coherent graphic and statistical displays of tactical situations as they develop, in real time, enhancing the battle commander's decision-making capabilities and his grasp of threats, risks, and options. "Without these any battle, conflict or operation, (e.g. peacekeeping support or emergency) will be unsuccessful. It is therefore essential to have total control over the technology, supply and operation of the software and equipment, which must also conform to the unique SANDF organisational doctrine and tactical requirements" (RSA, 1999, p.35).

The introduction of new technologies thus shifts the focus to ensure that the users of these new systems are adequately equipped to optimise their use and effectiveness. This, by default, poses new challenges for the training and development of all personnel within the SANDF.

1.1.3 The contextual setting of map use

Modern military divisions internationally make extensive use of Geographical Information Systems (GIS) and the use of digital battlefields to complement traditional paper maps. The digital battlefields integrate the information required to plan, prepare, and execute a full range of operations in a simulated or real environment. Battle commanders thus have access to relevant friendly and enemy intelligence, as well as weather and terrain data. Collectively, relevant information

and intelligence provide the situational awareness and battlefield visualization necessary for twenty-first-century commanders (Zimmerman, 2000). "A commander's abilities to visualize the enemy, the battlefield environment and subsequent activities, make correct and timely decisions, mentally clarify the battlefield's uncertainty and forge a coherent whole out of conflicting parts have been fundamental to tactical combat success" (Reinwald, 1998, p.1).

"The army must train competent, experienced commanders capable of making high-quality decisions in complex, volatile, ill-defined and novel situations" (Reisweber, 1997, p.1). One of the most important aspects of any military position is to be able to read and interpret maps. "The Army operates upon the earth's surface and its ephemeral natural surface covers. To be successful, the modern Army must be mobile and able to operate and perform effectively and efficiently in operational theaters from equatorial to polar latitudes, which may comprise a wide variety of environments, terrain, and weather conditions" (Reisweber, 1997, p.3).

"Army doctrine has long dictated that commanders know their weather and terrain" (Bach & Harmon, 1998, p.1). This stems form the fact that many military operations take place in unknown territory. Hooper, Murphy and Morken (2001, p.4) adds that "military commanders have long realized the interdependence of the earth's land features and success on the battlefield. Those who stand out in history have visualized the terrain and its effects on the battle's outcome. As part of information dominance, the commander's knowledge of the terrain allows him to obtain a superior advantage in shaping the battlespace". It becomes clear that the effective application of doctrine and tactics can only take place where an individual has obtained sufficient knowledge and skills regarding map use.

Not only is basic map reading skills thus necessary, but an analysis and subsequent interpretation of the terrain as well – this enables troops and commanders to form a mental picture of the terrain, as reflected by maps, in order to plan and make decisions. "The broad range of terrestrial features, materials, and environmental conditions found around the world can be either a most formidable barrier or a significant advantage for our forces… commanders at all

levels within the army also must be familiar with the environment at large and understand how environmental factors and conditions will impact their operations and the operations of their adversary, and be able to use this knowledge for military advantage" (Bach & Harmon, 1998, p.2).

This study will focus on the importance of map use skills in a military context, against the background of the importance of map use and the effective visualisation of information provided by maps. The study further attempts to identify the skills needed to practice effective map use as input to training needs analysis into map use in the SA Army.

1.2 PROBLEM FORMULATION AND AIMS OF THE STUDY

- This study broadly attempts to determine training needs in terms of map reading skills in a military context.

- The underlying goals of the study constitute the following:

  - to provide a detailed and comprehensive definition of the concept training needs analysis;

  - to identify a model/process in the literature for conducting a comprehensive training needs analysis;

  - to put into context the importance and relevance of map reading in the military for advanced, higher order command and control functions;

  - to provide a detailed description of the underlying competencies relevant to effective map use; and

- to determine whether a training need in terms of map use exists in the military context in South Africa and if so, in what areas or key functions.

1.3 ORGANISATION OF THESIS

The following outline attempts to explain how the goals outlined above will be achieved:

- Chapter 2 of this thesis presents a review of the relevant literature regarding training needs analysis and attempts to place this study in the context of the theory relating to this field and of research already conducted in this field. Special emphasis is placed on the process that needs to be followed in order to conduct a detailed and comprehensive training needs analysis.

- Chapter 3 attempts to put the importance and relevance of effective map use into context in the military environment, as well as define the what constitutes effective map use.

- Chapter 4 outlines the research methodology followed in executing the study in terms of the research questions addressed, the research hypotheses and the methods used for collecting the relevant data.

- In chapter 5 the analysis and interpretation of the results are presented. This includes the results and interpretation regarding the survey questionnaire.

- Chapter 6 presents the final conclusions that are derived from the findings. The problems and limitations that were experienced are also presented. Finally, recommendations are proposed for future research.

CHAPTER 2

TRAINING NEEDS ANALYSIS

2.1 INTRODUCTION

This study aims to conduct a training needs analysis, based on map use in the South African military context. In order to do so, the training needs analysis needs to be properly defined to serve as basis for the research process.

The aim of this chapter is to provide a detailed overview of the concept "training needs analysis" or TNA as it is commonly referred to. This chapter further aims to describe the different methods used to facilitate the training needs analysis, as well as provide a comprehensive model of training needs analysis, as basis for the study.

2.2 TRAINING NEEDS ANALYSIS AS RELATED TO TRAINING AND DEVELOPMENT

Training can be described as a *systematic* process of acquiring and improving skills, knowledge and attitudes in an attempt to improve individual and organisational performance. Wexley and Latham (1981, p.3) describe it as “a *planned* effort an organisation makes to facilitate the learning of job-related behaviour on the part of its employees”. From the above it thus becomes evident that training is not a haphazard event, but involves planning and must be directed at supporting organisational goals.

Training interventions are typically aimed at one or more of the following:

- improvement of the individual's self-awareness;
- increasing an individual's skills or knowledge; and/or
- increasing an individual's motivation to do his/her job well (Wexley & Latham, 1981, p.4).

In a similar vein, McGehee and Thayer (1961) states that training must have a specific purpose and must aim to develop the behaviour of employees in order to make such individual work performance more effective.

Training interventions, in order to be planned and directed towards achieving organisational goals, must be put in its proper context (McGehee & Thayer, 1961). "The use of training to achieve organisational goals requires careful assessment of the training needs within a company" (McGehee & Thayer, 1961, p.24). It is against this backdrop that the training needs analysis is discussed.

The training process typically starts when a performance need or problem becomes apparent in an organisation. In the literature (Goldstein, 1993; Gordon, 1994; Nadler, 1982; Rossett & Arwady 1987; Sparhawk, 1994), numerous models illustrating the training process, are proposed.

One commonality between these models is the fact that the training needs analysis forms the starting point of this process as illustrated by Sparhawk's model depicted in figure 2.1.

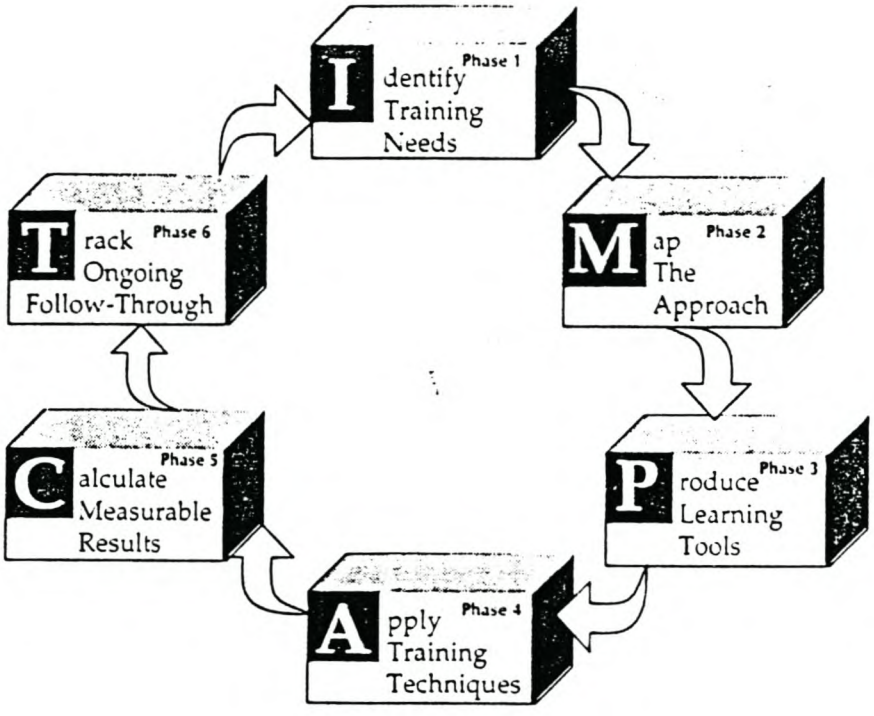

Figure 2.1: The Training Model (Sparhawk, 1994 p. 13)

From this it can be concluded that training needs analysis "provides the basis on which all other training activities can be considered" (Boydell & Leary, 1996, p.1).

2.3 TRAINING NEEDS ANALYSIS DEFINED

The term, "training needs analysis", is used to describe an array of activities such as needs assessment, front end analysis, discrepancy analysis, etc. (Nadler, 1982; Rossett & Arwady 1987; Sparhawk, 1994), which all describe the activity of determining the existing training need in an organisation (Mitchell, 1987). The training needs analysis forms part of the pre-training planning process and serves not to provide solutions for specific problems, but rather to gather data in order to

clarify and define existing performance problems as well as determine the actions needed to rectify it. "Analysing training needs provides a focus and direction for the investment an organisation has to make in its people" (Bartram & Gibson, 1995, p.3).

Dorfling (1989) describes a training need as an existing or expected deficiency in knowledge, skills and attitudes, which can best be addressed through the provision of training. Queeney (1995, p.81) describes a "need" as a "discrepancy between current and desired states". From this, it can be concluded that a training needs analysis is used to identify gaps in knowledge, skills, and attitudes. The aim of conducting a training needs analysis is two-fold (Odiorne & Rummler, 1988; Rossett & Arwady 1987; Rouda & Kusy, 1996; Smith, Delahaye, & Wiley 1983), namely to:

- determine the current level of performance; and
- determine the 'best' or 'ideal' standard of performance.

The information gained above makes it possible to establish the gap between the desired level of performance and the actual performance. This gap will determine the needs, purposes and objectives of the training intervention (Rouda & Kusy, 1996). Heimlich and Norland (1994) further states that the gaps identified from the above information need to be thoroughly assessed and prioritised in terms of importance, size, immediacy and requirements.

2.4. THE TRAINING NEEDS ANALYSIS PROCESS

The training needs analysis enables you to gather information in order to identify performance problems in the organisation. This provides the basis upon which subsequent phases in the training process are based as well as provides a focus and direction for the rest of the training process (Bartram & Gibson, 1995).

According to Gordon (1994) the training needs analysis will generally be initiated by the following circumstances:

- current employees exhibit low performance levels;
- new employees enter the organisation who do not have the requisite skills and knowledge; and/or
- a new job has been created or new technology introduced.

In the literature (Bramley, 1991; Goldstein, 1993; Schuler, 1981; Wexley & Latham, 1981) the following three levels of analysis are identified as integral to conducting a comprehensive training needs analysis:

- organisation analysis;
- task analysis;
- person analysis.

This method is considered as the generic method of analysing training needs (Rothwell & Kazanas, 1994). These levels will subsequently be discussed in more detail.

2.4.1 Organisation Analysis

This type of analysis focuses on the total organisation and thus takes the macro perspective in order to establish where training interventions should and could be applied (Bramley, 1991). An organisational analysis is thus an "examination of the systemwide components of the organisation that may affect the training program (Goldstein, 1993, p.36). This analysis involves the examination of the organisational goals and strategies, the external environment in which the organisation operates, the resources available and the organisational climate (Goldstein, 1993; Wexley & Latham, 1981).

The organisation analysis thus serves as a basis for determining where the emphasis can and should be placed in the organisation (McGehee & Thayer, 1961). In this manner, the training effort can be directed towards meeting overall organisational goals. McGehee and Thayer (1961) provide the following list of sources of organisational data critical to analysis on this level:

- organisational goals and objectives provides targets for the various functions in the organisation;
- the human resources plan will predict gaps caused by retirements, promotions and turnover;
- the skills pool inventory;
- organisational climate indices such as turnover, absenteeism, grievances, strikes and attitude surveys;
- efficiency indices such as cost of labour and materials, waste, equipment utilization and customer complaints;
- requests by superiors for training.

The methods for obtaining the above information is normally by means of interviews, observations and questionnaires (McGehee, 1961; Gordon, 1994).

2.4.2 Task Analysis

The task analysis phase involves collecting data in order to describe and identify a particular job and what tasks it consist of. This involves breaking a job down into its subtasks and evaluating each of those subtasks in detail (Gordon, 1994). The above thus enables the determination of required standards, as well as the knowledge, skills and attitudes required in order to achieve those standards (Bramley, 1991; Wexley & Latham, 1981). Task analysis is, therefore, a method of "determining the knowledge, skills, tools, conditions, and requirements needed to perform a job" (Gupta, 1999, p.90). The purpose of the task analysis is thus to gather information about the scope, responsibilities, and tasks related to a particular job function. The task analysis not only serves to create a clear picture

to employees about what is expected of them, but also serves as a basis for establishing criteria for job performance and performance management (Gupta, 1999).

According to McGehee and Thayer (1961) the task analysis should result in yielding the following key information:

- standards of performance for the task or job;
- the identification of the tasks of whithin the job;
- how each task must be performed if standards of performance are to be met;
- the skills, knowledge and attitudes which are basic to the performance of each task.

2.4.2.1 Methods for conducting a Task Analysis

The most commonly used approaches as outlined by Gordon (1994) to collecting information about jobs, tasks and the associated knowledge, skills and attitudes, are summarised in the paragraphs to follow.

Document and equipment analysis:
This refers to an analysis of relevant documents particularly manuals (operating procedures, job descriptions), or where equipment is used, an evaluation of the equipment itself, in order to form a picture of the job and its subsequent tasks. This type of analysis can provide the analyst with "clues as to what to observe in a job and what questions to ask" (McGehee & Thayer, 1961, p.71). This method will provide a good starting point for the task analysis, but will, however, not yield detailed information about the job and its subtasks.

Structured Interviews:
The analyst will usually conduct multiple interviews asking carefully prepared and structured questions. It is thus very important to establish goals for the type of

information to be elicited and plan the sequence of questions accordingly. This method is relatively simple and familiar but is time-consuming and it is often difficult to integrate differing viewpoints form all the interviewees. In addition, it is very often difficult for the interviewee to abstractly think about and discuss the job.

Group Interviews:

This method involves getting people to talk about their jobs together in groups. This method can result in a greater body of knowledge about the job in question. People tend to remember much more when there are other people present to trigger that information (Gordon, 1994). This method also allows the analyst to resolve inconsistencies, by allowing people to talk and integrate different perceptions on how the job is performed. This type of interview is, however, difficult to conduct as the interviewer needs to constantly control the direction of the discussions.

Questionnaires:

"Questionnaires are hardcopy or computer-based documents containing a limited set of written questions, usually in a fixed format" (Cooper, 1986 in Gordon, 1994, p.77). This medium is used to ask employees to evaluate some aspect of their work (Mitchell, 1987). This method is very cost-effective and simple and can be used to reach a very large number of potential respondents. The data collected is limited to being subjective and reflects opinions rather than facts.

Observation:

This method involves the observation of the behaviour of employees actually performing the job in question. Observation can be done using either the continuous method – observing the job continuously over a given period of time, or the sampling method – where observation is planned and usually of short duration, randomised over several days and over several employees (McGehee, 1961). This method usually most closely captures task performance since it is least disruptive, but it is very time-consuming.

Task simulation with questions

This involves asking an expert to perform the job in a simulated environment, while answering questions during the process. The method proves easier to conduct than observations and yields more information. The incumbent may, moreover, verbalise what he/she is doing and why.

2.4.3 Person Analysis

The person analysis focus on the individual and deals with how well he/she is carrying out the various tasks necessary for successful performance (Bramley, 1991; Wexley & Latham, 1981). This then enables the determination of exactly what knowledge or skills needs to be addressed with training interventions (Goldstein, 1993). The person analysis is thus aimed at determining:

- whether the employee requires training; and
- what training the employee requires
  (McGehee & Thayer, 1961; Wexley & Latham, 1981).

2.4.3.1 Methods for conducting a Person Analysis

The first step in conducting a person analysis is to evaluate whether or not an employee performs the job adequately. The methods for determining this can be categorised as either behavioural measures, economic measures or proficiency tests (Wexley & Latham, 1981).

Behavioural measures involves observations of the employee's on-the-job behaviours. *Economic measures* involves the recording of the amount of units produced during a specific time period, scrappage waste, number of injuries, etc. These can be classified as either those dealing with production and those dealing with personal information (grievances, absenteeism, etc.). *Proficiency tests* can take the form of a written test in order to assess job knowledge, or make take the form of a simulation exercise in order to measure proficiency in a specific job.

2.5 A TRAINING NEEDS ANALYSIS MODEL

The information gained from the above analysis enables the analyst to do the following (Rouda & Kusy, 1996):

- to perform a "gap" analysis between the current and desired situation;
- to identify priorities;
- to identify causes of performance problems; and
- to identify possible solutions.

The integration of the above three levels of analysis is depicted by Bramley (1991) in the following model:

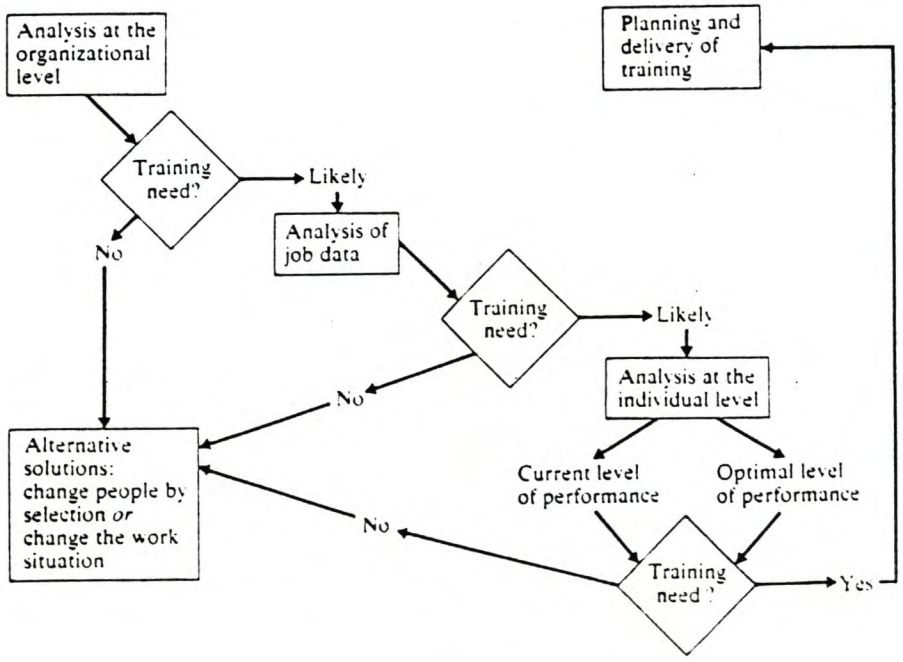

Figure 2.2: The Training Needs Assessment Model (Bramley, 1991, p.16)

This model suggests that the analysis are to be carried out in a sequential manner and the information gathered during one analysis provides the basis for the following level of analysis.

The process outlined above by Bramley (1991) is similar to a strategic needs assessment, as described by Gupta (1999), where:

- performance improvement needs must be linked to the business strategy of the organisation;
- performance improvement opportunities must be identified at the organisational, process and job level.

2.6 THE BENEFITS OF A TRAINING NEEDS ANALYSIS

The most important reason for conducting a thorough training needs analysis is to assure that training interventions, their nature and scope, poses the appropriate solution to solving specific organisational problems or needs. Bartram and Gibson (1995) identifies the following benefits of a well conducted training needs analysis to the organisation:

- priority training needs will become apparent;
- training will be systematic and planned;
- investment in training will have focus and direction;
- appropriate methods for meeting training needs will be identified;
- training's contribution to organisational growth will be recognised.

The needs analysis thus enables you to "develop a solid data base on which to build the justification for your training program" (Mitchell, 1987, p.104). The training needs analysis also serves to justify the costs of training to management, especially where the training needs are not obvious.

2.7 CONCLUSION

This chapter aimed to place into context the role of training needs analysis in the training process, as well as define the training needs analysis process.

Training needs analysis provides the foundation for subsequent training design and implementation, by clarifying the training problem that exists in the organisation. The process for achieving this is a sequential one, comprising three levels, namely: organisational-, task- and person analysis. This process serves to not only identify the gap between current and ideal performance, but also to prioritise training needs, and ensure that training is systematic and contributes to organisational goals.

CHAPTER 3

MAP USE IN A MILITARY CONTEXT

3.1 INTRODUCTION

This chapter presents an overview of the literature regarding map use in order to provide a detailed picture of the aspects regarding map use. An overview of human spatial cognition is provided first to put map use and the cognitive aspects surrounding it in context.

The chapter further aims to place the field of map use in the military context, and provide an understanding of the importance and relevance of map use in the SA Army.

3.2 HUMAN SPATIAL COGNITION

Human spatial cognition is fundamental to human life, since we move around every day, need to be able to navigate and are faced with a diverse range of geographical features every day (Medyckyj-Scott & Hearnshaw, 1993). The study of cognition deals with knowledge, its acquisition, storage and retrieval, manipulation and use. Spatial cognition deals with the cognition of the spatial properties of the world, including location, size, distance, direction, shape, pattern, movement and inter-object relations (Montello, 1997).

Spatial knowledge can be classified into three broad categories (Medyckyj-Scott & Hearnshaw, 1993; Philips, 1997; Postigo & Pozo, 1998; Schrettenbrunner & Westrhenen, 1992):

- declarative knowledge;

- procedural knowledge;
- configurational knowledge.

Declarative knowledge consists of geographical facts and generalisations (Medyckyj-Scott & Hearnshaw, 1993; Schrettenbrunner & Westrhenen, 1992) and thus refers to any knowledge about geographical space. Procedural knowledge refers to the ability to use geographical facts to navigate through geographical space (Medyckyj-Scott & Hearnshaw, 1993). Configurational knowledge refers to the ability of the user to be able to conceptualise the space as a whole (Darken & Silbert, 1996).

Presson and Roepnack (1992 in Bryant, 1993) point out that spatial information can be acquired in two ways:

- primary learning (direct experience with the environment);
- secondary learning (reading a map or picture).

Uttal (2000) proposes that the relationship between maps and spatial cognition is reciprocal in nature. This reciprocal relationship thus implies that the way we acquire, store and use spatial information influence our understanding of maps, and that maps influence how we understand and conceive of spatial information. Maps influence spatial cognition by allowing us to acquire, inspect and think about spatial information without direct experience with the real environment (Uttal, 2000).

According to Dent (1993 in Pickle & Herrman, 1994) successful map reading involves three components: the map itself, the experience and skill of the map reader, and the task to be done using the map. Each of these components affects the nature of the thought processes or cognition that underlie map reading. Pickle and Herrman (1994) concludes that successful map reading requires successful completion of four cognitive stages:

- map orientation (What geographic area does the map represent?);

- legend comprehension (How are the values of the map statistically represented?);
- map/legend integration (Match the legend scale with the map itself); and
- extracting information from the map.

Each of these cognitive stages depends on a series of processes, including perception, comprehension, encoding of information into memory, memory retrieval, and reasoning (Pickle & Herrman, 1994). The particular processes involved differ from stage to stage. This process is illustrated by Medyckyj-Scott and Hearnshaw (1993) in figure 3.1 below.

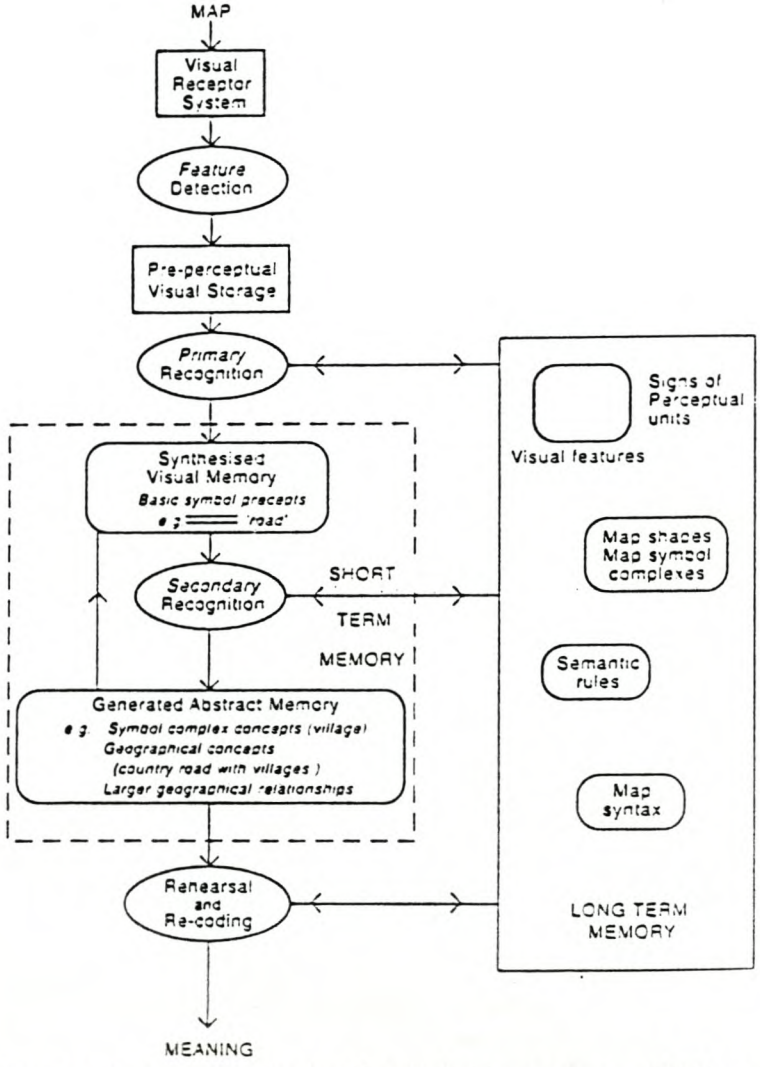

Figure 3.1: Map Processing (Medyckyj-Scott & Hearnshaw,1993, p.116)

3.3 CARTOGRAPHIC COMMUNICATION

Maps both record what is known and remembered about an environment and act as wayfinding aids (Golledge, 1999). Maps are thus graphic representations of the real world or portions thereof on a plane surface by means of signs and symbols. According to Foote and Crum (1995), maps gain their value by:

- acting as a way of recording and storing information;
- acting as a means of analysing locational distributions and spatial patterns;
- acting as a method of presenting information and communicating findings.

The information represented on a map is a conversion of three-dimensional information into two-dimensional form. Maps are thus prone to distortion, because it is impossible to capture all aspects of a three-dimensional world on a two-dimensional surface (Uttal, 2000). Maps, according to Klinkenberg (1997):

- are limited to two-dimensions;
- must show 3-D data projected onto a flat surface;
- give a distorted impression of spatial distributions on the globe;
- are static, and cannot show change through time.

Since maps, by their nature, distort spatial information, the map thus represents a cartographer's vision of a part of the earth's surface. "Maps are the result of the cartographic visualisation process" (Kraak, 1998, p.1).

Cartography does not merely concern itself with the making of maps, but with the study of maps in all its aspects (Foote & Crum, 1995). Cartography, very basically, is concerned with communicating environmental/geographical information effectively (Robinson, Morrison, Muehrcke, Kimerling, & Guptill , 1995).

Reading and interpreting information represented on a map is thus a process of interaction between the reader's mind and a cartographer's representation of such

spatial information (Lloyd, 1997). This process is referred to by Dudycha (2000) as the cartographic communication process, as illustrated below.

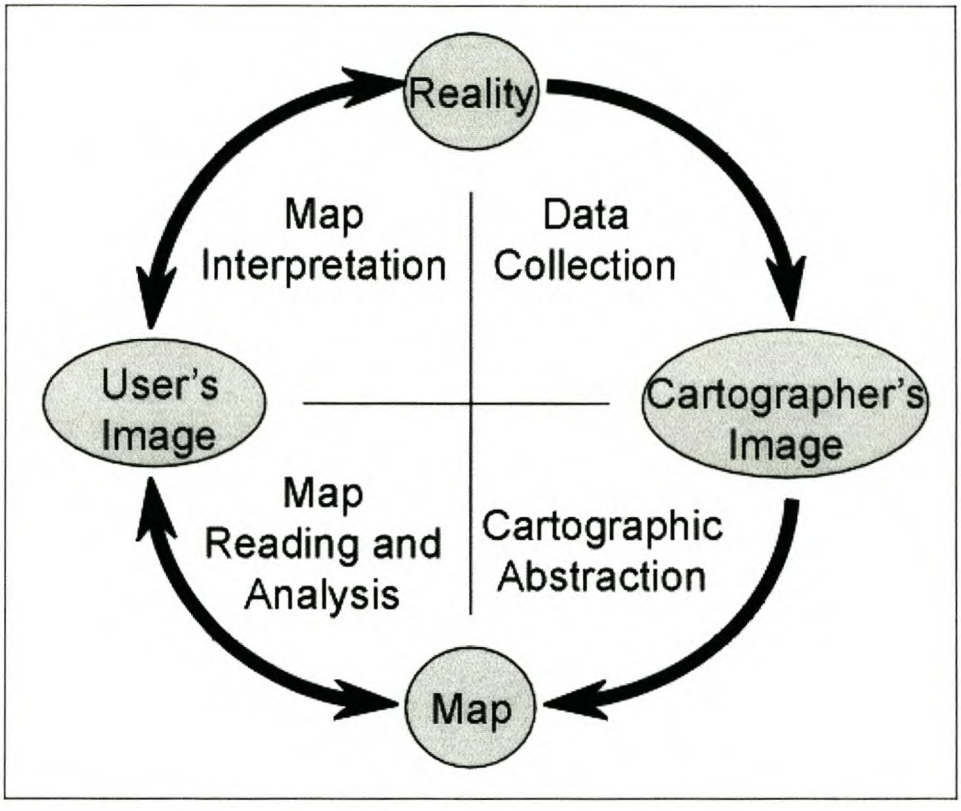

Figure 3.2: The Cartographic Communication process (Dudycha, 2000, p.1)

"Cartographic communication is a special form of graphic communication which differs from verbal communication" (Dudycha, 2000, p.1). Foote and Crum (1995) go further to describe cartography as a form of visual communication for describing spatial relationships. Cartographic communication is a one-way process in which the map reader interprets the symbols on the map to form a picture of the terrain.

Map use is described by Medyckyj-Scott and Hearnshaw (1993, p.112) as a user "interacting visually and mentally, in silent dialogue" with the map and the information contained therein.

The cartographer is responsible for collecting and selecting information and representing it on a map, while the map reader searches for information on the map and determine its meaning and significance (Lloyd, 1997).

3.3.1 Map Use

The use of maps is thus a process in which information is conveyed from the map maker to the map user. According to Liebenberg (1998) map use comprises the second transformation process in the cartographic communication process, the first one being map making. "Map use involves the reader's recognition of the marks and symbols on the map and the deduction of the spatial information message from them" (Liebenberg, 1998, p.111).

Map use comprises three distinct skills, also referred to as levels (Dudycha, 2000; Medyckyj-Scott & Hearnshaw, 1993; Muehrcke, 1978 in Liebenberg, 1998; Schrettenbrunner & Westrhenen, 1992). These levels/skills are referred to as map reading, map analysis and map interpretation.

3.3.1.1 Map Reading

Map reading comprises the first level of map use skills and involves "determining what map makers have depicted and how they have gone about it" (Dudycha, 2000, p3). Map reading refers to the identification and differentiation of phenomena represented on a map (Schrettenbrunner & Westrhenen, 1992; Liebenberg, 1998). This first level thus only requires the reader to be able to recognise the features represented on a map by discriminating between the different symbols used on the map.

3.3.1.2 Map Analysis

The second level of map use is map analysis and this level incorporates the first level tasks as well as higher-order tasks. Map analysis involves the pattern

recognition (Liebenberg, 1998), in which the map reader recognises symbol groups displayed on the map as a whole (Dudycha, 2000). This level thus requires the integration of separately presented information and leads to " the visualisation of spatial patterns" (Liebenberg, 1998, p.112) as displayed on the map. This recognition of spatial patterns is integral to the last level of tasks in map use, namely map interpretation.

3.3.1.3 Map Interpretation

The third level of map use integrates both the above levels and use the information gained through map reading and map analysis to identify causal relationships that are often not explicitly displayed on the map (Liebenberg, 1998). This process involves integrating map symbols with other information – symbols are identified as representing actual phenomena in a real landscape (Liebenberg, 1998). Map interpretation "requires relating new information contained in the map to the user's image of the environment" (Dudycha, 2000, p.4).

The levels of map use is also illustrated by the above model of the cartographic communication process (figure 3.2). Map reading and analysis from the information supplied by the map leads to a "cognitive" image formed by the user of the environment. Through map interpretation, this "cognitive" image is thus related back to the real world environment.

Map reading is a skill that requires particular high proficiency in a military context, due to the nature of military tasks, where military personnel are often called upon to navigate through certain locations, often unfamiliar.. "It is crucial that military personnel in the field be able to identify locations efficiently on a topographical map at any time" (Moore & Schofield, 1994).

The above discussion on map reading is thus placed in context in the military environment, in order to highlight its contribution and importance to effective military operations. This also serves to provide an organisational analysis as part of the training needs analysis process discussed in chapter 2.

3.4 DIGITISED BATTLEFIELDS

Geographical information systems (GIS) refers to "tools that capture, store, manage, manipulate, analyse, model and display information with respect to geographic space" (Medyckyj-Scott & Hearnshaw, 1993, p.1). The use of GIS has increased rapidly over the last years in all fields where the handling and analysis of spatial data forms part of the decision-making process, since the use of GIS serves to make faster and more accurate decisions. This form of technology are increasing being used in the military context, as a means of analysing and integrating spatial data.

GIS are used in situations where information regarding geographical features must be used to make decisions, in particular where the outcomes of these decisions have a spatial impact. The integration of GIS systems in the military context has become common practice, where the need to understand terrain has always been an essential skill for the military commander. The military has traditionally relied on the use of paper maps for this purpose, but increasingly, Geographic Information Systems, with the associated benefits of digitisation, has been introduced to enhance the representation of spatial information.

Advancements in technology will have and already has had profound effects on the manner of warfare in the 21st century. One of these is the introduction of the digitised battlefield. "Digitisation is the application of information technologies to acquire, exchange and employ timely battlefield information throughout the entire battlespace" (West & Reimer, 1997, p.1). GIS has an important role to play in displaying a digital representation of the battlefield (ESRI, 1998). "Technology has made warfare much more certain and precise than was ever thought possible...for all intents and purposes, commanders can get a technological God's eye view of the entire battlefield" (Dunn in Schmitt, 1997, p.3).

The digitised battlefield integrates information from the real battlefield to present a complete picture to the commander of what is happening on the battlefield on the ground, sea and air. "It enables friendly forces to share a relevant, common

picture of the battlefield…and decrease decision-making time by optimising the flow of command and control information" (West & Reimer, 1997, p.2). The digital battlefield allows infantry, combat vehicles, artillery, helicopters and aircraft to share the same near-real-time picture of the battlefield (Bourn, 1998).

Corona (1997) identifies the following characteristics and requirements of the battlefield:

- **Uncertainty**
  Traditionally, uncertainty was caused by a lack of information. With the advent of the digital battlefield, there will be no shortage of data, but it still needs to be filtered and converted in a form that is useful, since a new danger is now information-overload.

- **Information overload**
  Advances in communication systems, have dramatically increased the data available to commanders. Presently, technological systems are not capable of sorting or filtering the data in a manner consistent with the information requirements of the commander. The burden of integrating the information from different sources falls to the commander and staff.

- **Situational Awareness**
  Situational awareness in the context of military operations refers to being able to read the situation on the battlefield correctly. Achieving situational awareness is crucial for commanders, their staff, as well as the forces being commanded. This can only be achieved by ensuring that the relevant forces receive the information they need, when they need it.

- **Visualisation**
  In addition to maintaining situational awareness, commanders and their staffs must also be able to visualise the battlefield. They must understand factors such as terrain, unit and weapon system capabilities, time, distance factors, and the impact of the environment.

According to Krüger (1998) the volume of data generated in modern warfare is too great to assimilate without the help of sophisticated machines. Today's warfighters are thus increasingly required to perform their jobs – or portions thereof – with the aid of complex, specialised command and control systems (Cheikes, 2000).

3.4.1 Command and Control

Command and control is the exercise of authority and direction over combined forces in the battlefield – directed towards accomplishment of the assigned mission. "Command and control includes planning, directing, coordinating and controlling forces and operations, and is focused on the effective execution of the operational plan; but the central function is decision making". According to Reisweber (1997, p.4) the battle command follows this process:

- understanding the current state of the battlefield;
- visualising a desired future end state;
- communicating intent;
- making the desired end state a reality.

When military forces are deployed to locations to address various conflicts, they need up-to-the-minute information on battlefield conditions including maps of the terrain, locations of hostile, neutral and friendly forces, supply line and other logistical information if they are to safely accomplish their missions. According the Reisweber (1997) the battle commander needs to display the following to be effective:

- **Cognitive complexity**
  As mentioned above, battle commanders needs to be able to understand the present state and visualise a successful future end state. This demands high levels of cognitive complexity in order to understand conceptually complex, and volatile environments. Cognitive complexity involves

integration of information, abstraction, independent thought and the use of broad and complex frames of reference.

- **Practical thinking**
  Practical thinking' s goal is to use what is already known to reason about the problem at hand. The practical thinking approach emphasises skill in adapting to changing situations, openness to other positions and flexibility in approaching problems.

- **Situation assessment**
  This skills involves the ability to find the essence of a situation. The outcome of situation assessment is situational awareness, discussed in detail later in this chapter.

To be an effective commander of soldiers and units, the commander needs to exercise effective command and control of such units and supply them continuously with up-to-date information and instructions. Command and control functions thus rely on linking knowledge of 'what' to 'where' and 'when' through the use of maps or charts (Whittington, 1997), and as mentioned earlier, more commonly through the use of modern GIS.

Effective command and control, therefore, depends on the gathering and timely dissemination of battlefield information (Krüger, 1998) as well as linking military information with geospatial positions (Whittington, 1997).

Schmitt (1997) presents the following model of the command and control function.

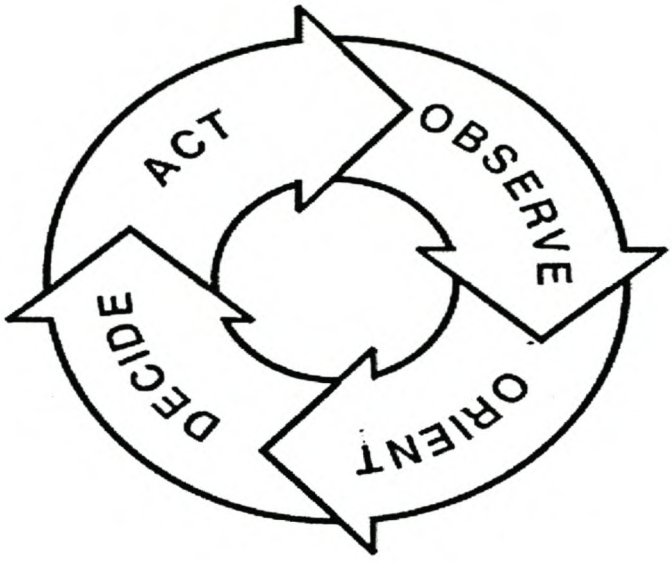

Figure 3.3: The Command & Control Process (Schmitt, 1997, p.7)

The model depicts the command and control process as one involving continuous observation of the situation, orienting the data in terms of previous experience, applying the knowledge gained to make a decision, and transforming the decision into action.

The process is also a circular one, where decision are made based on observations and implemented. The consequences of such decisions are then used as inputs for the next cycle – consequences of previous decisions are thus used as the basis for subsequent decision-making.

Medyckyj-Scott and Hearnshaw (1993, p.22) presents the following model of interactive GIS-based decision-making. This model presents the decision-making process using GIS as a complex one, comprising diverse facets.

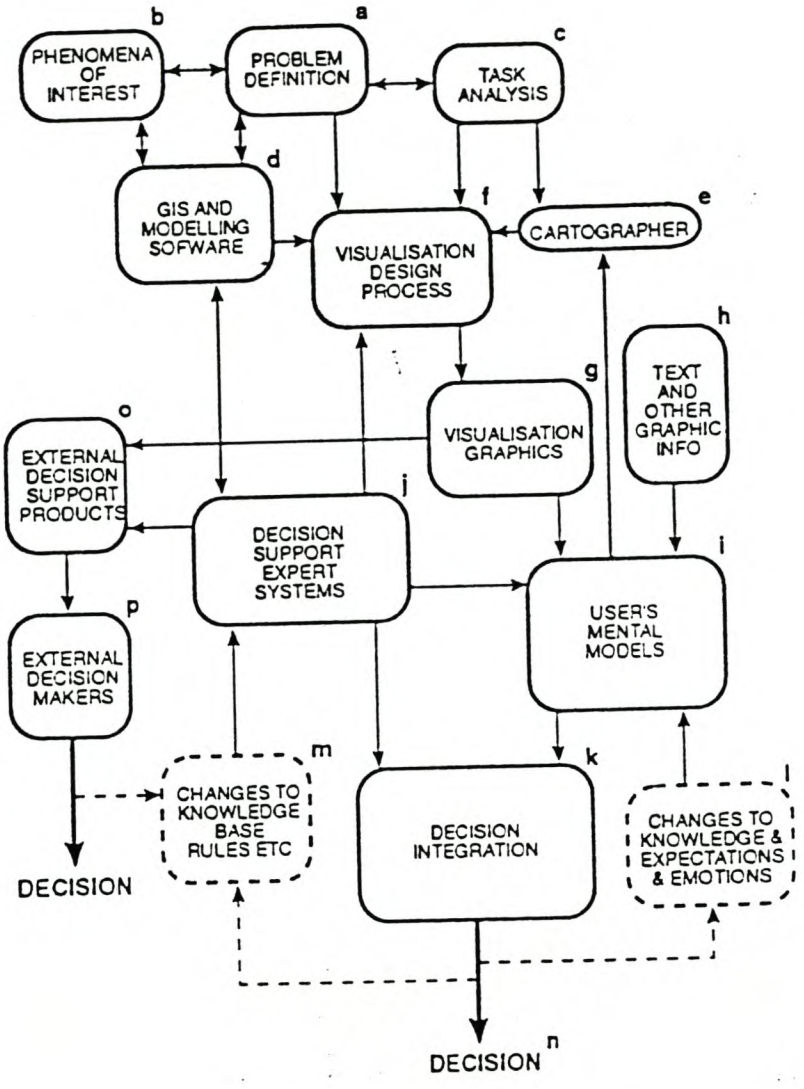

Figure 3.4: Aspects of decision-making using GIS (Medyckyj-Scott & Hearnshaw, 1993, p.22)

In order to observe, analyse and interpret the situation accurately, the battle commander thus needs to interpret the situation on the battlefield – this is referred to as situational awareness. The map serves to support situational awareness since the "map acts as the spatial framework upon which the situational display is

built (ESRI, 1998, p.7). According to Newell (1996) the digital battlefield will greatly enhance situational awareness, which forms an integral part of battle command, since all "commanders and their staff need to understand the battle situation" (ESRI, 1998, p.7).

3.5 SITUATIONAL AWARENESS

Situational awareness refers to the degree of accuracy by which one's perception of his current environment mirrors reality (Prendergast, 2001). More comprehensively, situational awareness can be described as a person's state of knowledge or mental model of the surrounding situation or environment (Blackwood, Anderson, Bennett, Corson, Endsley, Hancock, Hochberg, Hoffman, & Kruk, 1997). The concept of situational awareness includes not just spatial orientation but "includes and understanding of the dynamics of the situation and the actions that are expected to take place in the future" (Blackwood, et al., 1997, p.44). Situational awareness incorporates the commander's understanding of the situation he/she is faced with as a whole, thus forming the basis for decision-making (Endsley, 1995). Endsley (1995) provides the following model of situational awareness:

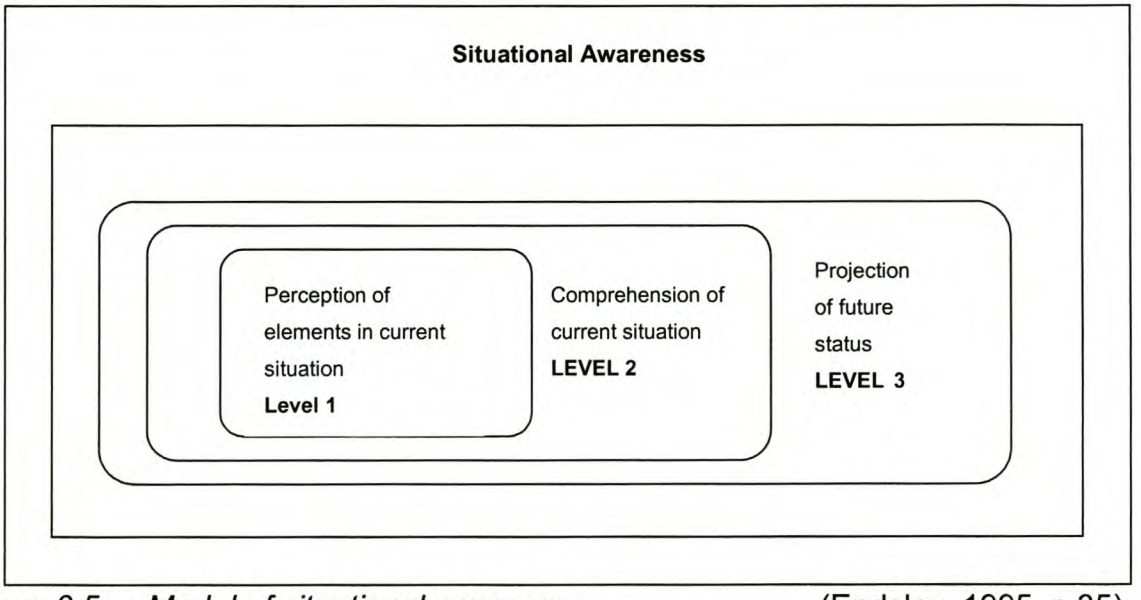

Figure 3.5: Model of situational awareness (Endsley, 1995, p.35)

- **Level 1:** The first step involves the perception of the status, attributes and dynamics of all the relevant elements in the environment.

- **Level 2:** Comprehension of the current situations involves an integration of the elements perceived in level 1.

- **Level 3:** The ability to project the future status of elements in the environment is the last level and is achieved through a synthesis of the information gathered during the previous two levels.

To achieve effective situational awareness, it is necessary to provide a commander with the information required, at the time it is needed and in a form that is useful. "It is necessary for a commander to have a superior understanding of all relevant elements of the battlespace relative to any potential adversary" (Unewisse, Gaertner, Grisogono, & Seymour, 1999).

According to Ntuen (1997) situational awareness involves three levels of the environment:

- The *physical environment,* which is the source of information such as the battlefield terrain.
- A *perceptual environment,* which refers to the result of the integration of information from human and artificial sensors.
- A *cognitive environment,* which involves information recall, situation analysis and eventual decision-making.

Blackwood et al. (1997) makes the distinction between global- and local situational awareness. Global situational awareness is constructed to include one's situation within a broad geographical area, while local situational awareness is only focused on the immediate environment.

Table 3.1: Global and Local situational awareness

Global situational awareness	Local situational awareness
location of self	target identification
location/movement of other units	target location
command/directions from headquarters	terrain/object distance
navigation information	cuing of hostile presence

(Blackwood, et al., 1997, p.45)

The local information is thus needed to effectively act to meet immediate needs, while global information is needed to employ oneself effectively in conjunction with other units to meet strategic goals.

An accurate and timely assessment of a situation would thus not only lead to more efficient problem solving but also provide battle commanders with "more flexibility and greater adaptability to changing situations and novel problems" (Reisweber, 1997, p.3).

In order to achieve accurate situational awareness – thus creating an accurate "picture" in the mind of the real battlefield from information provided on a digitised battlefield – requires the commander to be able to visualise the terrain (thus form a mental picture of what is happening on the ground).

3.6 TERRAIN VISUALISATION

According to Bushover (1997, p.1) "terrain visualization is a basic and fundamental leadership skill. A battle commander must understand how terrain influences every aspect of military operations". The function of maps has always been the transfer of spatial data not just a communication tool but also a tool to aid the user's (visual) thinking process (Kraak, 1998).

"At one level, all mapping can be considered a kind of visualisation – in the sense of 'making visible'" (Maceachren & Kraak, 1997, p.335). All map use thus involves both communication and visualisation (Maceachren & Kraak, 1997) but differs according to the importance attached to each of these activities.

Visualisation is described as a process for putting complex images into the minds of the users (Klinkenberg, 1997), using maps as the tool for visualising geography.

In order to form an accurate picture of any given situation, you need to effectively visualise it from the information provided. Terrain visualisation in the military context is the process "through which a commander sees how terrain influences battlespace in both his and the enemy's operations" (LaPorte & Melcher, 1997, p.1). According to Stevens (1997) terrain visualisation refers to the ability to see the terrain and its impact on military operations, whether viewed in person or as portrayed graphically, digitally, and/or as a physical model.

Terrain visualisation also provides the basis for total battlefield visualisation. "Commanders have always required a detailed awareness of the entire situation, to include the environment, the enemy, and the friendly situation. This total situational awareness is called battlefield visualization" (Bushover, 1997). Terrain visualization thus supports military situational awareness, command and control, and mission planning and rehearsal.

Terrain visualisation includes both natural and man-made features, manoeuvrability over terrain, vegetation, etc. It is thus the "subjective evaluation of the terrain's physical attributes as well as the physical capabilities of vehicles, equipment, and personnel that must cross over and occupy the terrain" (Shinseki, 2000, p.1).

According to LaPorte and Melcher (1997) effective terrain visualisation aids commanders in understanding the battlespace and using the terrain as a weapon through the effective analysis and subsequent understanding of the terrain.

"Terrain visualisation bring the battlefield to alive for the maneuver commander. It enables the commander to see how he and the enemy will fight, allowing him the opportunity to use terrain as a weapon" (LaPorte & Melcher, 1997, p.1). "The digital battlefield requires detailed and sophisticated information concerning distributed terrain features and conditions" (Bach & Harmon, 1998, p.4).

Shinseki (2000, p.1) sees terrain visualisation as providing a "detailed understanding of the background upon which enemy and friendly forces and actions are displayed. Topography provides the picture whereby the user can visualize the terrain". The information conveyed by maps thus forms an integral part to effective terrain- and subsequent battlefield visualisation. This aids the commander in the decision and strategising processes as he requires topographic analysis to gain a greater understanding of the entire battlefield, referred to as battlefield visualisation. This is used during terrain appreciation, where the commander takes into account his unit's mission (task and purpose), task organization, equipment, and the enemy. The result of the terrain appreciation is that the commander knows how he can best use the terrain to support his scheme of manoeuvre.

"Terrain visualization supports current and future national requirements for military forces. Upon notification of a possible operation, the commander needs immediate knowledge of the projected area of operations and of the area of interest" (Bushover, 1997, p.1).

3.7 CONCLUSION

Map use is one aspect which forms the basis for a battle commander to exercise effective leadership and direction towards successful completion of missions, by enhancing both visualisation of the battle terrain and subsequent accurate situational awareness.

The following model illustrates a summary of the above and illustrates how map use serves as the basis for eventual effective command and control.

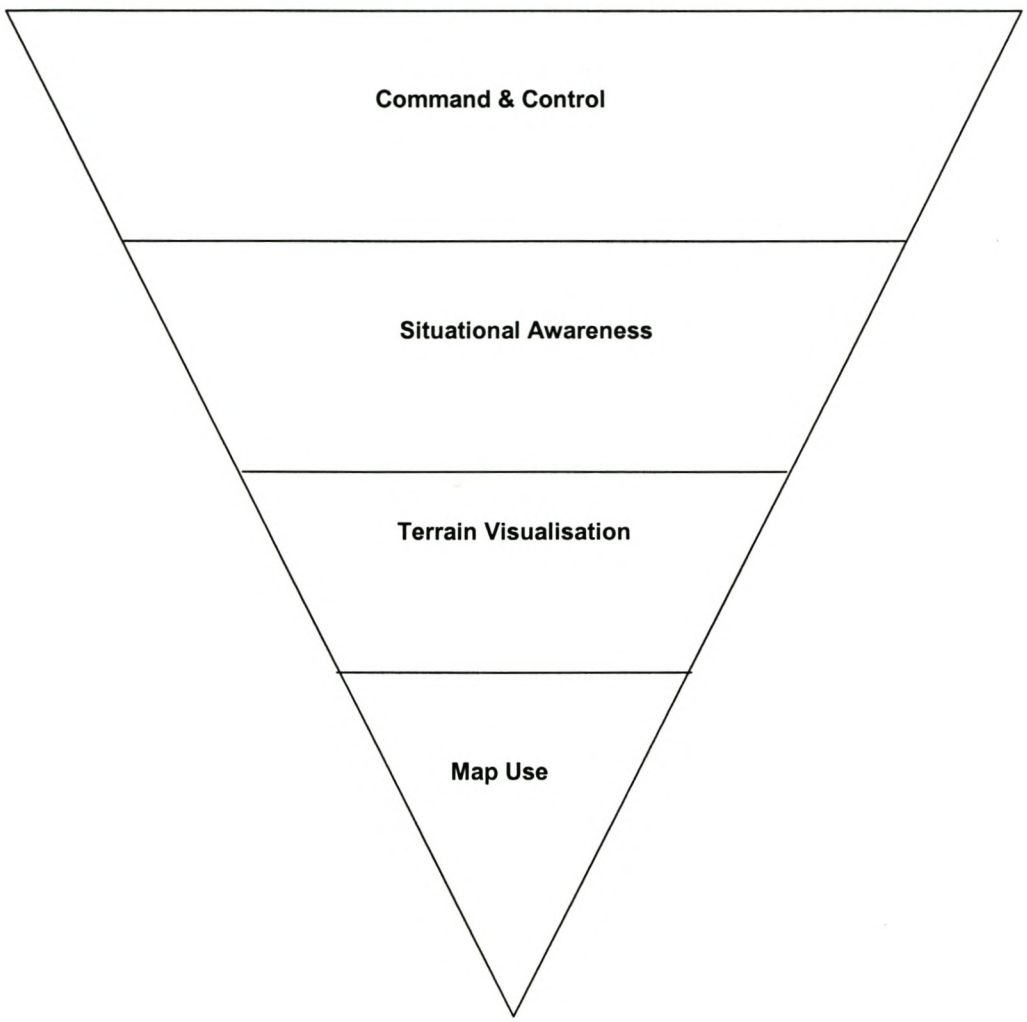

Figure 3.6: Map use as basis for Command & Control

Map use and the information derived from it, provides and integral input into the basis for effective command and control, by making possible the visualisation of the terrain in question, thus leading to situational awareness, to thus support command and contol.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

The aim of research, if correctly designed and undertaken, is to attempt to build knowledge because it represents an objective investigation of facts about a certain subject. Scientific research can therefore be defined as "a systematic investigation of a question, a phenomenon, or a problem using certain principles" (Bless & Higson-Smith, 1995, p.3). Social research has traditionally been concerned with "gathering data that can help us answer questions about various aspects of society and thus can enable us to understand society" (Bailey, 1982, p.3). To this end, the research process is thus used as a means to an end – to provide answers to questions of theoretical interest. Reaves (1992) outlines the goals of research and science as

- description (what happened?);
- prediction (what will happen next?);
- explanation (why did it happen that way?);
- control (how can I make something happen?).

Research is distinguished from other methods of achieving these goals by being systematic, empirical and logical (Bless & Higson-Smith, 1995).

Bailey (1982) outlines the stages of the research process as:

- choosing the research problem;
- stating the hypotheses;

- formulating the research design;
- gathering the data;
- coding and analysing the data; and
- interpreting the results so as to test the hypotheses.

The purpose of this chapter is to describe the methodology followed during this study in order to attain the goals of this study.

4.2 RESEARCH QUESTION

The research question which forms the focus of this study is stated as follows:

- Given the argument that map use forms a basis for effective command and control, does there exist a need for more effective map use training in the SA Army?

This implies the following the question:

- Is there a gap between optimal performance in map use in the SA Army and actual performance?

4.3 RESEARCH HYPOTHESIS

Optimal performance in the above study can, however, not be quantified in simple terms at present. The research hypothesis can thus not be stated in the conventional form, but rather exist as the expected results of the researcher.

It is expected that the following skills, based the task analysis:

- distinguishing between different types of maps and their application;
- interpretation of symbols and coding used on maps;
- terrain interpretation and analysis;
- the use of navigational aids; and
- navigational planning

will not be optimal, and thus a performance gap will exist. This performance gap would thus suggest that, training needs exist, in terms of map use in the SA Army.

4.4 RESEARCH DESIGN

The research design presents the 'plan' or structure of the research and serves to obtain empirical evidence that either confirms or disputes the hypotheses stated. The research design is "the plan and structure of investigation so conceived as to obtain answers to research questions" (Kerlinger, 1986, p.279). Bless & Higson-Smith (1995) thus accurately describes this process as 'research management'. This study makes use of a sample survey type research design.

.Surveys are non-experimental research designs and are classified as descriptive or exploratory, since the purpose of surveys are to obtain information of existing variables. For this study the survey thus serves to obtain information regarding the status quo of map use proficiency in the military context. Surveys are "a set of standard questions asked of a sample of people, whose answers are collected and combined to represent the answers of an entire population" (Reaves, 1992, p.105). The survey is usually concerned with large or widely dispersed groups of people and including the total population is thus impractical (Newcomb, 1953). For this reason, only a fraction of the entire population under study is thus included in the study. The sample is defined as " a subset or portion of the total population" (Bailey, 1982, p.85).

According to Bailey (1982) surveys are distinguished from methods such as document analysis and observation by the following:

- there is a fixed set of questions; and
- responses are systematically classified.

4.4.1 Advantages and Disadvantages of the Survey Method

In the literature (Babbie, 1979; Bailey, 1982; Dooley, 1995; Joppe, 1999) numerous advantages and disadvantages of using the survey method are cited:

Strengths:

- surveys are relatively inexpensive;
- they are useful in describing the characteristics of a large population;
- they can be administered from remote locations using mail, email or telephone;
- many questions can be asked about a given topic giving considerable flexibility to the analysis;
- standardized questions make measurement more precise by enforcing uniform definitions upon the participants;
- standardization ensures that similar data can be collected from groups then interpreted comparatively (between-group study);
- usually, high reliability is easy to obtain by presenting all subjects with a standardized stimulus, observer subjectivity is greatly eliminated.

Weaknesses:

- it forces the researcher to develop questions general enough to be minimally appropriate for all respondents, possibly missing what is most appropriate to many respondents;
- the researcher must ensure that a large number of the selected sample will reply;

- it may be hard for participants to recall information or to tell the truth about a controversial question;
- researchers often encounter difficulties in receiving the data back from respondents.

4.5 SAMPLING PROCEDURE

A sample, as defined above, is used to describe the representative fraction of the total population included in research. Researchers often use sample survey methodology to obtain information about a large aggregate or population by selecting and measuring a sample from the population. Due to the variability of characteristics among items in the population, researchers apply scientific sample designs in the sample selection process to reduce the risk of a distorted view of the population, and they make inferences about the population based on the information from the sample survey data.

The procedure by which a few subjects are chosen from the universe to be studied in such as way that the sample can be used to estimate the same characteristics in the total is referred to as sampling (Joppe, 1999). Sampling can thus be defined as the process of selecting units from a population of interest so that by studying the sample we may fairly generalize our results back to the population from which they were chosen (Trochim, 2001). According to Bless & Higson-Smith (1995) good sampling implies:

- a well defined population;
- an adequately chosen sample;
- an estimate of how representative the sample is.

Since this study focus on map reading in a South African military context, the total population or universe on which the study focuses is all military personnel who

currently or in future will need any form of map use knowledge or skill for application in any task in a military or non-military application environment.

4.5.1 Sampling Methods

Sampling methods can be classified as yielding either probability samples or non-probability samples (Bailey, 1982, Trochim, 2001). In probability sampling, the sample is selected in such a way that each unit within the population or universe has a known chance of being selected, while in non-probability sampling the sample is selected in such a way that the chance of being selected of each unit within the population or universe is unknown (Bailey, 1982; Joppe, 1999; Trochim, 2001). Since the sampling method employed to obtain the sample in this study yielded a non-probability sample, this sampling method will be discussed in more detail.

4.5.1.1 Non-probability Sampling

In this method the selection of the subjects is arbitrary or subjective, since the researcher relies on his/her experience and judgement. The disadvantage of this method of sampling is that since the probability of any person in the universe being selected is unknown, the researcher's ability to generalise findings to the universe is very limited (Bailey, 1982). The advantage of this method is that it is not very complicated and is generally inexpensive.

According to Trochim (2001) non-probability sampling can generally be divided into two broad types: opportunity or purposive. Since the opportunity sampling method was employed in this study, this method will be discussed in detail.

Opportunity sampling

Opportunity sampling (also referred to as haphazard or convenience sampling) presents the simplest form of non-probability sampling, which consists of simply choosing the members of the target population that happen to be handy (Bailey,

1982; Reaves, 1992; Trochim, 2001). The selection of units from the population is thus based on easy availability and/or accessibility (Joppe, 1999). The trade-off made for ease of sample obtention is the representativeness of the sample.

In this study, participants where chosen by their superiors for participation in the study, based on their availability for the survey. The sample for conducting the task analysis consisted of 10 participants at the School of Armour, Tempe Military Base, in Bloemfontein. The sample for the completion of the questionnaire consisted of 1112 participants from a sample of military bases across South Africa.

4.6 DATA COLLECTION INSTRUMENTS

As already discussed before, the survey is a research method where a large quantity of information is collected, in order to estimate certain population characteristics and/or relationships between variables. The survey lends itself to a variety of methods for the gathering of data. In this study, the interview method and questionnaire was primarily employed and will thus be discussed in detail.

4.6.1 The interview

The interview consists of "one person asking another person questions and recording the respondents answers" (Reaves, 1992, p.109). The interview may be either structured or unstructured (Bailey, 1982). Structured interviews involves a specific set of questions asked in a specific order, while unstructured interviews will only specify an area of interest and thus allows the interviewer to let the interview take its own course in exploring the specified area of interest (Reaves, 1992).

The interview method was used during the task analysis, and chosen for the following reasons (Anasuri, 2001; Bailey, 1982):

- **Flexibility**
  The interviewer can probe for more specific answers and can repeat questions when the response indicates that the question was misunderstood.

- **Response rate**
  The interview yields high response rates. People who cannot read or write can still be included in the survey while many people simply feel more comfortable talking than writing.

- **Nonverbal behaviour**
  The interviewer has the opportunity to observe nonverbal cues and thus assess the validity of the respondent's answers.

- **Control over environment**
  The interviewer can standardise the interview environment.

- **Question order**
  The interviewer can control over the structure and thus the order in which questions are answered.

- **Spontaneity**
  The interviewer can record spontaneous answers, which may be more informative than well-thought out answers

- **Respondent alone can answer**
  The respondent is unable to receive prompting or answers from others.

- **Completeness**
  The interviewer can ensure that all of the questions are answered.

- **Time of interview**
  The interviewer knows the exact time and date when the questions were answered and may thus be aware of any occurrence or events that may have influenced answers.

- **Greater complexity**
  Very complex questions can be used in an interview, since the interviewer is present to provide clarification and quide respondents to the appropriate/relevant information.

Sample

The task analysis, (see Appendix A) which forms an integral part of the training needs analysis (as previously discussed in chapter 2) was conducted at the School of Armour at the Tempe Military Base in Bloemfontein. The group consisted of 10 members of the military personnel and consisted of people from differing ranks in the military hierarchy.

Process

The group interview method was employed. The interviewing process was conducted over the period of a working day. The group interview was conducted according to a structured set of questions concerning the nature of the functional elements within the respondents' job, with particular emphasis on the map use component thereof.

Results

The group interview culminated in a detailed description of the map reading tasks in a military context as well as a flow diagram of the task structure.

4.6.2 The Questionnaire

The questionnaire is a formal approach to measuring certain characteristics, attitudes, motivations, opinions as well as past, current and possible future behaviours using a written set of structured questions (Joppe, 1999). Questionnaires may be used to gather demographic information, measures of the social environment, or may take the form of aptitude or achievement tests (Dooley, 1995).

Questionnaires are also categorised according to the medium used (Dooley, 1995). Questionnaires may thus be classified as either postal-, telephone-, e-mail- or internet surveys (Trochim, 2001).

The questionnaire designed for the purposes of this study (see Appendix B) took the form of a proficiency test. It was constructed using the inputs from both military and map reading subject-matter experts to make sure that the content was:

- related to functions which were identified during the task analysis;
- portrayed a high level of accuracy; and
- was relevant and representative of task definitions in the military context.

The first section of the questionnaire served to obtain biographical information, and included questions related to rank, gender, age, and length of employment. Questions also pertained to information regarding both map use experience and frequency of use. Opinions on the need for additional map use training were included. Questions related to computer experience, frequency of use of computer systems, and possible needs for formal computer training were also included.

The questionnaire was constructed using a combination of both open-ended and fixed-response questions. The sections serving to obtain biographical information, included both factual and subjective questions.

The questionnaire was constructed to measure the level of proficiency regarding tasks identified in the task analysis with the levels of map use, identified in the literature review as basis. The differing questions used in the test, thus each

pertain to one or more specific map reading tasks/map use levels. The proficiency test included both fixed-response (question 1 – 4) and open-ended (question 5 – 14) questions.

The questionnaire was mailed to respondents because of the following advantages of using this method (Bless and Higson-Smith, 1995; Frankfort-Nachimas & Nachimas, 1996):

Advantages:

- **Low cost**
  This method does not require a trained staff of interviewers, the low cost is also particularly evident when the population is spread over a large geographically spread area.

- **Reduction in biasing error**
  Biasing error that might be caused by interviewers is reduced. Personal interviews lends itself to bias based on the interaction between the interviewer and respondents.

- **Greater anonymity**
  The anonymity that questionnaires offers eliminates the possibility of respondents answers according to social desirability, and may thus answer more truthfully.

- **Considered answers and consultations**
  Respondents are offered the opportunity to consult and consider their responses before answering.

- **Accessibility**
  The questionnaire permits wide geographical contact at minimal cost.

4.7 CONCLUSION

This study thus takes the form of descriptive research, used to describe the status quo regarding map use in the military context. This is then compared with the task analysis, to determine if a training need exist in the military context in terms of map use.

The survey method is employed because this method lends itself to describing the characteristics of very large populations, it is relatively expensive, and can be administered to geographically spread locations. This was especially important since the military based which formed part of the sample was geographically diverse.

CHAPTER 5

DATA ANALYSIS AND INTERPRETATION OF RESULTS

5.1 INTRODUCTION

The purpose of this chapter is to provide a detailed explanation of the data obtained form the questionnaire. The data analysis and interpretation are reported in terms of:

- biographical information;
- map use experience;
- computer experience; and
- map use proficiency measurement.

5.1.1 Sample description

The sampling method used was opportunity sampling, where participants were selected based on their availability, and is a non-probability sample. This method was used due to time and logistical constraints.

The sample used in the study consisted of 1112 participants from different military bases across South Africa. The sample consisted of the following:

- 105 participants from the Senior Staff Course;
- 72 participants from the Junior Staff Course;
- 53 participants from the 43 Mechanical Brigade;
- 164 participants from the SA Army Gymnasium;

- 47 participants from the Leadership Development Program at the Army Gymnasium;
- 199 participants from the Infantry School;
- 220 participants from the School of Armour;
- 42 participants from the Artillery School;
- 134 participants from the SA Army Combat Training Centre; and
- 76 participants from 12 SAI.

5.2 BIOGRAPHICAL INFORMATION

A discussion of the biographical information obtained from the sample serves to provide a profile of the sample user that utilise map reading in the military context. The biographical information is discussed in terms of age, sex, rank and length of employment in the military.

The frequencies on the age dimension was as follows:

Table 5.1: Respondents' profile according to age

Age	**%**
18 – 24	20.2
25 – 34	51.1
35 – 44	20.1
45+	3.6

The majority of respondents fall in the age group 25 – 34 (51.1%), with the second largest portion (20.2%) within the age group 18 – 24. The remainder of respondents were older than 34. Thus, the majority of participants are relatively young.

The frequencies on the sex dimension was as follows:

Table 5.1: Respondents' profile according to sex

Sex	**%**
Males	82.7
Females	12.1

The majority of participants are males, comprising nearly 83% of the total sample. The distribution of participants according to sex is thus highly skewed, and this is probably due to the nature of the work environment.

The frequencies on the length of employment was distributed as follows:

Table 5.3: Respondents' profile according to length of employment

Length of employment (in years)	**%**
0 – 2	14.2
3 – 5	22.2
6 – 10	29.3
10+	26.6

The participants in the study are relatively evenly distributed according to length of employment in the SANDF. The highest percentage of respondents (29.3%) was employed for 6 years or longer in the SANDF.

The frequencies of ranks was as follows:

Table 5.4: Respondents' profile according to rank

Rank	**%**
Commander	0.2
Colonel	0.8
Lieutenant Colonel	9.9
Major	7.6
Captain	6
Lieutenant	5
2nd Lieutenant	0.1
Candidate Officer	9.4
Chaplain	0.7
Warrant Officer Class 1	0.9
Warrant Officer Class 2	1.4
Staff Sergeant	3.4
Sergeant	7.3
Corporal	9.2
Lance Corporal	16.4
Private	18.2

The ranks are ordered according to the hierarchy of authority in the military. The majority of participants (51.1%) was located in the lowest four rank, thus Sergeant to Private.

5.3 MAP USE EXPERIENCE

Participants where asked to indicate previous map reading training, the frequency of map use in the work environment, as well as the need for additional map use training and the reasons for their answers.
The distribution according to previous exposure to map reading training was as follows:

Table 5.5: Respondents' profile according to previous exposure to map use training

Previous map use training	**%**
None	5
Basic	43.9
Advanced	8.6
Not Answered	42.4

A large percentage of the respondents (42.2%) did not indicate whether they have had previous map use training, which makes interpretation of these results very difficult.

Of those that did provide an indication, the majority indicated previous exposure to only basic map use training, while 8.6% of the total sample indicated exposure to advanced map use training, which also included navigational courses. 5% of participants indicated that they have had no previous exposure to map use training.

The distribution of frequencies according to the frequency of map use at work was as follows:

Table 5.6: Respondents' profile according to frequency of map use

Frequency of map use	**%**
Almost never	56.9
Monthly	21.9
Weekly	8.2
Daily	6.7

The majority of respondents indicated that they almost never use maps during the course of their daily activities at the workplace. The majority did however indicate that map use are only important and used frequently during training and operational situations.

The distribution of frequencies according to the need for additional map use training was as follows:

Table 5.7: Percentage of respondents who perceive a need for additional map use training

Need for additional training	**%**
Yes	73.7
No	23.2

The majority of participants did indicate that they perceived a need for additional map reading training to be conducted in the military context. The reasons for their answers varied and the distribution was as follows:

Table 5.8: Reasons for perception of need for additional map use training

Reasons for needing additional map use training	**%**
Currently not adequate	18.3
Maintenance training	12.2
Job requirement	26.8
Know enough	5.9
Not part of daily activities	7.1

The majority reason for the need for additional map use training was that map use is an important skill for a soldier to have and is thus a job requirement.

The majority reason for not perceiving a need for additional map use training is that map use does not form part of the daily activities of the soldier, but is only used in operational situations.

5.4 COMPUTER EXPERIENCE

Participants were asked to indicate the frequency of computer use in the workplace, as well as previous computer training, the nature of such training, and the need for computer training in the military context.

This section was included to ascertain the importance of computer literacy in the military context, given the fact that new technology such as GIS and sophisticated command and control systems are becoming an integral part of modern warfare.

Computer based training systems could also be effectively employed to enhance map use training in the military context.

The frequency of computer use in the workplace was as follows:

Table 5.9: Respondents' profile according to frequency of computer use at work

Frequency of computer use	**%**
Almost never	54.5
Monthly	4.8
Weekly	4.9
Daily	31.1

The majority of respondents (54.4%) indicated that they almost never use computers or have access to a computer at the workplace, with the second largest portion (31.1%) indicating that they use computers daily at the workplace.

The use of computers at work was also related to rank, with the highest ranks indicating daily use and access to computers, while the lower ranks indicated very limited use/access to computers at work.

The distribution according to exposure to previous computer training was as follows:

Table 5.10: Respondents' profile according to previous computer training

Previous computer training	**%**
Yes	29.9
No	67.9

The majority of participants indicated that they have had no exposure to formal computer training. Only about 30% of respondents indicated previous exposure to formal computer training.

Of those that indicated previous exposure to formal computer training, 67.9% did not indicate the nature of this training, while 22.7% indicated that such training was only basic, and 7.4% indicated advanced computer training.

The distribution according to the need for formal computer training was as follows:

Table 5.11: Percentage of respondents who perceive a need for formal computer training

Need for formal computer training	**%**
Yes	85.4
No	9.4

The majority of respondents indicated that they perceive a need for formal computer training and the majority reason that was cited was that computers aid more effective and efficient work and enhances productivity.

5.5 MAP USE PROFICIENCY MEASUREMENT

The questionnaire included 15 questions, aimed at measuring proficiency in different map use skills. The identification of such skills was done using both the

existing literature on general map use levels, as well as specific skills for the military, as indicated by participants to the task analysis process (see Appendix A). The questions were thus aimed at measuring proficiency in map reading, map analysis and map interpretation.

Question 1.1 to question 4 were theoretical questions and offered respondents a choice of answers to choose from. The rest of the questions were practical questions, pertaining to a physical map provided to the respondents, and provided them no answers to choose from, but rather to formulate their own responses.

The following table represents the results for the individual questions:

Table 5.12: Distribution of results for individual questions

	INCORRECT (%)	**CORRECT (%)**
Q1.1 Map Scale	12.3	87.7
Q1.2 Grid projection	60.6	39.4
Q2 Height point	60.3	39.7
Q3 Use of navigational aids	9.4	90.6
Q4 Geographic North	28.9	71.1
Q5 Magnetic declination	30.5	69.5
Q6 Magnetic declination	71.9	28.1
Q7 Determine height difference	70	30
Q8 Determine distance	71.9	28.1
Q9 Determine grid coordinates	96.9	3.1
Q10 Determine distance	73.9	26.1
Q11 Identify man made feature	13.8	86.2
Q12 Determine intervisibility	57.7	42.3
Q13 Determine passability	70.9	29.1
Q14 Determine direction	54.8	45.2

Respondents scored highest in the following areas:

- the use of navigational aids (Q3);
- determining map scale (Q1.1);
- identifying features (Q11);
- identify geographic north (Q4); and
- identify magnetic declination on the map (Q5).

Respondents did not score very highly in the following areas:

- determining grid coordinates (Q9);
- terrain analysis (Q12, Q13);
- determining distance (Q8, Q10);
- determining direction (Q14);
- calculating current magnetic declination (Q6);
- calculating height differences (Q7);
- identifying grid projection (Q1.2); and
- identifying distance (Q2).

The mean average score of the respondents in the proficiency test was 47.8%, as illustrated by the figure below.

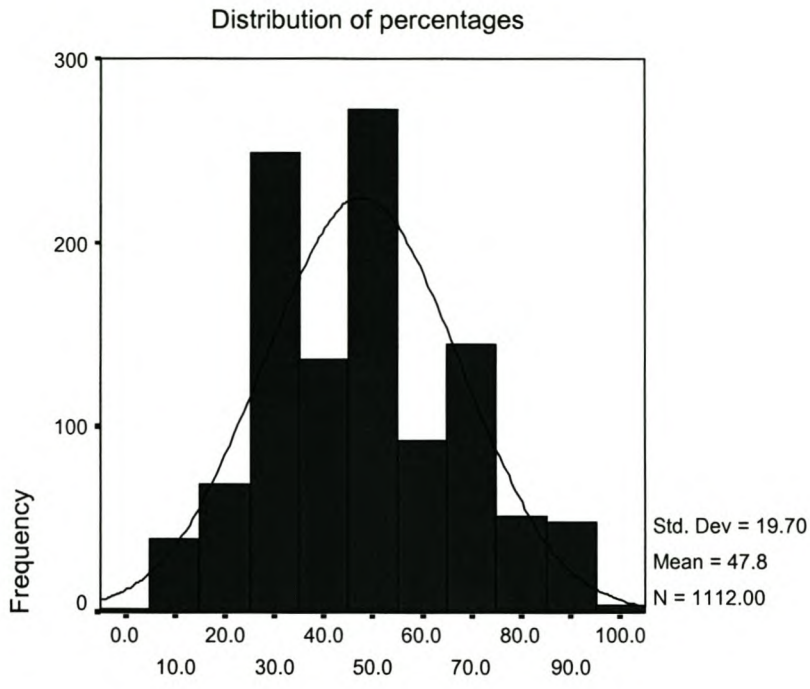

Figure 5.1: Distribution of results

The majority of respondents scored between 30 and 79% in the proficiency test as illustrated by the table below. 0.2% of the respondents scored 0%, while 0.4% of the respondents scored 100%. The largest percentage distribution was between 40 and 50%.

Table 5.13: Distribution of results

Results (%)	Frequency	Percentage
.00	2	0.2
6.67	7	0.6
13.33	33	3.0
20.00	69	6.2
26.67	102	9.2
33.33	147	13.2
40.00	137	12.3
46.67	147	13.2
53.33	125	11.2
60.00	93	8.4
66.67	76	6.8
73.33	69	6.2
80.00	52	4.7
86.67	33	3.0
93.33	16	1.4
100.00	4	0.4

The following graph represents the distribution of the different means across the different groups who participated in the study.

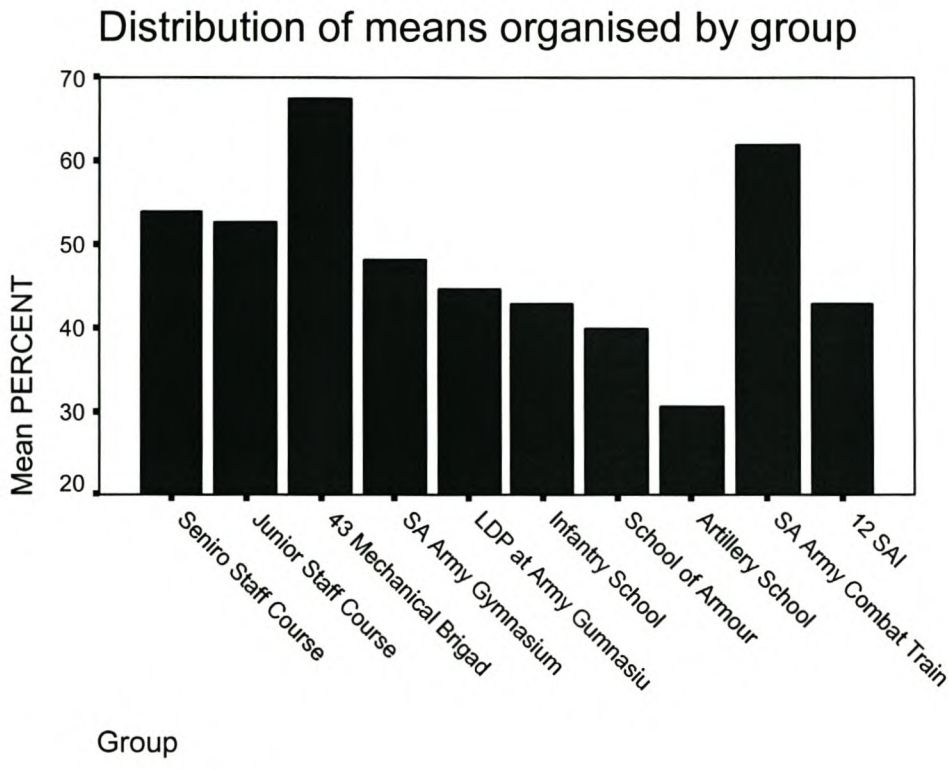

Figure 5.2: Distribution of means across groups

It appears that most of the groups who participated in the study, scored a mean percentage score of above 40% with two groups scoring above 60%.

5.6 CONCLUSION

The purpose of this chapter was to provide an analysis of the data obtained from the research questionnaire. The analysis of the data was based on the research questions and research hypothesis as stated earlier. The analysis was based on:

- biographical information;
- map use and computer experience; and

- map use proficiency.

The results indicated that most participants were relatively young, mostly males, have been employed for six years or longer in the SANDF and ranked in the lowest four ranks in the military hierarchy.

The results of the proficiency test indicated a mean average score of 47.8%, with the highest distribution between 30% and 59%.

CHAPTER 6

FINAL CONCLUSIONS AND RECOMMENDATIONS

The final chapter serves to provide a summary of the main findings of the research. The conclusions will be discussed in terms of the research questions and hypotheses stated earlier. The research problems encountered will also be discussed, along with recommendations for future research.

6.1 MAIN FINDINGS

The aim of the study was to establish whether a discrepancy exists between optimal and actual performance of map use in a military context. The skills identified during the task analysis on which the questionnaire was based are the following:

- distinguishing between different types of maps and their application;
- interpretation of symbols and coding used on maps;
- terrain interpretation and analysis;
- the use of navigational aids; and
- navigational planning.

The following represents a summary of the main conclusions based on the analysis of the data from the questionnaire.

6.1.1 Biographical Profile

The majority of the respondents from the sample (51.1%) were aged between 25 and 34 years, and the smallest percentage of participants (3.6%) were aged 45 or older. This indicates that the sample was relatively young, and have it can be

assumed that they still have a relatively long career in the military ahead of them. Any findings in terms of map use proficiency must thus take into account that these respondents, representative of the military personnel, must be prepared to become the future leaders in the military hierarchy. It can be argued that the earlier key competencies in terms of map use can be acquired, the higher the degree of effectiveness with which tasks can be executed during a career in the military context, during operational times.

In view of the theory discussed in chapter 3, linking effective map use to situational awareness and effective command and control, the development of map use skills is thus critical to ensure that personnel who are promoted in the military hierarchy to become leaders and/or battle commanders, must posses these critical skills in order to ensure effective command and control in an operational environment.

The respondents' profile according to length of employment suggest that the majority of respondents have been employed for 6 years or longer in the SANDF. It could thus be assumed that they should have had extensive exposure to map use in both training and simulation exercises. The results, however, indicate low levels of map use proficiency. It can, therefore, be assumed that map use training or simulations are either lacking, or ineffective to provide effective map use skills.

6.1.2 Map use experience

A large percentage of respondents did not indicate whether they have previous map use training, which makes interpretation of these results difficult. Failure to indicate a response could possibly imply that they did not receive formal map use training, or that it occurred too long ago to be of any relevance.

Of the 57.6% that did indicate a response to the nature of previous map use training, only 8.6% indicate that they have been exposed to advanced map use training, which included aspects such as navigation. 43.9% of the respondents

that did indicate a response, noted that they have only been exposed to basic map use training.

The results indicate that the majority of respondents (56.9%) were not regularly exposed to map use in their work environment. Map use requires practical application in order to make its use effective, and the results indicate that respondents are not provided the opportunity to regularly practice map use skills.

The results also indicate that a majority of respondents are of the opinion that additional map use training is needed. The need for complementary map reading training (being 73.7% of the total group) provides confirmation of the subjective need for training as stated by the respective participants. The reasons for this answer varied, but the largest percentage of respondents indicated that map use training needed to be expanded, because map use forms such an integral part of being deployed in the military, especially during training operations or operational situations.

An analysis of the results regarding map use experience, indicate that the majority of respondents use maps almost never during the course of their daily activities. These findings, plus those who indicated they use it only on a monthly basis (nearly 80% of the respondents), shows low levels of map use application at work. It can thus be expected that proficiency levels will drop over time. Map use requires practice and repetition of the skill, in order to do it effectively, coupled with constant maintenance training. The results indicate that the work environment, currently, does not support the use and practice of map use skills to such an extent as to make it effective.

The above results indicate that the relative importance of proficiency in map use is not fully appreciated as critical to successful leadership in the military context. This is in view of the fact that map use is not currently applied with sufficient regularity to maintain proficiency standards. Most respondents indicated a need for additional map use training (73.7%). The necessary structures and processes are

thus not in place to facilitate the development of map use as a critical success factor to military leadership.

6.1.3 Computer experience

In view of the future mode of warfare, where technology, and specifically the digital battlefield, will be integrated into command and control functions, computer literacy and computer use could be viewed as an important requirement for the effective soldier of the future.

The majority of respondents (54.5%) indicated that they have little or no access to the use of computers in their work environment. The majority (67.9%) also indicated that they have had no formal computer training, and of those that did indicate formal computer training, the majority indicated that it was only at a basic level. The majority of respondents indicated that they perceive a need for additional formal computer training, the reason being that computers enhance work efficiency.

In terms of the levels of computer literacy, it can be concluded that in general, very low levels of computer literacy exist within the general group who participated in the survey (67.9%). Possible skill deficiencies may become evident in career development if development and intentional training in this domain does not take place, in particular at higher levels of command and control. The need for formal computer training has been verified by the group by 85.4% of the total sample stating that such a need exists.

The above suggest that computer literacy does not receive high priorities in the military context. This is important in view of the changing nature of modern warfare, as discussed earlier, and the emergence of digitised battlefields to display spatial information.

6.1.4 Map use proficiency

The mean percentage score for the total sample was 47.8%. The distribution of results was between 0% and 100% (see figure 5.13). The majority of the total group scored under 60%. This intuitively suggests that the respondents are not adequately proficient in the use of maps and reflects on the performance gap. The focus is however on scoring on individual questions, as each of the questions was based on a specific map use skill as relevant in the South African military context.

The questions used in the questionnaire proficiency test (with the exception of navigational planning which constitutes a practical function) each related to the following key functions:

Table 6.1 Key functions as related to questionnaire

Distinguishing between different types of maps and their application	Q 1.1, Q1.2
Interpretation of symbols and coding used on maps	Q11
Terrain interpretation and analysis	Q2, Q7, Q8, Q9, Q10, Q12, Q13, Q14
The use of navigational aids	Q3, Q4, Q5, Q6

As mentioned in chapter 5, the respondents scored very low in the following areas:

- determining grid coordinates (Q9) 3.1%
- terrain analysis (Q12, Q13) 42.3%, 29.1%
- determining distance (Q8, Q10) 28.1%, 26.1%
- determining direction (Q14) 45.2%
- calculating current magnetic declination (Q6) 28.1%
- calculating height differences (Q7) 30%
- identifying grid projection (Q1.2) 39.4%
- identifying distance (Q2) 39.7%

As these questions relate to the above key functions as identified in the task analysis, the majority of questions that respondents scored poorly in, were related to aspects such as terrain analysis and interpretation. As is evident in the task analysis (Appendix A) paragraph 4, the flow chart depicting the task structure related to map use, indicates that map analysis and interpretation are critical to interpreting orders and planning to carry them out. In this manner, terrain analysis and interpretation also poses as inputs to the successful navigation, which is regarded as an essential skill for every member of any defence force.

Based on the above it could be argued that a gap exists between optimal and actual performance in map use in the military context, especially in aspects related to map analysis and interpretation.

6.2 PROBLEMS AND LIMITATIONS

No major problems were encountered in conducting the study, except those associated with the use of the format of the "mailed questionnaire". Questions had to be kept simple and straightforward to avoid ambiguity, and allowed no opportunity for further probing and clarification of answers. Because the names of individuals did not appear on the questionnaire, lower levels of performance may have resulted. The decision to make questionnaires anonymous, was associated with the ethical decision of the individual's freedom of choice to participate in the survey or not.

The major problem encountered during the study was that, due to logistical limitations, the questionnaire could not incorporate more aspects in terms of measuring map use proficiency, as well as illicit additional information regarding map use and the aspects surrounding it in the workplace.

The sample used was, as mentioned earlier, a non-probability opportunity sample, chosen by their supervisors based on availability. This places limitations on generalising the findings of the study to the entire population from which the sample was taken.

- The limitation of the current study is that it did not include representatives from all the different SA Army Corps, e.g. Intelligence. The Rank Level distribution is reasonably representative with the exception of the top levels, i.e. General.

- Sex distribution: Despite the fact that a limited number of females participated in the survey, the current number conforms to the White Paper on Defence whereby it is suggested to be 89% male, 11% female.

6.3 RECOMMENDATIONS

The recommendations for further research include the following:

- The task analysis should be expanded to include participants from all units in the SA Army. The analysis should be aimed at clarification of all functional requirements at the respective levels in the military context. This should form the basis for the definition of competencies and proficiency criteria at each of the respective levels and for the different Corps.

- The map use capability measurement incorporated in the questionnaire should be expanded in terms of the number of questions that addresses each key function, thus providing for a more comprehensive analysis of performance gaps, if any.

The SANDF should give careful consideration to the following issues:

- Structures and processes should be put in place to facilitate the application and practice of map use skills.

- Standards, proficiency levels and “pass-marks” should be reviewed with consideration and clear definition of the full impact of any risks involved if 100% is not achieved. Clarification should be provided as to the "optimal level of performance" per task domain.

- Review of current curricula in terms of map use training, to assess whether it proves to be adequate in the provision of the necessary skills and knowledge related to effective map use in the military context.

- Continuous evaluation of current map use standards and regular maintenance and practical training to facilitate continuous effective map use standards. The effectiveness of continuous, practical training is evidenced by the fact the participants from the 43 Mechanical Brigade and the SA Army Combat Training Centre, scored significantly higher than the other groups. These two bases are used for training, of which map use training forms an integral part.

- Consideration must be given to alternative training methodologies and techniques to enhance map use training. Consideration also of alternative training aids and media to improve the effectiveness of training.

- Evaluation methods and techniques should possibly be revised in line with the outcomes-based approach, directly associated with pre-defined competencies.

6.4 CONCLUSION

The use of maps has always formed an integral input into military decision-making during operational situations, due to the nature of their tasks and missions. During

modern day warfare map use still play an important role, incorporated through geographical information systems on the digital battlefield, as a key source of information for the modern battle commander.

Knowledge and skills concerning the effective use of maps and the spatial information conveyed on them, is thus imperative to effective command and control over joint, combined forces on the battlefield. In order to be an effective leader or battle commander, the commander must thus be able to accurately read, interpret and evaluate the terrain that his/her units are operating in.

The following conclusions can be drawn from the above results

- A performance gap has been identified within the SA Army in terms of basic map reading skills.

- The training needs which need to be addressed as a matter of critical importance, include the following key areas:

    - grid projection and grid coordinates;
    - determination of height points;
    - issues around magnetic declination;
    - determination of height differences;
    - measuring distances;
    - determine direction;
    - determination of intervisibility; and
    - determination of passability..

- The low standard achieved by the total group may reflect a lack of regular application and training of map use skills, as suggested earlier in this chapter. This may be linked to limited practical, field or simulated exercises.

From the analysis and interpretation of the results obtained from the questionnaire, it can be inferred that a training need exists with respect to map use in the South

African military context. This need is especially critical in areas related to map analysis and interpretation, the two more advanced levels of map use. The results also suggest that map use and computer use for most respondents are limited in their work environment, both contributing to developing critical skills for the future of military functioning as well as command and control functions.

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APPENDIX A

TASK ANALYSIS

TASK ANALYSIS: SCHOOL OF ARMOUR

MAP READING AND NAVIGATION

1. USERS

Basic map reading abilities and skills are relevant for all levels in the military hierarchy. These skills are however, applied more strategically by the users higher in the hierarchy.

Assignments and orders are received from one level higher up while feedback are given to one level higher up after completions of the order. This communication may be either verbal or written depending on the time aspect attached to the carrying out of the order.

2. DEFINITION OF FUNCTIONS AND GOALS

2.1 Goals

To interpret 2 dimensional information accurately 3 dimensionally and use it to:

- interpret orders
- to accurately plan and execute these order
- to provide accurate feedback to higher levels within given time parameters.

2.1 Basic map reading functions

- Preparation of maps

  Users must be able to demonstrate the skills necessary for the folding of maps, the joining of different maps to each other as well as the reinforcing of maps.

- Recognition of types of maps

  A distinction must be made between different types of maps in terms of the level of detail that each provides as well the advantages and disadvantages of use for a specific situation.

- Coding

  Users must demonstrate a thorough level of knowledge of the most common symbols and coding used on maps. They must be able to translate these from the map to the real environment, as well as from the real environment to back to the map.

- Terrain analysis and interpretation

  Users must be able to determine the passability, intervisibility and the tactical value of terrain as represented on a map. This requires translating 2 dimensional information into a 3 dimensional mental picture, to thus form an accurate picture of the real terrain.

- Use of Navigational aids

  Users must demonstrate an accurate use of the compass, GPS and stars for navigational purposes. They must be able to determine direction and take bearing using these aids. To do this, they must be able to determine and take into consideration: magnetic North, true North, grid North, magnetic declination and any disturbances that may affect measurements. The user must be able to translate a bearing taken from the aid to the map. A thorough level of knowledge of the UTM-grid system and co-ordinates are thus necessary.

- Navigational Planning

  Users must be able to construct a detailed navigational plan through determining time factors, position, distance and orienting a map. They must be able to communicate the above accurately in both verbal and written format.

- Updating maps

  Users must be able to recognise changes in the real terrain that is not represented on the map, and make the adequate changes on the map that they encounter in the real environment.

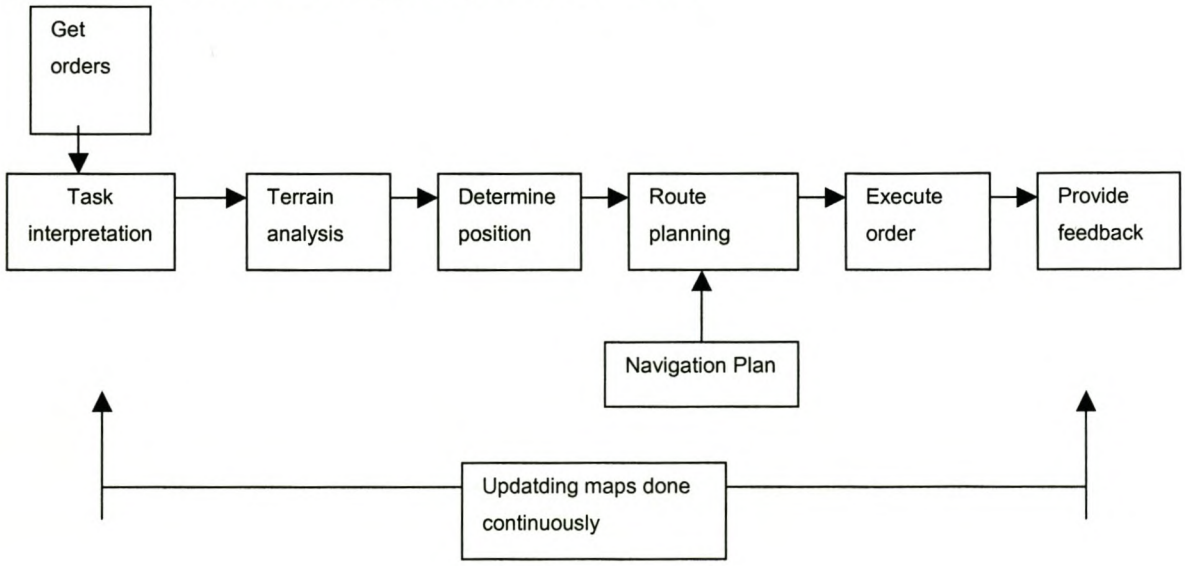
3. KEY CONSEQUENCES OF ERRORS

The consequences of errors in any of the above functions, could lead to navigational problems and hence
:

- targets are missed
- troops get lost
- reaction time longer
- pressure on scarce resources

4. TASK STRUCTURE

Die map reading process would typically look as follows:



APPENDIX B

MAP USE QUESTIONNAIRE

University of Stellenbosch Evaluation

Evaluation Number (For office use only) ☐

MAP READING EVALUATION

(This evaluation is anonymous and the information will be handled confidentially)

Rank: _____ Unit: _____

Biographic Information

Age	1. 18-24	2. 25-34	3. 35-44	4. 45+
Sex	1. Male		2. Female	

What position do you currently hold?				
How long have you been employed in the SANDF (years)?	1. 0-2	2. 3-5	3. 6-10	4. 10+

Map Reading Experience

What previous map reading training have you been exposed to?				
How often are you required to employ map reading skills during the course of your work?	1. Almost never	2. Monthly	3. Weekly	4. Daily
In your opinion, do you require any additional map reading training?	1. YES		2. NO	
Provide reasons for your answer				

Computer Experience

How often do you use computers in your work?	1. Almost never	2. Monthly	3. Weekly	4. Daily
Have you been exposed to any formal computer training?	1. YES		2. NO	
If yes, describe the nature of this training				
Do you think you will be able to work more effectively after being exposed to computer training?	1. YES		2. NO	
Provide reasons for your answer				

Time: 30 minutes

Mark the correct answer with an X:

1. For military purposes the standard (1).....scale topographical map series with the (2)..... .....grid projection superimposed on it is used by the SANDF for basic map reading purposes as well as planning and navigation.

(1) Scale			
1 : 100 000 000	1 : 250 000	1 : 50 000	1 : 100 000
(2) Grid Projection			
Cylindric Grid Projection (CGP)	Universal Transverse Mercator (UTM)	Conical Projection System (CPS)	Azimuthal Grid Projection (AGP)

Please turn over

2. The height/altitude of a point with reference to mean sea level is a...

1. Vertical distance	2. Slope distance	3. Horizontal distance	4. Gradient distance

3. A magnetic device used to calculate direction from north is...

1. GPS	2. Watch	3. Compass	4. Protractor

4. The Earth's geographic North Pole is known as...

1. Grid North	2. Magnetic North	3. True North	4. Real North

THE FOLLOWING QUESTIONS PERTAIN TO THE MAP PROVIDED

5. What is the correct Mean Magnetic Declination of the map supplied?
   Final answer: .....

6. Using this plus the mean annual change, determine the current magnetic declination.
   Final answer: .....

Please use the scrap paper provided for your calculations and only fill in your final answer in the space provided:

7. Calculate the height difference (vertical) between the highest point in the **Loskop** height ground in Grid **12F** and the height point in Grid **16E**.

   Final answer: .....

8. Calculate/determine the horizontal distance between the **Salt River Station** in Grid **10H** and the **Rosebank Store** in Grid **7E**.

   Final answer: .....

9. Determine the correct grid co-ordinates as well as the Latitude and Longitude grid reference accurate to the last minute and second for the **Sea Point** light house.

   Final answer: Eastings..... Northings..... Latitude.....Longitude.....

10. What is the distance of the shortest route (road) from the Police station in Grid **10C** and the Oasis Farm house in Grid **14D**?

    Final answer: .....

11. What is the man made feature that can be identified in Grid blocks **14G** and **15G**?

    Final answer: .....

12. Determine if you will be able to see (observe) the Windpump in Grid **20G**, if you were standing on the Height point 247.1 at Grid reference **169 D6**, considering that there is a road and railroad between these points.

    Final answer: .....

13. A particular vehicle cannot climb a gradient more than 15°. Determine whether this vehicle can travel directly (straight line distance of 3000m) from Height point 242 at Grid reference **205 H9** to link up with the road at Grid reference **176 J5**.

    Final answer: .....

14. What is the approximate direction to Mentzdam in Grid **14G** if you were standing at the highest point on Loskop in Grid **12F**?

    Final answer: .....

Thank you for your participation and inputs