A Case Study of Organisational Training and the Training Effectiveness Influences on Vertical and Horizontal Transfer

by

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Abstract

Organisations are often faced with many challenges when they attempt to implement an entire workforce to a technologically advanced and complex platform that will alter the skill-set requirements for performance. Training can be a very effective intervention strategy to implement this organisational change. However, theorists have proposed that training can also enhance organisational effectiveness, and it is believed that individual outcomes from training that emerge upward to achieve organisational objectives -vertical transfer- would strengthen the link between training effectiveness and organisational effectiveness. Using these theories as a foundation, this case study examined the effectiveness of an organisation's training to achieve performance objectives. Expansion from these theories was possible as this case study presented the multiple influences involved during successive interdependent team training to support the performance of safety-critical operations for a new working platform.

In achieving interdependent team vertical transfer in emergency management during this training, results have revealed that training must first focus on individual level skill proficiency and collective enabling process skills - horizontal transfer- as they are a critical antecedent to ensure cohesion in interdependent team performance. Findings have further identified that the training content and methods must both support and determine the achievement of individual required skills. While simulation training that reflected the working platform benefits both learning and performance. Conclusions can also be drawn from this exploratory case study that the efforts by individuals upward through to teams and across teams has enhanced training performance outcomes.

This empirical case study has shown that a multitude of factors and cumulative events that occurred prior to training and during training influenced the effectiveness of team training from multiple levels. Thus, this case study has been able to verify and expand current postulated models to provide foundation support for the design and delivery of interdependent training.

Key words: Team, Training, Transfer, Training Effectiveness, Horizontal Transfer, Vertical Transfer, Organisational Effectiveness.

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Teams

Acronyms

A/CO	Acting Commanding Officer
ACU	Air Conditioning Unit
AMS	Auxiliary Machine Space
BAE	British Aerospace Engineering
CF	Canadian Forces
CANSSOs	Canadian Submarine Standing Orders
CM	Corrective Maintenance
CO	Commanding Officer
CRM	Crew Resource Management
CSST	Captain Sea and Shore Training Management System
DC	Direct Current
DCHQ	Damage Control Headquarters
EOPs	Emergency Operating Procedures
FIV	Fire Isolation Valve
FOSM	Flag Officer Submarines
FMB	Fixed Main Broadcast
HMCS	Her Majesty's Canadian Ship
HMS	Her Majesty's Ship
HP	High Pressure
HTA	Hierarchical Task Analysis
IPB	Indicator Push Button
ISD	Instructional System Design
KSAs	Knowledge, Skill and Attitudes
MoD	Ministry of Defence
MCC	Machine Control Console Keeper
MG	Motor Group
NATO	North Atlantic Treaty Organisation
O- boat	Oberon Class submarine
OOW	Officer of the Watch
PD	Periscope Depth
PM	Planned Maintenance
P X C rule	Probability times Consequence or Cost rule
RN	Royal Navy
SCC	Ship Control Console Panel Watchkeeper
SCOOW	Ship Control Officer of the Watch
SOP	Standard Operating Procedures
TABs	Technical Specification Document
U-boat	Upholder class submarine
USQ	Upholder Submarine Qualifications
UTT	Upholder Training Team
VCS	Voice Communication System
VICES	Voice Internal Communication System
VIE	Expectancy, Instrumentality and Valence
VSEL	Vickers Shipbuilding and Engineering

1. Introduction

Setting the Scene

Advances in technology and rapid changes and instabilities in the world have placed increasingly difficult and demanding challenges on large, complex organisations such as the military. These challenges are further compounded by the ever-increasing requirement to economise and 'buy off-the-shelf' rather than design commercial systems to meet all expectations. As this economising trend is not likely to reverse itself, rather than accept the status quo, one practical and critical method to ensure effective utilisation of a commercial system is an effective training package that meets the needs of the organisation. For an organisation such as the Armed Forces effective training is critical, as military readiness, safety and performance depend largely on the extent to which training systems provide crucial knowledge and skills (Cannon-Bowers, Salas, Tannenbaum, & Mathieu, 1995; Tannenbaum, 1993). Although to gain the utmost from the investment of training, attention should also be directed at examining training effectiveness to identify what internal and external influences could impact the intended outcomes from training.

A great deal of money is spent on training and it has been estimated that only 10% of training expenditures transfer to the job (Georgenson, 1982) and, even today, statistics suggest further examination of training effectiveness is still necessary to gain a better return on investment from training (Cromwell & Kolb, 2002). The goal in training is to achieve the desired knowledge and skill level in the most cost effective manner in the shortest timeframe for optimum performance in the workplace. In practise, organisations tend to evaluate the success of training development by measuring the successful achievement of performance outcomes, but rarely is the approach of training effectiveness applied to understand why training did or did not achieve the desired outcomes or what factors influenced those outcomes. This inconsistency suggests there is a necessity to reciprocally improve the understanding between training effectiveness research and real-world applications to improve training and transfer outcomes.

As early as 1980 Goldstein identified, "we must consider training as a system within work organisations rather than simply treating instruction as a separate technology" (Goldstein, 1980). Even so, until the 1990's training design and effectiveness research focused primarily on variables within the training platform itself, such as training method, content, equipment and media (Cannon-Bowers *et al.*, 1995; Tannenbaum & Yukl, 1992). While training research has historically supported the importance of training design as a way of improving training effectiveness (Baldwin & Ford, 1988), it is only over the past 15 years that training researchers have moved beyond the focus of organisational objectives and training design to identify other factors that can influence training effectiveness to more fully explain why training does or does not work.

Training effectiveness research has now evolved to look at training intervention from a systems, macro perspective (Salas & Cannon-Bowers, 2001), where the success of training can be attributed to individual, organisational and training-related factors (Cannon-Bowers *et al.*, 1995; Cannon-Bowers, Tannenbaum, Salas, & Converse, 1991; Kozlowski, Brown, Weissbein, Cannon-Bowers, & Salas, 2000; Kraiger & Aguinis, 2001; Kraiger, Ford, & Salas, 1993, p. 312; Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992). Research has established that individual influences can influence training and transfer through their attitudes, behaviours and abilities; organisations can influence through their culture, history, policies, and attitudes; and, the training platform can influence training effectiveness through the methods, content, principles and support provided during training (Cannon-Bowers *et al.*, 1995).

The success of training and its implementation to the workplace requires individual training for specific tasks, but in many work environments, such as the nuclear power industry, emergency response teams and the military, seldom are those activities isolated to individuals themselves. Work efforts often require individuals to interact as a team, and teams interact with systems to meet organisational goals. Training becomes even more complex when activities depend upon coordinated efforts of a team. Thus, one can consider the factors that can influence the success of training and transfer of divergent team members, particularly those that require interdependent collaborative and effective safety and emergency management to prevent catastrophic losses (*e.g.*, human lives and property), as complex and multifactorial. Influencing factors from the trainee, the team, the training design and the organisation come together to influence individual learning, which can influence the transfer of that trained. Although there has been a great expansion of the breadth and depth of knowledge of the factors that can influence the success of training and transfer, training effectiveness research has for the most part placed its primary focus and effort on the influences on individual outcomes. This concept is referred to as horizontal transfer.

Beyond the uni-dimensional, horizontal influences of factors that impact individuals successful learning and transfer to the workplace, more recent research theories have proposed that individuals within an organisation are a dynamic entity and therefore the influence on training outcomes is also multi-dimensional, affecting more than the individual being trained (Kozlowski *et al.*, 2000). Distinct variables such as individual characteristics can impact a team through to the organisation, while an organisation can also impact the individual and the outcome from training, which in turn can influence the training design. Together, complex and different factors across individuals, through different levels contribute or deter intended learning and transfer to the workplace.

Research has shown that this complex multi-factorial interaction of individual, organisational and training factors influences individual learning and outcomes on the horizontal, individual platform (Kozlowski *et al.*, 2000; Kraiger & Aguinis, 2001; Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992). Research and modelling have also sufficiently established the knowledge that group and organisational factors have direct and moderating effects on individual learning and transfer (Cannon-Bowers *et al.*, 1995; Ford, Quinones, Sego, & Sorra, 1992). What has largely been neglected in training theory and research are the factors and processes by which individual-level outcomes can combine and emerge, from the bottom-up, to influence organisational objectives (Kozlowski *et al.*, 2000).This concept is known as vertical transfer.

Although formal research and training models have so far only assumed an upward linkage of individuals through to an organisation, it has been proposed that it is likely implicitly considered in practical training applications (Kozlowski & Salas, 1997). This assumption can be presumed that while training effectiveness efforts have almost exclusively been applied at the individual level, understanding the impact of factors will result in the design and delivery of effective training that contributes to the achievement of organisational objectives. Therefore, if training is based upon the achievement of organisational objectives then an individual must then have an influence on those objectives. One can then also infer that if the objective of training is to improve an organisation's capability to meet objectives, then training could also influence an organisation's effectiveness (Goldstein, 1993 cited in Kozlowski *et al.*, 2000). However, although it has been assumed that training with an aim to meet organisational objectives contributes to organisational effectiveness, to date this is only a theory. The linkage between vertical effects of individuals on organisational effectiveness has also not been well articulated, and as such it has received little research attention to date.

Thus, even though current research has elucidated the specific individual factors (or categories such as those from an individual, training or an organisation) that can influence training and outcomes, from an application point of view an organisation is more interested in the process to achieve a successful outcome from training. So how can research effectively support organisations' desired outcome of successful training and transfer to the workplace?

To aid organisations to achieve more effective outcomes from training it is important for research to explore and study the complex multilevel interactions of influences within an actual training environment, to identify the link between factors, limitations that impede success, and the formal and informal interventions and adaptations implemented to achieve successful outcomes. Research has established that influences and interventions do not impart their effects just uni-dimensionally; rather individuals, organisations and the training platform can impart effects both horizontally on an individual, and organisations can have a top-down effect. Accordingly, one can presume an even broader impact, that training effectiveness is a complex multi-dimensional, multi-directional interaction whereby individuals contribute to organisational goals, an organisation impacts an individual, both can affect the training design, and together they can influence the broader intended outcomes of achieving organisational objectives. Therefore, all factors that could impact the degree of success of training are important to determine their combined influence to achieve organisational objectives and thus trainings' impact to organisational effectiveness. Vertical transfer has been considered the key untapped leverage point to strengthening the link between training effectiveness and organisational effectiveness (Kozlowski *et al.*, 2000). Therefore, confirming and delineating this linkage would aid to derive the most from training opportunities.

Gaining the foundation knowledge and explanations for multilevel approaches and influences to training and organisational effectiveness would be almost impossible to create in a laboratory setting, as this would require the development of a study that included all of the potential influencing factors from the individual, organisation and the training platform. To truly identify the foundation for the theory of vertical transfer and multilevel approaches to training effectiveness, and thus provide evidence of its existence and application, empirical research needs to be performed in a setting where an organisation performs actual training. Even the best attempts to create a study of a complex training platform scenario in a laboratory could not possibly recreate all of the attitudes, beliefs, capabilities and interactions across and between levels, as this combined interaction has yet to be fully explored. Attempting to do so in a laboratory would provoke considerable risk of artificial, incomplete and perhaps erroneous findings. There is also an added benefit to performing research within a training environment, in that there is an opportunity to improve the integration and reciprocation of training research and training practice.

An ideal platform to provide evidence for the theory of vertical transfer and identify and assess the multi-dimensions and directions of training effectiveness in a complex environment would be to study military training. A unique opportunity was offered to study the Canadian Naval training programme to integrate the entire Canadian Navy's[1] submarine workforce to a new class of submarines, the Upholder class purchased from the United Kingdom's Royal Navy (RN). Specifically, training effectiveness research was performed as complete crews, of various experiences and occupations, were trained to learn the performance of safety-critical operations. Training an entire crew simultaneously is complex, but the multi-dimensional influences expand as the RN agreed contractually to provide four operationally certified submarines concurrently with four trained and sea-tested crews in succession after six years of inactivity with this class of submarine within very strict timelines.

Within this training platform it is likely that the potential impact of an individual on an organisation would likely be seen, as in any complex man-machine system such as a submarine, human actions can have a significant impact on safe and reliable operations. Therefore, individuals tend to be much more motivated to achieve successful performance, as the correct outcome is critical. Additionally, in an

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[1] In 1968, the Canadian Forces Reorganisation Act dissolved the Canadian Army, Royal Canadian Navy and Royal Canadian Air Force. In their stead, the Act created a single armed Service called the "Canadian Armed Forces." Henceforth, the former army, navy and air force were referred to as the "land, sea and air elements." The descriptor "Armed" was dropped later from the Service's title; it is now referred to as the "Canadian Forces." Over time, the land, sea and air elements reintroduced, unofficially, the terms army, navy and air force. For simplicity in this thesis, the sea element of the Canadian Forces will be referred to as the "Canadian Navy."

environment where collaborative work is essential the interactions expand beyond individuals to the co-ordination of activities within the team, the system, and their reactions, interactions, and adjustment to changing circumstances. This training process is further complicated as the training was provided by another military organisation with different norms, culture and training standards. The training therefore moves beyond the boundaries of training discrete individuals to achieve desired learning outcomes; the training further encompasses and is affected by the integration of individuals and their actions, social and organisational contributions, within and between two nations.

This training provided an ideal platform to lay the empirical foundation for the theory that combined influences from the organisation, individual, training programme and situational variables from pre-training through to training contribute and impact training effectiveness across multilevels to achieve organisational objectives. As well, that training effectiveness is reflected by horizontal, vertical and top-down influences that can impact organisational effectiveness, especially in the field of emergency management.

1.2 Research Aims and Objectives

The thesis puts forward that performing research while an organisation provides interdependent team training is an ideal platform to provide the empirical evidence to support the theory of vertical transfer. Further, as the intent of training was to provide outcomes that support organisational goals and strategies, proof that individual outcomes emerge upward from training to achieve higher level organisational outcomes will also provide evidence for the assumed link between training contributions, training outcomes and organisational effectiveness.

In monitoring an ongoing complex, team training programme there is also an opportunity to support the theory of multilevel approaches to training effectiveness by identifying the broad spectrum of factors and interventions that influence training and outcomes from, to and within an organisation.

The applied aim for this thesis is to provide insight to organisations that are responsible for safety-critical management of the range and interaction of factors that can influence the learning and application of safety-critical operations within a training programme. The cursory identification of individual upward linking influences can then be considered and applied in needs assessment and on-going evaluations of a programme so that they may improve the likelihood of successful training and transfer, and thus improve organisational effectiveness.

Objectives

The objective of this research was to follow the progress of successive training of team-oriented crews in learning the performance of safety-critical operations in a new system to identify and measure individual expectations, perceptions and satisfaction from within the training platform and the resulting influence on training success. Specifically, the objective is comprised of three components: 1) to provide empirical evidence to support the theory of interdependent team vertical transfer; 2) to identify the links and influences of training effectiveness factors from pre-training and training, organisational, situational and individual variables, with a focus on the training design, to broaden the scope of multilevel training effectiveness on vertical transfer; and, 3) to provide foundation evidence to support the theory linking training effectiveness to organisational effectiveness.

1.3 Scope of Thesis

As the scope of evaluating training effectiveness of the Canadian Navy's entire fleet of submariners to learn to operate a sea-going sailing vessel would be extremely time-consuming and intrusive (beyond the limits of a thesis), the research performed for this thesis has been limited to assessing training effectiveness in the performance of safety-critical elements of operation – the goal of effectively performing Emergency Operating Procedures (EOPs). In order to achieve the research objectives the scope of the work involved identifying all training related stakeholders at all stages in the process to clearly establish who was involved, the training rationale and process, and how adjustments to the training programme were put into practice.

1.4 Thesis Structure

Given that the Canadian Navy allowed research to be performed only on the condition that the study would not interfere with training, it is acknowledged that the limits of this case study could not provide a comprehensive detailing and review of all influencing factors identified in effectiveness research. The training programme was not simple; the RN was contracted to train the Canadian submariners within very restrictive timelines: the availability of trainees, trainers and access to the training platform was very limited. Moreover, pre-post assessments were not possible, and conditions of the contract identified the training programme, documentation, submarines and the simulator trainers were the property of the RN until the completion of training. Thus, within the realm of what was possible, the research focused on the key identifiers within the training programme that influence training success as it applies to the performance of safety-critical elements, identifying the perceptions, reactions and expectations of trainees, trainers and training management during the training process. It was also recognised that a military training environment may have unique conditions that might not be observed in all organisations or training programme. However, a very complex training environment provides ideal conditions to advance the knowledge of multilevel training effectiveness, as there is an opportunity to study training as it naturally proceeds to achieve required performance outcomes so that military objectives are accomplished and are effective. Successful training of interdependent teams is critical to achieve organisational objectives, and therefore this training platform provides ideal conditions to identify and explore the links of vertical transfer.

Within this training platform there is an opportunity to identify and assess combined influencing factors, their impact, link, and the interventions and adaptations implemented to achieve successful outcomes. Although unique, the scope of the work described in this thesis intends to provide empirical evidence to support the theory of interdependent team vertical transfer, and thus expand the framework of training effectiveness to identify the multi-faceted, multi-directional and continuum influence (prior, during and after training) of factors to training and outcomes. It is also the intent of this thesis to expand the understanding and therefore influence of training effectiveness factors with the inclusion of vertical transfer to the model, to link training effectiveness and the achievement of organisational effectiveness in safety-critical management.

1.5 Research in an Applied Environment

In this unique training environment that required international collaboration to create and implement a training programme for an entire workforce, there was an opportunity to observe successive 'conversion' training as it formally and informally adjusted and evolved to achieve intended organisational objectives. That is, the training platform intended to add to the knowledge and skill set of pre-qualified submariners to allow crews to operate a newly purchased class of submarines, that although similar to that previous owned required further training for successful operation. This can be considered a real-world, complicated training platform that allows the identification of individual, situational, organisational and training design factors identified within the training platform that could impact learning and ultimate transfer to the workplace.

2. Literature Review

The objectives for this thesis was to provide the empirical evidence to support the theory of interdependent team vertical transfer and the links and influences from the organisation, individual, training programme and situational variables that contribute and impact training effectiveness across multilevels to achieve organisational objectives. Further, these findings will provide exploratory empirical evidence to support the theory linking training effectiveness with organisational effectiveness. This chapter develops the background to these theories by laying the foundation upon which research in the thesis will be developed. The elements that are central to the thesis are the models of training effectiveness and training transfer.

For discussion purposes of what is already known in the literature this chapter reviews the overall theories and approaches of training effectiveness and training transfer, examines the influences that are central to these models (training design, work context, and individual and organisational inputs and outputs) both from within and outside this research domain (as they directly apply to topics), and summarises the collective findings and considerations to outline where the research forming this thesis can make a contribution.

2.1 Training Effectiveness and Training Transfer

This Section provides the background to training effectiveness and training transfer, identifying the origins, delineations, growth and similarities of the two models. This overview of similarities between training effectiveness and training transfer research will also identify from the literature the rationale to consider and apply training effectiveness in a broader context that extends the understanding and impact of training prior to, during and post-training.

2.1.1 Origins of Training Effectiveness and Training Transfer

Training research and the theories of training effectiveness and training transfer have formed on psychological foundations of instructional design (Tennyson & Schott, 1997; B. G. Wilson & Myers, 2000), which in its origins in the early 1900s linked the theories of learning with practical application (Tennyson & Schott, 1997). Integrating psychology and instruction emerged during World War II to aid the military in producing reliable training outcomes. Thus began the focus of research to develop approaches to analyse performance and design instruction to achieve specific learning outcomes. The popular model of Instructional System Design (ISD) introduced in the 1960s has been widely used for teaching job-skills and providing technical training (Torraco, 1999). This still used model of instruction is based upon the concept of linking needs assessment (analysis), training design and delivery, and evaluation. Training researchers have criticised ISD as being too narrowly training programme focused (Kozlowski *et al.*, 2000), prescriptive (Tennyson & Schott, 1997), linear, and insensitive to the context of practice (Torraco, 1999), as the model focuses on training design and learning and does not take into account the many factors that can influence training outcomes. However, this training model can be given credit for initiating the growth of the field of training research.

The roots and delineation of both training effectiveness and transfer research emerged and expanded from Kirkpatrick's 1967 training evaluation typology (Baldwin & Ford, 1988; Cannon-Bowers *et al.*, 1995; Cheng & Ho, 2001; Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992). Kirkpatrick's popular and still prevalent framework for categorising training criteria includes four-levels of evaluation taxonomy: trainee reactions; learning; behaviour; and, organisational results with an eye toward predicting learning and retention (Baldwin & Ford, 1988; Bryant & Angel, 2000; Tannenbaum & Yukl, 1992). This classification scheme by Kirkpatrick allowed trainers to measure, albeit roughly, the characteristics of the training course to determine the extent to which learners would benefit from the training (Bryant & Angel, 2000).

However, researchers have argued that the lack of clarity of Kirkpatrick's evaluation model (*i.e.*, what had been learned and why) (Kraiger *et al.*, 1993; Salas, Cannon-Bowers, & Kozlowski, 1997) has resulted in researchers to refer, use and misuse, and expand Kirkpatrick's typology as concepts of training effectiveness (Cannon-Bowers *et al.*, 1995; Kozlowski *et al.*, 2000; Tannenbaum & Yukl, 1992). Training effectiveness is not as simple as to categorise training criteria as suggested by Kirkpatrick (1976) into the outcomes of reactions, learning, behaviour and organisational results (Cannon-Bowers *et al.*, 1995; Kozlowski *et al.*, 2000; Tannenbaum & Yukl, 1992). Even Kirkpatrick identified, " there are however so many complicating factors that it is extremely difficult, if not impossible, to evaluate certain kinds of programmes in terms of their results".

Baldwin and Ford (1988) in their extensive review of the training transfer literature expanded upon Kirkpatrick's intended evaluation typology to provide a clearer understanding of what was meant by training transfer. They defined training transfer as the extent to which trainees effectively apply the knowledge, skills, and attitudes (KSAs) gained in the training context back to the job (generalisation) and subsequently the maintenance of that learning over time in the job (Ford & Weissbein, 1997; Richman-Hirsch, 2001; Smith-Jentsch, Salas, & Brannick, 2001; Yamnill & McLean, 2001). From their extensive review and critique of the literature, Baldwin and Ford (1988) can also be given credit for the development of the still referred and expanded model that describes the transfer process, linkages and factors among training inputs, training outputs, and the conditions of transfer (Figure 1). Their categories of trainee characteristics, training design and work environment input factors, defined from past research, was based upon the indirect effect on transfer through their impact on training outcomes (learning and retention).

In the past, training evaluation and training effectiveness were used interchangeably and there appeared to be confusion and controversy of how training evaluation plays a part in training effectiveness and workplace transfer and application. It was Kraiger (1993) who clarified that training evaluation and training effectiveness are not the same and pose two different research questions. *Training evaluation* examines *what* works in training, examining what KSAs were learned at different levels, whereas the study of *training transfer* follows through from training evaluation to examine *application*; the extent to which the KSAs acquired in a training programme are applied back to the job (generalisation) and maintained over time in the job. *Training effectiveness* research examines *why* training did or did not achieve the direct outcomes of learning and retention, and what factors influence those outcomes.

As a result of Baldwin and Ford's extensive review of the empirical training transfer literature and discussions of the research gaps (1988), training research has made tremendous progress in the form of greater sensitivity of criterion measures of transfer beyond self-reports; the use of more complex learning tasks that more closely mirror tasks in the work setting; development of more sophisticated key environment/workplace factors, such as transfer climate; and, more theoretical frameworks to drive the choice of trainee characteristics. However, in Ford's (1997) updated review of transfer he identified that a lack of attention to the multidimensional nature of transfer in past research has impacted the interpretation of results, which then can be incorrectly generalised to other samples, organisations and training.

There have been improvements to training and transfer research with more rigorous approaches to measuring transfer, including self-reporting measures using anchored behaviour ranking scales and expansion from self-rating to include supervisory and peers (Ford & Weissbein, 1997). Also, training effectiveness and transfer research have begun to focus on more complex tasks that are reflective of the work environment (Blanchard, Thacker, & Way, 2000; Ford *et al.*, 1992; Ford & Weissbein, 1997; Kontoghiorghes, 2001, 2002; Noe & Schmitt, 1986) with more sophisticated theoretical and operational measures of key work environmental factors (Cannon-Bowers & Salas, 1997b; Cannon-Bowers *et al.*, 1995; Ford & Weissbein, 1997; Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997; Kozlowski, Toney *et al.*, 2001; Salas & Cannon-Bowers, 2001).

Although researchers have criticised the use of Kirkpatrick's typology in training effectiveness research, it has provided a foundation for research into the factors that influence training to grow further and become more defined to now include: *training contexts* (training methods, content, climate, media, equipment and artefacts) (Cannon-Bowers *et al.*, 1995; Cannon-Bowers *et al.*, 1991; Salas, Dickinson, Converse, & Tannenbaum, 1992; Tannenbaum & Yukl, 1992); *organisational inputs* (culture, history, policies, attitude); and, *individual inputs* (attitudes and behaviour) (Cannon-Bowers *et al.*, 1995; Cannon-Bowers *et al.*, 1991; Kozlowski *et al.*, 2000; Kraiger & Aguinis, 2001; Kraiger *et al.*, 1993; Salas *et al.*, 1992). Thus, more recent research has provided a greater understanding that many factors can hinder or facilitate individual training outcomes of both learning and transfer, but also that training can be affected by a complex integration of influences. This complex integration of influences has been primarily focused on the individual and individual outcomes, and will be discussed in detail throughout the thesis.

2.1.2 Considerations in Training Effectiveness and Training Transfer

When a decision is made by an organisation to perform training, the training should support the strategic direction of the organisation and training objectives should align with organisational goals (Tannenbaum & Yukl, 1992). Accumulating evidence in the literature has shown that these prior training considerations can impact the effectiveness of training (Tannenbaum & Yukl, 1992). Pre-training impacts fall into three general categories: 1) what characteristics an individual brings to training; 2) variables that engage trainees to learn and participate in developmental activities; and, 3) how training can be prepared to maximise the learning experience (Salas & Cannon-Bowers, 2001). These factors need to be considered in a needs assessment.

The roots and credit can be given to McGehee and Thayer (as cited in Salas, Cannon-Bowers, & Kozlowski, 1997; Tannenbaum & Yukl, 1992) who in 1961 identified organisational analysis to aid organisations where and when training was needed. Thirty years later, McGehee and Thayer's framework for pre-training needs assessment (organisational, task and person analysis) remains prevalent but was expanded to suggest examination of system-wide components (Tannenbaum & Yukl, 1992), and further suggestions followed that organisational goals and objectives drive the training content and thus the success of training and transfer outcomes (Kozlowski & Salas, 1997).

Achieving the link between training and organisational strategy relies on the performance of a detailed training needs analysis that meets the objective of an organisation. Training courses should support the strategic direction of an organisation for future growth and success, and training objectives should align with organisational goals. To achieve the desired outcomes from training the needs assessment steps of organisational analysis, task analysis and person analysis should not be considered in isolation (Salas, Cannon-Bowers, & Kozlowski, 1997; Tannenbaum & Yukl, 1992). This approach should further include a detailed person analysis to assess the specific needs of the individual to meet organisational objectives. When a person analysis is inadequate and details of who should be trained, why, and what should be trained are not sufficiently completed, individual strengths and weaknesses are not identified and the result may be the provision of training at a level that results in sub-optimised training effectiveness (Feldman (1989) as cited in Salas, Cannon-Bowers, & Kozlowski, 1997; Tannenbaum & Yukl, 1992). Organisational analysis in which the goals, strategies, resources and determination as to whether training is the appropriate intervention to accomplish objectives should drive the determination of training objectives (Kozlowski *et al.*, 2000; Tannenbaum & Yukl, 1992). Further, in order to determine the success of a training programme through the evaluation process, the outcomes must be related to the objectives of the training programme (Kraiger *et al.*, 1993; Salas, Cannon-Bowers, & Kozlowski, 1997).

Contemporary models of training effectiveness are different from their traditional counterparts in that they now explicitly conceptualise training in an organisational context (Cannon-Bowers *et al.*, 1995; Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997; Tannenbaum & Yukl, 1992), and they have expanded the focus to identify the effect of organisational higher-level factors influence on training effectiveness along the individual-horizontal platform of the training process (Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997).

In addition, the level (s) at which organisational objectives are targeted and delivered in training require consideration as they can influence the intended training intervention and have a profound impact on the effectiveness of transfer (Kozlowski & Salas, 1997). Needs assessment requires a method to link higher-level objectives, goals, or outcomes with the individual training needs, considering each level within the organisation (Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997). Ideally, a needs assessment should identify and incorporate those training effectiveness factors that will influence the outcome from training. The deficiencies of the needs assessment process to consider multilevel linkages with training outcomes have been noted previously (Ostroff & Ford, 1989), including linkages to training outcomes at different levels (Kozlowski & Salas, 1997).

Traditionally, needs assessment focused on improving individual KSAs to consequently improving individual performance outcomes. With interdependent teams, the traditional form of needs assessment does not take into account that individual and higher-level outcomes are not the same (Kozlowski *et al.*, 2000). Further higher level analysis is required such a team-task analysis (Bowers, Baker, & Salas, 1995). Training needs for teams has been approached to understand crews' tasks and the processes that have led to performance outcomes (*e.g.*, Crew Resource Management) (Bowers *et al.*, 1995; Cannon-Bowers & Salas, 1998). However, the current knowledge of team and higher-level task analysis is limited and much is still to be learned about the effectiveness of different approaches (Cannon-Bowers & Salas, 1997a).

Without a validated method for needs assessment for higher-level task analysis (individual upward through a team), identification of all of the factors that contribute to intended organisational objectives should be undertaken. This may affect the intended outcomes from training, thus impeding the contributions vertically from individual through to team outcomes, which could further reduce the impact that training could have on organisational effectiveness. Thus, there is a necessity to empirically identify and consider the relationship among and between factors and levels for vertical transfer in a complex team-training platform to further delineate the training effectiveness factors and their links. There is a further need to identify the pre-training categories that can impact effectiveness, further clarifying what an individual brings to training and how and what variables and techniques combine and emerge in interdependent teams to learn and how training can maximise learning.

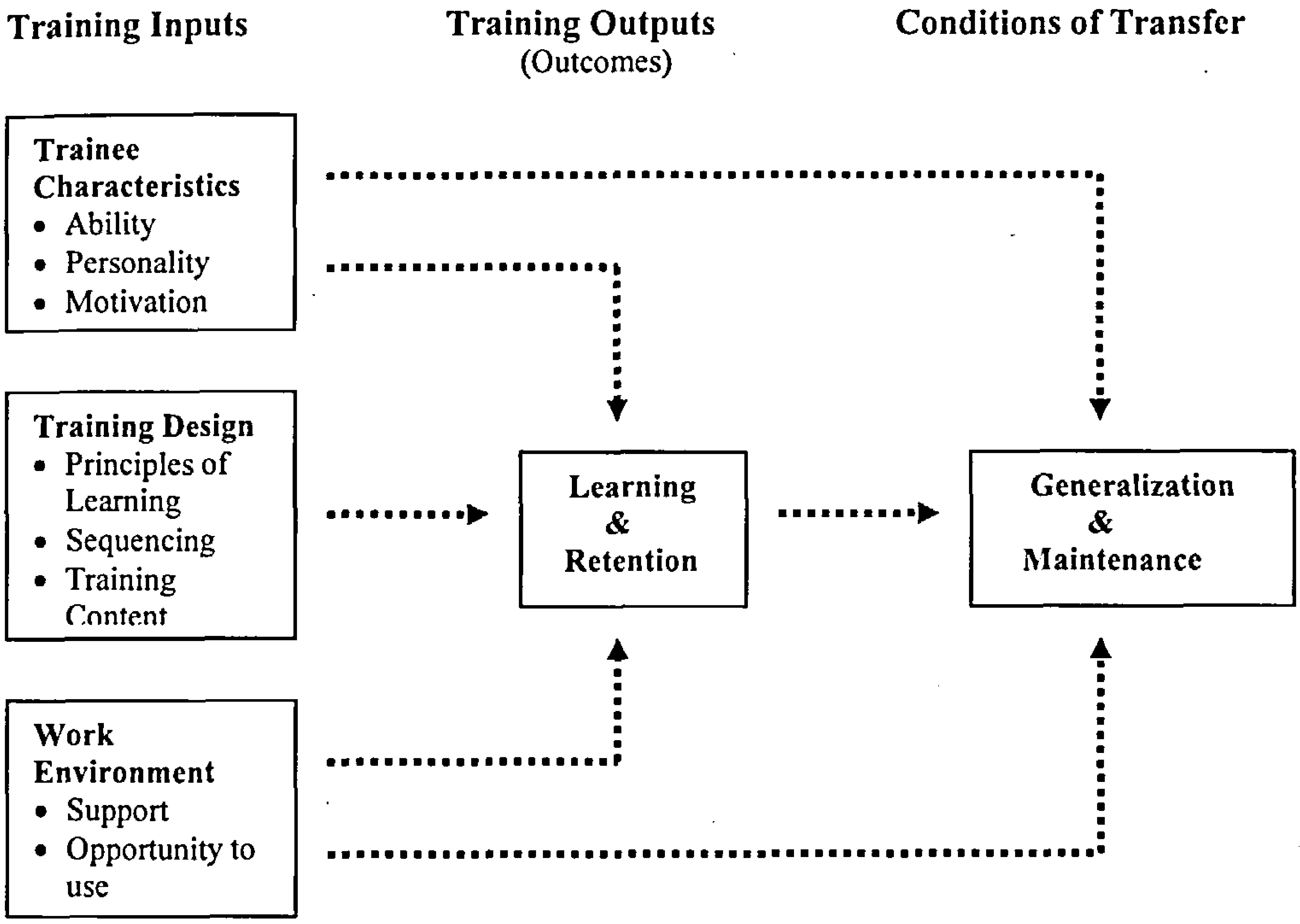
2.1.3 Similarities of Training Effectiveness and Training Transfer

Past research has tended to separate training and desired training outcomes from the application and maintenance of training in the workplace, and this may have been due to the confusion of the definitions of training effectiveness, transfer and evaluation. With the clarity provided by Kraiger (1993) it can be seen that transfer of training and training effectiveness are broader than training evaluation. But also, as training outcomes of learning and retention have a direct effect on the successful application to the workplace (Baldwin & Ford, 1988), then one can say that factors that influence training, influence outcomes, can therefore be an influence in the application back to the job (Figure 1).

The literature has shown what appears to be a more focused research effort on training transfer, but it can be seen that results found in transfer are also applicable in training, and therefore training effectiveness. The literature on training effectiveness has shown the variables that affect training and training outcomes include the categories of training contexts (including methods, content, principles and support); organisational inputs (including culture, history, policies, attitude); and, individual inputs (including the attitudes, behaviours and abilities of an individual) (Cannon-Bowers *et al.*, 1995).

It can be seen that training transfer has actually expanded the influencing factors in training effectiveness to include trainee characteristics that include ability, skill, personality, and motivation (Baldwin & Ford, 1988; Ford *et al.*, 1992; Ford & Weissbein, 1997; Hagman, 1983; Smith-Jentsch *et al.*, 2001; Yamnill & McLean, 2001; Yelon & Ford, 1999), locus of control, self-efficacy (Cheng & Ho, 2001) and experience (Ford & Weissbein, 1997). Training design has grown to include factors such as principles of learning, sequencing and training content (Baldwin & Ford, 1988; Ford & Weissbein, 1997; Hagman, 1983; Yamnill & McLean, 2001). While work environment factors have expanded to include, support to transfer climate, opportunity to use (Baldwin & Ford, 1988; Ford *et al.*, 1992; Ford & Weissbein, 1997; Salas, Cannon-Bowers, & Kozlowski, 1997; Smith-Jentsch *et al.*, 2001; Yamnill & McLean, 2001), and constraints and learning culture (Cheng & Ho, 2001; Ford & Weissbein, 1997; Richman-Hirsch, 2001).

Figure 1. A Model of the Transfer Process



Taken from Baldwin and Ford (1988) Transfer of Training: A Review and Directions for Future Research

The literature on training transfer also shows that the factors that impact has on training outcomes (training effectiveness) are also seen in conditions of transfer, and although applicable to training, the impacting characteristics identified in training transfer are even more expansive. There is also an overlap of the typical factors identified in training effectiveness and training transfer factors. The common elements of the individual inputs found in training effectiveness is also found in trainee characteristics in transfer, training context elements are seen in training design, and organisational characteristics are covered within the category of work environment. What is unique in the transfer model that is not seen in the training effectiveness model is the extension beyond training to address opportunity to use what is learned and of course, the conditions of transfer.

2.1.4 Summary

Although research has typically separated the impact of factors that influence training and transfer it can be seen that there is a commonality of impacting elements (Figure 1) that have both a direct or indirect effect on training and transfer. In review of the influencing characteristics examined in training and transfer it can be seen that the commonality of factors that has been identified as affecting training and transfer are in fact not separate issues at all but rather impacting factors in a longitudinal continuum; factors that affect learning will impact transfer to the workplace. Regardless whether the influences have been identified under training or transfer, the approach in effectiveness research has been to assure transfer of individual outcomes from training to performance in the job context to achieve organisational objectives.

With this mindset training effectiveness can be viewed in a much broader context. The value in viewing the approach as a continuum is that organisational objectives remain the prime focus, and achievement of the aim can be assessed prior to, throughout training and post training. For instance, a training programme may lead to learning and achievement of performance objectives, but if constraints are present in transfer, that learned may fail to completely transfer to the workplace. If one assessed training in isolation the conclusion would be that the training was effective, but if the training does not transfer then training was truly not completely effective. To achieve organisational objectives interventions must extend to facilitate effective transfer, and therefore the application of training effectiveness needs to address both training with the aim of learning, and successful and appropriate application to the workplace. Thus, to assure effective training and application, consideration and amalgamation of the factors that could influence training and transfer must be taken into account prior to, during and after training.

2.2 Broad Spectrum Influences for Training and Transfer

The historical basis and intent of training and development research over the last thirty years, as seen in the reviews by Baldwin and Ford (1988), Tannenbaum and Yukl (1992), and Salas and Cannon-Bowers (2001), has been to characterise and understand the factors and processes that training intervention have on an organisation, assuming that training has been developed to meet organisational objectives. However, in the traditional analysis approach there has always been an assumption that the individual level is the source of organisational change (Kozlowski & Salas, 1997), based on the premise that a needs assessment would identify organisational objectives and thus training of individual KSAs would meet the needs of the organisation.

Based on this assumption research in training effectiveness has made much progress, but the research has typically dealt with training effectiveness as a relatively simple, uni-dimensional (Cannon-Bowers *et al.*, 1995) and unidirectional individual-based construct, focusing on individual learning, enhancement and or improvement of performance, and successful transfer to the workplace. This limit in focus can be largely attributed to the continued dominance of instructional theory in training, which is based on individual-level changes (Kozlowski & Salas, 1997).

Evaluation of the definition of training effectiveness reveals that the focus has not been inappropriate or misplaced. Training effectiveness examines why training did or did not achieve the direct training outcomes of learning and retention, and the intended effective application of the desired KSAs to the workplace. Thus, as learning must first occur at the individual level, training and instructional design should first focus on the individual to achieve the desired organisational objectives.

However, research has traditionally assumed that a needs assessment would identify organisational goals and objectives (Kozlowski *et al.*, 2000) and learning outcomes at the individual level would emerge to influence the higher-level outcomes of an organisation (Salas & Cannon-Bowers, 2001). This premise also relates back to Kirkpatrick's 1976 evaluation typology, in which it has been assumed that if training is designed to support and attain results for an organisation and the results are important to organisational objectives, then improvement in organisational-level variables (within the training context) can be expected (Tannenbaum, 1993). Thus, within this frame of understanding and assuming the completion of a detailed needs assessment prior to training, appropriate training courses should support the direction and strategy of the organisation, and training objectives and individual outcomes should then align with organisational goals (Tannenbaum & Yukl, 1992). Although training is predicated on meeting organisational goals and objectives, the classic training models infer the development of training interventions will satisfy the goals through individual training, although they do not have the tendency to link the process directly to transfer (Kozlowski & Salas, 1997).

Although implied in past work, a fairly new emerging intervention theory has been put forward, although mostly assumed (Kozlowski *et al.*, 2000), that individual-level learning and transfer emerge upward through the group, unit, to yield effects at the organisational level over and above achieving organisational objectives. The theory, referred to as Vertical transfer (Kozlowski *et al.*, 2000; Salas & Cannon-Bowers, 2001), moves beyond the expectation that organisational objectives are met by individual outcomes, rather emerging outcomes from individuals can in fact enhance organisational effectiveness (Kozlowski *et al.*, 2000).

This proposition requires an expansion of the traditional approach to identify and assess training effectiveness beyond the uni-dimensional, horizontal construct. To aid organisations to improve and adapt with the dynamic technological, economic, political and social changes and demands, a greater emphasis is needed to understand the factors, processes and links between training outcomes and organisational objectives so that organisational effectiveness can be achieved. To bridge this gap in understanding, a multilevel approach to training effectiveness has been proposed by Kozlowski and colleagues (Kozlowski *et al.*, 2000; Kozlowski & Klein, 2000) that expands beyond the traditional approach.

Research has shown that this complex multi-factorial interaction of individual, organisational and training factors influences individual learning and outcomes on the horizontal platform (Kozlowski *et al.*, 2000; Kraiger & Aguinis, 2001; Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992). Research and modelling has also sufficiently established the knowledge that group and organisational factors have direct and moderating effects on individual learning and transfer (Cannon-Bowers *et al.*, 1995; Ford *et al.*, 1992). What have largely been neglected in training theory and research are the factors and processes by which individual-level outcomes combine and emerge, from the bottom up, to influence organisational objectives. This theoretical assertion of vertical transfer has yet to be empirically confirmed.

Although formal research and training models have so far only assumed an upward linkage of individuals through to an organisation, it has been proposed that it is likely implicitly considered in practical training applications (Kozlowski *et al.*, 2000), and therefore likely to be present. The assumption can be made that while training effectiveness efforts have almost exclusively been applied at the individual level, achievement of effective training is ultimately determined by the degree to which training contributed to the achievement of organisational objectives. Therefore, if training is based upon the achievement of organisational objectives then an individual must have an influence on those objectives. One can then also infer that if the objective of training is to improve an organisation's capability to meet objectives, then training could also influence an organisation's effectiveness (Goldstein (1993) cited in Kozlowski *et al.*, 2000; Salas, Cannon-Bowers, & Kozlowski, 1997). However, although it has been assumed that training with an aim to meet organisational objectives contributes to organisational effectiveness, to date this is only a theory. The linkage between vertical effects of individuals on organisational effectiveness has also not been well articulated and as such empirical evidence is needed to support the theory.

2.2.1 Multilevel Approaches to Training Effectiveness

Tannenbaum and Yukl's (1992) review of training and development within an organisation identified a recurring theme from practitioners, and one that should be present; the need to link training and organisational strategy to achieve desired outcomes. Achieving desired outcomes relies on the performance of a detailed training needs analysis that meets the objective of an organisation. Training courses should support the strategic direction of an organisation for future growth and success, and training objectives should align with organisational goals. This approach should further include a detailed person analysis to assess the specific needs of the individual to meet organisational objectives. When a person analysis is inadequate and details of who should be trained, why, and what should be trained are not sufficiently completed, individual strengths and weaknesses are not identified and the result may be the provision of training at a level that results in sub-optimised training effectiveness (Feldman (1989) as cited in Salas, Cannon-Bowers, & Kozlowski, 1997; Tannenbaum & Yukl, 1992). This weakness in training effectiveness identified a recurring theme from practitioners, and one that should be present, the need to link training and organisational strategy so as to achieve desired outcomes. Organisations may believe training is appropriately placed at the lowest common denominator, the individual, when in fact successful achievement of the tasks to achieve organisational objectives, requires collaboration from the team.

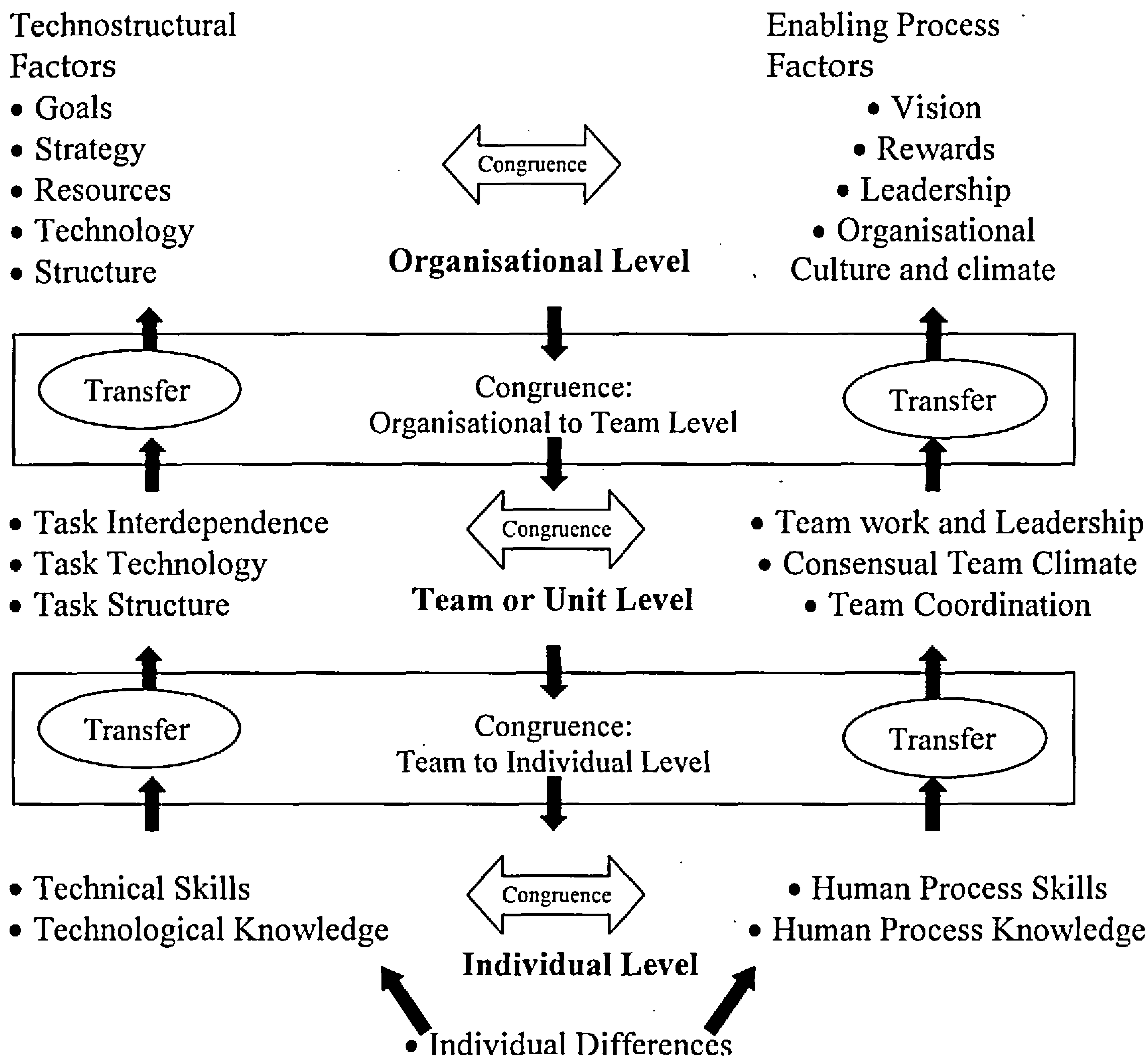
Kozlowski and Salas (1997), drawing from organisational theory, developed a theoretical framework to expand training and transfer research from an individual-level orientation focus to emphasis on an organisational systems perspective for training research. They were the first to propose a theoretical framework of vertical transfer to address the potential upward aggregate affect of the individual on the effectiveness of an organisation (Salas & Cannon-Bowers, 2001). They considered their approach consistent with the traditional training effectiveness perspective, but expanded considerations to more fully elaborate the linkages to an organisational context point of view, which they found needed to be modelled.

The importance of the individual was not discounted. Kozlowski and Salas' (1997) model recognises that training is generally delivered to individuals but often targets higher-level outcomes, and thus their model addresses the extent to which lower-level training (individual up through a team) can contribute to higher-level objectives, and *vice versa*. Their conceptualisation of training effectiveness identified an approach that recognises the multilevel factors and links that are present in the workplace. The model recognises these factors and requirements are then implemented and transferred across horizontal links (within the individual, team and organisation), both down and upward in the training platform to enhance the impact of training interventions on organisational objectives (Figure 2).

Specifically, Kozlowski and Salas (1997) state that the level at which training is delivered and the training content needs to be appropriate (*e.g.*, individual, team or organisational level). But as well, there needs to be an alignment or agreement of the training content within the level of training and between levels (identified as congruence). For example, if the workplace requires improving team performance then the training might necessitate training at the level of intact teams rather than training individuals across different teams (Figure 2) (Cannon-Bowers & Salas, 1997b).

To better achieve the desired outcomes from training, Kozlowski and Salas (1997) differentiated training content for each level into two components (Figure 2). They noted the components as either: 1) technostructural factors, which includes the knowledge and skills needed to fill the job, and as you move upward in levels content expands in scope for the level (*i.e.*, team interdependence, task structure, and upwards to organisational goals, strategy and structure); and, 2) enabling factors involves the human informal, social and interaction processes, from the social and interpersonal skills at the individual through to teamwork, coordination and leadership, to understanding at the organisational level the vision, culture, climate and leadership.

Figure 2. A Multilevel Model for Training Implementation and Transfer



Taken from Kozlowski and Salas (1997) A Multilevel Organisational Systems Approach for the Implementation and Transfer of Training

The model suggests that all of these factors need to be supportive of each other for successful performance in the workplace, and thus training needs to be provided at the appropriate level, across levels, and in alignment with the different levels for enhancement of training interventions on organisational objectives (Kozlowski & Salas, 1997). The intent of the framework is to ensure training is effective, and so they have proposed within their multilevel framework that training must be driven to link lower-level individual targets of training with higher-level outcomes (Kozlowski *et al.*, 2000).

Kozlowski and Salas'(1997) model is the first to identify and clarify the factors and processes of vertical transfer focused on achieving organisational objectives in training. However, the vertical transfer process has been posited as being much more complicated than linking individual and higher level outcomes; workflow interdependencies link the individual to the team through to the organisation, but it has been proposed that this can be achieved through two very different streams (Kozlowski *et al.*, 2000).

Past research has identified that training of the individual through the team to achieve organisational objectives can progress upward as either:

1). Independent, equivalent individual actions that aggregate to form teams in a linear additive fashion with no coordination required within the team; or,

2). Highly interdependent individual actions combine to form synchronous, coordinated team performance in a non-linear fashion (Cannon-Bowers & Salas, 1997b; Kozlowski & Salas, 1997; Salas *et al.*, 1992; A. M. Schaafstal, Johnston, & Oser, 2001).

But it was Kozlowski *et al* (2000) who proposed a detailed framework and developed the model that elaborates the implications of these different vertical transfer processes. Kozlowski *et al* (2000) further elaborated on their own multilevel approach to training effectiveness from an organisational context point of view (Kozlowski & Salas, 1997), proposing a framework to enhance both concepts of horizontal and vertical transfer that recognises and elaborates the different implications of training independent and interdependent teams. Kozlowski *et al.* (2000) identified their initial multilevel framework (Kozlowski & Salas, 1997) was a good foundation to address how individual learning and transfer yield upward effects, however, further elaboration and expansion of the framework was needed to distinguish and conceptualise the two types of team emergent vertical effects beyond the original single model.

Kozlowski *et al.* (2000) identified the two processes as *composition* and *compilation*. *Composition* refers to independent individual actions that aggregate in a linear additive fashion with no coordination within the team. An example of this would be a typing pool, where individuals form a pooled coordination that may vary in their amounts of contribution, but the contribution content is the same. This has been considered the primary and almost exclusive focus found in the literature of team training and performance (Kozlowski *et al.*, 2000).

Team performance that is based upon interdependent individual actions where each individual contributes different content to the team product has been referred to by Kozlowski *et al.* (2000) as *compilation.* Basically, there is a multidimensional and unique performance input from individuals who make up the team. For example, in a surgical team the individual performance of the nurse, surgeon, and anaesthesiologist are all different, comprising of different KSAs and different performance. Failure on the part of any one individual will jeopardise the team's performance, the well being of the patient and the successful outcome. Thus, in compilation the overall performance objective is similar across individuals, but the content that constitutes the individual contribution is diverse and unique, and the higher-level linkage of the individual contributions is different (Kozlowski *et al.*, 2000).

The vertical transfer models of team composition and compilation of Kozlowski *et al.* (2000) have theorised that there are different paths along which organisational objectives will be achieved, and if training is to contribute to organisational effectiveness it must have a higher-level impact (Kozlowski & Salas, 1997). Kozlowski *et al.* (2000) further posit that training results will be ineffective if the training process has not addressed the required combination of differing KSA content of the individuals in a team seen in the compilation model. For training to have the desired effectiveness on organisational objectives and to strengthen the opportunities for training to effect organisational effectiveness, the horizontal and vertical contributions from individuals need to be collectively identified and addressed together.

Kozlowski's two models (Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997) have identified and clarified the multilevel and direction individual, team and organisation factors and processes influence the outcomes from training to achieve organisational objectives, with an aim to achieve organisational effectiveness. The implications of these models broaden the approach to training effectiveness. However, to achieve the utmost from training empirical evidence is still needed to validate the multilevel framework. Performing research in a field setting will also aid in identifying the training effectiveness factors and links between levels. To further amplify the multilevel model, the two different vertical transfer pathways also need to be clarified and elaborated as two distinct and separate entities. Specifically, more research is needed for the proposed compilation model to clarify the linkages between interdependent teams and the individual and team training components required to assure achievement of organisational objectives. Failure to consider this type of vertical transfer in the training process could result in training that targets the wrong KSAs, the wrong individuals, or the wrong level, which will reduce the influence that training can have on higher-level objectives.

2.2.1.1 Organisational Influences and Effects

Kozlowski *et al.* (2000) expand on their multilevel model (Kozlowski & Salas, 1997) to suggest that even if individuals learn the trained knowledge and skills there are often many misaligned organisational contextual factors in the job setting that are not addressed as part of the developmental and training process. As such, organisational contextual factors such as leadership, structure, job-design, rewards and climate (Cannon-Bowers & Salas, 1997b; Clarke, 2002; Kraiger & Aguinis, 2001; Rouiller & Goldstein, 1993; Smith-Jentsch *et al.*, 2001; Tannenbaum & Yukl, 1992), can negatively impact horizontal transfer outcomes, and likely vertical transfer outcomes, when they are not aligned with the training content. Kozlowski *et al.* (2000) do however assert that the theory and research findings are sufficiently well developed such that top down contextual effects (from organisations, units and teams) should be incorporated in research and practised.

In their review of previous research Kozlowski *et al.* (2000) identified three types of higher-level organisational contextual factors that influence training effectiveness. These include pre-training influences, training and immediate post-training influences, and direct effects that facilitate retention and maintenance on-the-job. Although it is agreed that all contextual factors influence or impact training effectiveness, as the data for this thesis was collected while an organisation performed training, the thesis only addresses pre-training and training effects. Thus, contextual effects on retention and maintenance, which are outside the scope of the thesis, will not be discussed. The two types of higher-level contextual factors that influence training effectiveness prior and during training within the horizontal transfer plane are:

1) Contextual factors can affect pre-training motivation so that learning is enhanced or inhibited. In the longitudinal continuum, pre-training motivation is a critical precursor of learning and transfer as failure of the trainee to learn the required KSAs precludes training effectiveness (Cannon-Bowers *et al.*, 1995; Kozlowski & Salas, 1997; Tannenbaum & Yukl, 1992); and,

2) Contextual factors can moderate the extent to which learning during training is translated into new job behaviour and performance outcomes. Learning in the absence of transfer also precludes training effectiveness (Ford *et al.*, 1992; Kozlowski & Salas, 1997; Tannenbaum & Yukl, 1992; Yelon & Ford, 1999).

From the perspective of higher-level contextual factors and their effects, Kozlowski *et al.* (2000) have suggested that theory and research have sufficiently established and supported the incorporation of contextual factors as a likely influence on motivation constructs and facilitates post-training transfer, and thus principles for research and practical application need to be put into place.

Kozlowski *et al.* (2000) have put forward that contextual effects have generally been conceptualised as either *situational constraints* that affect motivation and learning, or as *perceptions* of organisational features, events and processes that are believed of importance and relevance to training, which in turn can influence motivation and learning (Kozlowski *et al.*, 2000). The conclusion that individual motivation is affected by organisational contextual factors has been observed and confirmed prior to Kozlowski *et al*'s (2000) model and since, and research has identified that organisational contexts or the environment surrounding a team cannot be ignored (Salas *et al.*, 1992).

Training research has shown that *situational constraints* such as insufficient job information, equipment, supplies, money and time can hinder motivation to learn (Kozlowski *et al.*, 2000; Kraiger & Aguinis, 2001; Mathieu & Matineau, 1997; Salas, Cannon-Bowers, & Kozlowski, 1997); trainees need an opportunity to perform (Ford *et al.*, 1992); heavy workload and time pressure pose significant barriers to implementing training (Clarke, 2002); and, mandating training can affect pre-training motivation (Kraiger & Aguinis, 2001). These research findings have supported the view that situational constructs can directly inhibit individual motivation and learning during training, therefore there is an influence on the effectiveness of training and application, which could impact organisational effectiveness.

Other work by researchers has identified that organisational contextual effects can also occur through the moderating influence of individual *perceptions*; that is, organisational features and events surrounding training that are perceived and interpreted by the trainees can moderate the extent of learning (Kozlowski *et al.*, 2000). Perceptions that can moderate individual outcomes include organisational support for training (*e.g.* offload work responsibilities), learning culture (Cheng &

Ho, 2001) and the policies and practices related to the value placed on training (Kraiger & Aguinis, 2001). Also, individuals who had the perception of supportive supervisors entered training with stronger beliefs of the value and support of training which positively affected motivation and learning, and so supervisory support is considered a key environmental factor that can affect the transfer process (Cheng & Ho, 2001; Gumuseli & Ergin, 2002; Kraiger & Aguinis, 2001; Tannenbaum & Yukl, 1992). Further, when there is a lack of support from one's leaders or peers and a climate exists that is inconsistent with the trained skills; horizontal transfer of the KSAs is unlikely (Kozlowski *et al.*, 2000).

Supervisors may be a primary influence on trainee expectation and motivation through the signals and messages they send (Tannenbaum, 1993). Baldwin and Magjuka (1997) in their review of pre-training influences identified that research has shown that supervisory support for trainees before or after training may facilitate motivation to transfer. Ford *et al.* (1992) found that supervisors gave some employees more opportunities to perform newly trained skills than they gave to others, based on preconceived notions of the employees (Kraiger & Aguinis, 2001). However, when employees have been socialised to mistrust management and change, they create a negative climate that can be a strong barrier to formal training (Chao, 1997). In one of the few studies looking at the combined effects of trainee characteristics, team leader support and team climate, Smith-Jentsch *et al.* (2001) found in their flight simulation study with 80 pilots, that team leader support can moderate maximum and typical post training performance, and perceptions of team transfer climate were found to mediate the team leaders' impact on trainees.

Research on transfer climate suggests climate matters (Kraiger & Aguinis, 2001); facilitating climate increases trainee focus, motivation and intention to transfer (Rouiller & Goldstein, 1993). A study conducted by Rouiller and Goldstein (1993) in a chain of fast food restaurants, demonstrated organisational climate (situational cues and consequences) was a powerful predictor of whether trainees transferred learned skills. Departmental/manager support was also seen by Clarke (2002) and Gumuseli and Ergin (2002) as affecting training transfer. Gumuseli and Ergin (2002) found in their study of Coca-Cola sales representatives that managers' support and guidance provided prior to and after training (measured at 30 days and 3 months) had a positive behavioural effect, a steady increase in efficiency and greater increases in job satisfaction than those who did not receive managerial support. In Clarke's research

(2002) the effect of perceptions related to in-service training within the social services industry suggested the absence of performance feedback mechanisms and reinforcement of training were seen as factors that undermined training transfer.

Organisational climate and culture, and transfer climate have also been considered as key components that affect both motivation and learning (Cannon-Bowers *et al.*, 1995; Mathieu & Matineau, 1997; Smith-Jentsch *et al.*, 2001). As well, situational cues and consequences were found to predict the extent to which transfer occurs (Rouiller & Goldstein, 1993). Team leaders can shape the degree of transfer through informal reinforcement (Cannon-Bowers & Salas, 1997b; Smith-Jentsch *et al.*, 2001); and, peer, subordinate and supervisor support all play a critical role in successful team training (Riemersma, 2001), including training interdependent teams for emergency management (A. M. Schaafstal *et al.*, 2001).

Research has found that employee commitment to the organisation is a strong predictor of motivation to learn, but also commitment was consistently related to expectations and desires (Cannon-Bowers *et al.*, 1995) and a predictor for motivation to learn and transfer (Kontoghiorghes, 2001, 2002). Both Cannon-Bowers (1995) and Kontoghiorghes (2001; 2002) findings were based on field research, either using Navy recruits (Cannon-Bowers) or health care employees (Kontoghiorghes).

In relation to assuring organisational objectives are met, trainees with a high level of organisational commitment were more optimistic albeit the likelihood of change (Cheng & Ho, 2001). Further, organisational policies may impact an individual's beliefs that developmental activities are worth the time and effort (Noe, Wilk, Mullen, & Wanek, 1997), and the willingness to try and apply newly learned knowledge and skills have been suggested by Noe and Schmitt (1986) as based upon the values trainees attach to training, their expectancy that the transfer will be successful, and their perception of the transfer climate.

Most research affecting transfer has focused on supervisor support as the critical environmental factor affecting training transfer (Baldwin & Ford, 1988), but positive findings have been found for the influence of goal-setting freedom and support (Ford *et al.*, 1992), and varied management styles, including 360 feedback (Noe *et al.*, 1997) and mentoring (Kraiger *et al.*, 1993). Recent research also suggests that the manner in which the organisation frames training, such as advanced or remedial training, influences both training motivation and learning (Quinones (1995, 1997) as cited in Salas & Cannon-Bowers, 2001; Salas, Cannon-Bowers, & Kozlowski, 1997).

Recent models (Kozlowski & Salas, 1997; Kraiger & Aguinis, 2001) and supportive research (Cannon-Bowers *et al.*, 1995, Mathieu, 1997 #343; Clarke, 2002; Ford *et al.*, 1992; Rouiller & Goldstein, 1993; Smith-Jentsch *et al.*, 2001) have considered and identified the direct and moderating influence of organisational contextual factors, both situational and perceptional, on individual-level outcomes of learning and transfer. Research has thus established that the theoretical and research foundation on the effects of contextual factors on horizontal transfer is sufficiently well developed to specify principles to guide theory, research and practice (Kozlowski *et al.*, 2000), but application is the key.

Much more attention has been given to integrating training as a system within an organisational context (Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997; Salas & Cannon-Bowers, 2001) and this progression to view training within a system forces consideration of the multilevel links (individual through to teams and organisation) in all levels of needs analysis (Kozlowski & Salas, 1997) to include organisational analysis. Ostroff and Ford (1989) have suggested that organisational analysis cannot be considered in isolation. However, organisational contextual factors can easily overwhelm the effects of the best planned and delivered training if the social environment and organisational context are not addressed (Baldwin & Magjuka, 1997).

2.2.1.1.1 Summary

Although research has expanded and improved the identification of the multidimensional, complex nature of key environmental constructs and the interaction on the individual, most studies reviewed by Ford (1997) looked only at one set of factors (trainee characteristics, design, work environment) or examined the impact of multiple sets of factors as if they were independent of each other. Organisational factors have tended to be researched in isolation, and further research is still needed to explicitly explore how organisational factors interact with training design elements and how they help or hinder learning (Baldwin & Magjuka, 1997) and the consequences to transfer (Kozlowski & Salas, 1997). Individual level factors can interact with the training context or situation and thus individual, training and organisational factors can impact both training and transfer.

Further research is still obviously necessary to identify and define organisational factors within the multilevel context. As a minimum, Kozlowski *et al.*

(2000) suggest research should incorporate organisational context factors that are likely to influence pre-training motivation (*e.g.*, training attitudes and expectations) and facilitate post-training transfer. Including organisational contextual factors will help the development of a more complete model of training effectiveness that will address both horizontal and vertical transfer. Although there are many principles of research identified by Kozlowski *et al.* (2000) that require consideration, within the context of this thesis further research needs to be performed to identify the direct pre-training motivation effects and the moderating effects on the vertical training-transfer linkage, from the organisational and unit level.

2.2.1.2 Individual Horizontal Transfer Influences

Within the context of horizontal transfer, Kozlowski *et al.* (2000) have proposed that both group and organisational factors have direct and moderating effects that can facilitate or inhibit individual learning and transfer. This premise is based on the fact that many, if not most organisations achieve quality (and thus objectives) through complex contributions across individuals and different levels within an organisation. This notion is in line with their multilevel model (Kozlowski & Salas, 1997) in which they specified that appropriate training to level and content, and alignment between levels is required to achieve effective training (Figure 2).

The framework proposed by Kozlowski and Salas (1997) identifies that at its basic level training induced change is ultimately rooted within the individual, but the influencing factors and processes to learn and be able to perform what is needed in the workplace is more complex than training at the individual level. From this horizontal platform the framework suggests that for training to have a positive effect on organisational objectives, issues beyond the individual need to be considered and applied prior to, during and after training for successful transfer to occur. Specifically, they identified that the level at which training is delivered and the training content needs to be appropriate (*i.e.*, individual, team or organisational level). But as well, there needs to be an alignment or agreement of the training content within the level of training and between levels. Knowledge and skills training, identified as technical structure, and social and interpersonal skills, identified as enabling factors, need to be supportive of each other for successful performance in the workplace, and the training needs to be provided at the appropriate level and in alignment with the different levels.

The training literature has suggested that an individual's ability is often related to the amount learned in training (Baldwin & Ford, 1988). However, Tannenbaum and Yukl (1992) suggest that trainability tests predict short-term training success better than long-term training success or subsequent job-performance. Research is well documented that general cognitive abilities have demonstrated predictive validity for training performance (Kozlowski, Toney *et al.*, 2001; Salas, Cannon-Bowers, & Kozlowski, 1997), and trainees with greater ability will demonstrate better training performance and higher scores on learning measures (Tannenbaum, 1993). Therefore, it is safe to conclude, based on the body of evidence, that general intelligence is good – it promotes self-efficacy and performance, helps a great deal with skill acquisition (Salas & Cannon-Bowers, 2001), and cognitive ability is a strong predictor of academic performance and of self-rated overall training performance (Cannon-Bowers *et al.*, 1995). Thus, those who have high cognitive ability (all other things equal) will likely learn more and succeed in training (Salas & Cannon-Bowers, 2001), but further research is necessary to look more closely at low- ability trainees and how to optimise their learning. It has been said that cognitive ability is a viable predictor of training performance (learning), but not necessarily performance on the job (Salas & Cannon-Bowers, 2001) as many jobs require much more than cognitive ability (psychomotor demands) and may depend on motivation for completion. Current empirical research has not simultaneously investigated the influence of ability and other antecedents on the participation of developmental activities (Noe *et al.*, 1997). Thus, cognitive ability can be considered an influencing factor, but other factors can and do affect both learning and transfer.

Specifically, individuals can be considered as either mastery oriented (able to adapt responses to novel or challenging situations) or performance oriented (affirm their own competence by seeking good performance evaluations) (Kozlowski, Gully *et al.*, 2001). Researchers have identified this individual characteristic as a goal orientation motive (Kozlowski, Toney *et al.*, 2001; Salas & Cannon-Bowers, 2001). The difference in the two types of individuals is that mastery oriented individuals develop competence, but performance oriented individuals are concerned with demonstrating competence to themselves or others (Kozlowski, Toney *et al.*, 2001) and tend to avoid novel situations where their competence is unknown or questionable (Dweck, (1986 and 1989) cited in Kozlowski, Toney *et al.*, 2001; Salas, Cannon-Bowers, & Kozlowski, 1997). Getting trainees to focus on learning strategies can create mastery orientation, whereas a performance orientation is created by getting individuals to focus on achieving task outcomes (Kozlowski, Gully *et al.*, 2001). From a training perspective, research has suggested that goal orientation ought to be an important individual difference relevant to learning, motivation and performance (Kozlowski, Gully *et al.*, 2001), but more research is needed to determine if goal orientation is a relatively stable trait or if it can be modified prior to training (Salas & Cannon-Bowers, 2001), flexible with situations (Mathieu & Matineau, 1997), and a factor on transfer (Kozlowski, Gully *et al.*, 2001).

Further advancements in trainee characteristics as they relate to subsequent task performance relates to the individual variable of self-efficacy (Tannenbaum & Yukl, 1992); defined as an individual's expectation or confidence that tasks can be successfully performed (Ford *et al.*, 1992). Noe (1986) has suggested that an individual's self-efficacy will have an impact on his or her motivation to transfer. Ford *et al.* (1992) found individuals high in self-efficacy were more likely to perform more of the tasks they were trained for and to perform the more complex and difficult tasks. While Cannon-Bowers *et al.* (1995) found Navy recruit trainees who possessed higher levels of physical self-efficacy and commitment had greater performance expectations and desires from the training. Noe *et al.* (1997) found, in their review of the theoretical and empirical literature supporting employee development, that individuals with high self-efficacy are more likely to participate in new and challenging situations than individuals with low levels of self-efficacy.

In Cheng and Ho's (2001) review of transfer training they noted that empirically, self-efficacy has been shown to be positively related to pre-training motivation (Noe & Schmitt, 1986), training performance (Ford *et al.*, 1992), transfer performance and skill maintenance (Cheng & Ho, 2001; Kozlowski, Gully *et al.*, 2001). It was also found that self-efficacy made significant contributions to the prediction of individual adaptability (Kozlowski, Gully *et al.*, 2001). Kozlowski *et al.*'s (2001) conclusions in their computer-based model research on the effects of training goals and goal orientation in university participants found when task characteristics are static, self-efficacy does not add much to the prediction of performance beyond previous skill levels. However, when transfer necessitates the adaptation of knowledge and skills to meet new demands, self-efficacy becomes important. Advancements in research have shown that self-efficacy enhances learning outcomes and performance, but research into self-efficacy of teams still needs to be further explored (Salas & Cannon-Bowers, 2001).

An individual behaviour that has received a great deal of research attention is motivation; conceptualised as the direction, effort, intensity and persistence that trainees apply to learning-oriented activities before, during and after training (Tannenbaum & Yukl, 1992). Early research identified, and it has been widely accepted, that learning and transfer will only occur when trainees have both the ability ("can do") and volition ("will do") to acquire and apply new skills (Noe & Schmitt, 1986). Several studies have found that trainees' motivation to learn and attend training has an affect on skill acquisition (Nease, 2000), and retention and willingness to apply newly acquired KSAs on the job (Milner, 2002; Tannenbaum & Yukl, 1992; Weissbein, 2000).

Recent work by Milner (2002) with university students found that motivation to learn strategies prior to training related only to the number of negotiations people reported during the week following training. Motivation to learn was not found to be related to the number or variety of skills people attempted in any of their negotiations, and even when individuals reported they were motivated to learn they were not likely to try and use the intervention strategies.

An individual's belief in and acceptance of the organisational goals and values, willingness to exert the effort and desire to belong within an organisation were seen to affect, in a training situation, their views on the usefulness of training, both to themselves and the organisation (Cheng & Ho, 2001).

Self-efficacy could potentially impact motivation to learn, motivation to transfer, and, subsequently development growth (Noe *et al.*, 1997), and motivation to learn has been proven to be a strong predictor of motivation to transfer (Kontoghiorghes, 2002). When transfer necessitates the adaptation of knowledge and skills to meet new demands, self-efficacy can be expected to influence motivational and self-control processes, which are seen to be important for effective transfer (Kozlowski, Gully *et al.*, 2001).

2.2.1.2.1 Summary

We see that individual characteristics interact with each other and their combined influence affect both training and transfer, however, further empirical research is still needed to identify the interactive influences of factors for learning (as it directly applies to individuals and teams) as it has a direct impact on the design and delivery of training, and thus could influence vertical transfer outcomes. As well, future work should consider the influence of training motivation on-the-job for situations where workers are required to acquire new skills through informal mechanisms (Salas & Cannon-Bowers, 2001).

It can be seen that current research has still focused on selective trainee characteristics to identify their impact on either training or transfer, with few addressing the longitudinal continuum (of training through to effective transfer) let alone the vertical potential effect. Further empirical and longitudinal studies are necessary to identify the multidimensional influences of trainee characteristics. Only then can more detailed multilevel frameworks and methodologies be proposed and developed.

This case study was not able to directly assess the influences of motivation, self-efficacy or goal orientation, however, exploratory inferences should be possible in the exploration of perceptions, expectations and satisfaction with the training design and organisational influences.

2.2.1.3 Vertical Transfer- Team Compilation Influences

Virtually all current models of training assume organisational goals and objectives achieved through training are critical aspect of training effectiveness (Kozlowski *et al.*, 2000). This traditional presumption is based on the fact that: 1) a needs assessment would identify organisational goals and objectives; 2) the training platform would support this, and individual learning occurs; 3) horizontal (individual) transfer of the KSAs are transferred to the workplace; and, 4) the effects of individual on-the-job behaviours emerge to influence outcomes at a higher level (Kozlowski *et al.*, 2000). It is not disputed that appropriate training courses developed from a needs assessment should support the direction and strategy of the organisation, and training objectives and individual outcomes will align with organisational goals (Tannenbaum & Yukl, 1992). That is not the case for the multilevel approach to training effectiveness as organisational, personnel and task factors are considered for the completion of a needs assessment. However, in the absence of theoretical underpinnings with empirical evidence, the extended assumption that individual-level outcomes transcend to emerge to team and organisational outcomes and impact effectiveness is unsubstantiated (Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997; Salas & Cannon-Bowers, 2001; Salas, Cannon-Bowers, & Kozlowski, 1997).

Kozlowski *et al*'s (2000) multilevel approach suggests that training results will be ineffective, as will organisational effectiveness, if the training process does not address the combination of differing KSA content of individuals in an interdependent team seen in the compilation model, and therefore the horizontal and vertical contributions from individuals through to the team need to be collectively identified and addressed together. The multilevel model proposed by Kozlowski and Salas (1997) discussed earlier in the chapter (Figure 2) poses a framework that can aid in identifying the factors that need to be considered in a needs assessment for interdependent team tasks. Even though they have noted that the theoretical principles inherent in their framework are abstract, generic and not specific, the proposed model can have practical applications for training effectiveness as the framework offers general team-based task requirements and team-work tasks that should be considered (as defined in Cannon-Bowers & Salas, 1997b).

Although specifics are not identified in the Kozlowski and Salas' (1997) multilevel framework, the basis of the framework is sound as it is based upon the requirement to meet organisational objectives, considers the link between levels, and provides the framework (albeit very broadly) to consider the key questions in training effectiveness – how, where and when to deliver different forms of training to enhance transfer (Cannon-Bowers *et al.*, 1995). Also, the identified general categories of task-work (knowledge, skill based training) and team-work (attitude, expectation and perception based training) are consistent with prior team training reviews and research (Cannon-Bowers & Salas, 1997b; Dyer, 1984; Salas *et al.*, 1992; Tannenbaum & Yukl, 1992; van Berlo, 1996), favourable to practical applications (Salas, Cannon-Bowers, & Blickensderfer, 1997) as well as, agree with prevailing views on transfer (as seen in the reviews by Baldwin & Ford, 1988; Ford & Weissbein, 1997; Salas & Cannon-Bowers, 2001; Salas, Cannon-Bowers, & Kozlowski, 1997).

As noted by Dyer (1984), Tannenbaum and Yukl (1992) and Frieling *et al* (1997) teams are heavily used by the military, governments and industry and therefore, to aid in the prevention of accidents and errors, resources and time have focused on emergencies, information transfer, team-training and communication (Donderi & Ostry, 1985). Yet, traditional training methods have been criticised for focusing on individual learning, development and change (Kozlowski *et al.*, 2000), and in the past an obstacle to developing an effective team-training programme has been the lack of methods for analysing team tasks, behaviours and skills (Tannenbaum & Yukl, 1992; van Berlo, 1996).

Although methods may not exist for analysing team-tasks, researchers have come to agree on a common definition of a team in that a team consists of two or more individuals, who interact, dynamically, interdependently and adaptively to work towards a common goal/objective/mission (Dyer, 1984; Salas, Cannon-Bowers, & Blickensderfer, 1997; Salas *et al.*, 1992; van Berlo, 1996) which happens to fit with the vertical transfer compilation model. Researchers are in agreement that individual skills are founded on, required and important for team success (Kozlowski, Toney *et al.*, 2001; Salas *et al.*, 1992; van Berlo, 1996), but to assure achievement of higher level objectives with interdependent teams both traditional individual-level analysis and higher level analysis such as team-task analysis are both necessary (Kozlowski *et al.*, 2000) in a combined integrative process.

Much of the early work by researchers on teams has been performance based (Cannon-Bowers & Salas, 1998; Salas, Cannon-Bowers, & Blickensderfer, 1997; Salas *et al.*, 1992), which identified two critical skill components to the development of a team; those related to the technical aspects of the task (labelled taskwork), and those associated with the team aspects of the task (labelled teamwork) (Morgan et al (1986) as cited in Cannon-Bowers & Salas, 1998; Salas, Cannon-Bowers, & Kozlowski, 1997). In the 1990s researchers turned their efforts towards the refinement of performance-based models to develop models of team effectiveness. Although still performance-based, Salas *et al* (1992) developed an integrative input, through put, out-put model, based on previous research and theory, that identified a link between organisational and situational contexts, task characteristics, work structure, individual characteristics, team characteristics and team processes. The model suggests that team performance is complex and affected by a host of internal and external factors (Salas, Cannon-Bowers, & Blickensderfer, 1997). This model could also be seen as an early version of the currently accepted model for training effectiveness, or could have been the basis thereof, whereby organisational, situational, individual and work factors influence the effectiveness of training, and it also uniquely deals with the characteristics required of a team. However, the shortcomings in this model is that it is performance based and not analysis or assessment based, the factors are unidirectional in their influence, and training is identified as a throughput rather than an affecting factor.

Although past research in team-training has been performance based, it was recognised at the time that beyond understanding the factors that influence tasks in teamwork, one must also have a clear understanding of how teams interact, coordinate, communicate and adapt (Salas *et al.*, 1992; Tannenbaum & Yukl, 1992). However, these skills have proven difficult to identify and explain (Salas, Cannon-Bowers, & Blickensderfer, 1997). Of late intervention team-training strategies have emerged that although performance, outcome based, the focus is on workflow interdependencies that rely upon effective coordination, cooperation and communication based upon the shared mental model theory (Cannon-Bowers & Salas, 1998).

These theoretical-driven team-driven strategies have grown to include: cross-training (Blickensderfer, Cannon-Bowers, & Salas, 1998); team self-correction (Smith-Jentsch, Johnston, & Payne, 1998); cross training and self correction (A. M. Schaafstal *et al.*, 2001); team leadership training (Smith-Jentsch *et al.*, 2001; Tannenbaum, Smith-Jentsch, & Behson, 1998); distributed team training (Garbis & Waern, 1999); and, adaptive team coordination training (Entin & Serfaty, 1995). All of these intervention forms have been tested and evaluated with positive results (Cannon-Bowers & Salas, 1998). They have a common theme in that a shared mental model approach in which there is a shared or common knowledge about the task and/or team, by at least two members (Cannon-Bowers & Salas, 1997b). Further, the mental model approach serves to help people describe, explain and predict system behaviour (Cannon-Bowers & Salas, 1998), and information that is compatible with existing mental models will be easier to learn (Wickens & Hollands, 1999). Thus, although outcome based, these factors are appropriate and applicable to training effectiveness and should be considered in training effectiveness application.

Theorists have hypothesised that training that fosters accurate mental models of systems will improve performance (Cannon-Bowers & Salas, 1998). The team cross-training research performed by Blickensderfer *et al* (1998) is an instructional strategy in which each team member is trained in the duties of his or her team-mates (Volpe, Cannon-Bowers, & Salas, 1996), a method of training that is heavily used in safety-critical training of submariners. The body of research gives strong support to building a team-shared understanding, identified as *implicit coordination*, where team-mates coordinate without overt communication (Blickensderfer *et al.*, 1998; Volpe *et al.*, 1996). When team members' task roles are highly differentiated and interdependent, coordination is a key focus for training in dealing with emergency management (A. M. Schaafstal *et al.*, 2001), requiring both team (coordination and communication) and task competencies to mitigate the risk of errors (Dobson *et al.*, 2001).

Other team training research has focused on developing strategies to train for specific competencies in stress management to aid performance for both individual and team tasks in high demand, high threat situations (Driskell, Salas, & Johnston, 2001). Driskell *et al* (2001) contend that team tasks require attention to both task related activities and interpersonal or teamwork activities, such as communication and coordination, and stress training can prepare individuals and teams to maintain effective performance in high demand, high stress situations. They do strongly suggest in their guidelines for stress training that careful needs analysis is required to develop appropriate training content.

Team performance research can be applied to the general team level categories of the multilevel framework of Kozlowski and Salas (1997), but they can also be applied to the compilation team framework identified by Kozlowski *et al* (2000). The skill component of taskwork reflects Kozlowski and Salas' (1997) general technostructure factors (task interdependencies, technology and structure) and teamwork reflects their enabling process factors (teamwork and leadership, consensual team climate, and team coordination). Although most of the recent team research has focused specifically on intervention strategies to improve performance, the intervention strategy of Crew Resource Management (CRM) is based on interdependent teams used by the aviator and military communities for over 20 years (Salas & Cannon-Bowers, 2001) as a tool to improve cockpit team training. More importantly, it was designed to reduce human-error, mishaps and accidents (Salas *et al.*, 1999).

Salas *et al*'s (1999) recent efforts at developing a methodology for design and delivery of a CRM programme for the US Navy was approached by integrating theoretical models of teamwork and human learning with training needs-analysis tools. The result was a family of instructional strategies identified through a rigorous coordination demands analysis, a set of coordination tasks, and appropriate training methods targeted at teamwork KSAs. CRM training seems to work by changing the crew's attitudes toward teamwork and by imparting the relevant team competencies

(Salas & Cannon-Bowers, 2001), which has advocated and resulted in effective, assertive crews who voiced concerns, as well as, pilots who accepted or even encouraged such communication (Kozlowski *et al.*, 2000). Even with all of these intervention strategies it is noteworthy that the current knowledge of front-end team task analysis and other forms of higher-level task assessments is limited and leaves a great deal to be learned about the effectiveness of different approaches (Cannon-Bowers & Salas, 1997b).

In follow on work by Kozlowski (1998) utilising his multilevel model for training implementation he indicates that team vertical transfer for pooled aggregate coordination (later referred to as compilation (Kozlowski *et al.*, 2000)), "transfer can compose vertically even when there is considerable variation in individual effectiveness following training because individual contributions to group performance are compensatory." However, when team coördination is interdependent (compilation) and each member has unique contributions that are critical to the outcome, training must focus not only on the individual but also on the fit and distinctive contributions of that individual to the higher-level outcome (Kozlowski *et al.*, 2000). In Kozlowski's (1998) work in developing adaptive teams he suggests that teams that are low on task interdependence can benefit from individually orientated training and generic training, and the absence of coordination allows traditional individual models to be useful for training design. However, teams with high interdependence demands require differential individual- and team-specific training (Cannon-Bowers *et al.*, 1995).

The question then arises that if there are degrees of dependence in a team, then what competencies are required for cooperative functioning within the team and are they effective? Cannon-Bowers and Salas (Cannon-Bowers & Salas, 1997b; Cannon-Bowers *et al.*, 1995) assert that depending on the characteristics of the task and team, several types of competencies can be distinguished. They suggest that teams competencies could be delineated into two platforms: a) whether they are task specific or task generic, and b) whether they are team specific or team generic. According to the authors this delineation is important because it determines how best to train and assess performance, and to be an effective team member specific KSAs vary depending on the four categories. Task-specific competencies are KSAs executed in a manner particular to the task, and task-generic KSAs are more generalised and can be transported across tasks (i.e communication and interpersonal skills). Team-specific competencies are KSAs particular to a set of team members (*e.g.*, shared knowledge), and team-generic KSAs can generalise to settings with different team-mates (*e.g.*, attitude toward teamwork, assertiveness).

These factors were then combined to produce four categories of a mix of team and team specific and generic competencies that identified specific team KSAs deemed appropriate for each of the conditions (for more details see Cannon-Bowers *et al.*, 1995; Salas, Cannon-Bowers, & Kozlowski, 1997). Cannon-Bowers and Salas (Cannon-Bowers & Salas, 1997b; Salas, Cannon-Bowers, & Kozlowski, 1997) then further delineated the KSAs to identify those that are shared amongst the team and those that should be compatible, intending to allow team members to execute coordinated sequences. They concluded that for team performance to be optimised, it is imperative that there is a detailed understanding of the team's competencies to achieve the status of an effective team member and a relationship amongst team members (Cannon-Bowers & Salas, 1997b).

Cannon-Bowers (1995; 1997b) and Salas (1997b; 1995; Salas, Cannon-Bowers, & Kozlowski, 1997) suggest that their framework of team competencies is differentially applicable depending on the nature of the task and environment in which the teams perform, and for greater understanding and application they have provided a series of proposed links to categories and selected tasks and environments. They do not however suggest in their framework that any of the KSAs as identified in each of the categories should be expanded to include those from other categories for training if the task and environment deem appropriate, suggest potential cross-linkage between categories, or identify that certain tasks or environments may not fit into their framework.

Herein the framework poses some difficulties, as within the military most operational teams and team tasks are characterised as high task interdependence, low membership in multiple teams, possible member turnover and low variety (van Berlo, 1996). This combination would fall under the context driven, team-contingent and task-contingent competencies, which is not addressed well by their categorisations. van Berlo (1996) further disputes the categorisation as too absolute, as in combat, stress factors (voluntary or not) can influence the rate of membership turnover, thus the task/environment stability is low (team-contingent) and team membership turnover is high (task-contingent). This is not captured in the categorisation. Cannon-

Bowers and Salas (1997b) do indicate in their summary of this body of work that they have attempted to decompose competencies and relate them to training and management, but validation of the framework and competencies is needed, as well as, testing of propositions stemming from it.

2.2.1.3.1 Summary

Defining, refining and potentially expanding the varied KSAs for generic and specific task and team competencies to include more varied roles and tasks for teams is thus needed to better understand and train teams to ensure effective performance. Further research is also needed to gain a greater understanding of team relationships and the impacting variables (physical, task, environment) to expand the knowledge of factors that will affect training, and therefore the influence of training on organisational effectiveness. A field case study can help to define and understand the team and task competencies for complex varied tasks. This baseline research should be performed in the field to assure real-world training conditions, interactive factors and interventions can be identified.

The literature has begun to show that team training works, whether it is theoretically driven, focused on the delivery of required (and known and relevant) competencies (Salas & Cannon-Bowers, 2001) or designed to provide trainees with realistic opportunities for practice (as in Crew Resource Management) (Helmreich, Merritt, & Willhelm, 1999; Salas *et al.*, 1999), and feedback opportunities (Smith-Jentsch *et al.*, 2001). However, in order to better deliver effective training, from the individual through to the team to meet organisational objectives, it can be seen that although not identified, training objectives must be set towards organisational goals. Current knowledge of team-task analysis and other forms of higher level assessments are limited and leave a great deal to be learned about the effectiveness of different approaches (Cannon-Bowers & Salas, 1997b) that focus on the team rather than the individual level. There is significant literature addressing improving team performance and workflow interdependencies, and opportunities should be taken to use and expand the workflow models to make a workable compilation-based model for vertical transfer (Kozlowski *et al.*, 2000).

2.2.1.4 Training Design Influences

Although the multilevel model from Kozlowski and Salas (1997) does not address or include training design in their model, as factors within training are known to influence training effectiveness it is appropriate to discuss and review the literature as training design could impact vertical transfer outcomes and thus potentially influence the impact training could have on organisational effectiveness.

Instructional strategies used for training have been defined as a set of tools (*e.g.* task analysis), methods (*e.g.* simulation training) and content (required competencies) that, when combined, create an instructional approach (Salas, Cannon-Bowers, & Blickensderfer, 1997). In the earlier work performed in the area of training transfer, Baldwin and Ford's (1988) review identified that a large proportion of the empirical research on transfer concentrated on improving the design of training programmes through the incorporation of learning principles such as identical elements (as in identical training as that of the workplace (Smith, Ford, & Kozlowski, 1997)); teaching of general principles; stimulus variability; and, various conditions of practice. They identified that the limitations of the majority of training design studies used simple motor and memory skills in laboratory settings (Tannenbaum & Yukl, 1992) with college students (Ford & Weissbein, 1997). Thus, short-term retention was the criterion (Ford & Weissbein, 1997), and thus the results are not truly reflective of the various work environments, which may improve acquisition and immediate retention but have a detrimental effect on long range transfer (Ford & Weissbein, 1997).

Because there is no single 'perfect' method to deliver training, researchers continue to address how to best target and deliver information to trainees (Salas & Cannon-Bowers, 2001). Traditional methods of designing training systems use a behaviourist approach that emphasises correct performance (Kozlowski, 1998), and traditionally researchers investigated approaches on how to optimise learning and retention by manipulating feedback, practice intervals, reinforcement schedules, and other conditions within the learning environment itself (Salas & Cannon-Bowers, 2001). The traditional instructional-based method using behaviour-modelling approaches teaching primarily through lectures following a deductive learning, task-focused model, where learners proceed from general rules to specific examples (Chou, 2001). In Chou's (2001) field computer training study with students he found the behaviour-modelling training method superior with respect to learning performance and computer self-efficacy.

Some researchers have identified this approach as too narrow an approach as it emphasises correct performance (Kozlowski, 1998), and training that produces observable improvements in behaviour has led to a too narrow framework of learning and training outcomes (Kraiger *et al.*, 1993). Kraiger *et al* (1993) posit there are differences between learning- and performance oriented training outcomes such as retention and adaptation. Further research in the area of organisational and educational psychology has emphasised the distinction between learning goals (where trainees seek to improve their knowledge and skills) and performance goals (where trainees are concerned with demonstrating their competence) (Kozlowski, 1998).

But emerging research that shows promise for improving training design for more adaptive and effective training transfer uses an inductive approach to learning (Ford & Weissbein, 1997), and includes guided discovery learning, error-based instruction and the training of metacognitive skills (Smith *et al.*, 1997). Metacognition is considered an advanced form of learning, that is, knowledge about one's own information processing, problem solving, feeling and acting during learning (Seel, 1997). The traditional deductive approach explicitly instructs trainees on the complete task to be learned in terms of concepts, rules and task strategies (Ford & Weissbein, 1997); but with advances in technology and the demand for more complex cognitive requirements and the ability to adapt to changing circumstance and problem-solve (Smith *et al.*, 1997), it has been suggested that technology will influence the design and delivery of training and a deeper understanding is needed on how to build expertise and adaptability through training (Salas & Cannon-Bowers, 2001).

This revelation of potential technological impact could be seen as a controversy of appropriate training methods, when in fact, as Smith *et al* (1997) have identified, training research and practise have traditionally focused on a narrow range of learning outcomes to evaluate training effectiveness, and have in the past not trained specifically for adaptive expertise. The need to broaden training methods and style to adjust to learning outcomes can also be seen in the theoretical proposal of vertical transfer effect to organisational effectiveness, in that compilation teams (interdependent integration of unique skills) require practice of the intact unit to be beneficial (Kozlowski, 1998). Effective compilation team training requires both individual (for task-specific skills) and intact unit training for integration (Kozlowski & Klein, 2000). The field research discussed later in this thesis will demonstrate this assertion.

Within the vertical transfer framework, Kozlowski *et al* (2000) propose that transfer will be enhanced when individual-level technical skills are trained to proficiency prior to the delivery of training at the team level. The growth and significant evolution of training design has been given credit from the influence of cognitive theory (Kozlowski *et al.*, 2000). Different types of knowledge acquisition require different types of training (Rogers, Maurer, Salas, & Fisk, 1997). Anderson (1982) (cited in Rogers *et al.*, 1997; Salas, Cannon-Bowers, & Kozlowski, 1997; Tannenbaum & Yukl, 1992) made a distinction between declarative knowledge, or fact knowledge (*i.e.,* knowing what) and procedural knowledge (*i.e.,* knowing how), and each differs in the training process to acquire knowledge (Rogers *et al.*, 1997).

Kraiger *et al* (1993) further defined the direct outcomes from training as declarative, procedural and strategic, whereby learning begins with declarative (what), which is then organised and compiled into procedural (how) and then with greater experience becomes strategic (which, when and why). Procedural knowledge is often considered to be directly reflected in successful performance outcomes, but Kozlowski *et al* (2001) caution methods used to assess whether key portions of the task have been successfully learned may not be reflective of the ability to actually perform the task. Task analysis should address these issues prior to training design to determine if the task requires declarative knowledge, which encourages memorisation (Rogers *et al.*, 1997), or whether procedural or problem solving, or strategic knowledge is required.

Pokorny *et al* (1996) found using their model of skilled troubleshooting to evaluate tutor effectiveness and trouble shooting performance, that declarative, procedural and strategic knowledge were hierarchical and that declarative and procedural knowledge were the first to develop. They found that only after a certain amount of declarative knowledge and use of the procedures is the technician aware, and able to troubleshoot, as they then have developed a strategic capability. This observation refers directly back to Salas and Cannon-Bowers' (2001) identification that the most effective training strategies are created around four basic principles, of which presenting relevant information or concepts to be learned and demonstrating the KSAs to be learned are critical.

Effective team performance also requires the knowledge of cognitive processes, as the behaviour of the individual and the team must be known for reliable design of team training (Bowers *et al.*, 1995). Individual training is not sufficient to guarantee collective work coordination during team handling of an emergency (Dowell, 1995). Dowell (1995) found that a distributed cognition framework can provide effective co-ordination of training for a team.

Methods for delivering, obtaining and assessing domain-specific knowledge and the methods to assess the achievement of the different levels of knowledge have resulted, in part, from research in expert-novice group differences (Goldsmith & Kraiger, 1997). Research has shown there are fundamental differences in the ways in which experts and novices solve problems (Abernethy, 2001; Coovert & Craiger, 1997), and experts and novices have been shown to differ in the organisation and content of their structure knowledge (Smith *et al.*, 1997) but interestingly, a student's cognitive structure becomes more similar to an expert's with instruction (Goldsmith & Kraiger, 1997). Experts are typically faster at problem solving (Pokorny *et al.*, 1996), display superior short-term and long-term memory for material, have superior knowledge of relevant facts and procedures, and spend less time analysing problems (Abernethy, 2001). However, the expert's advantage is almost always confined to their domain of expertise and is not generalisable to other domains expertise (Abernethy, 2001). When experts are presented with a novel situation, expert's behaviour appears to resemble that of a novice (Coovert & Craiger, 1997).

Consequently, a trainee's background knowledge is an important factor to consider in the learning process (Smith *et al.*, 1997), to ensure effective training that supports successful transfer. This aspect of a pre-existing knowledge base has been identified in the earlier work by Kanfer and Ackerman (1989) who in their study of over 1000 US Air Force trainees found evidence to support the realisation that interrelationships exist between cognitive resource demands imposed by tasks and motivational processing and attention to task effort. They found that interventions designed to engage motivation might impede task learning when presented prior to the understanding of the task. They also proposed that their results suggest methods for optimal tailored training programmes for trainees of differing ability, and that further intervening measures may directly moderate ability-performance.

The incorporation of guided discovery learning, error-based instruction and the training of metacognitive skills has shown promise to improve training design and effective transfer (Ford & Weissbein, 1997; Smith *et al.*, 1997). In guided discovery trainees explore and experiment with the training tasks to infer and learn the rules, principles and strategies for effective performance, learning through the process of providing leading questions and prompts without providing the solutions (Ford & Weissbein, 1997). This form of training can be achieved formally or informally, and informal peer-to peer training as seen by Wu and Rocheleau (2001) in their survey of informal efforts of computer training found no difference between the private and public sector, but peer-to-peer training appeared to play an important role in the acquisition of knowledge in the workplace. Smith *et al* (1997) identified that research in discovery learning leads to greater transfer of training to novel transfer tasks compared to procedural instruction, and there is greater integration of trained material to the trainees' previous experience (Ford & Weissbein, 1997).

Closely related to discovery learning is error-based learning which approaches training seeking minimal incorrect responses (Ford & Weissbein, 1997), and research has argued that learning environments designed to be filled with error-filled experiences can be quite effective for learning and transfer (Smith *et al.*, 1997). Both discovery learning and error-based learning suggest that allowing individuals latitude to explore the content and develop their own understanding can lead to the development of higher quality knowledge structures (Smith *et al.*, 1997). It is proposed that errors get the learners' attention and alert them to incorrect assumptions (Ford & Weissbein, 1997), but the distinction between the two methods of training is that error-training contains error management elements (Smith *et al.*, 1997). As such, error-based training identifies errors likely to be committed, providing examples of what should not be done, and it has been suggested this approach would benefit both novices, who don't know what to do, and intermediate experts who do not know what not to do (Smith *et al.*, 1997). Smith *et al* (1997) also suggest that if problem-solving skills are required this method may not be ideal and may not lead to effective transfer. Therefore, distinction of the level of expertise of task and knowledge and skill level of individuals must be identified in the needs assessment prior to initiating training.

The third inductive design strategy is to train metacognitive skills (Ford & Weissbein, 1997); intended to develop one's knowledge to monitor individual thought processes (self-regulation) and using strategies for learning and remembering information (learning strategies) (Kozlowski, Toney *et al.*, 2001) to monitor and regulate mental activities (Smith *et al.*, 1997). It has been argued that self-regulation and metacognition are two distinct processes operating at different levels of goal specificity, where self-regulation is a micro process involving planning and monitoring of both cognitive and behavioural strategies to achieve goals (Kozlowski, 1998). Research has identified that experts possess superior metacognitive capabilities compared to novices (Smith *et al.*, 1997). Both metacognition and self-regulation are relevant to learning and performance of complex activities and have been seen as the foundation for individual adaptability (Kozlowski & Salas, 1997; Smith *et al.*, 1997). It has been said that experts pay particular attention to failures, modifying their strategies when appropriate, as individuals who possess superior metacognitive skills are able to adapt and learn as needed (Smith *et al.*, 1997).

Training to support and develop metacognitive skills can be seen to be appropriate for compilation teams to aid in the ability to identify skill integration problems, requirements and preferences within and between team members, as development and expansion of metacognition develop a common mental understanding, which in turn can lead to appropriate anticipation of activities (Kozlowski *et al.*, 2000). Metacognition has also been argued as crucial in stressful decision-making situations (Cannon-Bowers & Salas, 1998).

Most training for team-based tasks is still designed for delivery at the individual level with faith that the individual skills will combine to yield effective teams (Kozlowski *et al.*, 2000; Salas *et al.*, 1992). It has been said that where technical skills comprise the differentiated task of team members, individual delivery is appropriate initially (Kozlowski *et al.*, 2000) as individuals must develop some proficiency on their task before they can devote attention and skill in team-based activities (Kozlowski, Gully, McHugh, Salas, & Cannon-Bowers, 1996; Salas *et al.*, 1992). There is some corroboration to this proposition, but research incorporating the upward vertical transfer framework is still required (Baker & Salas, 1992; Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997). Training methods have also focused on developing collaborative training protocols different from team training in that collaborative learning refers to training in groups but not necessarily to perform a team task (Salas & Cannon-Bowers, 2001). There is a benefit to collaborative learning in that it has been shown to reduce required instructor time and resources by half (Shebilske *et al* (1998) cited in Kozlowski *et al.*, 2000).

Advanced technologies require advanced cognitive requirements which in turn require changes to how we propose to train (Smith *et al.*, 1997), but advanced technologies can also be used to advance and improve instructional methods and capabilities to enhance learning and human performance. Early work by Schaafstal (1993) and Mumaw and Roth (1995) supported the theory that explicit training in theories, fundamentals and principles failed to enhance performance, and was in some cases found to degrade performance. However, they found when skill integration using simulator training was incorporated, complex skills such as component skills, metacognitive skills, complex decision making, and problem solving were best brought together in a simulator.

Simulation training continues to be the popular method for delivery of training (Salas & Cannon-Bowers, 2001), creation of a learning environment that closely resembles a real-world situation supports effective training (Hitt II, Kass, Wils, & Salas, 2001).as Simulation systems (including simulators and virtual environments) have the capability to mimic detailed terrains, equipment failures, motion, vibration and visual cues of a situation (Salas & Cannon-Bowers, 2001).

Early work done by Allen (1985) to identify simulator fidelity and training effectiveness to see the effects of physical and functional computer fidelity effects with college students found both were interdependent to performance effect, and fidelity effects must be interpreted in the context of both task and trainee characteristics. In Carver's (1992) review and assessment of flight accidents and prevention, he suggests that full flight simulators are proving invaluable in their ability to provide flight management training and full mission handling. He also suggests that the weaker the fidelity of the simulator, the stronger the training programme should be. Why simulation and simulators work is not well known (Salas & Cannon-Bowers, 2001), but Salas *et al* (1998) state that most evaluations rely on trainee reaction data and not on performance or learning.

Review of a nuclear plant operation by Macris *et al*, (1986) with a focus to optimise performance considered a training curriculum from a multifaceted system-based framework, effect of procedures, control room design, and simulator training. They propose that all components affect performance in total, and simulators must be considered as an integral part of the overall training scheme. Further work within the nuclear power industry by Toquam *et al* (1997) used rating data from team experts to assess effective crew performance and to identify factors that contribute to crew performance variability during a week long formal training course. Their findings suggest that trainers should not trade validity of the environment for assessment and ease, and team performance assessment should be reserved for procedural and problem-solving tasks to assure adherence to routine procedures, and to diagnose and correct plant problems and malfunctions.

2.2.1.4.1 Summary

Although simulators have begun to be widely used in medicine, maintenance, emergency management, and military settings, Salas and Cannon-Bowers (2001; 1997) ascertain that more systematic and rigorous evaluations of large-scale simulations and simulators are needed. Some researchers have noted (Salas *et al.*, 1998) that simulation and simulators are being used without much consideration of what has been learned about cognition, training design, or effectiveness. As such, the advances in training research need to be applied to simulation design and practice. Proposals have been made to suggest that an event-based approach to simulations would suffice (Cannon-Bowers & Salas, 1998). Future research must also be cognisant of the intent of simulation training, whether the primary purpose is to estimate the on-the-job performance improvement or to test the impact of manipulation (Smith-Jentsch *et al.*, 2001) or problem solving. Smith-Jentsch *et al*'s (2001) flight simulation study findings suggest training considerations should include identification of team makeup and consistency thereof, and when team crews are consistent, low-skill performance in a simulator could help organisations identify teams that are more likely to have transfer problems.

The multilevel model has not incorporated training design components as factors that could influence vertical transfer and organisational effectiveness. However, components within the training design can affect outcomes, and thus they should be examined. Identifying these components within a complex team training field study setting would provide further evidence to expand the model to include training design factors and provide additional training effectiveness factors of importance to achieve organisational effectiveness from training.

2.2.2 Multilevel Approach Summary and Future Research Needs

The expanded theory of multilevel approach to training effectiveness intends to approach training effectiveness from a more holistic human-system interactive approach, and therefore a multilevel phenomenon. Although the root of organisational effectiveness will stem from the individual, implications to an organisation and its effectiveness can cross over multiple levels (Kozlowski *et al.*, 2000). If training design can affect training outcomes horizontally to affect individual transfer, and an organisation can affect training and individual outcomes (top-down approach), then one could presume that individual outcomes can affect a team through to organisational outcomes vertically. The research has shown that training effectiveness also extends within a time continuum; training success is affected by the environment (Tannenbaum & Yukl, 1992), organisational and individual (Kraiger & Aguinis, 2001) factors, before, during and after training. It has been proposed by Kozlowski *et al* (2000) that the basis of training effectiveness is to understand and model the combined individual and team contributions and develop a training system that will influence organisational effectiveness.

Although the framework to lay the conceptual foundation to link individual level skills, behaviours and performance with higher-level organisational outcomes (Vertical transfer) has been identified, to date this is really only a theory. To extend and expand training effectiveness in organisations, a multilevel model is needed if training is to contribute to organisational effectiveness (Kozlowski *et al.*, 2000). For effective application of training to achieve organisational objectives the literature suggests that the factors that influence the individual upward through to the organisation need to be further identified, considered and modelled so as to strengthen the link between training and organisational effectiveness. But as well, the review of the literature on teams has shown that most of the research has focused on improving performance, and so further work is needed to identify the effectiveness of the approaches. Following that, those competencies can then be used to identify the factors that influence training effectiveness.

Training effectiveness is not a micro-phenomenon based on individual-level transfer, rather training effectiveness involves the link between individual and team outcomes (not jobs) with the higher-level organisational objectives that emerge and transcend both vertically across levels and horizontally. The multilevel model proposed by Kozlowski *et al* (2000) also identified two fundamentally different emergence forms of vertical transfer, composition and compilation. Composition is based upon the combination of similar contributions across trained individuals, and research has identified that the traditional assessment and effectiveness models have considered these contextual influences to achieve outcomes. Therefore, if vertical transfer occurs through a composition process then successful outcomes should be achieved. However, the compilation vertical transfer framework has not been modelled previously, and thus much work is needed in the area of training needs assessment, design, delivery and evaluation. One of the primary concerns to formulate a model for compilation is to identify the linkages between individuals, team and higher-level outcomes across levels (Kozlowski *et al.*, 2000), which then requires further efforts to develop techniques and methods to complete process. Within design and delivery, vertical transfer compilation requires the integration of individual and team level training, what KSAs are required at each level, what sequence is required, and where and what training should be performed (classroom, simulator, unit driven). Multilevel training effectiveness still requires foundation for the theory, empirical validation, and applications to support the enhanced role of training in achieving organisational effectiveness.

2.2.3 Training Outputs

According to the model of the transfer process proposed by Baldwin and Ford (1988) (Figure 1) training outcomes of learning and retention are directly affected by training input factors, and are seen to have a direct effect on conditions of transfer. At that time the model was developed as a framework for describing the transfer process, but as Baldwin and Ford (1988) specified in their review of the transfer literature, future research must take into account a variety of factors and linkages that to date have not been adequately or thoroughly examined.

To ensure successful transfer to the workplace, training development needs to consider, and analyse, where training is needed, what needs to be taught and who needs to be trained (Ostroff & Ford, 1989), and as discussed earlier in the chapter many factors have been shown to affect both learning and transfer (singly, and although limited in the scope of research in combination, or theoretically assumed). However, it has been noted that focusing on a correct performance outcome to training has led to a too narrow conceptualisation of learning and training outcomes (Ford, Smith, Sego, & Quinones, 1993), and a multi-dimensional perspective identifying the differences between learning and performance-oriented outcomes would better ensure the expected training outcomes. Kozlowski *et al* (2001) have delineated outcomes identified in Baldwin and Ford's (1988) transfer model as either proximal or distal. Proximal outcomes are exhibited as either learning or performance oriented immediately on completion of training. Distal outcomes or retention refers to the maintenance of learning outcomes over time, which is a prerequisite to transfer.

Learning outcomes include the distinction between declarative (what should be learned), and procedural (how), and with greater experience strategic knowledge (which, when and why) (Kozlowski, Toney *et al.*, 2001; Kraiger *et al.*, 1993; Yelon & Ford, 1999), which are a prerequisite for skilled performance (Kozlowski, Toney *et al.*, 2001) and considered relevant to most job performances (Yelon & Ford, 1999).

Performance outcome has been considered as the ability to successfully complete the behavioural requirements outlined by training objectives (Yelon & Ford, 1999). Theorists have posited that there are three stages of skill level: initial skill acquisition (novice rudimentary skills); skill composition (advanced skill); and, skill automaticity or mastery (Yelon & Ford, 1999) that encompasses situational awareness, prioritisation and implementation of task strategies (Kozlowski, Toney *et al.*, 2001).

Much of what we have learned of how knowledge and skill are obtained (Goldsmith & Kraiger, 1997), how knowledge is structured (Smith *et al.*, 1997), memory for material (Abernethy, 2001), problem-solving capabilities (Abernethy, 2001; Coovert & Craiger, 1997; Pokorny *et al.*, 1996), and the limits of domain expertise (Abernethy, 2001) have resulted, in part, from research in expert-novice group differences. Although much has been learned of the characteristics and capabilities of novice and experts, knowledge of how to facilitate the transition is still largely based on inference (Abernethy, 2001). Genter *et al* (2003) do caution that the intervention strategy whereby learners compare examples cannot be counted on to spontaneously draw appropriate conclusions, even when the cases are presented closely together. Thus, further understanding is still necessary to define the differences between individual experiences (and thus the varied KSAs) and how they learn and transfer.

Distal outcomes have been identified by Kozlowski *et al* (2001) as retention, and the maintenance of learned outcomes over time, which has also been considered an output from training (Baldwin & Ford, 1988). The course of retention is predictable, and is well established; typically performance decreases rapidly soon after training and continues to drop, although at a slower rate, as the retention interval increases (Schendel & Hagman, 1991). It has been said that the growth of training research has increased due to the involvement and cross-pollination with other disciplines, most notably cognitive, instructional and social psychology (Tannenbaum & Yukl, 1992). This is the case for most studies in the realm of retention that has in a large part used military platforms, but also has been guided within the organisational management platform. Early work on sustaining procedural skills using military soldiers and tasks found the intervention strategy of over training eliminates task degradation and task time over those with refresher training, and both were much better than with no additional training (Schendel & Hagman, 1982). Thus, it can be said with army individual tasks that repetition during training improves (relative short term, eight-weeks) retention, is better when repetition is spaced over-training, but repetition testing was not effective when tasks are job-aided (Hagman, 1983).

These findings were not those of Goldberg and O'Roarke (1989), who found in their study using computer games (heavy and light workload) that performance at retention and retraining is more dependent on individual performance differences at the completion of training than on duration of skill-retention, training workload or duration of training. Schendel and Hagman's (1991) review of the literature on long-term retention found, that in general, retention decreases over time but the decay is dependent on a host of variables, of which original learning is key, repetition is important to learning and retention (including over training), that they are facilitated by quality and quantity feedback, and learners may depend on augmented cues, and therefore decay may result from removal of the cues.

Of concern in past retention research is the design of protocols and paradigms to enhance skill retention (factors are not related to training), the lack of attention given to skill acquisition, the lack of consensus criteria for the end of acquisition and the beginning of the retention interval, the failure to assess level of previous skill or knowledge, the role of motivation and individual differences, skill decay in team tasks and skills, and, the lack of complete reporting findings in preliminary studies (Winfred, Winston, Stanush, & McNelly, 1998).

Research, although limited in its specificity to direct outcomes of learning and retention from training, has had an impact in identifying the factors that affect training effectiveness and assurance of affective transfer. However, an outcome of training that has only recently been theorised as a potential training outcome, is the extent to which training may affect the range of organisational processes and characteristics (Klein & Ralls, 1997), and the impact of individuals within a training platform to influence organisational effectiveness – vertical transfer (Kozlowski *et* *al.*, 2000). Progress has been made to understand and refine the intended outcomes of training, but there is much to learn. Proposals have been made that researchers should approach training from a multilevel approach (Klein & Ralls, 1997; Kozlowski *et al.*, 2000; Kozlowski & Klein, 2000) but for vertical transfer-compilation, individual-level and higher-level measures are needed to aid in the development and validation of specified models linking individual-level outcomes to higher-level outcomes (Kozlowski *et al.*, 2000).

2.3 Supportive Theoretical Frameworks

To support and advance the validity of training effectiveness and transfer research, and to help guide research choices for this thesis, it is of value to identify the theoretical frameworks on which training effectiveness has been tested and validated. Basing the research on sound theoretical frameworks will identify relevant theories that will further support and advance the understanding of training and transfer.

2.3.1 Trainee Characteristics

In Baldwin and Ford's (1988) review of the literature they found a substantial lack of theoretical frameworks for guiding trainee characteristic factors that can affect training outcomes. They did highlight that the use of *Expectancy theory* would guide the understanding of motivation in transfer. First presented by Vroom in 1964 (see Yamnill & McLean, 2001), Vroom defined expectancy as a momentary belief concerning the likelihood that a particular act will precede a particular outcome. Thus, within the *expectancy* framework there are numerous factors (locus of control, self esteem, past communication and obtaining intrinsic and extrinsic incentives) that are relevant to the training transfer process (Baldwin & Ford, 1988; Ford & Weissbein, 1997). Although minimal in its application, this theory has been used and has been found to be successful in guiding motivation (Kontoghiorghes, 2001, 2002; Tannenbaum, 1993; Yamnill & McLean, 2001). Further expansion of this theory that directly applies to training is the *Valence-Instrumentality-Expectancy (VIE) theory* also first presented by Vroom in 1964 (see Mathieu & Matineau, 1997). The theory has also been used to guide the understanding of motivation in training, but what is unique in this theory that directly supports and guides the understanding of vertical transfer is that the theory is linked to training outcomes as is vertical transfer. The theory identifies *expectancy* as the personal belief that one can acquire a given skill, *instrumentality* concerns the perception that the acquired skill will lead to specific outcomes, and *valence* is the relative desire of those outcomes for each individual. Utilising the VIE approach will allow the perceived consequences of not doing well in training to be identified, but as well, along with the perceptions and satisfaction from training this approach will aid in identifying the lengths to which trainees will go to achieve that outcome and the result from those efforts. Thus, this theory can also serve as a guide to support and validate the linkage of vertical transfer and organisational effectiveness.

Further suggested theoretical frameworks to guide in the selection of trainee characteristics include *Equity theory*, first identified by Adams (1963) and Vroom (1964) (cited in Lim & Johnston, 2002; Milner, 2002; Salas, Cannon-Bowers, & Kozlowski, 1997; Yamnill & McLean, 2001), which is based on the premise that individuals wish to be treated fairly (a motivational factor); and, *Goal setting Theory* (Locke (1968) cited in Richman-Hirsch, 2001; Salas, Cannon-Bowers, & Kozlowski, 1997; Yamnill & McLean, 2001) which suggests that intentions are viewed as the immediate precursors to human action, which will manifest as an acceptance of the intention and commitment to the goal. Goal setting is believed to have been shown to lead to higher performance because they direct attention, mobilise effort, and encourage persistence on a task. This theory is appropriate to guide research in an applied environment to assess horizontal and top down transfer from an individual, but also, goal commitment is an appropriate theory to use to assess goal commitment affects of an individual on an organisation, therefore providing theoretical support to the notion of vertical transfer effects and organisational effectiveness.

Ford *et al* (1997) also found that concepts of the *Social Learning Theory* were applied to examine the impact of trainee confidence (self-efficacy) in their ability to perform tasks on transfer. This theory is also appropriate when assessing vertical transfer as an individual's confidence level would be a significant factor in successful transfer and maintenance, especially so, when it is expected that the task would be performed with no supervision. But as well, self-confidence could influence individual initiative to provoke change and thus influence organisational effectiveness.

2.3.2 Work Environment

Theoretical frameworks that have been used to support and advance understanding of the influences of work environment variables such as support of the environment and organisational support (climate transfer) include *Social Learning Theory* (Baldwin & Ford, 1988; Ford & Weissbein, 1997; Yamnill & McLean, 2001) and *Organisational Theory* (Yamnill & McLean, 2001). In Ford and Weissbein's (1997) review of the training transfer literature they found the use of the *Social Learning Theory*. Rouiller and Goldstein (1993) in their extensive transfer climate survey found that situational cues (goal, social, task and self-control cues) remind trainees of the opportunities to use what they have learned in the workplace. Further consequence cues (positive, negative and no feedback, and punishment) are the feedback trainees receive to apply their KSAs (Kozlowski *et al.*, 2000). As social learning theory suggests the direct implications of social support from the organisation, *Organisational Theory* enhances the tangible elements that affect the work environment by analysing factors that exert an influence on individuals' responses such as their perception of the organisation. According to the theory, trained KSAs at the individual level are embedded in team and unit level technology, coordination process, and social contexts (Yamnill & McLean, 2001), but likely improvement of transfer is further affected by the organisational support for training (policies, practices and procedures) (Kozlowski *et al.*, 2000). Thus, these theories provide frameworks to analyse both the individual horizontal affect to training outcomes but also there is an opportunity to assess organisational affects to training and transfer, or top-down assessment approach, both appropriate and applicable in identifying and assessing training effectiveness in the workplace.

2.3.3 Training Design

Theories that provide guidelines to help us understand the influences of training design on learning and transfer include both *Instructional Design Theory* and *Identical Elements Theory*. *Instructional Design Theory* is nested within Instructional System Design, providing a set of prescriptive instructional strategies to enable learners to acquire instructional goals (Merrill, 1997). The theory provides the descriptive concepts of how a trainee acquires a particular knowledge and skill, the descriptive strategies an instructor must apply to promote this learning, and the resulting prescriptive guidelines that relate knowledge and skill and strategy. As revealed previously educational based training (which relies upon ISD) and the theories associated are considered limiting in that the theories relate solely to learning knowledge and skill and do not incorporate behavioural affects.

The theory of *Identical Elements* first proposed by Thorndike and Woodworth (1901) (as cited in Baldwin & Ford, 1988; Yamnill & McLean, 2001), proposed transfer was enhanced by increasing the degree of identical stimulus and response elements in training to that of the transfer setting. The theory was further detailed to include near and far transfer by Laker (1990) (as cited in Yamnill & McLean, 2001; Yelon & Ford, 1999), where the constructs of the learning environment and its similarity and reflection to the workplace (near transfer) was most desired for technical/procedural training; while training to situations dissimilar to the workplace (far transfer) was more applicable to a workplace where knowledge was abstracted and required problem solving with a leeway in job performance. Thus, the theory of identical elements and application of near and far transfer refer to not only the similarity and fidelity of training programmes and devices (Lintern, 1991), they pose the importance of the relevance of training content to the goals and objectives of the training – top down affect of the organisation and testing of the training platform for successful transfer.

2.3.4 Summary

A review of the theories has helped to understand the factors that can both hinder and support both learning and transfer. As well, the theories have suggested application of these known relevant factors should be applied prior to, during and after training to enhance transfer. But, for the theories to have value in an applied environment there is a need to combine theories to determine the integrated effect of factors on training and transfer, employing a true examination of system wide components effect. It is recognised that isolated factors have an impact on training and transfer. However, to identify the impact in a real-working-world scenario a global effect approach would identify those factors that hinder learning and transfer. This approach could also identify those factors that could compensate (directly or indirectly) for influences that are beyond control (*e.g.*, individual attitude), both from a longitudinal and vertical perspective. Uses of the appropriately fitting theoretical underpinnings will also support the validity of findings and link of vertical transfer and organisational effectiveness.

3. Preliminary Background and Research Relevance

An unique opportunity was offered to the author to study a large organisation, the Canadian military, during their conversion training to integrate an entire workforce of Canadian Navy submariners to a new class of submarine purchased from the United Kingdom's Royal Navy. To have a better understanding of the usefulness and significance of performing training effectiveness research within an applied environment, it is important to understand the environment under which the research was performed. This preliminary effort to identify the background history of the CF and RN submarine history, procurement of the RN Upholder class submarines, and the subsequent contract to deliver operationally capable crews and submarines would also set the baseline and determine the conditions under which the research could proceed. Identification of the organisational history, philosophy and development of the training programme will also identify some of the pre-training factors and training design factors that could impact the effectiveness of training interdependent teams.

To train an entire workforce to a new system requires significant planning, organisation, coordination and collaboration, and this case study exemplifies the numerous factors that can influence training effectiveness. As noted by Goldstein (1980), "we must consider training as a system within work organisations rather than simply treating instruction as a separate technology." Understanding the history, complexity and uniqueness of the training, and the complications, restrictions and limitations will provide a better understanding of the many factors that may contribute to, or detract from training effectiveness.

Research in this applied environment also provided an opportunity to demonstrate the value and validity of performing training effectiveness research within the real-world working environment by examining the combined variety and links of often overlooked variables and their impact on a training platform's capability to achieve an organisation's objectives. The historical background also identifies the pre-training factors that could influence the perceptions and expectations from training, and therefore identifies factors that contribute to the potential influences of vertical transfer and the preconceived notions that could impact organisational effectiveness.

3.1 Canadian Navy Submarine History and Procurement Policy

For many years, Canada's military had expressed the requirement to replace its ageing fleet of Oberon class submarines, a fleet that was considered beyond its life expectancy and one that had reached the limit of its capacity for future modifications. A true need existed to maintain underwater surveillance and patrol of the extensive Canadian maritime zones and approaches achieved by a submarine fleet. However, with severe defence cuts, further substantive upgrading and competing replacement requirements for the entire Canadian military (armoured vehicles, transport aircraft, helicopters, patrol frigates) and taking into account an unsupportive public's perception of what Canada's military needed, the CF had to prioritise within its budget. Submarine replacement was viewed neither as cost-effective nor an urgent requirement. However, an opportunity presented itself in the early 1990s when the UK offered its conventional submarines to Canada, and the government announced in the Canadian 1994 Defence White paper " The United Kingdom is seeking to sell four recently constructed conventional submarines of the Upholder class, preferably to a NATO (North Atlantic Treaty Organisation) partner. The government intends to explore this option" (Mainguy, 1995). Canada purchased the four diesel-operated submarines and negotiations and contracts were initiated for training and delivery.

3.2 Royal Navy Involvement

The conventional diesel Upholder class submarine was by no means left over or unwanted by the Royal Navy; the British Armed Forces were also the subject of defence cuts. With the aim of saving revenue for the Treasury a decision was made in 1993 to focus on a total nuclear submarine force and the newly built diesel fleet of submarines was declared surplus and withdrawn from service. The RN reluctantly decided that at a cost of $900 million to build, with two submarines only just entering service and two never deployed in operational roles, nuclear submarines would pick up the tasks of the Upholder fleet (Hillbeck, 1999; Romanow, 1998) and the diesel-electric powered fleet would be placed in dry dock awaiting purchase by another nation.

3.3 Submarine Purchase and Contract Development

In 1998, after much speculation and negotiation, announcements were made that a contract had been signed with the UK, and Canada would purchase the four

Upholder class submarines. The package was considered lucrative, with an eight year, interest free, lease-to-buy arrangement. With no hard currency payments Canada would receive four submarines, associated trainers and simulators, crew training, initial spare parts and a technical data package. The acquisition was considered not only the 'bargain of the century' but a quantum leap in capability for the Canadian Navy. With its extensive automation, the Upholder submarine is still considered one of the most technologically advanced in the world. As well, with a crew size reduced to two thirds, from 69 on the old CF Oberon class to 49 on the Upholder class, the smaller crew size was most appealing during a period of personnel cutback as it was considered a significant benefit (Romanow, 1998).

The contract identified Vickers Shipbuilding and Engineering (VSEL), now part of British Aerospace Engineering (BAE)), with the support of the RN would provide classroom, simulator and onboard continuation training for all crew for each of the four submarines and supporting personnel. But as well, as all of the submarines had been in long term storage for an average of five years, the submarines themselves would require servicing and potential replacement of parts prior to reactivation. To achieve both requirements within a reasonable and agreed upon finite timeframe of four years it was decided to train, test and qualify crews in parallel with the servicing schedules of the submarines, so both crew and the submarines would be ready simultaneously.

The contract stipulated that the RN would be responsible for reactivating the submarines, putting them through sea-trials and returning them to operational readiness before delivering them as 'safe-to-dive' certified to Canada. The RN would also be responsible for crew training and assurance of capability by: providing individual occupational operator and maintainer training and team training; and, certification of crewmembers' capability to perform the necessary skills in a sea-going setting. The contract stipulated that the RN was responsible for delivery of a competent trained crew and an operationally functional and safe submarine (safe-to-dive), but until that occurred the RN retained ownership of the submarines and any associated technical or training equipment and material. Thus, certification of the capability of both the crew and the submarine was the responsibility of the RN commander of the submarine fleet, and with that came the responsibility of assuring the adequacy of the procedural documents that would be used on the submarine. Therefore, the RN would train, assess and qualify according to their policy and procedures, mainly the RN Submarine Sea Training Guide (Royal Navy, 1999a). Transfer of ownership would not occur until all components of the contract were met to the satisfaction of first the RN and then the CF.

3.4 Pre-training and Training Requirements and Complications

3.4.1 Pre-training

The purchase of the Upholder class submarines from the RN involved a complicated collaborative contract that required the delivery of operational submarines and trained CF personnel to operate them. To achieve this within the defined stringent timeline, very specific pre-training and sequenced training was necessary to meet requirements, not only for the Canadians but also for the RN submariners identified to perform the training.

Prior to serving on any submarine in the CF (or the RN for that matter), military submariners must as a prerequisite know the basics of a diesel class submarine and earn their 'dolphins' (comparable to earning pilot wings), typically a yearlong process of classroom training (6 weeks) for theory with an in-depth onboard qualification regime. The process involves a comprehensive study of the specific class of submarine, operations and all systems (air, hydraulic, electrical, mechanical, weapons, safety, and escape and rescue), and each portion is tested for both knowledge and skill (Sullivan, 1998). As the consequence of error could be catastrophic for both the men and the submarine, prior to active service on a submarine the trainee must be able to prove his ability to 'make the submarine safe' and is examined on the entire operation of a submarine, systems requirement, function, and operation as a whole.

Prior to entering continuation training all personnel who were assigned to be future crew or support to the Upholder class submarines needed to fully understand all safety aspects of the submarine and, therefore, must have obtained their basic submarine qualification (dolphins). It may seem that the prerequisite training of the Canadian submariner would not apply to the Upholder class of submarine. That is not the case, as both classes of submarines are diesel-electric composed of the same operating systems, and the basic operating procedures and emergency operating procedures (EOPs) were considered almost the same. The only difference from a technical operating perspective is that Canada's Oberon class was entirely manually operated while the Upholder class is semi-automated with a redundant back up manual system. Although this difference has been considered minor from a technical perspective (organisationally), putting aside the potentially ingrained knowledge and skill and learning a new operating method could prove to be a challenge. The main body of research for this thesis and the performance of a Hierarchical Task Analysis and training effectiveness assessment of emergency procedures will determine if this is the case.

Pre-training and upgrading was also necessary for the RN prior to initiating training. In January of 1996 the RN was informed of Canada's intended purchase of the submarines and preparatory events were set into motion; an Upholder Training Team (UTT) was created from Naval technical crew who had once served on the Upholder submarines. As training of the Canadian submariners would require an overlap of successive crews training (*i.e.*, crew one skill phase, crew two knowledge phase) to meet the contract timeline (Section 3.2.2), all available Upholder class submarine technical experts were brought together to form the UTT, including those who were still in the RN, and those who had retired from the military were contracted as VSEL staff.

Also, with a lapse of over five years since any training or active service had been engaged, the training curriculum and procedural documentation needed review for the programme to proceed. As well, as the submarines were only in active service for about a year prior to decommissioning, not all of the training curriculum or procedural documentation had been completed or formally approved. The UTT interview revealed, "No true documents were left over, a curriculum was left over from original training, (but) no training package was available or made for the 'U-boats' (Upholder submarines) when they were the property of the RN." The standards for documentation and training had also changed and required significantly more details, thus the training team was required to upgrade and complete the documentation and training plans where needed prior to initiating training. As in most major organisations, including the CF, the late 1990s brought a move toward standardisation of format and content in all documentation to ensure quality of outcomes (training or otherwise) to meet objectives.

To effectively teach the Canadian submariners, the UK training personnel also needed to be brought up-to-speed and reacquainted with all of the operating details of the submarine. Although all team members were selected based upon their detailed knowledge and capabilities and were considered very experienced and capable of teaching, they still needed refresher training to bring them to an acceptable level. But the challenges were immense, as no one had been involved with diesel submarines, or submarines at all in some cases in over five years. They had very little to aid them besides memory and determination: no up to date documentation; sketchy training outlines; no other experts to seek guidance from; and, access to the submarines was a continuing problem and not within their control. As stated by the RN Commanding Officer, "It was intense self-training, 'learn as you go', they are/were submariners first and instructors second, they knew the people and the environment, and knew how critical training was. Flagship (contractors) wrote their own lectures but they were reviewed and approved by UTT, based upon existing RN documents, although the information available was very scant, part broad statements, and very sparse. When a decision was made to go nuclear, all training, formulation and production of documents was stopped, and was in its infancy."

The delivery contract identified re-activation of the submarines would run parallel with training, so ideally both the submarine and the CF crew would be ready at the same time and would sail to Canada. Significant maintenance and unexpected repairs required more time than expected and therefore a very stringent time line was needed to meet acceptance dates. Also, for safety reasons only maintenance personnel had access to the submarines during reactivation.

The conundrum faced by the training team was how to assure the documentation is complete if knowledge and skill are not current, and how do you reacquaint instructors with systems when not have all the necessary resources are available? Compounding this dilemma, there are no qualified experts outside the team to seek guidance from to ensure correctness or sufficient detail of the documentation or the training syllabus, as all previously Upholder qualified submariners had been seconded to the training team.

Thus, although standards for documentation and training had become more stringent, the RN department responsible for the quality control, Op Doc, did not have the technical expertise for the Upholder class submarine and was only able to review the syllabus and documents for style and format. The lack of submarine technical expertise by Op Doc would not be considered unusual, as a standard department's role is to ensure quality control of style and format in accordance with technical and training objectives. As all Upholder qualified submariners had been seconded to the training team, unfortunately, there was no one outside the team with the knowledge, skill, or experience with this class of submarine to provide an unbiased and objective judgement of accuracy or completeness of the training syllabus or the supporting technical documentation. Even if there had been additional Upholder qualified personnel available to form a training standards cell, as a period of over 5 years had lapsed since there were any dealings with the Upholder class submarine, there was no one who had any more knowledge or experience than those who already were seconded to the training team. Interviews with the UTT team members revealed, "No one in CSST (Captain Sea and Shore Training) has 'U-boat' knowledge, UTT act as CSST assessors on behalf of CSST. CSST came to assess UTT, against up to date standards for style and policy, this has nothing to do with technical content." As a result, the writing and upgrading of documents was completed almost entirely from memory by the UTT team.

Further, the contract did not stipulate the level of knowledge or skill required by the training team or the assurance thereof. With an average of over twenty years service on submarines and a professionalism that should be commended, the team recognised all of these shortfalls and took it upon themselves to try to bring themselves up to speed, became reacquainted, and then tested their knowledge against the pre-existing USQ specifications, first completed in 1990, before initiating training to the Canadians.

3.4.2 Training Requirements

It was agreed that the RN would be responsible for providing conversion training to 344 basic submarine qualified Canadian personnel, for all occupations and all experience levels (both technical and management). This would include personnel, who would form the crew on the submarines, and management and support personnel who would develop, implement and guide policies, procedures and guidelines, as well as those who would perform future CF training. To meet contract requirements to supply both a competent crew and an operationally capable and safe submarine, training was performed from a systems performance basis. All crew who were needed to operate a submarine, with the addition of spare personnel to account for attrition were trained simultaneously, receiving individual occupational operator and maintainer training; team training; and then as a complete crew, testing on the reactivated submarine to certify all crewmembers were capable of performing the necessary skills in an operational setting. As Canada would be purchasing four submarines, training to achieve a functionally capable crew would be completed in four successive waves with training of an entire crew, providing specific occupational and general safety conversion training to all personnel, for each successive submarine. Upon completion of training and certification of operational capability of both the crew and the submarine, each certified crew would then sail its submarine back to Canada.

All individuals from each crew would first be provided system specific training for their occupation, lasting from three to four months depending on the occupation. During this knowledge acquisition period no team or skill training would occur, and the training was not intended at this phase to be operational, tactical or ship-wide organisation training (Detachment, 2000). Training was provided at a level to understand system functionality, and not intended to be detailed to complete maintenance (Detachment, 2000). On completion of individual training personnel were expected to have a good theoretical knowledge of this class of submarine and its equipment. This phase of training was completed at the RN Submarine Training Centres in Farham and Portsmouth[2], UK.

The next phase of training was individual skill acquisition and certification. Upon successful completion of individual occupation training, crews then continued their individual training in the north of England, at Barrow-in-Furness, where the submarines were being reactivated, to complete systems qualification certification – Upholder Submarine Qualification. As in training for any class of submarine, qualification to becoming a crewmember requires as a pre-requisite the confirmation that each member has an in-depth understanding of the class of submarine aboard which they will be working. As is standard for most nations and mirrored in the type of training previously completed by the Canadian Navy, the process involved a comprehensive study of the submarine, operations and all systems (air, hydraulic, electrical, mechanical, weapons, safety, and escape and rescue), and individuals were tested for both knowledge and skill for each portion.

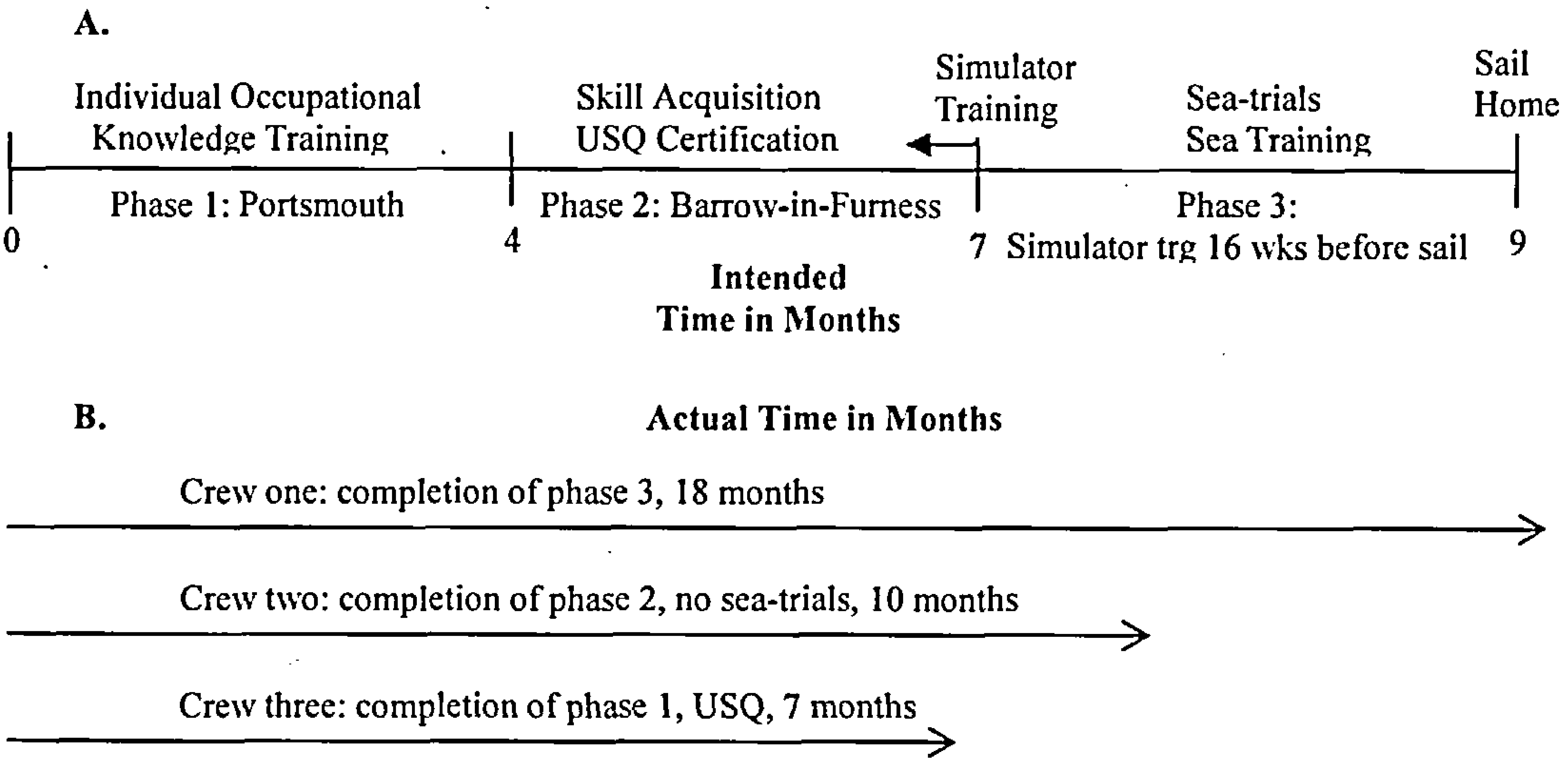
This was achieved through six weeks of lectures, walk-through and detailed situational simulations onboard the submarine to understand the systems, their interaction, and to practise their skills that may be needed. This was also the first time

.[2] HMS Collingwood in Farham provided classroom training, while individual and team simulator training were provided in Portsmouth, UK.

HMS Collingwood in Farham provided classroom training, while individual and team simulator training were provided in Portsmouth, UK
any crewmember would have seen the submarine and spent any time onboard.

Upon successful completion of examination by board (both oral and written), the member would be awarded an Upholder Submarine Qualification (USQ) (Team, 1999), which is the achievement of a 'dolphins' certificate for the Upholder class of submarine. Without prior training and knowledge of a submarine this phase would normally take about a year to complete. However, as the prerequisite to this training required that each CF member must have achieved the basic submarine qualifications, in an Oberon class (in which the principles and requirements are the same for any class of diesel-electric submarine), the time to achieve the USQ, including the board exam was estimated to be three months, with small individual variations.

Figure 3. Submarine Training Programme Timeline – Intended and Outcome



The sequence of training then would proceed with 2 weeks of individual simulator training in the machinery-control and full-motion ship-control trainers, and then 1 week of team training in the same simulators would follow. Both simulation trainers were built to reflect the display and function of the machinery/engine room and control room of the Upholder class submarine. This training also occurred in Portsmouth, UK. Ideally, completion of training would follow shortly thereafter with sea-trials to provide sequenced formal training time on the submarine to put into practice the knowledge and skills, and to test the capability of the entire crew. To ensure the crew had the knowledge and skill necessary to complete the required tasks, the contract stipulated that crews must be tested and pass identified requirements in the simulators (machinery and control room trainers) 16 weeks prior to sail.

The entire training programme and expected delivery of each submarine was expected to take nine months, and a new crew would begin phase-one, individual training, upon completion of the preceding crew. However, very soon after the contract was initiated it was realised that these stringent timelines could not be met as structural and mechanical problems were identified in the submarines (*e.g.*, defective joint welds in three of four submarines, corrosion issues, fuel leaks and battery charging problems in HMCS WINDSOR (ex- HMS UNICORN). "Fixing the problem meant two-to-three-month delays in delivery of the first submarine, HMCS VICTORIA, and similar delays on the next two boats"(Hobson, 2001). This anticipated delay turned out to be a very conservative estimate.

3.4.3 Training Complications

The contract specified that a trained crew and an operationally serviceable submarine would be provided simultaneously. Although there was some flexibility in negotiating timeframes to ensure four submarines and four crews were delivered, mechanical and structural problems with the submarines were not foreseen and the result was a significant delay in reactivating the submarines. This had a significant cascade effect on the training programme: training staff and crew were not permitted access during the maintenance of the submarines; CF crew USQ training and certification times were extended; sea-trials were delayed; and, as a result trainees required further simulator training as the 16 week window before sea-trials could not be met.

Even from the very beginning repair to the submarines posed a problem and, with very little access to a submarine the UTT staff had to retrain themselves and write the technical and training material mostly from memory. Difficulties in access thus made learning and practising what was learned a challenge for the trainers and the trainees. The submarine control room and machinery room simulators were available however, geographical distance of the trainers and the crews from the simulator made hands-on training difficult and access infrequent.

Maintaining the training momentum was a problem that not only influenced the first crew the effect cascaded to training all subsequent crews. The delays in delivering the first submarine required the first crew to receive retraining on the simulators to refresh and regain their knowledge and skills prior to sailing the submarine. Although the training of subsequent crews had been pushed back by six-nine months, the crews for the second and third submarine were in various stages of the training programme. Even though retraining was necessary, rescheduling became a problem; class training had to continue for the next submarine crew, available simulator time and staff had to be found to support the additional training, retraining was required before the 16-week window to sail, and the amount of time required to retrain was not known as the degree of degradation of knowledge and skill was not known. This significant adjustment to the training schedule was not anticipated. There weren't enough staff to perform the regular training in addition to performing the required retraining that was anticipated to last at least one month, and thus further delays and interruptions were imposed on the subsequent crews under training.

Training complications also resulted from the lapse of over five years since any training or active service had been engaged, as the training curriculum and procedural documentation needed a review of requirements, completion and upgrade for the programme to proceed. Interviews with the training team clarified memory served as the primary resource, "Even though some things were documented, a lot of things were not saved. UTT saved all documents when the submarines were laid up, and didn't throw out anything. However, Abbeywood (submarine designers), FOSM (Flag Officer Submarines) and the submarine squadrons threw everything out. (We) Couldn't remember everything, historical info was not kept or available, and not all technical data was (sic) available." These circumstances created a training programme, and procedural and technical documentation to be a living/working process, changing as necessary when memories were triggered, questions arose that couldn't be answered, or new information was brought to light.

3.4.3 Summary of Pre-training Influences

The history of the RN preparation for training, the CF pre-training requirements and the contract development, complications and restrictions suggests that pre-training individual and organisational factors would likely impact the training platform and thus impact the perceptions and expectations of trainers, management and CF trainees. These pre-training influences can be categorised into pre-training participant characteristics (trainers, management and trainees); training contents and principles; formal and informal training aids; and, instructor characteristics. The specific pre-training influence on individual training and training effectiveness are discussed in detail in Chapter 6.

4. Methods

Through a case study evaluation, the aim of the thesis was to advance the understanding of collective, multi-dimensional influences, limitations, interactions and adaptations that can influence training and ultimate transfer to a complex interdependent team-oriented work environment. However, the scope of evaluating training effectiveness of the Canadian Navy's entire training programme would be extremely time-consuming and intrusive (beyond the limits of a thesis). Permission was thus obtained to assess training effectiveness in the interdependent team performance of safety-critical elements of operation – the goal of effectively performing Emergency Operating Procedures (EOPs).

To aid in the achievement of the objectives for this thesis, the multi-level framework proposed by Kozlowski and Salas (1997) was used as a guide in data collection. It supported this effort, as the theory was developed to ensure training outcomes achieve organisational objectives. The theory also aided data collection in that it provides a framework, albeit very broadly, of the factors from the organization, team and individual that needs to be supportive of each other for successful performance in the workplace (Figure 2). The theory therefore also identifies the generic multi-level factors that training interventions need to target at each level, and the alignment needed between levels for successful transfer. As well, as Kozlowski and Salas' (1997) model further proposes that for training to be effective lower-level individual targets must link with higher level outcomes, the multi-level factors identified for individuals and teams also provides indicators for assessment of the content, delivery and timings of training for interdependent teams.

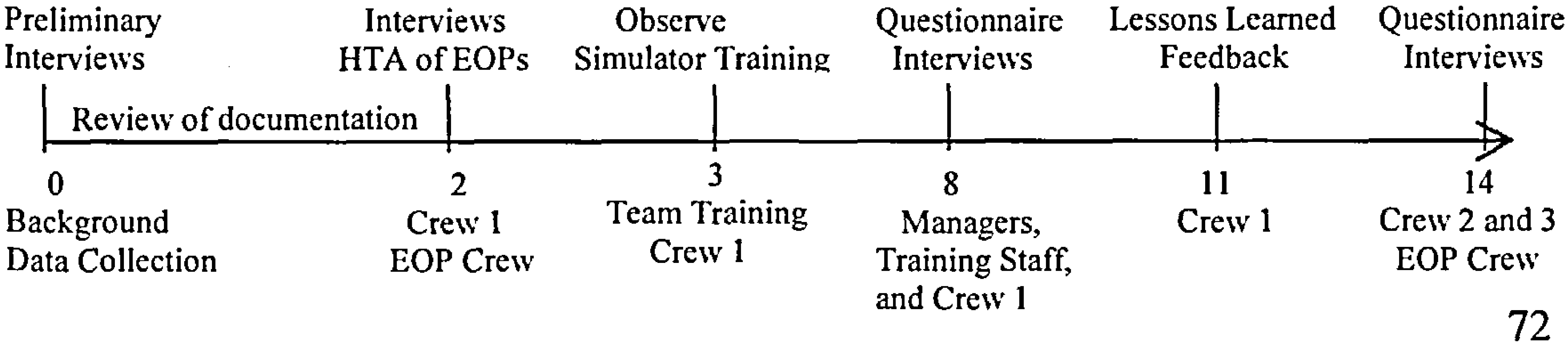
Due to the constraints imposed when performing research in a field setting, this case study was not able to provide a comprehensive detailing and review of all influencing factors identified in effectiveness research. However, to explore the breadth of factors that could influence both training and outcomes, background individual, situational and organisational influences to this training platform from the involved organisations (RN and Canadian Forces (CF)) were identified. As well, to identify and link the combined training effectiveness influences that could facilitate or hinder successful team transfer of that learned, training influences from the organisations, upward link from individuals, and impacts directly from the training design and the relationship to the work platform were identified within the framework of the training platform. This thesis thus focused on selective identifiers prior to and during training (that could be studied without interference) that influenced training success as it applies to the performance of safety-critical elements in a new working platform for trainees.

Data collection was thus exploratory but also qualitative, structured to observe training and also to identify the perceptions, reactions, expectations and satisfaction of trainees, trainers and management in this complex, team-oriented training platform. This data collection, supported by the theoretical framework from Kozlowski and Salas (1997) was derived to provide the foundation empirical evidence to support the theory of interdependent vertical transfer and thus provide evidence to expand training effectiveness outlook as multidirectional and multidimensional that can support the achievement of organisational objectives. Data collection methods were also derived to aid in determining if the upward linkage of individuals through to interdependent teams has the capacity to influence organisational effectiveness.

4.1 *In situ* Protocol Design

As the research was performed during the actual training of the Canadian Navy to integrate submariners to a new class of submarine, with the condition of non-interference, the design and application of the research was restricted to: 1) historical review of pre-training influences from both organisations, prior training of the trainers and the trainees, and the considerations and development of the training platform; 2) Hierarchical Task Analysis (HTA) of workplace emergency procedures to identify conditions which are necessary to undertake the operations and achieve system and organisational goals; 3) review of the training process, methods and training aids (technical documentation, procedures, simulators, and walk-through training); 4) observation and monitoring of the successive crews training process; and, 5) administration of interviews and questionnaires to relevant and involved personnel.

Figure 4. Training Effectiveness Protocol Design and Timelines (months)



Case study approach

1. Develop an understanding of the historical background and the training platform and process baseline. Completed through interviews with managers and trainers, and review of supporting documentation;
2. Develop an in-depth understanding of emergency operating procedures, the tasks required, sequence, their interrelationships with systems and personnel, and their difficulty and criticality. Completed through in-depth interviews with crew who perform the duties, review of EOP procedures, simulator-training observation, and in depth observation of the working platform; and,
3. Identify the effectiveness of the training platform capability to provide training for emergency operating procedures for transfer. Completed through questionnaire and interviews with relevant crewmembers in training from the first, second and third submarine crews.

4.1.1. Integration Process and Training Timeline

The integration process involved the successive training for four complete crews, intended to train personnel (individually and as a team) to form competent crews, one crew at a time, in an expected total timeframe of 4 years. The contract intended to provide conversion training to Canadian submariners and thus all selected personnel must have achieved the required pre-requisite knowledge and skills prior to course loading (discussed later in Chapter 4.4.1). Military succession planning for operations, training and recruiting is an ongoing process and thus personnel were course loaded as required. Therefore, the relevant data was collected during the training regime with those who performed the training irrespective of individual prior experience or expertise (*i.e.*, time qualified as a submariner, years of operational experience, and years since operational service).

The case study was performed in the midst of continuation training. All personnel were either active military in the CF or RN, or contracted personnel with Vickers Shipbuilding & Engineering Limited (VSEL) to perform training (through RN); with training observation, interviews and questionnaires completed with available personnel as training and operational commitments proceeded and allowed. Due to unpredicted significant delays in reactivating the submarines, beyond collection of data from RN trainers and Canadian management, data could only be collected from the first three Canadian crews at various stages of completion of the training programme. The training of the first crew was considered a pilot course (within this training platform), and just prior to their departure from the UK to Canada an invitation to participate in the post training lessons learned meeting with the involved crew and management was conducted to identify shortfalls and appropriate training changes for further crew training implementation to ensure effective transfer of training.

4.1.2 Stakeholder Involvement

Prior to initiating the case study formal approval was sought from senior military stakeholders to approve the proposed research. This included approval from the post-graduate sponsor of this author for this PhD thesis and approval to conduct research within this platform was sought from the senior managers of Navy Personnel and Material (Appendix A). Once approval was gained, interviews were conducted with management of the new submarine programme and training to gain support for the intended research and the methods to achieve results, as well as to delineate who were the training stakeholders, both nationally and internationally. In order to achieve the research objectives the scope of the work involved all training stakeholders at all stages in the process as it unfolded, to identify who were involved, the rationale and process of the training programme, what was involved, and how adjustments to the programme were put into practice.

International stakeholders were identified as those RN staff who were either responsible for the submarine fleet prior to transfer of ownership (RN Commanding officer (CO)) or RN training staff. National stakeholders were Canadian training managers, Commanding Officers for each of the submarines, and the crew directly involved in the performance of EOPs. These were individuals who perform the duties of Ship Control Officer of the Watch (SCOOW, officer in charge on a watch for systems, manoeuvres, SOPs and EOPs), Ship Control Console Panel Watchkeeper's (SCC 1 and 2, senior control room panel operator and junior assistant), Machine Control Console WatchKeepers' (MCC 1 and 2, motor room senior control panel operator and junior assistant) and the Helmsman (driver of the submarine).

4.1.3 Experimental Design

The case study was approached and conducted recognising the variable control limits imposed by performing research within an ongoing training programme as it proceeded. First, background information was collected to identify the details of the purchasing of the submarines and the training contract, training platform, timelines, and the details of the instructors (history, experience). Then, a detailed task analysis was completed for all EOPs (Section 4.2) with Hierarchical Task Analysis of the system and personnel contributing factors, concurrent with the observation of team simulator training. This work was followed by interviews and completion of questionnaires by the identified stakeholders. Beyond the trainers, RN manager and Canadian Navy management, three successive crews were interviewed and provided questionnaires: 1) to crew one after the initial completion of the final phase of training and testing of capability (knowledge, skill and Upholder Submarine Qualification (USQ) certification), and immediately upon completion of sea-trials; 2) to crew two after the completion of formal training (knowledge and skill acquisition and USQ certification) but having not completed sea-trial testing; and, 3) to crew three after completion of phase one classroom training and submarine certification (knowledge acquisition, USQ certification, and individual simulator training) but not having completed simulator team training or sea-trials.

Interviews with the respondents and questionnaires were completed simultaneously; either individually, or where multiple individuals performed common tasks or duties in the work environment (*i.e.*, trainers and trainees) the format for discussion was set up in a focus group format incorporating all available participants. The same individuals perform both the duties of the SCC and MCC, on a rotational schedule, thus the focus groups for these tasks were grouped into senior and junior technicians. The Helmsman was not interviewed as all members of a crew are capable of performing the task, therefore this position would not be considered an interdependent. Data collection for involved crewmembers for each of the three submarines was completed consecutively, or as near as possible, to control for inter-group interference. Timeframe between crew interviews could not be controlled.

Detailed discussions were held with crew-one post-training at a formal post-training lessons learned meeting to identify shortcomings and changes for future implementation for successive training.

Participants: Of the 71 possible individuals involved in managing (3) or providing training (10), management of the CF crew (4), or the crew from each of the three submarines employed in performing EOPs (SCOOW (6/submarine), SCC 1 and MCC 1 (6/submarine), and SCC2 and MCC 2 (6/submarine)), 42 individuals were available to be interviewed and receive questionnaires. All participants were men as there were no women submariners at the time of this study.

Demographic variables: In addition to the collection of responses to the perceptions, desires and expectation of training, training aids and support, several demographic variables were identified. These variables included: rank, occupation, years in the military, education, years qualified as a submariner, years of operational service, and years since operational service and on what vessel. These factors were considered valuable as depth and range of experience and training and operational currency could be related to perception and expectation of the training and outcomes.

4.2 Task Analysis Technique

The Hierarchical Task Analysis approach was used to identify and define each of the 16 EOP tasks with a total of 31 different subtasks performed to achieve system safety goals during an emergency. Specifically, HTA was used to identify the plan to achieve each EOP goal; the set of sub-operations that each person must carry out to achieve the desired goal (s); the sequence between personnel to achieve desired results; and, when they are carried out, based upon the operational goal, task and the contextual constraints of the operational system and resources available (B. Kirwan & Ainsworth, 1993). All 16 EOP categories and 31 specific EOPs were delineated for the goal, task and operations with the aid of detailed interviews and walk-through with personnel/positions who performed the specific tasks (*i.e.*, SCOOW, SCC1 and SCC2, MCC1 and 2 and Helmsman). Examples of the task analysis provided in Appendix D have been prepared in the style and format used today by the Canadian Navy, as the task descriptions have been used in the procedural development of the Emergency Operating Procedures document. Although for discussion purposes within this dissertation detailed description of the tasks,

4.2.1 Simulator Training Observation

Observation of simulator training served two functions: 1) to observe the integrated performance of EOPs by crewmembers in both the control room and motor room, and, 2) to observe the team training and assessment process. Two opportunities were made available to observe ship control team training and formal assessment of team capabilities to successfully complete EOPs for the first crew in the control room and motor room simulators. First, within the scheduled 5-day training programme, then again 2 months later in the added 5-day refresher team training and re-certification provided to meet the requirement to have successfully completed team training 16-weeks prior to completion of sea-trials.

Observation involved the onsite real-time training and testing of progressive single to multiple EOP drills within both simulators with pre-selected teams (available for training) who will perform the required tasks on transfer (SCOOW, SCC1 and SCC2, MCC1 and 2 and Helmsman), as well as, discussion amongst trainers of progress of individual trainees and, provision of criteria to determine successful completion of team-training.

4.3 Questionnaire and Interviews

The intention of this empirical case study was to broaden the scope of multilevel training effectiveness understanding as it relates to the links and influence of constructs from the training programme, individual, organisation and situation to have a vertical effect to learning and subsequent transfer to the workplace. There have been no studies to date that have simultaneously identified or examined the link between individual through to team influences, training outcomes and organisational effectiveness (Salas & Cannon-Bowers, 2001), and it is argued that multilevel issues must become more central in research if training is to contribute to training effectiveness (Kozlowski *et al.*, 2000).

However, although there are a very large number of factors related to training effectiveness, as this research was performed during an organisation's training with the understanding there would be no interference it was impossible to design and measure for all variables and their interrelationships. This empirical case study could not control for the impact of variables, nor was measurement of all factors possible. The limitations of this case study will be described in detail in Chapter 8.

It has been said that as a result of individual characteristics and experiences (within and outside an organisation), individuals enter into training with different expectations and desires that play a central role in determining training effectiveness (Tannenbaum, 1993). Over and above the critical variables such as organisational support and input, training medium, training design and quality of delivery (Kraiger & Aguinis, 2001), it has been further suggested that interpersonal perception of the organisational climate (Noe *et al.*, 1997; Rouiller & Goldstein, 1993), perception of trainees on instructors and vice versa (Kraiger & Aguinis, 2001) and expectations from training (Cannon-Bowers *et al.*, 1995; Mathieu & Matineau, 1997; Tannenbaum, 1993) will affect motivation to learn and transfer. Thus, factors related to perception, expectation, and satisfaction with the training platform could therefore provide broad indications of the perceived success and changes of the training platform over time with successive crews, which would therefore provide an indication of vertical transfer and the effect to an organisation.

Therefore, within the constraints of this research platform, the questionnaire was developed to identify organisational, trainer and trainee perception, expectation and satisfaction with the training platform, aids and support, and the resulting reactions and perceived influences on the training platform after completion of various phases of training. Interviews further delineate and expand on individual responses and provide details of individual, team and organisations' reactions.

4.3.1 Questionnaire Development

The questionnaire was developed into two Sections (Appendix C), and development ensured a discrete question from each of the respondents would result in a single data point relating to the pre-training and training influences. One portion was given only to managers and trainers that dealt with perceived pre-training knowledge, skill, ability and experience, preparations for training and training needs analysis; information that individual crewmembers would not be aware of and therefore presentation of this to all crew would very likely artificially skew results. Also, it was felt by the experimenter and training managers that presentation of this portion of the questionnaire to crew might raise doubts of the capability of the training staff and thus have a negative impact on training.

The second portion of the questionnaire was standardised and given to all interviewees to identify their perceptions and expectations to: training content, format, formal and informal training aids, team composition influences, evaluation methods, learning outputs, and, degree of learning of knowledge and skills; as well as, their expectations from training and the satisfaction with the outcome of training, or the phase (s) completed (Appendix C).

The questionnaire was tailored to meet the specific needs of the unique training environment, and although items to support the thesis were identified (Noe & Schmitt, 1986) it was supplemented by the experimenter based on the theoretical constructs for multilevel approach to training effectiveness and vertical transfer that met the unique training platform. The draft questionnaire was then circulated within the university to assess clarity, detail, completeness, and circulated to Canadian Navy managers familiar with the programme, but not involved in the case study, to identify relevancy, clarity, detail and completeness (J. R. Wilson, 1998).

4.3.2 Questionnaire Content

Training expectations, desires and perceptions must be tailored to the training environment (Tannenbaum, 1993) and, as such, the items to support the questionnaire and the thesis were identified from previous motivational constructs related to training and transfer (Noe & Schmitt, 1986) but also supplemented to meet the research outcomes and the specific training platform.

The questionnaire contained as a preface a request to provide demographic details such as: name, rank, and identified work position (for identification purposes only); and, number of years in the military, education, number of years qualified as a submariner, number of years of operational service, and number of years since operational service and on which vessel. Managers and trainers were provided 18 questions as identified in Section 4.3.1. The remaining 34 questions, as amplified in Section 4.3.1 were distributed to all participants.

The self-reported response to each question was based on a 5-point Likert scale (1=strongly agree, 3= neither agree or disagree, 5= strongly disagree) with a random inversion of the scale throughout the questionnaire to prevent the likelihood of an automated response. The only exceptions were four questions to identify self-reported perceptions for the pre-training guidance given in training preparation (*e.g.*, Did the trainers receive any guidance for the training syllabus content?), provided only to the RN trainers and CF managers, and three self-reported perceptions of the changes to training curriculum, content and supporting documentation were provided to all participants (Appendix C). The scale was denoted as 'entirely, some, barely, and not at all' for all seven questions. To attempt to control for misinterpretation of the questions and thus contamination of data, each distinct question was placed on a separate page. The questions were then presented, one at a time.

4.3.3 Questionnaire Distribution

Upon initiation of each individual or group interview, each participant was given an introduction letter, a consent form, and the questionnaire. The experimenter welcomed the participant (s) and informed them that the intent of the research was to investigate perceptions, expectations and satisfaction with how knowledge and skill are acquired, and what support and value the training programme, individuals and resources were provided to aid them in their expected emergency operating duties (Appendix B). Individuals were advised that participation was voluntary, and along with completion of the questionnaire an interview/focus group would be conducted to provide participants the opportunity to voice their opinions and expand on their questionnaire responses as it applied to them at this point in their training. Participants were asked for permission to record the interview to prevent response misinterpretations and so comparisons could be made with other interviewees at a later time.

Participants were also advised that if they chose to participate, their identity and all information supplied in this interview would be treated confidentially, and used solely for this study. Participants were advised that the provision of personal demographic information would only be used to identify and categorise responses to determine if any of the specific groups had a unique view or requirements. As the participants were military, members were further advised they should not fear repercussion for speaking freely in regards to perceptions, expectations and satisfaction with the training programme.

Following the introduction and consent to participate, the experimenter led the participants through each question in the questionnaire and invited conversation or discussion surrounding each question (Appendix C).

4.4 Statistical Analysis

Confidence intervals were computed for the demographic historical data of qualification, operational experience and number of years since operational service to identify within crew, within position and across crew variation. The non-parametric statistic, Spearman rank correlation coefficient, was performed on pre-training and training perception factors and with training perception and training expectation factors. Additionally, the non-parametric equivalent to the ANOVA, Kruskal-Wallis test and Chi-square was used to identify possible differences of training perception and expectation between crews. Prior to statistical analysis, all questionnaire responses denoting a negative impact were reverse coded.

4.5 Role of Researcher, Opportunities and Constraints

As a member of the Canadian Forces, there was an awareness of the training to integrate the Canadian Navy to a new system, and thus an opportunity to assess the training programme, upon approval. Formal approval was gained to perform the research, as the Canadian Navy considered the research of value to identify improvements to training, if needed. In spite of the military association, the sole role of the researcher was that of a scientist, to collect the necessary data to achieve the research objectives. The Canadian Navy did not direct the research design, nor did they censor the findings from this research. The Canadian Forces also advocates a transparency in their work efforts and research findings. Thus, the Canadian Navy also provided approval to have the thesis published in the open literature.

However, although research efforts were welcome, they could not interfere with the training process or outcomes. Constraints were not imposed to limit access or conceal portions of the training programme, individual opinion, or state of the systems. Rather, research constraints were imposed to ensure that the strict timelines to complete the total training for all crews were met, conditions of the contract to perform training were adhered and individual and crew training proceeded as planned. Furthermore, research could not create perceptions that might negatively influence training progress or outcomes.

To meet with these conditions, the research constraints were such that not all of the multi-level influences to training effectiveness could be assessed. This would include assessment of cognitive and performance abilities and trainability, as well as, behavioural influences such as self-efficacy and motivation. Further, questions relating to the perceptions of the pre-training influences from the historical RN training programme were not distributed to the trainees, as perceptions of the value of the training programme could have been altered. For the same reason, individual perceptions of the influence from organisational factors were also not obtained.

Although there are constraints to performing research while an actual training programme is being conducted, valuable information can be obtained. This training platform provided the opportunity to examine the integrated influences of the organisation, individuals, the training programme, and situational variables to training effectiveness. Thus, within an actual training platform there was an opportunity to identify and assess combined influencing factors, their impact, link, and the interventions and adaptations taken to achieve organisational objectives from pre-training through to training. This case study thus afforded the opportunity to broaden the scope of multi-level approaches to training effectiveness by examining the links between individual through to team influences, learning, training outcomes and organisational effectiveness.

The completion of this research also had to conform within the timelines of the training programme as it progressed. Intended timelines for training each of the four successive crews was nine months, with each new crew initiating training as the previous crew completed the first phase of training. However, unexpected, significant cascading training delays further controlled the protocol design. Data collection occurred over a period of 14 months (Figure 4), and although data was collected during the midst of training, if training had proceeded as planned, three crews could have been interviewed upon completion of their entire training. As such, pre-training influences were identified retrospectively, monitoring of individual and team simulator training only occurred with crew one, during both sessions, and crew interviews and questionnaire distribution occurred at various stages of training completion. Interviews for each of the crews were thus staggered over time, and as training had to proceed without interruption, only available personnel could be interviewed.

4.6 Evaluation and Implementation of Proposals

The results of the task analysis of the EOPs, questionnaire and interview responses, and resulting conclusions from this case study were presented to senior Canadian submarine managers prior to submission for review of accuracy, completeness, and acceptability (submitted to Captain (N) L.M. Hickey, 5th Maritime Operational Group Headquarters Commander and Commander S. Virgin, Commander Submarine Sea Trainer Group). Hierarchical Task Analysis for all EOPs was supplied to the Canadian Navy to assist in the development of the CF submarine training programme and policy and procedural development.

5. Hierarchical Task Analysis of Emergency Operating Procedures

In order to have a greater understanding of all of the Emergency Operating Procedures (EOPs) that could be required to be performed, at any time, by selected positions in a submarine (SCOOW, SCC1 and SCC2, MCC 1 and 2 and Helmsman), a detailed Hierarchical Task Analysis was completed on all 16 categories of EOPs that contained a total of 31 separate EOPs. The objective was to have a greater understanding of the crews' perceived and actual training outcome acceptability of their knowledge and skill acquisition, a detailed HTA would also identify if the training platform reflected the environment, task, and tools of the working platform.

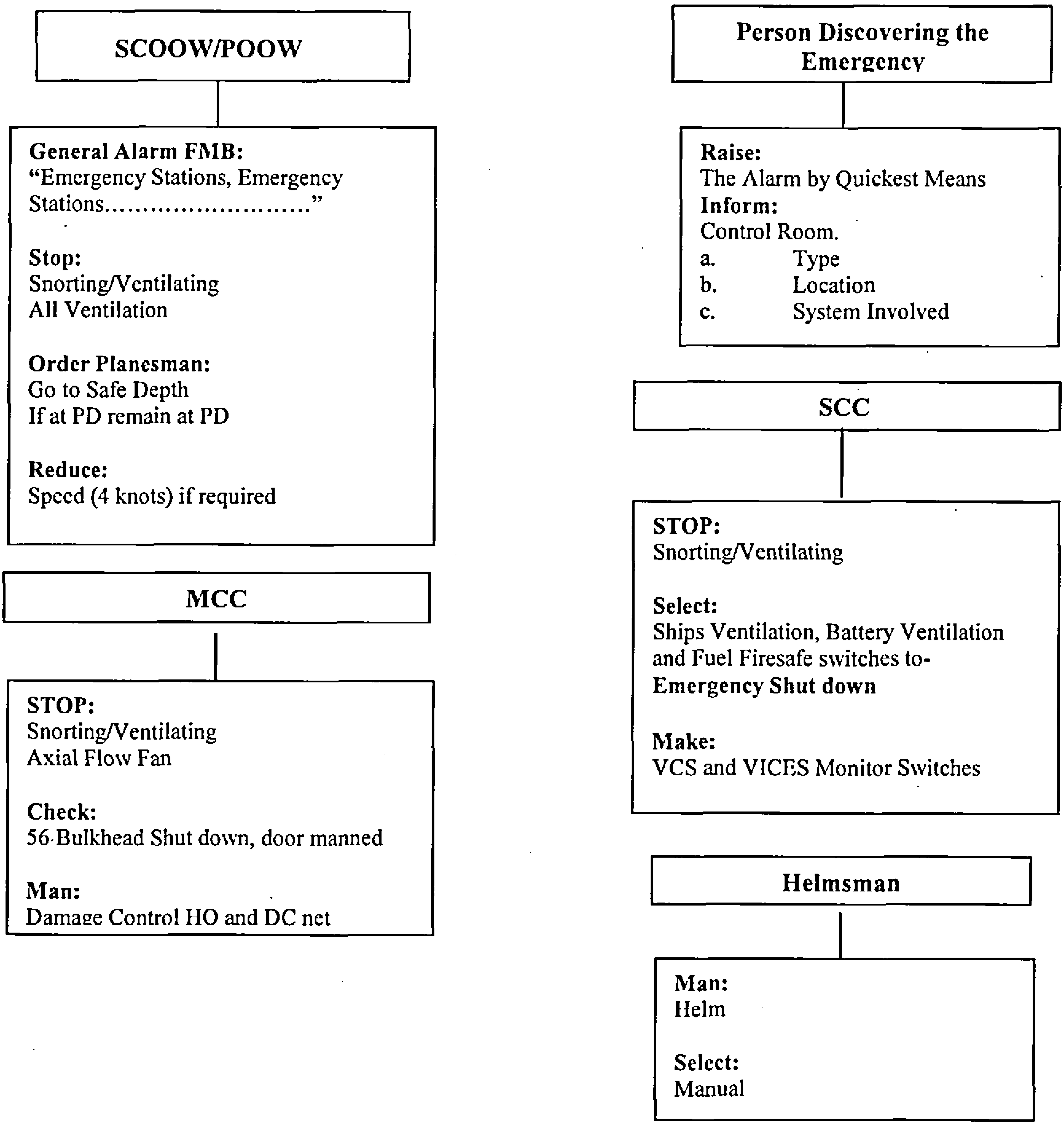
Emergency Operating Procedures are a sequence of tasks that must be collaboratively performed by a series of crewmembers to deal with any emergency that arises to ensure the safety of the crew and the submarine. The tasks must be performed accurately and completely. Although procedures are kept onboard the submarine the tasks must be performed in an expedient, controlled manner, and thus all sequences for each EOP are expected to be memorised. Thus, the criticality of successful completion is paramount. Performing a task analysis using HTA was considered appropriate as tasks detailed through this process identify the operation, provide a detailed statement of conditions to undertake the specific goal, and the personnel and system interactions involved to successfully complete the operational goal (B Kirwan, 1998; Shepherd, 1993). To assure training effectiveness and identification of the factors that could contribute or deter learning and transferring what was learned, a clear understanding must be had of the operational goal, and the individual (s) and system (s) requirements to achieve that goal. Within the context of training effectiveness HTA also provided the details necessary to delineate the task (s) to identify the complexity of the task and with that the physical and cognitive demands on personnel (Brauchler & Landau, 1998). Defining these specifics aided in establishing the training needs (Landau, Rohmert, & Brauchler, 1998), redefined, as needed, the training design requirements thus aiding in identifying improvements that could be made to the training programme (Shepherd, 1985; Stammers & Shepherd, 1998). As well, the HTA helped to define the added support mechanisms, in the form of training and operational training aids that would support the learning, transfer, and maintenance of what has been learned in this applied environment (Brauchler & Landau, 1998; B. Kirwan & Ainsworth, 1993; Landau *et al.*, 1998).

The rules for HTA were applied, in that tasks were described in sufficient detail utilising the stopping rule criterion, 'P X C rule', where re-description of the tasks were described to the point where the *Probability* (P) of inadequate performance of the operation and the *Consequence or Cost* (C) of inadequate performance are considered acceptable to the operator (B. Kirwan & Ainsworth, 1993; Redmill & Rejan, 1997; Shepherd, 1985). As the consequences of an accident or ineffective response to an emergency in this operational environment can be catastrophic, sufficient detail was supplied to ensure the motto of the submarine environment "to keep the men and the boat safe" was applied. Thus, although the P X C rule is suggested as a guiding rule-of thumb for stopping the detailing of a task (B. Kirwan & Ainsworth, 1993), it also prompted consideration (through detailed discussion with operators) of the severe consequence of an emergency in this environment, the operational requirement to have mastered all of the procedures, and how they might be achieved and maintained – through training and non-training solutions.

As part of the information gathering, comparisons were made with the CF EOPs, Canadian Submarine Standing Orders (CANSSOs) (Navy, 1997) from their now decommissioned Oberon class submarine and with the RN Upholder class EOPs (Royal Navy, 1999b) used in the training programme. Completion of a previous task analysis from the RN could not be determined; however, discussions with both RN and Canadian managing staff and students identified their discontent with the RN format within the training platform. Canadian crews identified, "With less (submariner) experience, I had trouble; I didn't know the details of how to perform shortened descriptions (EOP format). (I) did not know the details to complete Sections of EOP, had a great deal of difficulty. With training lapses (2 months), did find it difficult to learn" (crew one). "From a learning process it would have been much easier to have everything in a list, there should be a training EOP book" (crew two). "Would have to refer to Standard Operating Procedures (SOPs) to identify the steps" (crew three). Over all, crews two and three found EOP procedures incomplete, sequencing poor, and difficult to learn.

Upon review of the RN EOPs (see Figure 5 as an example), the structure of the operating procedure appears to follow the entity-relationship based analysis format (McCrohan, 1997), in which individuals perform actions upon objects changing the attributes of the object in the process. There is a relationship between objects that can be related to each other by physical location or to actions that are either performed with them or on them. Figure 5 indicates within each individual box the roles for each team member (SCOOW, SCC, MCC, Helmsman, person identifying the emergency), the verb action is highlighted and the specific object or task is then indicated.

Figure 5. Royal Navy EOP 1.1: Emergency Stations at Sea



Each task box for the RN EOPs provides in sequence the activity to be performed for each member (*e.g.*, STOP: snorting/ventilating found in SCOOW (2nd action), SCC (1st action) and MCC (1st action)), but the format does not describe how that should be achieved for each member (*e.g.*, SCOOW- via communication, MCC and SCC- via perform panel sequence of events), nor does the format supply further detailed sub-operations, or indications if a sequence between members is required for completion of the task or if they should be performed simultaneously. Further descriptive details of the emergency procedures are discussed below in Section 5.1, but it appears that the EOP document was not written for training purposes, but as a job aid to cue memory of task requirements and assure completion thereof, as well as to identify the role (s) and inter-relationship of each member of the team.

In reviewing the EOPs previously used in the Canadian Oberon class, the display of the information was not in a text box format, but as in the RN format each position was identified and the tasks listed. The only difference between the two is that in the previous Canadian format, verb actions do not precede the task and the verbiage for the same task is described slightly differently. For instance, in the SCOOW, Canada CANSSOs provide two task orders, as in the RN's (Figure 5), to sound the general alarm and broadcast "Emergency Stations, Emergency Stations", then, crash stop ship's ventilation, rather than, STOP: snorting/ventilation, all ventilation as seen in the RN EOP. The guidelines for the person discovering the emergency are the same; however, the Canadian Oberon EOPs provided no further indications for orders to the Planesman/Helmsman, as seen in the RN EOPs. Thus, the RN EOPs seem to have more details and are inclusive for all positions and all broad identification of actions, but rather than sequencing the events/actions required, the RN has separated the duties into a box format.

Perhaps part of the perceived differences, and likely discomfort, with training expectations for the trainees is that the tasks in the Upholder class submarine are semi-automated, and tasks once performed solely by technical personnel in the motor room/engine room have expanded duties (such as managing water levels in ballast tanks) that are now performed in the control room, on the control room panel. There appears to be familiarity with duties, and as such a comfort, in the motor room/engine room, even though they will now be performed on a panel rather than manually. One could assume then that the difficulties lie in new skill requirements rather than presentation of documentation. The specific tasks in the control room for the SCC 1 and 2 are new roles for personnel and have not been performed before (quote: "Electricians have never been in the control room."), although the systems requiring the effort such as stop snorting/ventilating are familiar. Thus, those most dissatisfied with the format of the RN EOPs are for those tasks performed by the SCC 1 and SCC2 in the control room.

What is also different between the RN and the CF performance of EOPs, and likely the cause for the significant discomfort for the individuals performing these duties is that the RN has one occupation that performs the combined duties of SCC and MCC operator in the control room and motor room. By contrast, the CF has an occupational structure in which the duties are performed by two occupations, electrician and a marine engineer, which on the previous CF class of submarines was only performed in the motor room. There was an overwhelming agreement amongst the senior technical operators to merge the occupations within the CF, and as a minimum provide more detailed cross-training in both occupations so that upon completion of training the basic knowledge and skill for an electrician and a marine engineer were known and individuals could thus feel more secure that they could operate the submarine sufficiently and capably. Interviews with senior electrical technicians revealed, "Integrate the marine engineers and electrician training, as the trades are now combined (for the RN)." "Cross-train the engineers and electricians, engineers only got engineering courses, and vice versa. Or at least provide general knowledge in the other trade (marine engineer), as the occupation has now merged, and we now need to know both jobs (in this submarine)." The same feeling was felt by the CF marine engineer occupation, "Procedures are different for the RN than for the CF, marine engineers are not allowed to touch breakers and must be certified as an electrician (in the CF)." "They (RN) have integrated the marine engineer and electrician trade and so the RN had an expectation that Canada would have the basic knowledge. The marine engineer was not allowed to touch the stuff; in O-boats we weren't responsible."

This conversion course was taught within the RN training platform, and thus there was an assumption that individuals had the basic knowledge required. Thus, from the interviews it could be seen that the trainees have neither previously performed or know the details of each others' duties, and therefore discomfort is based on a true lack of knowledge, not just discomfort with performing a new activity in the control room or performing a task differently (on a panel rather than manually). This would suggest that there would be a reliance on training content within this training platform to achieve the desired (would like to happen) knowledge and skill for their future duties.

5.1 EOP Work Description

The RN Ships Operating Procedures, which outline the Emergency Operating Procedures for a submarine, are identified in a sequence from 1-35. Each EOP is designated with a specific number, not necessarily in sequence, as an EOP is defined for a specific task in a submarine and the operating procedures for each class only define those that are needed for that specific class of submarine. For instance, although there are 35 EOPs in existence, only sixteen classes of EOPs are used in the diesel electric Upholder class submarine. Thus, EOPs 3, 9, 13, 15-25, 30, and 33-35 are not used for this class of submarine, and therefore were not reviewed.

The specific EOPs that have been indicated as a safety requirement procedure for this class of submarine, that have been reviewed through an HTA include:

1) Emergency Stations;

2) Collision –a) surfaced, b) dived, and, c) grounding;

4) Flooding accident- a) surfaced, b) dived;

5) Control Surface Failure – a) dived, b) surfaced, c) Loss of Foreplanes, d) Loss of Control of Afterplanes – Failed to Dive, and, e) Loss of Control of Afterplanes – Failed to Rise;

6) Man Overboard at Sea;

7) Hydraulic Burst- a) Hydraulic Burst, b) Recommissioning an Hydraulic Plant, and, c) Emergency Repressurization of Hydraulic System;

8) High Pressure Air Burst;

10) 140 KW Motor Group (MG) Failure, a) Single MG Failure with both MGs Running, and, b) Complete Failure: Loss of Single MG when Supplying both AC Switch boards;

11) 24 Volt Failure- a) Total 24 Volt DC Failure, and, b) Loss of 24 Volt DC Grade 2 Implications of Failure;

14) Fire General (at sea);

26) Fire in Battery Switchboard at Sea;

27) Fire in Main Battery at Sea;

28) Fire in Main Propulsion Switchboard;

29) Propulsion Failures- a) Loss of Foreward/Aft Field Converters, b) Loss of all Field Converters, c) and d) combined – Loss of ACU when not in known Group or Camshaft has run out, and, e) Loss of Camshaft Drive Motors;

31) Fire in an Oxygen Generator; and,

32) Accidental Initiation of Man Overboard Marker.

The duties of those crewmembers who perform the EOPs (beyond those of the individual who discovers the emergency) are divided between two Sections of the submarine, those within the main operational centre of the submarine, the control room, and those who perform the complementary required duties in the motor room, both on the same deck of the submarine. The duties of the members in the control room include: the SCOOW, an officer responsible for the overall state of the submarine, and control of tactics and navigation; the SCC 1, a senior technician responsible for the ships' control systems managed by operating the control panel; the SCC2, a junior technician who acts as a runner when needed and performs the manual tasks within the control room and surroundings as necessary, as directed by the SCC1; and, the Helmsman, a duty that can be allocated to all other submarine qualified technicians within the submarine, responsible for steering and trimming the submarine.

The motor room is monitored and controlled by only two members of the submarine crew, the MCC 1 a senior technician and the MCC 2 a junior technician, both of whom are either an electrician or a marine engineer, although not necessarily one of each during a shift. The MCC 1 is responsible for the electrical and mechanical portions of the submarine (*e.g.*, engines, batteries, compressors, propulsion, electrical) that are controlled by the panel in the motor room, and the MCC 2 acts as a runner and performs manual duties as assigned by the MCC1 within the motor and engine room compartments. The duties and responsibilities are allocated according to trained capabilities, but the Commanding Officer is always ultimately responsible for the crew and the submarine and if needed (*e.g.*, state of emergency) will take charge of the submarine from the SCOOW.

5.1.1 Description of Tasks

Of the 16 categories of EOPs with a total of 31 separate EOPs, HTA identified that all procedures require the efforts of all six positions who respond directly to EOPs (SCOOW, SCC 1 and 2, MCC 1 and 2, and Helmsman), with the exception of EOPs: 1.2 Emergency Stations in Harbour, which is performed, if needed, by crew on duty-watch; and, 4.2 Flooding Accident Surfaced, where there are no directives for the Helmsman. Emergency Stations in Harbour do not have specific directives for each position as in the other EOPs as the submarine is tied up along side and is not operational, thus minimally manned. But, if an emergency were to occur, the general emergency knowledge and skill obtained by all submariners in their dolphin qualification would allow duty crew to complete and deal with any emergency. The procedure for Emergency Station in Harbour would be to announce the emergency within the submarine, which can be done by any member onboard, man stations, and if needed, the control room duty-watch would stop battery charging and ventilation, and contact shore duty officer[3].

Emergency Stations, the first EOP, is used to bring the Ships' Company to the highest possible degree of readiness to respond to any situation that threatens the safety of the submarine or crew (Royal Navy, 1999b). The submarine is brought to Emergency Stations for collision and grounding (EOP 2), flooding (EOP 4), hydraulic burst (EOP 7), fire (EOP 14) and any other situation requiring a high degree of readiness (*e.g.*, intruder alert).

As seen in Figure 6 as an example of a detailed HTA, when Emergency Stations is indicated at sea (by any member of the crew) a simultaneous interdependent coordinated effort occurs by all six members, controlled by the SCOOW. Many activities to secure the submarine and make it safe must occur together. Once the emergency is indicated and announced on the general alarm system (located throughout the submarine), the SCOOW then provides the string of orders to "Stop snorting/Stop ventilating, Do Not lower masts, Do Not flood the induction system" if at periscope depth (PD), if not then he will say " Go to safe depth (55m), 6 down." This initial communication provides the direction for the members in the control room (SCCs and Helmsman) and the motor room (MCCs), who then simultaneously complete the series of functions to stop engines, ventilation, compressors, and change the depth and speed of submarine, and if needed (if at PD) secure openings in the submarine to prevent flooding. The SCC1 and MCC1 complete their portions on their respective panels, but as seen in Figure 6, plan 3 a) and b), further orders are given to their second-in-command for manual completion.

To ensure the orders are understood and completed as directed, all orders at all times are repeated by the actionee prior to execution and then reported when

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[3] Emergency Stations in Harbour have specific actions but tasks cannot be position driven, as the location of the limited number of duty personnel onboard is not static and the duties require submarine inspections.

completed, as the command was given (see Appendix D for complete details). Communication of events is provided verbally, and progress within the motor room is relayed directly from the MCC1 to the SCC 1 (via direct communication through headset), and then relayed to the SCOOW. As there are many activities occurring simultaneously in a stressful situation, communications are given when appropriate so the SCCOW is kept appraised of the status of the condition of the emergency and the state of resolution and its effect.

The directives for EOPs dictate that if the submarine is brought to Emergency Stations for collision, grounding, flooding, hydraulic burst and fire, then one would presume that the tasks and sequencing identified in EOP 1.1 would be identical, or at least provided in the initial sequences for each of the EOPs for all positions. That is not always the case, as depending upon the emergency other tasks must proceed for safety or other tasks must be put into the sequence. The sequence is dependent upon the danger and the priority for resolution.

For instance, in collision, dived and surfaced, or grounding none of the three EOPs are identical to the EOP for Emergency Stations for all positions (see Appendix D, EOP 1 and 2). The duties of the MCC 1 and 2 are the only tasks that remain the same. However, the SCOOW's initial directions for each EOP are different, in that beyond identification of what the emergency is the SCOOW first orders are to deal first with the crisis and avert the potential outcome and then to ensure the safety of the submarine. In the collision EOP, the changes/additions are that the SCOOW first indicates "Emergency Stations, Emergency Stations, Stand-by Collision", indicates port or starboard, then "Shut bulkhead doors, shut all hatches, Man compartment blow" whether the emergency occurs surfaced or while dived. The sequence of tasks for the SCC remains the same, except monitoring and blowing the ballast tanks as required when surfaced, but when dived the additional task of lowering and securing the masts and periscopes are inserted midway through the sequence. The Helmsman will as in EOP 1 go off autopilot, if needed, and await direction to change course and speed. Additionally, for the EOP Collision Dived, the initial order will proceed with "Go Deep, Go Deep, Go Deep, keep safe depth" and as such the tasks change for the Helmsman. When initiating the Grounding EOP, the initial direction and response is to reverse the submarine and open vents to attempt to prevent grounding, and then to secure the integrity of the submarine by shutting the doors and hatches. This follows through with the immediate and initial response by the SCC to open vents, and then proceeds with the sequence in Emergency Stations. While the Helmsman duties change again from the Emergency Station EOP and that for collision dived (for HTA details see Appendix D).

From this overview of four of the 31 EOPs it can be seen that there are variations of the tasks and sequencing for the three types of collisions from the general EOP for Emergency Stations. Although in some cases small insertions for the SCC and in the case of the Helmsman major changes to the sequence, all tasks and the sequence in which they are ordered are very explicit and critical to providing an effective emergency response as an interdependent team.

In further comparison of the additional three EOP categories in which the submarine is brought to Emergency Stations, for flooding, hydraulic burst and fire, it can be seen again that the tasks for each of the 7 EOPs does not follow that for the Emergency Stations EOP for all positions, even the MCC positions except when dealing with Flooding Accident Surfaced, which remained the same (Appendix D). The changes range from small insertions (2-4) to the Emergency Station sequence in the hydraulic burst for SCC and Fire at Sea for both SCC and MCC, to major changes, such as those seen in Flooding for SCC and Hydraulic Burst for the MCC. The changes to the SCOOW and thus the directions and sequence of actions from the Helmsman are very different for the flooding and hydraulic burst EOP from that of the Emergency Station EOP, with minor alterations, and acute vigilance of the status of the fire. Although many of the commands are similar with the Helmsman, such as "disengage autopilot" and "go to safe depth" to manage pitch, depth and direction, the task and sequence is very dependent in an emergency and will vary on the type of emergency.

In a selected review of the remaining EOPs to identify the consistency of the tasks and sequence, responsibilities, and knowledge needed to perform the skills, a representative EOPs (8, High Pressure (HP) Air Burst, 10, 140 MG Failure, and 11, 24 Volt Failure), provides a selection of the range. Complete outline of the HTA for all positions can be found in Appendix D. The HP Burst EOP follows the EOP for Emergency Stations closely for the SCC and MCC with the added requirement at the end of the sequence to be able to shut down the air compressors and group isolation valves.

The Helmsman as in Emergency Stations disengages the autopilot, then maintains depth, course and speed and awaits further direction. The tasks for the SCOOW are new from those seen previously. In EOP 10, there is an electrical failure and in EOP 11 the battery power has failed. The initial sequence for both the SCC and the MCC are the same as Emergency Stations but the final half of the sequence requires the checking of the panel to identify loss of capabilities (by SCC and MCC) and switching off and overriding those systems that are not functional both from the control room and motor room for EOP 10, and additionally in EOP 11, switching systems to manual override. Override to manual may also be required in EOP 10, depending on the severity of the loss of electrical power. The initial order by the SCOOW is the same for EOP 10 and 11, however the rest of the orders have not been seen previously. The Helmsman also has some of the same tasks, to disengage autopilot and come to safe depth. But in these two EOPs, the Helmsman must engage the back up compass as capability is, or might be lost. In DC Failure, propulsion is lost and this capability cannot be maintained in the control room and is managed in this EOP in the motor room. If hydroplanes are not available in EOP 11, the SCC runner moves forward or aft to centre the Foreplanes or Afterplanes manually.

As seen in the diagrammatic HTA task detailing of the simplest EOP completed by the crew, Emergency at Sea (Figure 6), and further selected review of the 11 EOPs in which the submarine would be brought to Emergency Stations to deal with a specific emergency (see Appendix D for complete details), the tasks are very complex, integrative and involve interdependent actions by six-team members. As such, the similar tabular approach taken by both the RN and the Canadian Navy, although different in their presentation style, the format clearly identifies the goal, a detailed task description, resources, interactions and communications with team members, and the sequence in which the procedure is to be completed.

5.1.2 Requirements for Undertaking the Tasks

The HTA has identified that all 31 EOPs are different, some follow the same partial sequences for some positions, some of the tasks have minor and some have major task insertions, while some of the tasks in the EOPs are almost entirely unique. To carry out the tasks capably there is a requirement to learn the procedures individually and with intact teams to achieve competency. Also, as the tasks may be performed infrequently, under stressful conditions, but still require an expedient, controlled response, each EOP is performed in the same sequence each and every time. The capability to perform EOPs accurately must be maintained, and crewmembers must also remain current and their performance error-free, as errors could be catastrophic. Thus, the performance of the EOPs must be an automatic response and therefore are expected to be memorised.

The EOP document is not intended to provide cues during an incident. It is a referral document that is kept onboard to remind crewmembers of the procedures and sequence for each of the critical positions. Initiation of drills for EOPs occur regularly to ensure competency, and for post emergency support and review for accurate completion the EOP document is further reduced and simplified to the major task elements in a referral document (also called Scandex cards by submariners).

The review of the tasks and the procedures required to complete the tasks indicate the procedures are very clear for task initiation; the event is identified by a crewmember and reiterated by the Officer-of-the-Watch (OOW) who confirms and identifies the requirement to proceed with the action. The communication of the events, actions to be completed and feedback of completion are also clear and concise, as is who is responsible to complete the procedures and in what sequence.

The HTA identified that all personnel on a submarine must fully understand and be capable of performing all safety aspects within the submarine given that an emergency could occur at any time, anywhere, and therefore all crewmembers must have a comprehensive understanding of submarine operations, systems (air, hydraulics, mechanical, weapons, safety and escape and rescue), and functioning, and have the skill set to complete emergency procedures (for further details see Sullivan, 1998). As identified in Section 4.4.1, prior to initiating the Upholder class submarine training all personnel must as a pre-requisite have obtained their basic submarine certification, although this qualification was based upon Canada's former Oberon class submarine. Upon completion of the knowledge acquisition phase of training, the training platform (Figure 4) required all trainees to successfully achieve the Upholder submarine qualification through a process of self and directed-learning, walk-through of the submarine, and a verbal exam to confirm knowledge and skill (Section 4.4.2.).
The training platform provided individuals with systems knowledge based upon their occupations, but specific EOPs and the interaction of systems were not taught in the knowledge acquisition phase. Trainees reiterated this sentiment. In crew one the impression was, "Systems were taught separately but not brought together." While in crew two they identified in a separate interview, "Knowledge of systems we've learned throughout the curriculum, EOPs we've had to learn on our own"; and, in crew three the technicians reported, "The knowledge we learned from the training but the skill we learned a lot from the O-boat (Oberon class submarine)." Training provided occupational knowledge, but there was an impact to those designated to

perform EOPs. Interviews revealed, " Initially, when learning EOPs (We) needed to refer to TABs (technical specification documentation) to find out the details of procedures (*e.g.*, putting on a snort)." This was further amplified by the technical operators in crew two who indicated, "In learning the EOPs, had to look at the SOP (Standard Operating Procedures) and had to know the SOP."

For those individuals who were designated to perform the functions of SCOOW, SCC 1 and 2, MCC 1 and 2 and the Helmsman, individual and team practice and testing of capabilities occurred during simulation training and during sea-trials (Figure 4). As clarified by the technical staff who were responsible for operating the console, "having less than 1-year active service (in submarines), and having never seen the control room (which now I have the responsibility of as first panel), the (knowledge) training (3 ½ wks) in Collingwood helped, but it was the training at sea that provided the operational experience." Formally, the EOPs were not distributed until just prior to simulator training, although informally, the crew one distributed the EOPs to those in earlier phases of training and discussed the knowledge gained extensively. The interview with crew two revealed, "Teaching and guiding crew three will happen informally, it happened with crew one we drilled them for hours."

5.2 Challenges and Limitations

Performing the HTA also identified the operator resources, constraints and preferences to establish how these combined factors influenced the trainees in their success to learn and to transfer what was learned. Specifically, beyond the detailing of the task requirements for EOPs, the work environment (Upholder submarine) was examined, which included the operating requirements, limitations of the technology, the structure of the interface, physical factors, over and above the review of supporting documents such as the emergency operating procedures (Stammers & Shepherd, 1998). The interviews with trainers, management and all individuals who performed EOPs supplemented the physical examination to gain a full and accurate picture of the environment and events, but also, the interviews provided an understanding of the perceived and actual difficulties with training and the preconceived notions and experiences that the trainees brought to the training platform. Thus, a detailed HTA provides support for the research as the review identifies the task, system, tools and personnel requirements and limitations within

Figure 6: Hierarchical Task Analysis for Emergency at Sea

the workplace. Therefore, the information aids in determining the training requirements and methods needed to provide the necessary skills and system knowledge to effectively operate the system under the range of anticipated (or perhaps unanticipated) conditions (B. Kirwan & Ainsworth, 1993).

The overall impression of the conversion training from technical trainees who perform the EOPs is that, "You can operate the console without knowing behind why" but "Technical aspects we've fallen short, we have operators only not maintainers." The officers concurred with the statements from the technicians, with crew one indicating "With 20 plus years experience on submarines (for all senior technicians), there are small things you don't know, but the gun drills (performing EOPs) you do, (based on) experience." "(They) can operate the submarine, but problem solving is another story."

These reiterations from trainees reflect the type of training provided, even though there was dissatisfaction and a perception of concern with the depth of training. The training was intended and provided conversion training, expecting and requiring submariners to have the basic safety qualifications, to which the training programme provided the knowledge and skill "to safely sail surfaced or submerged back to Canada" from an operating view as well as the capability to perform emergency operating procedures studied for this thesis. The training was not intended to provide training to a level that maintenance or problem solving could occur proficiently, that level of training could not be provided in the timeframe of nine months allocated for each successive submarine.

As indicated in crew ones' post-training lessons learned meeting, "From a training design perspective, not all Planned Maintenance (PM) or Corrective Maintenance (CM) procedures are taught in the classroom. What actually takes place is the teaching of overall system knowledge, followed by the practical execution of a broad spectrum of PM and CM tasks. Training design assumes that given system knowledge and the appropriate technical background, maintainers will be capable of performing all PM and CM tasks in the workplace. As a result, from a training design perspective, the fact that certain PM tasks related to Latent Failure Checks are not being taught should not be considered a shortcoming of the training." (Detachment, 2001) Further maintenance and problem-solving training was expected to be done with the crews once they returned to Canada.

5.2.1 System Design

In relation to system design, the intention of performing an HTA was to support the completion of tasks, ensure there are sufficient personnel to perform the tasks, but as well, to identify if the system design could increase the likelihood of errors and what solutions might be available to reduce errors. In stressful situations, inadequate design features such as awkward movements in performance of the tasks, poor visual identifiers, lack of labelling, and scattered or non-grouped actions within a panel can increase the risk for operator error.

The panels in both the control room and the two panels in the motor room (motors, electrical, battery, pumps on one and propulsion system on the other panel) identify problems centrally within the submarine and manage the systems and functions in most all of the submarine semi-automatically, unless there is a power failure and then the responsibilities must be turned to a manual operation. Both panels are therefore complex and full of dials, meters, gauges, switches and buttons.

Although both panels are very complex they both contain well-marked demarcations to divide systems, with well-marked lines that indicate the flow of systems and joining of systems. It is realised that major redesign of system panels is not within the realm of possibility, but small changes could be made to ease performance and reduce the risk of errors.

In review of the EOP task sequences with the operators of the panel it was noted that all emergency shut down switches were covered with Plexiglas to prevent accidental depression. Although this protection will prevent accidental errors, the operators indicated that during a blackout or night conditions under red lighting the switches were difficult to find. If the switches were backlit making the LEDs red they would be easier to find during night operations.

Panel operators also found that the motor room panel notations were inconsistent with the EOPs, in that the EOP directions did not reflect the notations on the panel. Specifically, the directions in the EOPs to control the batteries indicated the MCC operator must 'OPEN and Tag open', however, the selector switch on the panel required the motion of moving the switch from the marking of 'close' to the position of 'off'. Another mismatch between EOPs and the motor room panel is that the EOP direction to manage the DC power provides the directions to "Affected DC contactor to STOP", however, the panel selector switch again requires the motion of moving the switch from 'close' to 'off'. In discussion with the operators it was determined that what appeared an error was in fact a mismatch in terminology; the console used lay terminology while the EOPs used electrical terminology.

Although the MCC position is now filled by electricians and marine engineers, common, consistent terminology needs to be used, in EOPs, SOPs, training, and panel indicators as confusion arises and there can be difficulties in learning, memorising and performing the tasks. As the panel cannot be changed easily, it is suggested that the changes should occur within the EOP document, directions or teachings so that passage of information reflects the console panel and the working platform. This mismatch between the working environment and the training platform content and training aids would suggest that these factors could pose a problem with learning and subsequent transfer. Case study findings of the specific training effectiveness factors and links will be discussed in detail in Chapter 6.

As identified earlier in this chapter no two EOPs are exactly the same or require the same actions, thus the manoeuvres on the panel are never exactly the same routine. Thus, although the panels are complicated, a sequence or pattern display change would not make the motions any easier. Only adequate training and consistent practice to achieve a comfort and in-depth knowledge of the position of each system component and the location of all dials, switches, gauges and valves would solve this problem. Small changes that could ease the performance and provide clear indication to the operator would be to explicitly identify set points on gauges. There were several console gauges on the control room panel which indicate the critical state of various system pressures, flow or position as in the state of the mast; providing clear markings of the critical set-point would further assure performance and reduce the risk of human-error because of oversight or misread. Also, beyond the panels, all manual operating portions of the submarine that are critical to the safety of the men and the submarine should provide clear labels to indicate sufficient information to perform the task at hand correctly (for example, providing the direction of movement required to open and shut a valve).

5.2.2 Documentation

In review of the EOPs with the operators it was identified that some of the operating procedures used during training did not directly reflect the task; contained errors; provided taskings in which there were insufficient personnel; identified taskings that were not reflective of an emergency action; or, the sequence of the taskings could be changed to make the tasking more efficient and timely.

As identified in Section 5.2.1 the EOPs did not always reflect the labelling in the panels, as that seen in the motor room for the battery and DC switches. Common terminology must be used that is reflective of operations and the panels. The EOP for grounding contains errors such that the procedure does not make sense to the operator. The directions for the SCC indicates 'STOP generating/ventilating', but generating indicates that the submarine is surfaced and the engine is running and ventilating also indicates surfaced or dived at periscope depth, as the engines do not operate when dived. Thus, the term generating is incorrect and should be removed from the procedure. In review this is likely a typographical error, but changes should be made to ensure no misinterpretation and thus potential affects to learning and subsequent performance.

In the EOP for hydraulic burst there were several observations from individuals who performed the taskings. It was noted by the SCC operators that the sequence of the taskings was not efficient, and the current sequence made it difficult to learn, memorise and perform, especially in an emergency, as the sequence was made up of a decision tree, 'with if this result perform this action, if that result perform this alternate action'. This class of submarine is different from the CF's earlier Oberon class submarine in that this system has three hydraulic plants rather than the one, so the sequence of performance is not as that performed previously nor is it as simple as that done previously. The EOP for hydraulic burst used for training indicated observations were required prior to action to identify where the burst has occurred, and then one of two sequences would be followed (see Appendix D for specific details). The operators suggested that rather than waiting until confirmation of which system is known to be down, the EOP should be adjusted so that the action required would be to shut all hydraulics (*e.g.*, the Fire Isolation Valves (FIV)) as a precaution, as they can be brought back up. They indicated that this method would be much easier to remember as one sequence would be applied rather than trying to remember the ifs and/or statement currently identified (*e.g.*, if not in the AMS..in system.. shut FIV, if in AMS...then plant...leave open).

It was further identified that the EOP 7.3, Emergency Repressurization of Hydraulic System, should not be present in the EOPs as this task is not performed in an emergency, the task is performed after the emergency by the Damage Control Headquarters (DCHQ) team, therefore is not within the principles of an EOP to "make boat and men safe".

In procedures such as in a hydraulic burst when manual operation might be required, the currently proposed two sole crewmembers allocated in the motor room to perform the functions are not sufficient to complete all of the tasks required. For instance, in EOP 28.1: Fire in the Main Propulsion Switchboard, the task in the RN EOPs identified that the MCC_2 will fight the fire until relieved by the attack party. This insufficiency of personnel was not dealt with in training. The potential problem is that panel operation must still occur, and if manual operation is required insufficient personnel are present to also fight the fire. The HTA suggests, and individuals have concurred, that there is a requirement during these types of emergencies to have three personnel stationed back-aft of 56 bulkhead. The potential problem without three personnel will be that the access to the after ends part of the submarine is not readily available as the hatch to this part of the submarine will be shut, as a common practice to protect the submarine during an emergency. Therefore, proactive planning is necessary to designate an individual to aid in these potential emergency functions.

The overall observation by the trainees as identified earlier in the chapter was their displeasure with the current RN format of the EOP document. There was no indication of lines of communication or how, link between each of the team members activities, no indications in the current EOPs that activities of team members must precede another's action for success of the task, nor are the EOPs considered sufficient enough in their detail. Crewmembers clarified, "There is no clear direction as to who is responsible, CANSSOs defined who, when and sequence." " (EOPs) not written as a task, want chronological with orders". "We have had in the past more details in EOPs and structure."

This difficulty was further discussed in the interviews in terms of learning the EOP procedures. Even after changes were made to the curriculum and EOP procedures document, those who were in the second wave of training commented that, "From a learning process it would have been much easier to have everything in a list, but after in ops you don't have time." "The EOPs are written (and) assumed you have the knowledge of why it is written." "There should be a training EOP book." However, the technicians commented that "Training in O-boats (you) know what stop snorting means, the operation of the submarine is different (for the Upholder submarine) but the process is more or less the same, and everyone has their dolphins." But when asked for further details in regards to the benefit of the document for training, the technicians responded that, "Another book would be beneficial, but don't see the need for ops (operations). A book to explain why for the inexperienced would have made the learning much easier as they want to learn why." "In learning the EOP had to look at the SOP and had to know the SOP."

Review of the additional supporting technical and procedural documentation used for training identified, and was confirmed in interviews, that the SOPs, technical documents, even after the third crew commenced training were still in the update and re-writing process. Individuals from crew three also revealed, "There were less discrepancies and inconsistencies with us than with the earlier submarines, but still some." "When we went through they were only through 50% of rewriting (basic 255 course) ref material, especially the electrical documents."

These quotes suggest there was a perception and expectation in EOP documentation to provide two different capabilities, reading to learn and reading to do (Duffy & Curran, 1983). There was also an underlying perception that previous experience was and will continue to provide the background needed to perform the duties onboard the submarine. However during training, some individuals found their experience was not sufficient enough and training did not supply sufficient details for all to satisfactorily learn and complete emergency procedures. The EOP document was therefore considered insufficient in detail and thus, as a formal training aid also considered insufficient. Further results of perception and expectation are presented in Chapter 6 as they relate to training content, support from formal training aids (*e.g.*, EOP documentation, technical documents) and the perceived accuracy of the training platform and supporting tools and aids to reflect the intended working platform.

The HTA detailing of the 31 EOP tasks (representations seen in Appendix D) further provided detailing of the tasks than that provided in training by the RN, as seen in Figure 5, and was reviewed and edited to ensure correctness of terminology and completeness of the sequences. The HTA results were passed on to the Canadian crews, at their request, to assist them in future learning of EOPs and have been used to aid in the preparation of the Canadian EOP document.

5.2.3 Training

5.2.3.1 Training Staff

The historical review of the Upholder submarine purchase and the subsequent training programme development identified many challenges and limitations to successfully train the Canadian crews. A definite hurdle was the preparation and challenges that needed to be overcome by training staff before and during training (Chapter 4.4.3). The RN had decommissioned the Upholder class six years prior to initiating training for the Canadians, thus documents, lectures, and the RN trainers needed to be refreshed, updated and upgraded to meet the training needs, but also to meet the increased requirements of today's standards of teaching.

The UTT team took it upon themselves to complete all that was required, but the training team did acknowledge their shortcomings and difficulties in trying to regain their lost knowledge and skill to achieve a personal aim as the contract did not dictate what level of expertise was required by the trainers. The trainers identified in their interview, "The entire RN team is not well rounded, have not sailed for a long time, and the selected team does not have a pool (collectively) of all the knowledge (needed)." This lack of initial capability of the trainers appeared to be a significant hurdle that could significantly affect the quality of initial and ongoing training, and therefore could influence the teaching of the knowledge and skill needed. The Canadian crews acknowledged the lack of knowledge and skill, but the perception in interviews was that the RN trainers' depth of knowledge and skill progressed over time; "UTT definitely had holes in their knowledge and skill initially, but they made sure they needed what they needed to know." The first trained crew further clarified, "Without a doubt, it was a learning process for them as well." "They learned a lot during fast cruising (sea-trial testing of personnel and submarine capabilities), it was a double-edged sword, sea-training by committee." Technicians from crew one revealed, "Instructors didn't know everything about the submarine, they admitted when they didn't, would search out the answer and then come back to you." This would suggest that the training platform did not formally supply what was perceived to be needed for emergency management, but the information was sought out and provided by the trainers, when requested. This would suggest a definite informal component to the training platform. Discussion of the impact of informal training aids and the possible link with instructor capabilities and training content to influence learning are discussed in detail in Chapter 6.

5.2.3.2 Training Platform

The training for emergency operation was also seen to be deficient in that training was provided at one level and operational duties and responsibilities within the submarine are divided and increase with increased rank (management and technician). The first trained Canadian crew, in their interview expressed this concern, "(We) need to have level of knowledge and skill for rank/responsibility, we are all taught to the same level." This deficiency was formally presented at the post-training lessons learned meeting, "Most operator courses were focused on equipment functionality rather than the operational employment of the equipment." The training management cell, noted that this point was raised at the end of crew one classroom training (crew one) and changes were implemented to improve the situation from Wave 2 onwards (crew two-four) (Detachment, 2001).

Even though changes were brought to the training platform to change training to include a more operationally focused platform, the Canadian crews still informally obtained knowledge outside of the training platform. Both the second and third trained crew expressed this view, "Don't need to know everything to do EOPs, they give us the basics, although, we're not all that comfortable yet with all the information needed. System knowledge had to gain from elsewhere, but experience, training and documents help carry us over." "We have a number of resources to draw from, that is informal" (crew two, senior technicians). "(We) didn't *get all* we need from the training (formally), there's Standard Operating Procedure (SOP) or EOP training, it's fine for a certain level but NOT for all" (crew three).

Further issues in training as they applied to the performance of emergency procedures were: the lack of systems knowledge and the integration of systems; the EOPs documented sequences were not as suggested in training (*e.g.*, EOP 4.1-Flooding Dived); there were no standards for testing or assurance of capability; and, sufficient skill training for dealing with multi-emergencies.

Trainees found that there were discrepancies between the EOP document and that trained, as that seen in EOP 4.1 Flooding dived, where the document had errors in the procedure (see Section 5.2.2). This discrepancy was frustrating for the trainees but it was also considered to make the learning process more difficult. This sentiment was presented even in crew three training, "I was under the impression that everything had to be done as it was written." "The way they're written is not how they are done, the individual training was not as they are written and the pattern in Collingwood (skill training) was much easier."

Hierarchical Task Analysis interviews with the trainees also indicated that the emergency procedures sequences taught in training for the common tasks seen in Emergency at Sea were neither efficient nor timely, and thus the performance of the sequence as trained could increase the likelihood of errors. Technicians suggested that the sequences (1-4) performed on the motor room panel for the MCC1 to stop the engines and compressors would improve if the shutting down of port and starboard engines and compressors was done simultaneously (port with left hand, starboard with right hand), or if the sequence of the task was changed such that a complete system was shut down before proceeding to the next (see Appendix D for details). That is, that the port engine is shut down then the starboard, rather than performing each sequence for port and starboard (Stop port and starboard engines, shut controllers, shut hull valve, agitation for each, *etc*).

Hierarchical Tasks Analysis identified that knowledge training was specific for the systems that each occupation was responsible for but no formal knowledge was provided to gain an understanding of how the systems were connected and the potential multi- or cascade consequences that could occur in an emergency. There was no formal knowledge training for the sequencing or systems involved in EOPs during phase-one training. Hands-on skill training occurred during simulator training and again during attainment of USQ. Also, the training platform provided individual and team training in the simulators, but time constraints specified within the contract did not allow all permutations of each emergency to be practised in simulator training. The limitations of the training contract and the very restrictive timelines to complete the training did not allow much room to expand the training platform. In the post lessons learned meeting with crew one, training management identified they had completed a cursory survey with both crew one and two to determine if they felt confident to do their jobs safely at sea, to which crews replied in the affirmative. They further noted that a balance between the knowledge and skill training was needed, and those personnel who had achieved operational certification were already subjected to one of the longest training profiles of any crewmember (Detachment, 2001), but they would continue to track the capability of ongoing crews training and satisfaction. This would again suggest a heavy reliance on past capability and achievement of submarine certification prior to attending the training. This would also again suggest a heavy reliance on informal training aids to support the gaining of knowledge and skill to perform the required duties.

The final issue with the training platform that was identified in the HTA was that of testing to assure capability, both in knowledge and in skill. This question was posed in the interview to the trainers, management and to the trainees of crews one through three, in regard to assurance of trainers' capability and that of the trainees.

The interviews revealed each group's perceived capability or comfort with what had been achieved to date. The interview with the UTT training team revealed their own misgivings with testing of their own capabilities, "There are definite gaps in assessment, no confirmation or assurance that all is known (by the instructors)." This statement reflects the fact that there were no standards to identify the knowledge or skill levels which the trainers must attain, they trained themselves, and tested themselves against the USQ that was written by the training team (see Chapter 4 for more details). The perception of the trainees was that they did not know if the trainers were tested to a standard to assure capability, but they did assume that even if there were no standards that the training team would do their utmost, "It's hard to say we don't know if the trainers have the knowledge or skill, that's all we have, they are the only ones who know." "I believe UTT truly care and want to make sure you know."

In regard to the trainees' perception that measures were in place in the training platform to test and confirm the skill and knowledge of the crew, the overall consensus was that the testing in the first phase of the training tested knowledge. The second phase, including the individual and team simulator training tested both knowledge and skill, and the final confirmation of team (crew) capability was tested during sea-trials. However, testing of skill was based upon achievement of a successful endpoint for that tested, and as testing was not done with a checklist to assure successful performance of sequences, confirmation of ability can be considered somewhat subjective.

Management concurred with the sentiments, " Certainly the trainees were tested in the motor room and control room trainer, spot walk-through, and USQ are a confirmation of knowledge." "I don't think it is a confirmation of skill." "Testing I think it is a combination of both end-point or series testing, is certainly subjective as the RN CO makes the final decision of capability on board (during sea-trials)." The trainees' overall view was that, "The trainers confirm you know your job (endpoint only), and spot checks by UTT, confirms I know what I'm doing." "Sea-trials tested our general ability, safety wise." This again confirms the aim of the training, to assure a safe transport surface and sub-surface. Training was not intended to supply maintenance capability or problem solving.

The issue was, in fact, not the testing, but confirmation that individual crewmembers had attained the desired knowledge and skill. Trainees did not receive formal debriefs of performance or an outline of strengths or weaknesses after evaluations. The trainees identified, "Have not seen any of my reports after simulator training and the evolutions performed, and it would definitely be worthwhile to see as it is a performance objective" "I don't know how well I'm doing, or how much I need to grow." "There is nothing official, nothing formal to say strengths or weaknesses." With no feedback of strengths and weaknesses trainees had to presume their own and their crewmembers capabilities. This shortcoming in the training programme would suggest that the training methods employed could influence learning and thus subsequent transfer. Further discussion of the impact of training methods to test and confirm capability and the potential links with other training factors is included in Chapter 6.

5.2.3.3 Repercussion from Training Delays

The skill set training for emergency operating procedures was provided individually and in a team setting in the control room and motor room simulators, and final training and assessment of a complete crews' capability was completed during sea-trials. Simulator training initially provided individual and team training in a five-day period for the first trained crew. During this initial "continuation" training team-crew selection occurred randomly based on availability of trainees and did not necessarily represent those who would be performing the duties let alone those who would perform the operational duties as intact teams.

The post training lessons learned meeting with the first crew upon their return to Canada identified, "That training was designed as conversion training for an existing submariner with the intention that training would be completed and then immediately followed by sea-trials. Due to programme delays, this did not happen. In some cases end of training occurred more than one year prior to the commencement of sea-trials. Accordingly, it was noted that some skills were lost or suffered from skill fade over time, therefore it was felt that more training time was required closer to sea-trials." (Detachment, 2001) This expression of dissatisfaction was based upon crew ones' own training that took more than 18 months to complete. As it had been over a year between training and sea-trials, simulator training and testing had to be performed again to meet the 16-week window criterion for continuation team training. As a result of this meeting, in which advice was sought from this research, individual and team continuation training was extended to a two-week period for all follow on crew training.

The need for further hands-on training was identified but as well, the post training lessons learned meeting with crew one also formally identified the emphasis of crew selection for individual and team training. It was noted in that meeting that, "That particular emphasis should be placed on the selection of crewmembers for continuation training (simulator training), to ensure that the Helmsmen who needs the most time get the best opportunity" (Detachment, 2001). Further details of the perception of the benefit of composition for learning and performance are discussed in Chapter 6.

5.2.3.4 Individual Background Influences

Review of the demographic data, as seen in Figure 7, has shown that the RN and CF training team, senior managers (RN Captain, crew one Commanding Officer (CO) and crew two CO) have been submarine qualified for the longest (RN training team CI, 22.5 $\pm$ 6.0 yr., CF training managers CI,21 $\pm$ 8.5 yr., senior managers CI, 14.3 $\pm$ 3.8 yr.) and have the most experience (RN training team CI, 21.5 $\pm$ 5.1 yr., CF training managers CI, 10.1$\pm$ 7.6 yr., senior managers CI, 9.2 $\pm$ 3.3 yr.). However, it was the SCOOW, the person in charge of the control room during emergency procedures, that has the least time qualified across submarines (CI, 7.93 $\pm$ 2.18 yr., Table 1), but overall also has the least experience across the three submarines (CI, 5.64 $\pm$ 1.77 yr., Table 2), and it can be seen that this inexperience is more pronounced for crew two (CI, 3.25 $\pm$ 2.66 yr., Table 2) and is also present in crew 3 (CI, 5.58 $\pm$ 1.5 yr., Table 2). While the senior non-commissioned members First Panels (combined control room and motor room SCC1 and MCC1 panel operators) have a wide distribution of the number of years qualified (CI, crew 1, 11.5 $\pm$ 7.69 yr., crew 2, CI, 13.63 $\pm$ 10.01 yr., and, crew 3, CI, 9.2 $\pm$ 8.84 yr., Table 1) and years of experience (crew 1, CI, 9.43 $\pm$ 7.02 yr., crew 2, CI, 11.75 $\pm$ 11.24 yr., and, crew 3, CI, 7.63 $\pm$ 7.4 yr., Table 2) within crews.

Table 1. 95% Confidence Intervals for the Number of Years Qualified as a Submariner for Trainees Prior to Initiating Training (Crew one, two and three represents the crew who would perform EOPs for each of the three submarines under going training. Years qualified is presented as Confidence Intervals).

Position	Crew one	Crew two	Crew three	Total
SCOOW	10.0 $\pm$ 4.66	7.13 $\pm$ 6.54	7.08 $\pm$ 1.0	7.93 $\pm$ 2.18
1st Panel	11.5 $\pm$ 7.69	13.63 $\pm$ 10.1	9.2 $\pm$ 8.84	11.27 $\pm$ 4.85
2nd Panel	10.88 $\pm$ 4.66	9.3 $\pm$ 6.62		10.21 $\pm$ 3.96
Total	10.79 $\pm$ 3.26	10.09 $\pm$ 4.56	8.05 $\pm$ 3.85	

This was especially apparent in crew three in which three of the five operators had been qualified as a submariner for two years, with experience that ranged from two years to two weeks. There was a great variance between the senior First Panel operators, in that at least two First Panel operators from each crew had greater than 10 years as a qualified submariner with equal operational experience, but also each submarine had at least one member designated for First Panel with less than three years of qualification.

Table 2. 95% Confidence Intervals for the Number of Years of Operational Experience by Trainees by Position and by Crew for each Submarine. (Crew one, two and three represents the crew who would perform EOPs for each of the three submarines under going training. Years of experience are presented as Confidence Intervals).

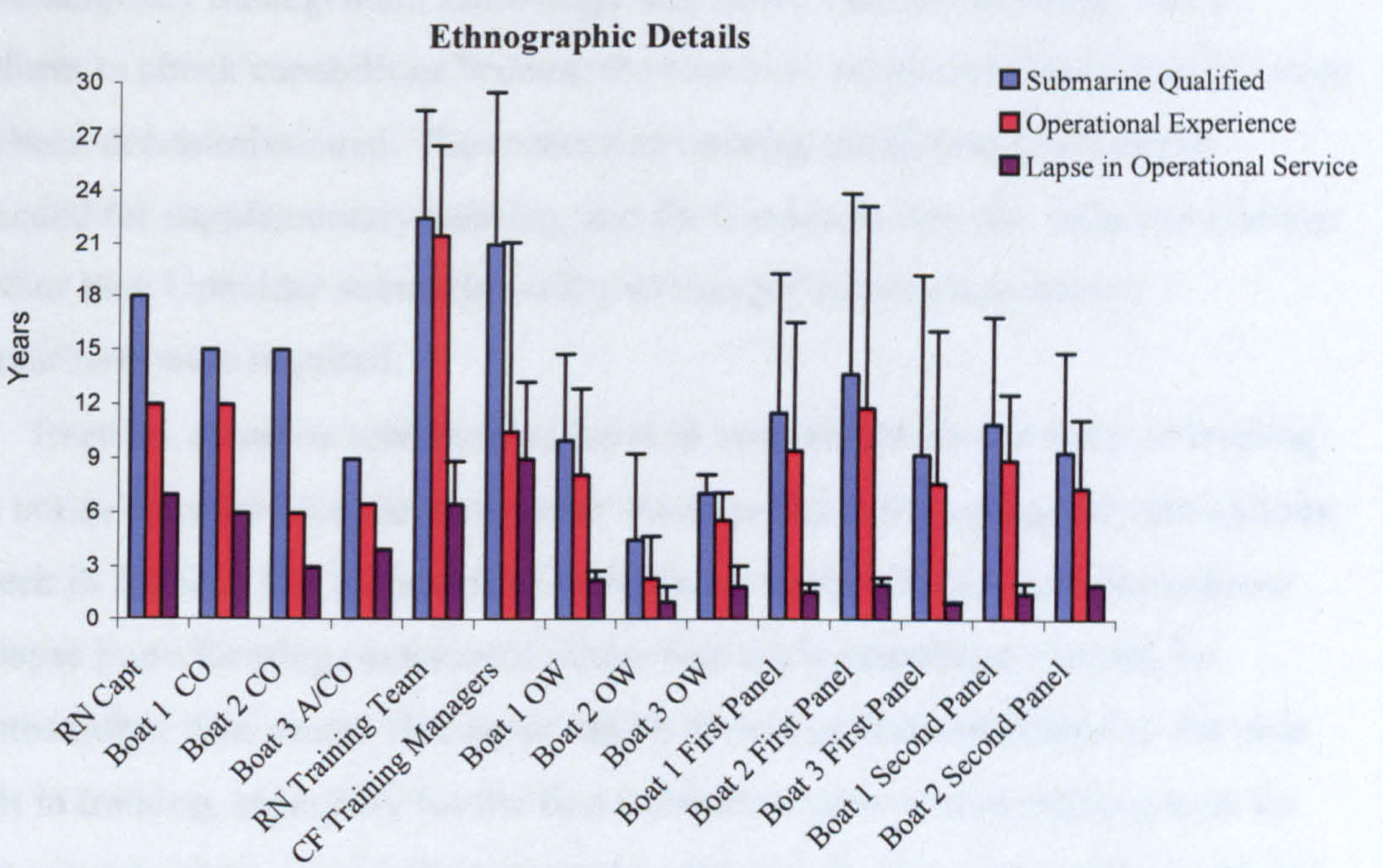
Position	Crew one	Crew two	Crew three	Total
SCOOW	8.13 ± 4.64	3.25 ± 2.66	5.58 ± 1.5	5.64 ± 1.77
1st Panel	9.43 ± 7.02	11.75 ± 11.24	7.63 ± 7.4	9.6 ± 4.63
2nd Panel	8.88 ± 4.64	7.33 ± 4.23		8.21 ± 2.56
Total	8.81 ± 2.77	7.45 ± 4.54	6.4 ± 3.01	

It could be said that the lack of experience may have an affect on learning and subsequent performance. The trainees commented that, "There is a lot of concern in regards to knowledge, especially in senior (engineering) positions, because O-boats served 15-20 years and gained a lot of expertise and knew the equipment inside and out. Here, the training process that lasts 5 weeks (for engineering knowledge acquisition) we're expected to have the same level (of knowledge and skill) which is impossible." " There is a lot of apprehension because we haven't grown up with the material." This would suggest a lack of confidence in their capabilities and perceived difficulties in achieving what was expected from training individually. From a performance perspective the demographic data indicate there was for the most part a balance between qualification and experience within each crew (Table 1and 2).

What is also notable from the demographic data that could affect learning is the lapse in operational experience (Figure 7). The trainees were expected to have their basic submarine qualification prior to entering training, but the currency of that qualification and time since they last served operationally on a submarine were not considered in the training platform. Thus, a potential degradation and loss of skill and knowledge was apparent in the RN Captain (7 years) who was the final assessor of skill and knowledge prior to hand-over, the CF managers (CI, 9 ±

4.2 yr.) who implement and suggest changes to the training programme, and the Commanding Officers of the submarines (CI, 5 $\pm$ 1 yr.) who have final authority and control of operations on their submarines.

Figure 7. Demographic Details of the Trainers, Trainees and Management for the Upholder Submarine Training Programme. (Management designated as RN Captain and Commanding Officers (CO) of each submarine, and crews indicated by position: OW= Ship Control Officer of the Watch (SCOOW), and 1st Panel and 2nd Panel = merging of Ship and Machine Control Console Operator (SCC and MCC) senior and junior positions, provided as mean years of crew with standard deviation of crew positions).



This lack of recent operational experience in senior military personnel would not however be considered unusual in the military, as members progress in rank in the military they move to managerial responsibilities. Progression in rank and delegation of responsibilities is based upon occupational and leadership capabilities, thus there is a reliance on the hierarchy of junior members, of varied occupations, to successfully perform their assigned duties during operations. Senior members involved in this training platform did, however, make final assessments of the crews' capabilities, monitored training and made the ultimate decisions to change the training platform. This lapse in operational experience could therefore have potentially influenced the training platform and outcomes from training. Results of the perceived influences of the demographic history of trainers, trainees and management on learning and training outcomes, and the expectations of training that were developed from the demographic history are discussed in detail in Chapter 6.

However, lapse in operational experience was not considered or dealt with in the training programme for many reasons. The basic submarine qualification (Oberon class) was considered a sufficient prerequisite of the submarine systems and emergency management knowledge and skills. Canada no longer had a platform to check capabilities because the previous submarine fleet (Oberon class) had been decommissioned. The contracted training timeframe could not be extended for supplementary training, and for Canada to operate, train and manage the four new Upholder submarines all previously Oberon-class trained submariners were required.

Even so, it can be seen that the lapse in operational service prior to training was not as extensive for the crews who would perform the emergency procedures, as seen in Table 3. For all positions within each submarine and across positions the lapse in performing operational duties was fairly consistent, varying by months rather than years. This lapse can be almost entirely attributed to the time spent in training, especially for the first submarine crew whose training took for most crewmembers 18-months to complete (Figure 4). Thus, it would appear that the SCOOW from the first crew had the greatest length of time since actively performing duties on a submarine (2.25 ± 0.49 yr., Table 3). However, excluding training this lapse would have actually only have been of several months duration prior to initiating training. For the latter crews, who had been in training for 10 months and seven months for crew two and 3 respectively (Figure 4), there had been at least a year lapse for most crew since they had actively performed their duties. The officers from crew 2 had the least lapse in time for the officers in training and the least operational experience, while in crew three the officers had the greatest lapse since performing their duties when compared to their crewmates, but did have more experience than the second SCOOW crew.

Table 3. 95% Confidence Intervals for the Years Lapse in Operational Experience for Trainees by position and by crew for each submarine (years). **(Crew one, two and three represents the crew who would perform EOPs for each of the three submarines under going training. Lapse in experience is presented as Confidence Intervals).**

Position	**Crew one**	**Crew two**	**Crew three**	**Total**
SCOOW	2.25 $\pm$ 0.49	1.0 $\pm$ 0.85	1.50 $\pm$ 1.22	1.88 $\pm$ 0.52
1st Panel	1.58 $\pm$ 0.42	2.0 $\pm$ 0.4	0.98 $\pm$ 0.04	1.48 $\pm$ 0.29
2nd Panel	1.5 $\pm$ 0.49	2.0 $\pm$ 0	ND	1.71 $\pm$ 0.36
Total	1.78 $\pm$ 0.33	2.0 $\pm$ 0.44	0.91 $\pm$ 0.55	

Review of the demographic details from the trainees reveals that from a performance perspective all three crews appear balanced in the combination of operationally experienced members with those that do not have many years as a qualified submariner, and lapse of operational service was less than three years for any crewmember on training. However, although opportunities are available to gain knowledge and skill from others during simulator team training and during sea-trials, there is an individual-based learning requirement as each member must be able to perform his respective duties. The method of training, delays and complications within this training platform (see Sections 4.4.3, Training Complications, 5.2.2 Documentations, and 5.2.3.2, Training Platform for more details) would suggest inexperienced individuals would rely on the more experienced to support them in learning to achieve performance requirements. This reliance on other team members to achieve organisational goals would suggest an inherent vertical transfer process. The perceived effect of the delays in training and the support of individual learning in the training platform and influence to learning are discussed in Chapter 6.

Over and above experience and time lapses in experience, it was agreed in the interviews from all involved in the training programme that the perceived percentage of new knowledge and skill required to perform the tasks in the Upholder submarine varied depending upon whether the crew position was that of an operator or a maintainer.

The difference in what needed to be learned between the two was considered significantly different, with the overall view that the percentage of new knowledge and skill for operators was 32.63 $\pm$ 5.31%, while the new knowledge and skill required for the maintainers was considered 73.38 $\pm$ 9.7%. Interviewees revealed that, "From an operator's point of view, quite a bit of what needs to be done are the basics and the same (as before), but automated now with different positions. Dolphins give you the groundwork (theory and the way systems work), but base knowledge is the same it's just changing the application." "The only thing that remains constant is the commands, the operations (duties of the SCOOW), the hierarchy is the same but the technical ability has to change." "For the maintainers, it's difficult receiving training they have never received or know of, they have to understand their equipment and everything around them (SCC and MCC positions)."

With this information it could be concluded that for those individuals who would be maintainers in the submarine there would be a heavy reliance on the training platform content, presentation and training aid material to learn the new knowledge and skill required. It was unfortunate that no crewmembers were available from crew three-second panel for interviews. Thus, for consistency of comparisons for all material for the thesis no demographic data were taken for these positions.

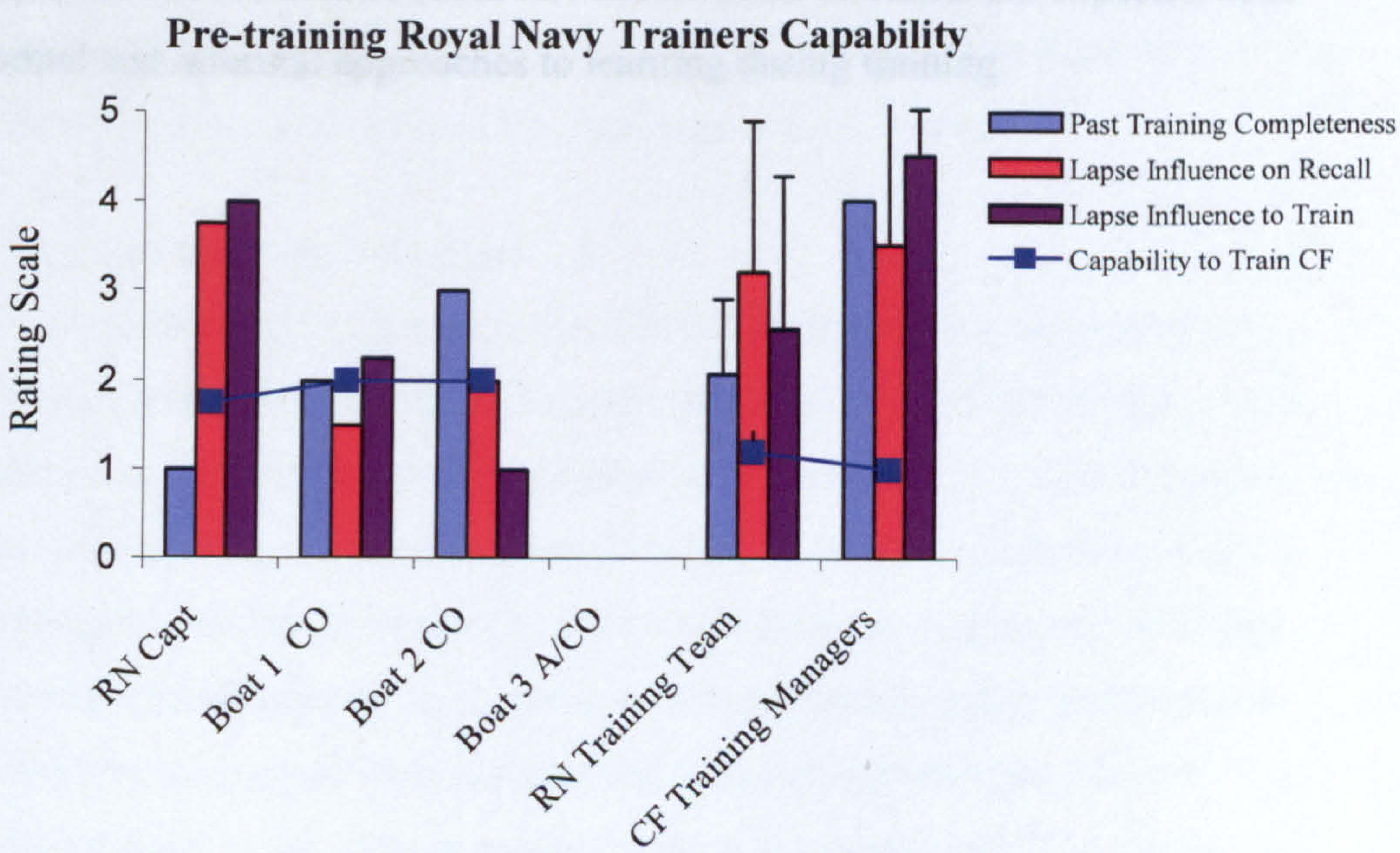
There were clear indications by all training stakeholders, especially the trainees, that the knowledge and skill needed to be gained to adequately perform duties on the submarine would require a sufficiently detailed training programme. Furthermore, the HTA identified that the characteristics that an individual brings to the training programme and the compensations derived from more experienced team members and crew are all-important factors to the success of the training programme and ultimate transfer of performance outcomes. Although the RN training team had a great deal of experience on submarines (CI, 21.5 $\pm$ 5.1yr.) the RN training team also had a lapse in operational experience (CI, 6.5 $\pm$ 2.4 yr). Also, their experience with the Upholder class consisted of only a period of seven years (1987-1993) during the building, activation (1990-1993) and operational usage (3 and 1.5 years with 2 of 4 submarines) of the four submarines (see Sections 4.3 and 4.4 for more details).

The trainers and management had differing opinions on the completeness of the past training package (Figure 8). The questionnaire indicated that the training team agreed to somewhat agreed to the completeness of past training, while the RN Captain responsible for the overall assessment indicated he strongly agreed to past training completeness. Although both are RN, the apparent difference in the opinion of training completeness could be that the RN Captain, although submarine trained, had never served on the Upholder class nor had he taken part in any portion of the training for that class of submarine. The trainers revealed that the training, at that time, consisted of little formal training, "There was an informal passage of knowledge, interaction and presence during the building of the boats and testing of systems to see parts of the boat, how it works." "The USQ was used, as is now (although) during the building phase, then Operational Certification during sea-trials." This information was known to the Canadian training managers, which may have contributed to their likely opinion of the completeness of training.

The opinion of the completeness of the past Upholder submarine training by the trainers could also be due to the fact that they are the ones who had to prepare and complete the training package for the Canadians, thus they had a more accurate picture of the historical influences and the subsequent work involved for preparation. Upon completion of the preparation for training and having completed crew ones' complete training and crew two and three partial training, the trainers indicated that the lapse in operational service somewhat affected to not having affected recall at all, but there was almost complete agreement that the lapse somewhat influenced their ability to train.

The RN Captain and the Canadian training managers revealed that the lapse did have some, albeit small, affect on the trainers' recall but disagreed that the lapse affected their ability to train. Both COs felt the lapse affected the RN trainers' ability to recall, the first CO more so than the second CO, probably because the first course was considered a pilot course and documents to support training became available sporadically through training. Both also agreed that the lapse influenced the trainers' ability to train. Both COs had significant time qualified as submariners (15 years), although differences in operational experience (crew one CO, 12 years and crew two CO, six years), the first crew CO had a six year lapse in operational experience while the second only had three. Thus, their differences in response were not considered related to historical experience. This would suggest that although changes had been made to the training programme after crew one's completion of the pilot course, either the changes were not seen by crew two at their stage of training or further changes were still deemed to be necessary.

Figure 8. Historical Influences of the Trainers and the Perceived Capability to Prepare and Train (Rating scale: 1 = strongly agree, 3 = neither agree nor disagree, 5 = strongly disagree).



This was clarified in the interview with Canadian management by the comment that "Late crews had the benefit of courses developed specifically for U-boats (rather than heavy reliance from training from the Trafalgar class submarine), but once again these appear to never have been fully developed and validated." The Upholder class submarine design was based upon the Trafalgar class nuclear submarine, and many of the original courses provided to the RN on training and initially in this training platform were courses developed for the Trafalgar class. Thus, the comments suggest lack of specificity of the courses to the Upholder class submarine, providing instead general submarine concepts.

The Acting Commanding Officer (A/CO) for crew three had the opportunity to be interviewed only with the officers of crew three, and therefore questions regarding the capability of the training team were not discussed so that the crew would not question the capability of the trainers or the training platform, therefore potentially influence the training.

Thus, although there was an agreement that lapse in operational service with the Upholder class affected recall of the trainers and training, all agreed on the trainers' capability to train the Canadian Navy. As discussed in detail in Chapter 6, and has been to earlier, this belief is due in part to the historical training approach of submariners (both RN and CF) that included and expected both formal and informal approaches to learning during training.

6. Training Effectiveness Influences

As identified earlier, the research for this thesis was performed while an organisation engaged in training and, as such, permission was granted on the condition that there would be no interference with the training. Interference was deemed interruption in the conduct of training, but as well, interruption was also considered as perceptions developed by trainees from this research that could influence training progress or outcomes.

Therefore, training effectiveness factors to support the thesis objectives were limited to the identifiers that could be obtained retroactively for pre-training influences, as well as, identification of the perceptions, reactions, expectations and satisfaction of trainees, trainers and management of the training process as it related to the performance of safety-critical elements of operation (performing Emergency Operating Procedures (EOPs)). Further, to ensure that trainees' perceptions of the training programme were not altered, questions related to the potential influences of the training programme history to this training platform were only provided to CF and RN management and trainers.

6.1 Pre-training Influences

As identified in Chapter 3 (Section 3.3.2), individual responses were obtained for the pre-training factors for participants' characteristics (years of military service, education, years qualified as a submariner, years of operational experience, and years lapse in operational experience), and the RN historical training programme influences to the current training programme (including training content, principles, formal and informal training aids, and instructor ability) were obtained from management and trainers only (see Chapter 3 for further details). Individual responses to the perception of additional influence from organisational factors were not obtained to avoid potentially influencing training perception. However, general situational and perceptional influences of the organisational climate from both the CF and RN were identified during the investigation of the background history of the Upholder class submarine and subsequent CF submarine procurement and contract details for the training and submarine reactivation requirements (see Chapter 4 for further details). Specific perceptions of organisational influences were also identified through the interview process with stakeholders in the training programme.

6.1.1 Participant Characteristics

As discussed in detail in Section 5.2.3.3 the demographic details of the trainees suggest there was a balance between submarine crews for the number of years qualified as a submariner (Table 1) and years of Oberon-class submarine operational experience (Table 2) that would support and ensure operational capability on the platform that utilises the experience. Although there was a balance between experienced and inexperienced crew within submarines, individual crew history has shown that crew one had the most overall experience, but at least one member designated for First Panel within each crew had less than three years of qualification as a submariner. The SCOOW of the crew three had two members with less than two years experience and within crew three, three of the five senior First Panel operators' experience ranged from two weeks to two years. Lapse in operational experience was not significant between crews or positions, but the senior managers and trainers, the key decision makers, did have a lapse of five years or more (Figure 7), and only the Commanding Officers completed the training. As indicated in Section 5.2.3.3, experience and inexperience were not seen as significant deterrents to learning. Officers revealed, "The experience you gained on the O-boats was a massive foundation on which to build, and it made the learning process that much easier. You found that it is more of a positive influence as it is only the changes that have to be learned." Inexperience was also not considered a deterrent to learning, "Inexperience was not thought of as a learning problem (knowledge) just practising of skills missing."

Further, there was a general agreement among trainees that the prerequisite submariner certification was of value, "Having dolphins and experience makes a difference, requirement of contract to have dolphins was in hindsight a true necessity." These comments would suggest that overall the trainees had the necessary certification pre-requisites for training and considered the pre-requisite certification a sufficient antecedent. Thus, one would conclude that there was a misconception of what the training platform would provide, which then transferred to an expectation that the training platform would provide the knowledge and skills needed for transfer.

The phrase 'young man's game' is commonly referred to in the submariner community and this phrase might suggest that age might be a factor that would influence learning. However, interviews revealed that age and level of scholastic education were not considered a deterrent to learning. Interviews also identified that age was considered a factor in performance capability. As one gets older one loses agility and may not fit as well into the small compartments to perform maintenance. But interestingly, the submariners believe with age the willingness to take risks decline, "Young men will take more risks in operations. The older you are you know you have more to lose, you're not invincible." This view of risk-taking and the relationship to age may be related to influences outside of the work environment such as social influences and responsibilities to family and the community. As well, although this case study was not able to delineate or confirm the associations, the relationship between age and risk-taking may be related to life experiences gained with aging and recognising one's own limitations.

Thus, rather than experience influencing learning, comments from the interviews have suggested that the perceived amount of knowledge and skill to be learned for this new class of vessel was dependent upon whether the crew position was that of an operator ($32.63 \pm 5.31\%$) or a maintainer ($73.28 \pm 9.7\%$). From a maintainer's viewpoint there was a perceived discomfort whether the training platform would provide the necessary knowledge and skills, "In some cases a little of the machine is the same, more automation, more intimidating (combination electrical/engineering trades) and some view as a positive most do not. Also, introduction of digital electronics, worries me, we have been instructed but the fault finding defects is going to be a hard-learned skill, that we haven't even looked at."

The perceived differences in the amount to be learned between the operators and maintainers and the discomfort voiced by the maintainers would suggest that perceptions of dissatisfaction and greater expectations from training would not be to the same degree for operators as that for maintainers. The specific influences from training and the differences of perception and expectation between trainers, management, crews and positions are discussed in Section 6.2.

6.1.2 Organisational Influences

Although specific questions were not asked about the perception of the pre-training organisational influences from the CF and RN, information was gained from interviews and historical information. Therefore, although statistical comparisons cannot be made, those pre-training organisational contextual situational factors and perceptions of the organisation and their influence on training that are known are discussed to gain a better understanding of the multi-factorial and multi-dimensional influence on training effectiveness.

6.1.2.1 CF Organisational Influences

The CF conversion-training programme to the Upholder class submarine was considered mandatory for all submariners who would hold a position on the submarines, act as trainers in the future, and for those who would hold management positions responsible for the submarines. Although mandatory, accommodating and supporting the training was not an issue as the organisation was supportive of the training and recognised the need for training for all. Canada had decommissioned their previous class of submarine and recognised that RN personnel, although not current at the time of purchase of the submarines, were the only individuals who had a repository of information on the Upholder class submarine. The CF did have an input to the training programme, "The guidance given from Canada was based on a plan initiated in 1995 by Canadian representatives. The rationale was to bring back as much information to Canada as possible so that by the end of training in the UK we would be the repository for everything U-boat."

The training objective of the organisation was to ensure that adequate training was received within the constraints of the contract to ensure safe passage of the crew and submarine back to Canada, both in a surfaced or submerged configuration. It was, however, realised from the outset of planning that the RN training of 344 basic submarine qualified personnel within the time constraints could not provide the detailed knowledge and skills for personnel to perform all operating and maintenance tasks. The interview with management who attended the planning meeting identified that, "In the first meeting (1995) with Canada the RN discussed courses for each position and RN courses and depth were recommended. Dilution (from all courses and content) was agreed." The resulting package was then sent to the FOSM for approval to ensure the courses covered the required safety aspects. At that time it was also determined that pre-requisite qualifications were necessary for the course (dolphins).

This philosophy continued throughout training, as training management sought the opinion of trainees from crew one and two to see if they felt confident to do their jobs at sea. Although the initial indications were positive the training management continued to monitor the progression of the courses and address the concerns identified by crew.

However, trainees were not always aware of this proactive monitoring and the resulting changes implemented to the training programme to support the need to achieve the desired knowledge and skill. As the training programme was the responsibility of the RN, any changes made to the training content required the approval through the RN hierarchy (MoD) to assure safety was maintained. This took time, and resulted in the first and in some cases the second crew not seeing many of the resulting training programme changes. Trainees agreed they could provide critique on courses, although they were not aware whether all their concerns were investigated and if they needed to be addressed. However, with regard to documentation, changes were quick and apparent, although not formally processed and approved. "We were able to provide suggestions, had lots of opportunity (course critiques) for input/suggestions taken regarding documentation. The final input to RN documentation required approval by MoD. Initial approval and temporary changes were made and done by UTT."

Enabling subordinates is a foundation principle of the military for operational functionality. Leadership in the form of mentorship, guidance, discipline when needed, and reinforcement is provided throughout the military hierarchy, both formally and formally. This supervisor and peer support network was especially evident within the submarine community, perhaps derived from necessity because of the inherent risk and consequence of the working platform. As well, working in an enclosed and isolated environment with essentially no privacy and nowhere else to go, requires direct and effective communication skills to facilitate an efficient and productive workforce. Submariners further clarified, "Individuals in a crew are a close bunch and if someone is having a problem someone will pull you aside and let you know. It behooves the panel watch keeper, in one way or another, to let them (crewmembers) know there is a problem as they could be or are putting the submarine at risk. A submariner is more conscientious about their decisions and the consequence." Management endorsed and amplified this leadership philosophy both within the work environment and during training. This endorsement was personified in their operational policies. "The checks are there, but if it (*sic*) is bypassed then the supervisor will pick it up or someone within the crew. Incompetence will be picked up, and then they will be given more training, more time at sea or more time in the trainer. If he can't do it at the end of the day, he's gone." It could therefore be inferred from comments that the policies and procedures within the submarine workforce provided a supportive climate both in pre-training and during training. The comments would also suggest there was a reliance on the organisational leadership climate (management and crew), both prior to and during training, to identify and deal with crew capabilities and individual shortcomings that may or may not be identified or dealt within the training programme.

6.1.2.2 RN Organisational Influences

Leadership and enabling subordinates was not unique to the CF; it is a foundation for the successful function and operation of any military organisation. The RN submariners were not any different in that regard, and the sentiments and philosophy of leadership between submarine crewmembers and forthright communication of capabilities appeared to be the same. The training and performance philosophy within the RN submarine community was also essentially the same as that of the Canadian Navy. As a norm the submarine organisational hierarchy monitors performance and capabilities internally (on a micro-level); individuals and teams are expected to identify performance capability shortfalls. As identified in the interview with the RN trainers, the RN submariner historical training philosophy was such that individuals were expected to identify further training or refresher needs, "I'm not happy with the time span between courses, and want a refresher." It is not known if this training philosophy continues with the RN submariners, but the historical organisational climate whereby the onus of identifying perceived performance shortfalls was in part the responsibility of the individual could have impacted the degree of knowledge and skill obtained by trainers, affected the forthcoming attitude of the trainers to train the Canadian Navy, and, as a result, could have had an impact on the resulting training to the CF. The perception of the effect of the pre-training influences is discussed in Section 6.1.3., Historical Training Influences. It should be noted that on a macro-level, training and capabilities (in the form of yearly evaluations) are monitored within the military for occupational and leadership requirements within the varied occupational structures and levels of responsibility (military rank structure) to identify criteria and eligibility for promotion and career progression, for both the RN and the CF. The submariners maintain a formal and informal support climate.

Like the Canadian submariners the RN submariners have an organisational structure that requires interdependence of individuals within a team. This characteristic is observed upward through the organisation, and forthright and direct communication of capabilities and shortcomings both upward and down the chain-of-command was (and is) common and expected. There was a "can do, must do" attitude amongst this group of individuals as it applied to their submarine training. Interviews with the RN trainers in regards to their initial training for the Upholder class submarine revealed, "We were around while the submarines were being built, testing of systems, thus (there was) no formal training. There was an informal passage of knowledge and presence during testing of systems, and thus we had a chance to see parts of the submarine, how it works, that you would not normally see." These statements identify both the formal and informal qualities and expectations from past RN submariner training, that was perceived in a positive light rather than a negative influence. Further distinctions of RN and CF management and trainer perception of specific historical pre-training factor influences are discussed in Section 6.1.3

6.1.3 RN Training Preparation and Historical Influences

6.1.3.1 Training Content

The overall general perceptions of the historical influences to the trainers' perceived capability to prepare and train by the trainers and management were discussed in Chapter 5 (Section 5.2.3.3). There was a varying degree of agreement on the completeness of past submariner training by RN trainers and the RN and CF management, and only the CF training managers disagreed with the past training completeness (Figure 8). The background history and interviews indicated that the variance in response was likely due to either the direct involvement with the initial Upholder training and preparation for the CF training, or direct and intimate knowledge thereof. This was seen in the questionnaires, with a general agreement of the RN trainers and COs who were involved in training, while the RN Captain and the CF Training Managers formed either extreme response (strongly agreeing and disagreeing to strongly disagreeing, respectively). The RN Captain who had not received the Upholder initial training had also not been involved in the preparation of the training for the CF, while the CF training managers were directly involved in determining the courses and depth requirements for the trainees.

The remainder of the questions indicated the perceived impact of the lapse in operational experience to recall and train the Canadians and the influence of the imposed training principles and the supporting training aids. To aid in defining specific factors that could have a pre-training impact, questions were divided into the categories of: training aids (3); instructor characteristics (5); training principles (4); and, informal aids (3) (see Appendix C for questions and divisions). Training aids and informal training aids were differentiated to determine if informal training aids formed a significant portion of the RN training regime.

6.1.3.2 Training Aids

There was an overall agreement by all (1.45 ± 0.62) that the technical documents, simulator training and access to the submarine provided assistance in recalling that learned (Appendix E). As most of the documents had not been completed, much of the supporting information had been destroyed upon decommissioning of the submarines, and the original training lectures contained only broad statements with very little detail (see Section 4.4.1 for more details), it was not surprising that both the simulator and the submarine were considered as significant support mechanisms in regaining the knowledge and skills lost. It was somewhat surprising that the documents were considered a significant support, but as an aid to recalling the systems and functioning of the Upholder submarine any completed portions or remnants of the SOPs and technical manuals (TABs) would provide systems description. Supporting documentation would also further aid in amplifying the sequence statements in the original RN EOP document, which provided only broad overview functional statements.

6.1.3.3 Informal Training Aids

With the reliance upon incomplete documentation, the geographical distance from the simulators and difficulties in gaining access to the submarines during reactivation, it could be presumed that other avenues would be sought to obtain information. Not surprisingly that was found to be the case. However, the extent to which informal aids were used to gain more details than those provided when the submarine was in active service was not considered the same for the RN trainers (UTT) and the BAE contractors (retired submariners from Flagship). All respondents showed a strong agreement ($1.44 \pm .44$) that the RN trainers utilised informal mechanisms to obtain or regain the lost knowledge and skills. But, the perceived degree to which the training contractors sought out informal mechanisms was not considered as great (1.94 ± 0.45). This variance may seem small, but there was a considerable difference of opinion amongst the interviewed groups. Only the CF training managers strongly agreed that the contractors used informal mechanisms, while the RN Captain and the second CO agreed, but the RN training team and the first CO only somewhat agreed (2.65 ± 0.42). This difference in opinion could again be related to either the amount of direct involvement with Flagship during the preparation for training or the perception developed during training. As the first crew training was considered a pilot course and resulting changes were subsequently applied, this could account for the greater agreement of the second CO from the first.

Interviews with the UTT team confirmed their motivation and reliance to seek external aid to ensure currency of knowledge and skill, "We went to the T-submarines (Trafalgar class submarine) initially, did fast cruises with them, fought fires, DCHQ, and CSST training. We volunteered, thought it was good idea to increase current knowledge and update (skills). We saw the vision of what was needed in both knowledge and skill, knew that in order to have credibility (we) have to increase and assure (we) have the knowledge, can't best guess. Went to companies that supplied systems for water plant, mustered all the documentation held by any of the submariners." However, the BAE contractors were not involved in this process as they were contracted to provide training support after UTT had completed the process very near to the time that training of the CF began. Interviews with UTT revealed, "When the contract (with the CF) was signed, BAE were late in being notified and it was too late to train themselves." Even though the contractors were not involved in re-training the selection process was stringent, albeit subjective and based upon the UTT's own current knowledge and skill base. UTT quotes further revealed, "In selecting the

BAE training team, UTT was present in the interview board, assessed skill and knowledge, capability, (based upon) previous rank. We looked to see what the requirements were, vetoed some people, exchange views even now."

Although informal aids were considered a large part of the trainers' methods to regain their knowledge and skill after a lapse of experience of 6.5 $\pm$ 2.4 yr. (for UTT), no significant correlation (Spearman rho) was found between formal and informal training aids for either the UTT or Flagship trainers.

Questions relating to the formal and informal methods used to prepare the instructors to train the Canadians were created to identify the perception of preparation methods to train. While questions relating to instructor characteristics indicated the perception of instructor capabilities and the influence of the lapse in experience on the trainer's ability to recall, train and assess, as well as, identifying the perception of the trainers' (UTT and Flagship) overall knowledge and skill once training began.

6.1.3.4 Instructor Characteristics

As seen in Figure 8, and discussed in Chapter 5 (Section 5.2.3.3) the RN training team, RN Captain and the CF training managers were more or less in concurrence of the lack of effect lapse in experience had on recall and ability to train than were the two Commanding Officers. This pattern of perception was also seen in the influence of lapse of experience on ability to assess the trainees. Again, both the CF training managers and the RN Captain disagreed there was an influence, the RN trainers somewhat agreed, but the COs shifted their opinion slightly to somewhat agreeing that there was an influence. It could be assumed that the perception of influence from lapse in experience to recall, train and assess would be reflected in the opinion of the trainers overall knowledge and skill, and therefore capability to train. All agreed (1.39 $\pm$ 0.44) that the UTT team were very capable of training the Canadians (Figure 8, Capability to train), but the knowledge and skill of the Flagship contractors were not seen to be adequately sufficient (3.05$\pm$ 1.37), by some. The RN trainers and RN Captain agreed to somewhat agreed on the capabilities of the contractors to train, but there was a wide discrepancy among the Canadians, the first CO disagreeing, the second agreed, but the RN training managers were on either end of the spectrum (either strongly agreeing or disagreeing).

What is noticeable from this is that although there were varied opinions of the influence of lapse in operational experience on ability to recall, train and assess, all agreed that the UTT training team was capable of training. This response to capability seems to contradict those perceptions from the influences from lapse in experience. However, many factors could have influenced the opinions of those interviewed: knowledge of the training preparation; experiences during the current training; past training experiences; training philosophy of both countries; and, expectations from this training platform, based on what was expected to be provided, what was hoped to be provided, or a mixture. Past training experiences could have had a significant influence in the perception of the capability to train and the degree of expectation from the trainers. What appears to be a contradiction could in fact be related to the expectation from training based upon the training philosophy of submariners. As identified in Section 6.1.2.2 the RN submariner training involved and expected both formal and informal training approaches for learning. Thus, formal training would not be expected to provide individuals with all that they needed to learn. Therefore, capability to train would likely have been subjectively based on what individuals felt was needed formally within the programme with the understanding that information would also be gained informally, and was expected.

The apparent discrepancy of responses between influences and capability from the CF managers could be attributed to the expected reliance on the leadership climate within a submarine to identify and deal with individual shortcomings (as described in Section 6.1.2.1). Thus, crewmembers would be expected to identify individual deficiencies (within training or operationally) that were not identified within the training platform. Therefore, expectations from the training programme would be likely be lower, especially for the pilot course as it was recognised that the training programme would likely require adjustments. The CF managers confirm this sentiment; "It seems to be getting better over time.

First crews were exposed very much to a learning experience on behalf of the 'trainers'. Feedback loop (between trainers and trainees) was heavily relied on and as a result things improved."

One would expect then that correlations would be found between instructor characteristics and formal and informal training aids, but this was not the case. Further comparisons of the training programme expectations and perceptions are discussed in Section 6.2, under Training Influences.

6.1.3.5 Training Principles

The last group of questions was developed to identify pre-training influences related to training principles. Specifically, questions were designed to identify the perceptions surrounding the guidance given to the training programme, syllabus content, depth and breadth of courses, and assessments standards (identified as either entirely, some, barely, not at all). Responses from all respondents were fairly consistent for all four questions, responding that some guidance was given in all four areas. All but two individuals replied differently to training programme (rating entirely), depth and breadth of courses (rating barely) and assessment standards (one barely the other entirely), while only one individual stated that guidance was given for the entire syllabus content.

The response that some guidance was given to the training programme, syllabus content and depth and breadth of courses directly relates to the historical preparation and development of the conversion course, and therefore assumptions could be made quite confidently that most managers were intimately aware and likely involved with the development process. This was confirmed during the interview process whereby the Canadian managers indicated, "The guidance given from Canada was based on a plan initiated in '95 by Canadian representatives. Canada discussed courses for each position and RN courses and depth were recommended." (see Section 6.1.2.1 for further details) The contract indicated the RN were responsible for crew training, and thus the RN would train, assess and qualify according to their policy and procedures (see Section 4.3 for further details). Writing and upgrading of the courses, lectures and documents began in 1997 with the intention to mimic the RN submarine qualification format and, although the intention may have been to follow the RN policies and procedures, once training began adjustments were needed. The RN trainers identified, " (We) went through the procedures and process of how the RN would normally follow training. The six-part qualification normally done onboard (individually), given the book and do it, but realised at the time that the Canadians would be in the UK (we) couldn't proceed as the RN would have." As the RN historical training method for the Upholder class submarine involved learning through the building, activation and operational usage of the submarines, relying upon formal, self-study and informal methods, this same process could not be reinstated. As well, the contract stipulated very strict timelines to which sea-tested qualified crew and the reactivation of submarines would be delivered simultaneously. However, it is likely that the cascade complications that arose from delays in reactivation of submarines severely altered the intended training plan (see Section 4.4.3 for further details).

Although most managers thought that some guidance was given on assessments standards, the RN Captain revealed, "(CF trainees would be) tested against standard of the levels of training, knowledge and skill required by the RN during Upholder training." That is, MoD, OpDoc, were responsible for document format and style control, but the guidance for assessment standards and the determination of the content, detail and quality were not managed or monitored by a forum outside of the Upholder training staff. Although CSST (Captain Sea and Shore Training) was responsible for determining the acceptability of training, the UTT team acted as assessors on behalf of CSST as they did not have any Upholder experience. The UTT team revealed, "CSST came to assess UTT against up-to-date standards for style and policy, but this has nothing to do with technical content. No one determined how the programme should go, although CSST had final approval (of the training programme)." This would suggest that there was no external quality control of assessment standards, and assessment standards were based on historical RN training methods.

6.1.4 Summary

Although no significant correlation differences (Spearman's rho) were found between the pre-training factors of training aids, instructor characteristics and informal aids when questions were presented to trainers and management (n=9), the relationships of these pre-training factors to each other cannot be completely discounted, as insignificant findings could be attributed to the small number of subjects questioned. Further, there were an insufficient number of questions and responses to achieve sufficient power to apply any form of statistics for the pre-training content that related to the historical Upholder training provided by the RN.

Since the instructors had obtained very little experience with the Upholder class submarine prior to decommissioning, the knowledge and skill gained from previous training would be heavily relied upon to instruct trainees. As well, prior knowledge, skill and experience, thus expertise, would determine the perception of competency by the trainers. Do I know all that I have to know in order to instruct? Thus, guidance, application and monitoring of training principles from prior training could have affected the knowledge and skill acquired, while lack thereof could invoke inaccurate estimates of competency by the trainers, which in turn would influence the capability to adequately instruct.

In addition, statistical comparisons of training principles could not be made with the other pre-training factors, however, guidance in training content, depth, breadth and methods assessment could alter the degree of knowledge and skill obtained from prior training. Therefore, prior training could impact trainers' capability and attitude (*e.g.*, self-efficacy) to instruct, which could also impact training outcomes and therefore achievement of organisational objectives. Pre-training influences could thus have an impact on vertical transfer. Although no statistical comparisons could be performed on the internal consistency of the questions in pre-training, face validity of findings suggest that a capability to provide training is dependent upon the prior training received.

6.2 Training Influences

The training influences in this case study of an organisation's training were indicated through questionnaire responses that, when needed, were discussed and expanded upon by the interviewees' concurrently during interviews (single and as a focus group as required). Further information pertaining to training influences was gathered through investigation of the historical training programme and the subsequent development of the RN training and submarine reactivation contract, and through the Hierarchal Task Analysis investigation. All available training stakeholders (n=42) were involved in identifying their perception, reaction, expectation and satisfaction with the training influences to include the RN trainers and the senior manager responsible for the submarine fleet, and the CF trainees, senior managers (Commanding Officers), and training managers. For ease of discussion, and in an effort to identify specific training effectiveness factors that could have an impact, questions were divided into the category of perception (training content, training aids, instructor characteristics, informal aids, training methods, training content intervention, and learning). Further questions were also developed to identify expectations (training content, trainee performance, and operational and maintainer knowledge and skill performance) from the training platform.

6.2.1 Training Programme

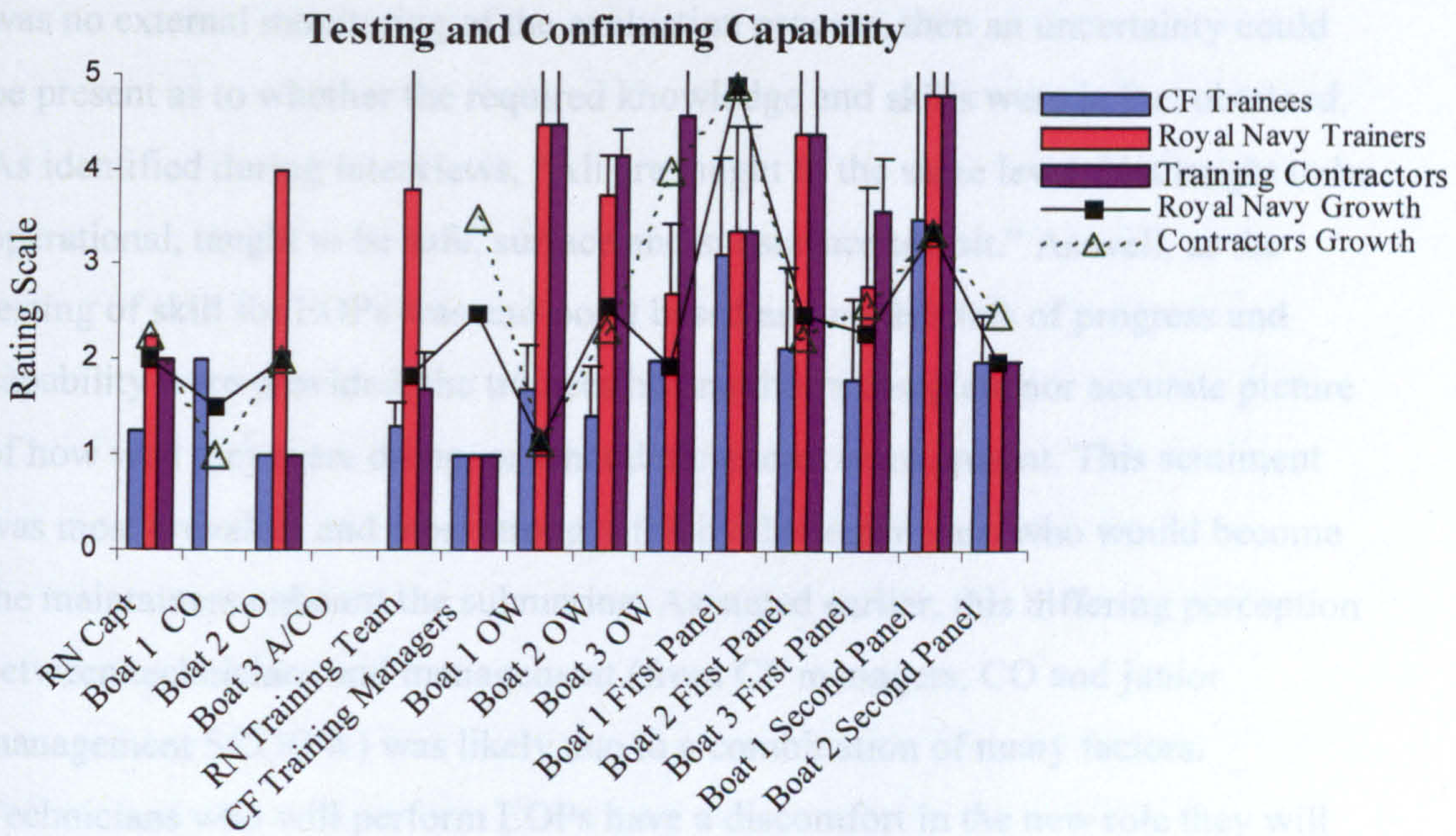
Training Programme methods, contents and instructor characteristics findings from questionnaire and interviews are discussed in this Section. Details of the specific training programme, training requirements and training complications can be found in Section 4.4.2 and 4.4.3.

6.2.1.1 Training Methods and Content

6.2.1.1.1 Training Methods

The training methods observed and rated in this study related to the perceptions of the training measures in place to test and confirm the knowledge and skill of the trainees, RN trainers and contracted trainers (Appendix C). The training methods employed to evaluate the progression and capability of trainees and trainers during training also relates directly back to the pre-training influence of training principles; the guidance given to the RN trainers of the necessary training content, depth, breadth and assessment requirements to assure organisational objectives were met. As identified in Section 6.1.2, the CF provided some guidance as to what RN courses were needed. However, a training analysis of the needs of the CF submarine fleet was not completed prior to training, and the routine training practices of RN training could not be exactly followed. Historical RN training for this class of submarine consisted of formal training and direct involvement of crewmembers during the building, activation and operational usage of the submarine. As well, no external guidance or monitoring of evaluation criteria was supplied to the RN trainers. This background would set the tone of the training programme and provide the rationale for the differences in responses by the varying groups interviewed.

Figure 9. Perceived Training Programme Testing and Confirming of Capability of Trainees and Trainers and Knowledge and Skill Growth of Trainees
(Rating scale: 1 = strongly agree, 3 = neither agree nor disagree, 5 = strongly disagree)



As seen in Figure 9, the responses to whether measures were in place to test and confirm both knowledge and skill of trainees and trainers differed greatly, but perceptions also varied between management, trainers and between submarine crews. The RN manager, RN trainers, CO and the SCOOWs all agreed that measures were in place to test and confirm CF trainees. This strong belief was not as apparent from the technicians, and although they somewhat agreed that measures were in place to test and confirm capabilities, it was crew one technicians (SCC1 3.13$\pm$ 1.01, and SCC2, 3.5 $\pm$ 1.78) who disagreed that measures were in place. As discussed in Section 5.2.3.2 (HTA of the training platform), all those interviewed generally agreed that the first phase of training tested knowledge, and the second phase (USQ and individual and team simulator training) tested skill, with sea-trials providing the final test of team-capability.

However, as identified earlier in Section 5.2.3.1, the concern was not testing of knowledge and skill but confirmation that knowledge and skills were in fact obtained. It could be said that testing is a confirmation of knowledge and skill, however, if no criterion was provided to identify the details of what should be tested (knowledge or skill objectives) or how testing should proceed, and there was no external monitoring of the evaluation process, then an uncertainty could be present as to whether the required knowledge and skills were in fact obtained. As identified during interviews, "All are taught to the same level. Not taught to be operational, taught to be safe, surface and subsurface transit." As well, as the testing of skill for EOPs was end-point based and no debriefs of progress and capability were provided, the trainees had neither a complete nor accurate picture of how well they were doing, or what deficiencies were present. This sentiment was most prevalent and most strongly felt by the technicians who would become the maintainers onboard the submarine. As stated earlier, this differing perception between technicians and management (from CF managers, CO and junior management SCOOW) was likely due to a combination of many factors. Technicians who will perform EOPs have a discomfort in the new role they will assume, in that this RN training platform (based on the RN submarine workforce) requires individuals in the positions to have the combined knowledge and skill that in the Canadian Navy is considered two occupations, marine engineer and electrician. Also, the volume of new knowledge and skill to be learned to operate this class of submarine was considered by all to be significantly different between operators (32.63 $\pm$ 5.31%) and technicians (73.38 $\pm$ 9.7%). Although, the training platform was not designed to provide maintenance or problem-solving capabilities, technicians felt they needed more to be able to adequately perform their duties. Thus, the managers' agreement that measures were in place to test and confirm was again likely based upon the organisational training mindset and the supportive training climate of both the CF and RN. The training philosophy is such that submariner training involves both a formal and informal component and deficiencies that are not picked up in training will be picked up on transfer to the workplace. Management stated, " (Deficiencies will be) picked up through formal training, (and) the chain-of-command and trainers will pick up satisfaction and capability. The system works, it is thought that Flagship and UTT were reluctant to fail anyone and gave everyone a rubber-stamp, but this was not the case. In the process it will be picked up."

The agreement that measures was in place to test and confirm the trainers (both UTT and Flagship) was not as positive. As discussed briefly in Section 5.2.3.2 (HTA, Training platform), there were no set knowledge and skill standards which the trainers must achieve in order to instruct: they prepared their own lectures, documents and tested themselves against the USQ for capability, and there was no outside, objective body to monitor or assess training. The RN trainers acknowledged this deficiency. The RN training team also identified that the contract trainers, Flagship, did not have the opportunity to train before instructing the Canadians. Thus, it was not surprising that the RN trainers disagreed that measures were in place to test and confirm their own and the contract trainers' capability.

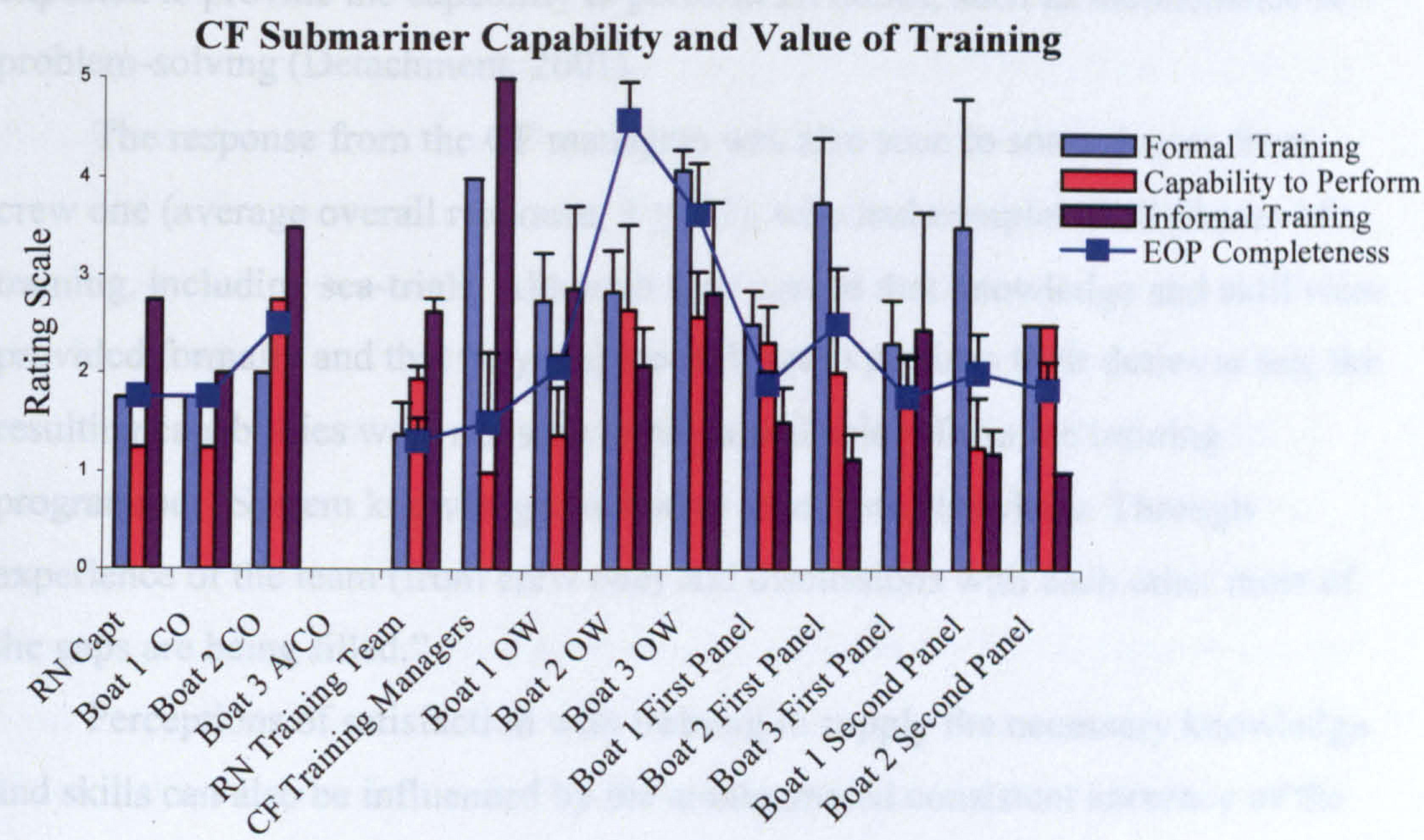
This was not the sentiment of the RN Captain nor the CF training managers, who both strongly agreed that measures were in place for the RN trainers, although the RN Captain only agreed that measures were in place for the contracted trainers. The RN Captain's perception was that the trainers were tested against the prior RN Upholder training standard. Further, even the trainees were not completely sure if the training teams, either the RN trainers or Flagship, were tested or assessed for their knowledge and skill (for quotes see Section 5.2.3.2). It was not surprising then that all crewmembers disagreed that testing measures were in place, with the exception of the SCC2 from crew two who agreed. Their response as junior members of the military was likely a combination of lack of knowledge of the process, not a party to conversations with those who may have had doubts (which would not be considered uncommon in a military hierarchical platform to discuss perceived deficiencies with junior members) and thus there was a faith in the system or a presumed assumption that testing was present. These findings suggest there was a lack in confidence of the knowledge and skills obtained from training.

6.2.1.1.2 Training Contents

The training contents observed and rated in this case study related to the perceptions of the completeness of the formal training to provide the knowledge and skills, the continuity and accuracy of the training tools and aids and the perceptions of any changes made to the tools and aids (Appendix C). To account for the various stages of completion of training for the three crews and, thus, in an effort to control for conjecture or hearsay rather than training first-hand experience, all of the questions to the trainees were posed so that respondents considered only those portions of training that they had completed. For the managers and trainers, as they were well acquainted with the plans, processes and procedures of the training programme and made decisions as to what changes, if any were made, questions regarding training content were framed within the context of the training programme from its onset.

The interview findings for the completeness of the formal training to provide the knowledge and skills for those trainees who were in varying stages of the training programme indicated that as of the training to date they agree they have received the knowledge needed, but do not feel they have received the skills training as yet. Crew two revealed, "Yes we have the skill we know all the pipes and know the procedures, but we haven't tied it to a ship wide evolution yet. We have the skill and knowledge, but need the practice. We'll find out in the sea-trials, it will pull us together as a team, it's still training." While crew three stated, " Based on what we're supposed to get we expect we will have the knowledge and skill, but from where we are today, we haven't had team training, so no we do not have all that we need, yet." Thus, crew two trainees who had completed the formal training portion of training but had not yet completed any sea-testing or sea trails, and crew three who had completed the knowledge phase and Upholder certification, did not believe they had the skill set at this stage of training to perform their portion of emergency tasks in an operational setting.

Figure 10. Perceived Trainees' Capability and Value of Training
(Rating scale: 1 = strongly agree, 3 = neither agree nor disagree, 5 = strongly disagree)



The disagreement that the second and third crew undergoing training had not received the knowledge and skill to date was not surprising as the training was such that the integration of knowledge and skill and applying what was learned comes together during sea-trials (Figure 10, Formal Training). Thus, what appeared to be an extreme alternate response to agree that formal training provided the knowledge and skills from trainees and managers was not the case.

The managers, including the RN Captain and trainers and the Canadian COs agreed that formal training would provide the knowledge and skills needed based upon the entire training programme, to include sea-trials. The response that does, however appear out of character from the other managers, was the disagreement of the Canadian training managers that formal training would provide the knowledge and skill; this response would also seem out of character for them as they have indicated they agreed with the process and the capabilities of the trainers prior to initiating this conversion course. This disagreement can be explained in that the CF training managers recognised that the Canadians would not be taught all they needed to know, both in knowledge and skill, as the training was considered a conversion course. Trainees were expected to have pre-requisite submarine knowledge and skill and the training platform was neither intended nor expected to provide the capability to perform all duties, such as maintenance or problem-solving (Detachment, 2001).

The response from the CF managers was also seen to some degree from crew one (average overall response, $3 \pm .82$), who had completed all phases of training, including sea-trials. Although they agreed that knowledge and skill were provided formally and that they had the skill set to perform their duties at sea, the resulting capabilities were not seen to be gained solely from the training programme. "System knowledge we had to gain from elsewhere. Through experience of the team (from crew one) and discussions with each other most of the gaps are being filled."

Perceptions of satisfaction with training to supply the necessary knowledge and skills can also be influenced by the amalgamated consistent accuracy of the training tools and aids used during training, but also satisfaction and outcome from training can be influenced by the reflection of the training programme tools and aids to the workplace. As indicated and supported from the *Identical Elements Theory*, learning and successful transfer to the workplace are enhanced with a training platform that is reflective of the workplace, both in stimulus and response. The overall perception by the respondents was an agreement to identical elements within training and that they closely mirrored those of the working environment (1.99 ± 0.68). The managers and trainers (to include the junior officers undergoing training) provided the more positive agreement, while the senior technicians from crews one and two leaned toward lesser satisfaction (crew one, 2.88 ± .66, and crew two, 2.44 ± .52). Senior technicians identified, "The display consoles in the simulator are close enough to the submarine. Because of the programme in the simulator the compensations (reactions) are different in trainers than in the boat." As described in Section 5.2.1, the degree of response of satisfaction was not due to the reactionary differences between the simulators and the submarine, senior technicians found the discrepancies were between the RN EOP document and the panel onboard the submarines. This sentiment was not seen or described by the senior technicians from crew three (1.85 ± .14), and likely due to the resulting changes to the EOP document at the time of their training. Although, as crew three had not completed simulator training at the time of the interview, their perception of identical elements can only be based upon their satisfaction with the knowledge portion of training and not skill.

The differences in the changes in perceptions of satisfaction with the training programme as each crew progressed in training, although slight, could also be related to the changes that occurred during training. This perception was reflected in the responses to changes to the training curriculum and content, in which all respondents agreed that changes had occurred. When asked to what degree changes had been made to the training curriculum, training content and documentation, there was almost a complete agreement from all respondents that some changes had occurred to the curriculum, content and documentation. Of the 42 respondents a distributed few identified that the training curriculum had barely changed (13), fewer indicated that training content had barely changed (four, senior technicians from crew two and three); and, surprisingly only seven responded that the documentation had only barely been changed (distributed through the three crews, from officers, senior and junior technicians). This was a surprising outcome as the discrepancies and differences between the RN and the CF content and format of EOPs appeared to be a major concern, especially for technicians (Section 5.2.2). However, the questions only addressed changes to documentation and not to the perceived impact of learning and performance from the changes. The perceived effect of changes to learning is discussed in Section 6.2.2 and training expectations are discussed in Section 6.2.3.

The differences identified between managers, trainers and trainees would suggest that significant differences would be found for both methods and content between trainers, crews and managers. The Kruskal-Wallis analysis of variance identified there was a significant difference in training methods (x^2=18.91, *df*=4, p=.001) and training content (x^2 =15.58, *df*=4, p=.004) (Appendix E). In training methods the CF managers indicated more of an agreement of testing capabilities than the RN trainers, while for training content it was the RN trainers who agreed more to the completeness and accuracy than the CF managers.

The Spearman rank correlation identified there was a significant positive correlation between training content and training methods (p= <.05, r_s= .378, Table 4), suggesting satisfaction that training would provide the necessary knowledge and skills directly connected to the methods employed to assess the knowledge and skill of both the trainers and the trainees. Trainees agreed they had received the knowledge and skill as appropriate to the phase of training and that the training aids closely mirrored those of the working platform. Thus, with the support from the qualifying statements from the interviews of the lack of feedback of progress, the correlation would further suggest that the confidence in the training programme to provide the knowledge and skills was also based upon the self-confidence (self-efficacy) of trainees to achieve the expected outcomes from training. As discussed in Section 6.2.1.2, the degree of self-efficacy of trainees can be directly related to formal and informal training aids.

6.2.1.2 Formal and Informal Training Aids

When respondents were asked the value of the training aids and tools to support learning, their response was that individual and team simulator training was considered extremely useful to learning. This response would not be considered unusual as all those interviewed agreed that the simulator training reflected that of the submarine, and thus observations and any practise of the EOP sequences individually or in a team would aid in learning. Trainees identified, " Simulator training solidified what you already knew, allowed you to practise the conditional response required in EOPs." As crew three had completed individual training in the simulator but had not as yet completed team training, they did not respond to perceptions of the value of simulator team training.

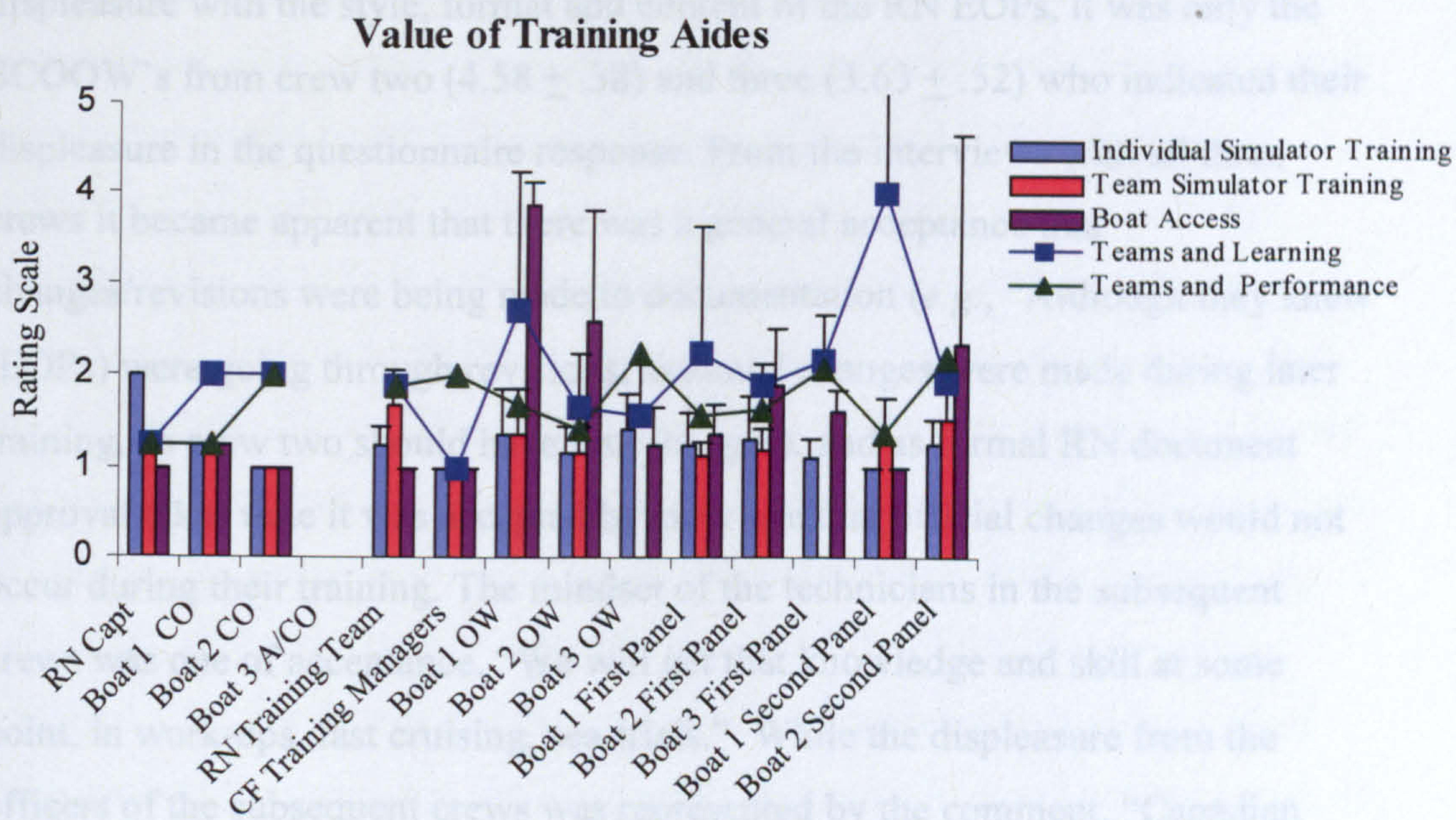
Table 4. Spearman Rank Correlation Coefficients for Expectations and Perceptions from Training for Trainers, Management and Trainees (number of questions per category identified beside measure category, M=Mean, SD = Standard Deviation, KS = Knowledge and Skill, Ops = operational, main= maintainer).

Measures	M and SD	1	2	3	4	5	6	7	8	9	10
Expectation											
1. Training Content (3)	1.98 ± .76										
2. Trainee Performance (3)	1.94 ± 0.51	-.181									
3. Trainee Performance % New Ops KS (1)	32.63 ± 5.3	.077	-.257								
4. Trainee Performance % New main KS (1)	73.38 ± 9.7	-.040	-.122	.258							
Perception											
5.Training Content (4)	2.44 ± .63	-.335*	.081	-.01	.089						
6.Formal Training Aids (5)	1.66± .87	-.354*	.368*	.034	.005	.440**					
7. Instructor Characteristics (5)	2.6 ± .91	-.055	.063	-.20	-.306	.442**	.095				
8.Informal Aids (2)	2.17 ± 1.1	.039	.093	.033	-.375*	-.230	.107	-.397**			
9. Training Methods (3)	2.97± 1.39	-.177	-.163	-.065	.049	.378*	.224	.260	-.276		
10. Training Content Intervention (2)	2.3 ± .95	.139	-.294	.164	.039	-.424**	-.443**	-.093	-.008	-.085	
11. Learning (4)	3.15 ± 1.05	.068	-.374*	.000	.106	.065	-.394**	.183	-.313*	.307*	.13

N=42 * p= <.05 **p= <.01

As seen in Figure 11, access to the submarine was also considered a valuable tool to aid in learning, although the responses of crew one and two SCOOW and crew two, SCC2, do not appear to reflect this. Trainees found overall that, "Accessing the boat allowed the average submariner to consolidate the knowledge", however, as detailed in Section 4.4.3 (training complications), while a submarine was being reactivated access was not always possible for safety reasons and although observation was possible, manipulation of the dials, gauges, levers was not. During crew ones' training, access to the submarines posed more of a problem than that seen in subsequent crews' training, "Didn't have 100% access, maintenance problems, but could look at panel and systems, but not able to punch dials, or touch things." The variation of response seen by crew two, SCC2, was due to one extreme outlier. This individual did not feel there was sufficient access or support.

Figure 11. Value of Training Aids and the Perceived Influence of Team Composition to Learning and Subsequent Performance
(Rating scale: 1 = strongly agree, 3 = neither agree nor disagree, 5 = strongly disagree)



All respondents also mutually agreed that the technical documents (TABs) and Standard Operating Procedures were an excellent support aid to learning (1.57 ± 74). Trainees indicated, "TABs were outstanding, best we have ever had, format, indexing good. Tabs are brilliant, but maintaining them, currency, is difficult. Some things were not accurate. Think they could have had more stuff, SOPs, become your user level document, (you) need the TABs and SOPs for daily use."

This perception of exceptional value of documentation was not equally supported for the EOP document (2.33 ± .99). The original document supplied by the RN, as discussed in detail in Section 5.2.2 (HTA of documentation), indicated that some of the EOPs did not directly reflect the tasks in the workplace, contained errors and the sequences for some of the tasks were found to be difficult to learn. With no systems integration knowledge provided during training and only general task sequence descriptions to refer to in the EOP document, individuals found they needed, and were expected, to refer to other methods of support (*e.g.*, TABs, SOPs, other trainees) to aid in learning and memorising each of the 31 EOP tasks. As seen in Figure 10, EOP Completeness, although interview comments from the trainees, especially the technicians, identified an overall displeasure with the style, format and content of the RN EOPs, it was only the SCOOW's from crew two (4.58 $\pm$ .38) and three (3.63 $\pm$ .52) who indicated their displeasure in the questionnaire response. From the interviews with all three crews it became apparent that there was a general acceptance that changes/revisions were being made to documentation (*e.g.*, "Although they knew (EOPs) were going through revisions, assumed changes were made during later training, so crew two should have less changes), and as formal RN document approval takes time it was accepted by crew one that official changes would not occur during their training. The mindset of the technicians in the subsequent crews was one of acceptance. "We will get that knowledge and skill at some point, in work-ups, fast cruising, sea-trials." While the displeasure from the officers of the subsequent crews was represented by the comment, "Canadian training would benefit from (EOPs) details to learn, incorporate it all as a reference in one place, but here (UK)." This statement suggests a frustration, but it also refers to the limitations of providing training within a contract and thus the constraints and capabilities imposed to the Canadians and the RN within that timeline.

As discussed in detail in Section 5.2.3.2 (Training Platform), all trainees relied upon informal sources (*e.g.*, "looked to each other, dockyard, UTT, Abbeywood, Collingwood, technical agencies, equipment/instrument contractors") to gain knowledge outside the formal platform (2.24 $\pm$ 1.12). Results have shown that even with changes to the training programme, subsequent crews still sought out information informally, especially so for the technicians (Figure 10, Informal Training). Technical crews from the second and third wave of training indicated, "Working on systems (we) found we needed more information than was given, didn't have the experience (with this class of submarine). There are no holes safety wise, 'Know I'm safe.', but information was definitely passed informally as 40-50% of maintenance needed to be learned on our own." Even the RN trainers, RN Captain and the CO somewhat agreed that other methods were used to extend the knowledge and skill than training provided formally. Only the CF training managers strongly disagreed. This extreme response by the CF training managers could be explained by the fact that "the CF training design assumed that given system knowledge and the appropriate technical background, maintainers would be capable of performing all PM and CM tasks in the workplace" (Detachment, 2001). One could then presume that CF training managers did not believe seeking out informal support should be necessary.

The differences identified between managers, trainers and trainees would suggest that significant differences would be found for both formal and informal training aids between trainers, crews and managers. The Kruskal-Wallis analysis of variance indicated there was a significant difference in formal training aids (x^2=11.90, *df*=4, p=.018) and with informal aids (x^2 =16.54, *df*=4, p=.002) (Appendix E). For formal training aids the CF managers indicated more of an agreement of the value than the RN trainers. These findings are not surprising, as the managers believed the prerequisite training was sufficient. However, for informal training it was crew two (1.38 $\pm$ .54) who agreed more to using informal aids than crew one. (1.85 $\pm$ 0.91) (Appendix E). These findings of an informal aid requirement by trainees were not surprising. However, as changes were put into place in the training programme it would have been expected that crew one would have indicated a greater reliance on informal training aids. Crew two's greater reliance on informal aids would suggest that the changes to the training content and aids had not been implemented during their training, or any changes that had been made were not considered sufficient and reliance on informal training aids was still considered necessary. These deficiencies in the training programme could effect intended training outcomes, and thus impact vertical transfer.

The Spearman rank correlation identified there was no significant correlation between formal and informal aids, but there was a significant positive correlation between formal training aids and training content ($p= <.01$, $r_s= .440$, Table 4). From the above discussion it was not surprising to discover that the more useful the training aids the less likely training intervention was needed.

6.2.1.3 Instructor Characteristics

As identified in pre-training influences and discussed in detail in Chapter 5 (5.2.3.3), the capability of an instructor and therefore his ability to pass on knowledge and skill was based upon the initial knowledge and skill gained and the experience obtained to ingrain capabilities and develop expertise. The opinions of the influence of lapse in active experience to recall the knowledge and skill and instruct varied between management. The RN manager and CF training managers believed there was enough run-up time to regain what was needed, but the remainder perceived the lapse had an influence (Figure 8). However, there was an agreement amongst managers that once notification was given that training would begin the UTT training team was considered very capable of training the CF (N=9, 1.39 ± 0.44), while the overall perception of the contract trainers knowledge and skill (Flagship) was not considered to be sufficient (N=9, 3.05 ± 1.37).

This pre-training background of the instructor characteristics would set the tone and lay the foundation for the training of the Canadians. Although not all of the information regarding the background capabilities of the training teams (UTT and Flagship) was known to the trainees, they were all aware that the Upholder class submarine had been withdrawn from active service and thus they would be aware that there was a lapse in operational experience for the RN trainers. Thus, preconceived notions of capabilities were very likely made by the trainees, which could in turn influence their perception of the instructors' capability and resulting value of training. This in turn could then influence an individual's successful outcome, which could impact the team and crew. This would suggest a potential influence on vertical transfer outcomes, and as well, the necessity to identify the pre-training influences and the effect during training.

However, as this training platform was lengthy (four years) and training involved successive training of four complete crews, it was also likely that the capabilities of the instructors would change over time and, with that, perhaps a change in perception of the instructor characteristics. This change could alter training effectiveness of the programme over time. Thus, questions regarding the growth of the knowledge and skill of the trainers were deemed pertinent.

As seen in Figure 9, there was a general agreement by all that the RN training team knowledge and skill had changed over the course of the training programme (2.43 $\pm$ 1.19), with the exception seen from crew one senior technicians. This general agreement of growth was reflected in the trainees' interview response to the perception of growth of knowledge and skill of trainers from crew one, "Without a doubt, it was a learning process for them as well. They learned a lot during fast cruising, it was a double edged sword, sea training by committee." However, the senior technicians revealed, "Instructors didn't know everything about the boat, they admitted when they didn't, would search out the answer and then come back to you." This statement likely represents the perceptions of trainers seen from crew one technicians, in that they perceived the trainers did not have the knowledge and therefore needed to seek out answers when asked.

As seen in the pre-training perceptions, the growth of the Flagship contractor's knowledge and skill over time was not seen to be as great as that of UTT training team (2.78$\pm$ 1.24). Again, the most extreme disagreement was seen from the senior technicians from crew one who believed there was almost no growth, but crew three as a whole also perceived a lack of growth from Flagship, and somewhat agreed to disagreed that Flagship knowledge and skill had changed over time (3.36 $\pm$ .95).

Although most respondents indicated that they agreed that the trainers' knowledge and skill had grown over time, beyond the crew one senior technicians, there was not, however, a mutual agreement that change in knowledge and skill had an influence on the instructors' ability to train. Training staff and managers strongly disagreed that changes in knowledge and skill of the trainers would detrimentally influence training, as did all of crew one. This apparent inconsistency from senior technicians was clarified during the interview, "Digging for answers increased your depth of knowledge, your problem solving, and damage control skills, the more they know the more they can pass onto us." This would suggest an acceptance of the training style, but also the motivation and persistence to learn (on their own) what was needed would suggest goal commitment by the trainees. The commitment to achieve the higher-level goals was not just individually driven, efforts to assure that the knowledge and skills perceived to be required in the workplace were extended within and between crews.

Both crew two and crew three agreed to somewhat agreed that changes in knowledge and skill of training staff detrimentally affected training. As crew three did not believe Flagship's knowledge and skill had changed over time, they have perceived that this would affect training. This response would be heavily based upon the Flagship trainers and not RN Trainers, as crew three had just completed phase-one training to which Flagship instructed. The response from crew two suggests that changes in knowledge and skill of the trainers had a negative impact on capability to train. In fact, the sentiments in the interview indicated that although they agreed that changes in knowledge and skill had occurred, they did not believe that positive changes were put into place as a result. Crew two clarified, "The changes, even from boat one should have been documented. The system has allowed for improvements and the weaknesses have been indicated. Thus, teaching and guiding crew three will happen informally, as it happened with crew one we drilled them for hours." Although dissatisfied that changes had not been formally put into place, again we see from trainees a personal drive and commitment to seek outside sources to achieve the intended personal training outcome, but as well, an emergence of support from individuals upward through to the team and between team members.

The differences between managers, trainers and trainees would suggest that significant differences would be found for the perceptions of instructor knowledge and skill and their development over time between trainers, crews and managers. The Kruskal-Wallis analysis of variance revealed there was a significant difference in perception of instructor characteristics ($x^2 = 11.63$, $df = 4$, $p = .020$) (Appendix E), with the CF managers indicating less of an impact than the RN trainers. These findings are not surprising, as the managers believed the instructors had the capability prior to training.

It was not a surprise then that a significant positive correlation was found between instructor characteristics and training content ($p = <.01$, $r_s = .442$) and a negative correlation was found with informal aids ($p = <.01$, $r_s = -.397$, Table 4). This would suggest that changes in training content are directly related to instructor capabilities, and as instructor capabilities improved there was less need to employ informal training aids. These significant relationship findings corroborate the interview statements, suggesting that globally there was a commitment from the trainees, within and between successive crews, to seek out and mutually support the retrieval of information outside the training platform. As this was a global effort from within and between crews, these findings would suggest the efforts expand beyond assurance of achievement of personal outcomes to the commitment to achieve the higher-level organisational goal from training- as a crew, to safely sail the submarine back to Canada. This individual commitment to assure team competency would suggest the existence of vertical transfer.

6.2.2 Learning Perceptions and Training Interventions

The perceptions of training have thus far examined potential influencing factors within this training platform but not on their perceived impact to learning (Table 4). As such, learning could be influenced by the overall accuracy of the training contents, aids and tools and the resulting changes to the training content and documentation that had occurred over the course of the training programme.

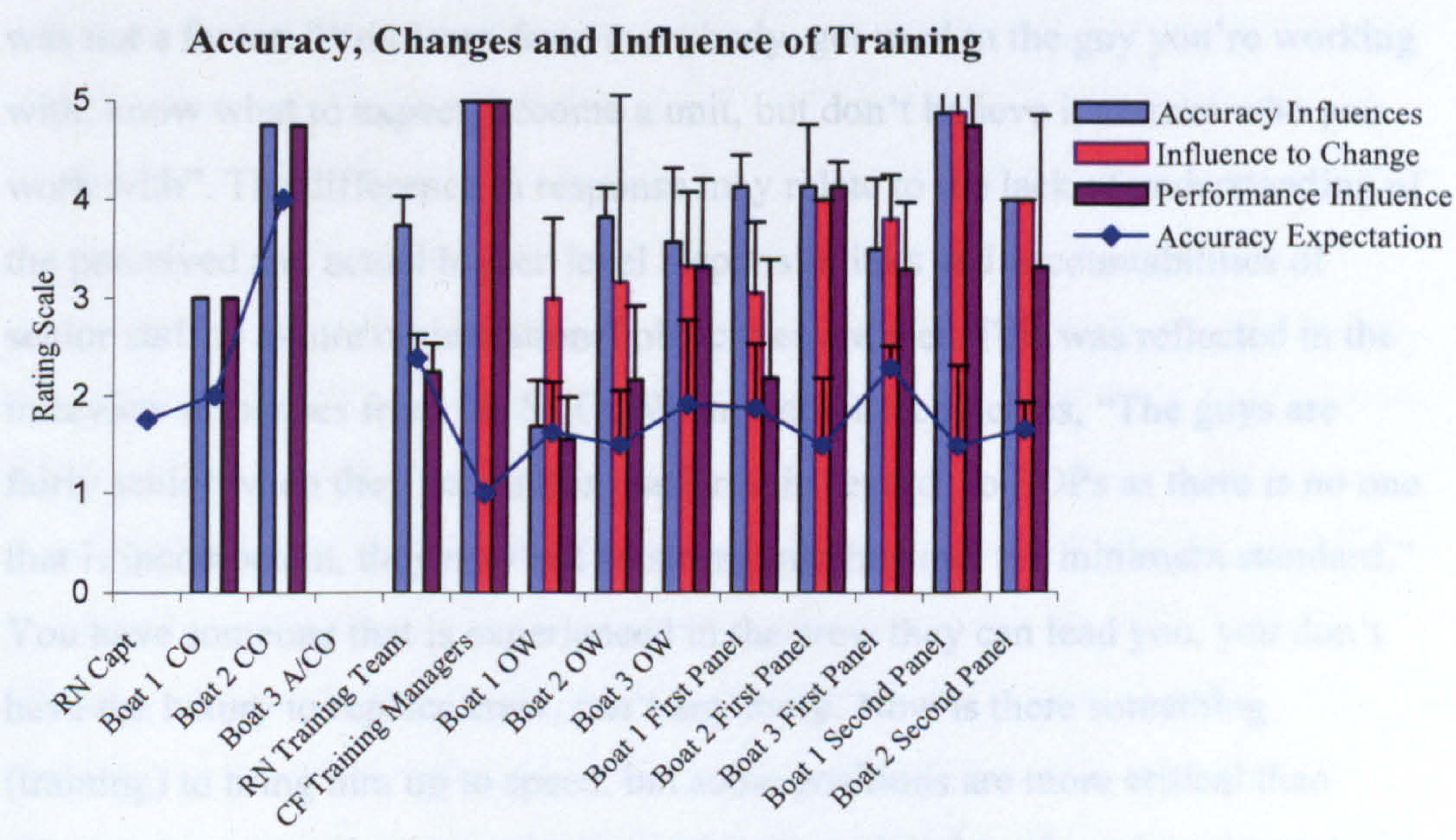
As discussed in Section 6.2.1.1, Training Content, the respondents generally agreed that the training material, tools and aids were an accurate representation of the working environment. However, the strength of the agreement was not found to be as strong with the technicians, but the degree of satisfaction did improve with each successive crew. From the Hierarchical Task Analysis, the reason for this lesser degree of agreement from the technicians was thought to have been attributed to their strong dissatisfaction with the EOPs (as detailed in Section 5.2.2), but that was not the case. The technicians agreed that although the document had errors and omissions, the EOP document did, in fact, support learning. It was the SCOOWs from crew two and three who disagreed that the EOP document supported learning (Section 6.2.1.2) suggesting details for EOPs should be incorporated into one reference to aid learning. It would be expected then that the response to the influence of the accuracy of the training content, tools and aids on learning should reflect this sentiment and effect of changes to the training content and aids should follow this trend.

As seen in Figure 12, Accuracy Influence, there was an overall slight to strong disagreement that accuracy influenced learning (3.77 $\pm$ .95), but this time it was the SCOOW from the crew one who agreed that accuracy affected learning (1.69 $\pm$ .42). These responses from crew one are reflective of fact that the crew one training was a pilot course and documents contained omissions and inaccuracies, but they did however agree that EOPs aided in learning, as did the rest of crew one. This apparent concurrence would suggest that any information was of value to learning but as the SCOOW from crew one only somewhat agreed to using other methods to extend their knowledge and skills (2.88 $\pm$ .66), this might suggest that although informal aids were used they were either not as effective as hoped or perhaps they were not able to find effective or sufficient external resources.

One would have expected the SCOOWs from crew two and three to also identify an influence on learning as they had implied their displeasure with the state of EOPs during their training (4.58 $\pm$ .38 and 3.63 $\pm$ .52, respectively) but this was not the case. Changes made to the training content and training aids were also not perceived to have an overall detrimental influence on the ability to learn from the CF training managers and all trainees (3.72 ± .93, Figure 12, Influence to Change). Two SCOOWs from crew two and three did however respond that they respectively strongly agreed and agreed that changes did influence the ability to learn.

As the concept of vertical transfer refers to the upward transfer of individual training outcomes to combine and emerge to yield effects at the team and organisational level (Kozlowski & Salas, 1997), it was deemed appropriate to distinguish the perceived influence of team composition to learning as this could influence both individual and team outcomes. As well, to assist in delineating the influences from pre-training and training, the influence of prior experience was also identified.

Figure 12. Perceived Accuracy of Training, Changes, and Influence to Learning and Performance (rating scale: 1 = strongly agree, 3 = neither agree nor disagree, 5 = strongly disagree. Accuracy Influences and Performance Influences were reverse scaled as degree of negative impact).



Findings indicated that generally respondents did not consider previous experience a detrimental effect on learning (3.77 ± .95), however, senior technicians from crew one strongly agreed it was (1.13 $\pm$ .14). Although crew one technicians had a mix of experienced (> 15 yr.) and inexperienced (one and six years) personnel, all senior technicians strongly agreed that previous experience had a detrimental affect on learning. The general impression in interviews with senior technicians from crew one was they felt that lack of experience on submarines made it more difficult to learn, "You needed time on the submarines to be comfortable. The contract required us to have dolphins, but it is a general course, very basic, and if you had any time on the boats you'd know." These comments would suggest a heavy reliance on course content to achieve the expected knowledge and skill, but also that there might be a reliance on crewmembers for support.

As seen in Figure 11, Teams and Learning, respondents agreed that team composition did influence learning (2.12 $\pm$ 1.04), but is was the junior technicians from crew one who disagreed that team composition affects the ability to learn (4.0 $\pm$ 1.0). The junior technicians qualified this sentiment to mean that they learn from all members on the crew and they believed that specific crew composition was not a factor; "You learn from everybody, get used to the guy you're working with, know what to expect, become a unit, but don't believe it matters who you work with". The difference in response may relate to the lack of understanding of the perceived and actual higher-level responsibilities and accountabilities of senior staff to assure organisational objectives are met. This was reflected in the interview responses from the SCOOW and senior technicians, "The guys are fairly senior when they get on this platform, in regards to EOPs as there is no one that is incompetent, they may not be strong but they met the minimum standard." You have someone that is experienced in the crew they can lead you, you don't have the luxury to replace crew, can't any more. Now is there something (training) to bring him up to speed, but some positions are more critical than others." Team structure may change within crews but there is an interdependence to assure successful completion of emergency tasks.

6.2.2.1 Training Interventions

As much as training content and changes can influence training and subsequent learning, the opportunity to provide changes to the training content and aids can also moderate the ability to learn or have a direct impact. When respondents were asked if suggestions could be made to change training content and the documents, the respondents somewhat agreed that changes could be made to the training content (2.43 ± 1.0) and mutually agreed that changes could be made to training aids (1.99 ± 0.62). As detailed in Section 5.2.2 although formal approval was required for documentation, UTT were very receptive to suggestions to changes in documentation and quick to respond. It would seem unusual, however, that all respondents replied positively to the ability to provide changes to the training content, including the CF managers, however, selectively as a group the RN training team disagreed that suggestions could be made to the training content (3.81 ± 1.19). The training platform was based on and controlled by RN policies and procedures, thus changes would have to go through a formal approval process. The CF training managers unfortunately did not respond to this question, but the response from the senior CF managers would suggest their reply was based on the fact that discussions for changes occurred between senior CF managers and the RN, and although many of the changes requested were made to the training content, implementation was only possible after the fact. This was confirmed in interviews with the trainees, "Although receptive to changes (we) did not see any of them directly as it took time for the changes to be implemented, RN approval, but the next course would see."

The differences identified between managers, trainers and trainees would suggest that there are significant differences of perceptions for influences on ability to learn and intervention capabilities between trainers, crews and managers. This was not found to be the case for training content intervention. However, a Kruskal-Wallis analysis of variance identified there was a significant difference in perception of factors that influenced ability to learn ($x^2 = 10.37$, $df=4$, $p=.035$), with crew three indicating less of an impact than the RN trainers (Appendix E).

The results of differences between these two groups from crew one and two and the CF managers are in fact not unexpected. The RN trainers have likely based their opinion on past training experience and a belief that the RN training philosophy provides what is needed (Section 5.2.3.3 and 6.1.3). Thus, it would appear that they did not believe accuracy or changes to the training influenced ability to learn, but prior experience and team composition, as heavily relied upon historically, was considered an asset to learning. Crew threes' indication of the least impact to learning suggests that thus far in training there was a greater satisfaction with the training platform and changes to support learning, and as such previous experience did not impact learning. This difference in perception from the previously trained crews could also be influenced by the fact that crew three had the least overall experience, and thus drawing less on past experience to aid in learning and more receptive and open to the training platform.

However, crew three believed that team composition was a strong support net for learning, "The stronger support the weaker, the stronger the team the better. To remain a submariner you have to be able to communicate and ask for support." These findings would suggest a strong support climate outside of the training platform. Overall face validity of crew consistency in responses also supports the model of interdependent teams and vertical transfer, in that specific and unique individual learning outcomes are directly linked to the success of team outcomes. Thus to achieve effectiveness, individuals must be trained in their specific roles as each role provides a distinctive contribution. The statistical differences within positions between crews were not performed as each crew was at different stages of training, therefore it would be inappropriate to compare training perceptions with unequal comparisons. Insufficient numbers of respondents were present to perform within crew statistical variations. Discussion of performance expectations and consequences from training are discussed in Section 6.2.3, Training Expectations.

In determining the potential relationships between learning and the various factors and interventions in the training platform, rank order correlations were not found between learning and training content intervention. However, learning positively correlated with training methods (p= <.05, r_s= .307) and negatively correlated with both formal training aids (p= <.01, r_s= -.394) and informal training aids (p= <.05, r_s= -.313) (Table 4). These findings might be considered at odds with each other. However, this intercorrelation suggests that learning improves with the ongoing confirmation of knowledge and skill capabilities provided by instructors and attained by trainers, and as formal training aids improve there is less of an influence to learning. As learning progresses from the training platform there is also less of a reliance on informal training aids. Learning did not significantly correlate with training content or instructor characteristics.

Training content intervention did, however, negatively correlate with both training content (p= <.01, r_s= -.424) and formal training aids (p= <.01, r_s= -.443, Table 4). This would not surprisingly suggest that as training content and formal training aids improve and supply the knowledge and skills there is less of a need to suggest training content interventions.

6.2.3 Training Expectations

Perceptions of a training programme can influence the outcome from training and therefore can influence training effectiveness. Trainees' readiness and thus willingness to transfer the newly acquired knowledge and skills can also be based upon the value attached to the training and support climate, but also are affected by the expectation that transfer to the job will be successful (Noe & Schmitt, 1986). Expectations from training could therefore influence the individual outcome from training. But in interdependent teams such as those found in the military, unfulfilled expectations could influence upward through to the team in the form of attitudes that may impede the successful achievement of organisational objectives –vertical transfer. Comparing expectations of the training content and performance with perceptions from the training platform will identify if the training programme provided what was expected and whether the resulting knowledge and skill will lead to perceived specific and desired performance outcomes. Thus, achieving vertical transfer outcomes.

6.2.3.1 Training Content

Expectations of training content indicated whether changes to the training programme and instructor capabilities affected subsequent training outcomes, and if further changes were still needed to the training content and documentation. Respondents all mutually disagreed (4.26 $\pm$ 0.71) that changes in training content or growth in instructor capabilities would detrimentally affect the success of further training. This outcome was expected as respondents agreed they have received the knowledge and skills, even with changes to the programme content and documentation (6.2.1.1, Training Content). Respondents also agreed that the instructor characteristics had changed over time (6.2.1.3, Instructor Characteristics), but changes were seen as a positive outcome to achieving the knowledge and skills needed to perform future duties.

When asked if changes could still be made to the training content and supporting documents to support achievement of outcomes, respondents agreed that changes could still be made (training content, 1.85 $\pm$ 0.72 and documentation, 2.23 $\pm$ 0.84) to improve the depth and breadth of training courses. With the exception of one manager, all respondents believed changes could still be made to the training content to include: more knowledge for the maintainers; specific knowledge and skill training in EOPs; more operational training for SCOOW; and, expansion of EOP training in both the classroom and the simulator to include post-emergency actions to restore and repair, if needed, after an emergency. Most respondents also agreed that changes could still be made to documentation, specifically the EOPs as the technical documents were considered in good order, clear and detailed (Figure 12, Expectation Accuracy). As detailed in Section 5.2.2, the EOPs, although learned with the support of informal mechanisms, EOPs were considered inadequate in content, format and style and thus were thought to be more difficult to understand, learn and memorise than necessary. It was identified that the current EOP document supports the capability to perform the tasks but does not supply sufficient details to learn the sequences. As the training platform did not supply formal knowledge training in systems integration or EOPs, it was felt that an EOP document specifically designed for learning would be of assistance, especially so for inexperienced submariners.

Although most crewmembers discussed their displeasure with EOPs, this sentiment was not identified by most when asked if EOPs aided in learning (Section 6.2.1.2). Crew two and three SCOOWs did identify their displeasure, but this did not affect their response when asked to identify if the accuracy of the training content and aids influenced learning. It was the officers of crew one. These select groups did agree however that changes could still be made to documentation. However, it was the majority of junior technicians from crew one who disagreed that further changes could still me made (4.00 ± 0.00).

6.2.3.2 Performance Expectation

Expectations for performance were designed to identify whether the knowledge and skills gained from the training programme would lead to perceived specific and desired performance outcomes. As seen in Figure 9, Capability to Perform, all agreed that the trainees will have the knowledge and skill to perform their duties during sea-trials and thus have the capabilities to perform once the submarines belong to Canada (1.92 ± .61). However, when asked if changes to the training content and aids would have a detrimental influence on their capability to perform, there was only a overall slight disagreement (3.34 ± 1.20). These results would seem to conflict with the responses for capability to perform. The skewing of results was seen by the officers of crew one and two who agreed to performance influences (1.56 ± 0.43 and 2.17 ± 0.76), but also the senior technicians agreed (2.17 ± 0.76) that changes would have a detrimental affect to performance (Figure 12, Performance Influence). These findings do not agree with the response of training content expectations to changes in content and instructor capabilities to effect future training outcomes (4.26 ± 0.71). The perceived detrimental influence of changes in the training platform to performance during sea-trials from crew one and two was based upon their concerns of the delays to deliver submarines (Section 4.4.3). Thus, cumulative effects from the delays in delivering the submarines resulted in cascade delays in training to successive crews that had an effect on performance. What was learned could not be practised and therefore not ingrained, thus there was decay in both knowledge and skills. The apparent discrepancy between responses of agreement that knowledge and skill would be obtained to perform sea-trials and strong agreement by some that changes would affect performance could suggest that if the training platform could not provide what was needed, it would be gained elsewhere.

When asked if team composition would have an effect on subsequent job performance, there was a resounding agreement (1.80 ± 0.72) of the support team composition provides (Figure 11, Teams and Performance). Expectations of team support for performance was in agreement with the overall perceptions of team composition influence on learning (2.12 ± 1.04). This was reflected in the interviews, "Learning and subsequent job performance go hand in hand. Team composition is a factor when things go wrong." This response reflects the concept of interdependent teams and vertical transfer, in that individual learning has an effect on performance and that performance also influences the capabilities of the team. Thus, individual outcomes are directly linked upward to team and organisational outcomes. Interviews revealed that many individual factors play a part in the support provided by a team member, "Personality, method of delivery and knowledge and skill combine to make the difference."

6.2.3.3 Operator and Maintainer Expectations

Although an unexpected finding in studying this training platform, it was identified and agreed by all involved in the training programme that the perceived percentage of new knowledge and skills required to perform the tasks in this class of submarine differed depending upon whether the crew position was that of an operator ($32.63 \pm 5.31\%$) or a maintainer ($73.38 \pm 9.7\%$) (Section 5.2.3.3). Although this study focused on the training effectiveness factors associated with the performance of emergency procedures, background knowledge and skill is necessary to perform each role to understand the complexity of the systems, their reactions, and to problem solve when needed. Expectations of the new knowledge and skill to be acquired also relates to the perceptions of desired performance outcomes, and relating performance expectations with perceptions of training satisfaction will identify if the training provided what was expected and to what extent.

To identify whether expectations of training content and performance varied significantly between trainers, managers and trainees, a Kruskal-Wallis Analysis of Variance was undertaken. No significance differences were found between groups for training content expectations or expectations of performance outcomes from the training platform. This was not unexpected as all respondents generally agreed that changes would not detrimentally affect future training, but changes could still be made to the content and documents to improve the training. Differences between crews were however expected for training performance as both crew one and two identified changes, or rather delays in the training programme had a detrimental influence on performance. This difference did not ultimately have an effect when expectation training content questions were combined. As expected there were also no significant differences between group expectations of knowledge and skill to be acquired for operators.

However, significant group differences were found for expectations of knowledge and skill needed for maintainers to perform ($x^2 = 12.95$, $df = 4$, $p = .012$), with crew three having lower expectations than crew one, whose expectations were lower than the CF managers (Appendix E). The differences between these groups and crew two, the CF managers and the RN trainers can be somewhat explained. It would have been expected that crew one would have had the highest level of expectation as they did not know what to expect from training, and crew one had the greatest overall experience. Thus, one would expect perception to be biased on past experience. Interviews have corroborated that crew ones' lower expectations are likely due to the fact that the course was a pilot course and therefore training content and documentation were in a state of transition, "The content was predetermined, some changes have been put in place but they have not affected the crew at the time (of training), but will affect subsequent boats (crews)."

Crew threes' lower indication of the knowledge and skill required for maintainers could be explained by the fact that they were the third crew to be trained, and knowing that maintenance would not be taught in detail, they had lower expectations. The lower expectation could have alternatively been related to the changes in the training platform and the realisation that the training methods employed to learn had in fact supplied the knowledge and skill needed to perform the tasks for the workplace. This would be a reasonable explanation as it has been identified that formal and informal learning is expected within this community (both RN and CF), and this style has successfully achieved performance outcome requirements (for further details see Sections 5.2.3.3 and 6.2.1.2.). "Submariners learn formally and informally, that how it is, and how it should be." However, although this method has been the norm (sic) for training, this training style was not found to be completely satisfactory to assure the performance outcomes. Interviews revealed, " They knew we would informally train, but we have requested improvements in technical training to formalise that training. In operations (performance) we're fine but on the technical side we need more." This would suggest that expectations of training were not being met.

The lower expectations of the CF manager did not include the CF training managers, as they did not respond to this question. Thus, the response from the COs was likely a close reflection of their crews' perception, which closely followed their junior officers' responses.

This case study also examined the relationships between perceptions and expectations to identify if expectations were met, if the training programme met those expectations, and what factors within the training design influenced the success of training. Significant relationships were identified. Training content expectations negatively correlated with perceptions of both training content and formal training aids ($p = <.05$, $r_s = -.335$ and $p = <.05$, $r_s = -.354$, respectively, Table 4). This suggests findings that as training content and formal training aids improve and provide the expected knowledge and skill, there is a reduced requirement for further changes to the training platform to meet expectations. Also, trainee performance expectations positively correlated with perceptions of formal training aids ($p= <.05$, $r_s= .368$) and negatively correlated with learning ($p= <.05$, $r_s= -.374$, Table 4). These findings suggest that as formal training aids improve and become more helpful in improving learning (such as greater individual and team integration simulator training and sea-trials) the more likely expected performance outcomes will be achieved.

As the training programme intended to provide training with an operator focus it was not surprising that no significant correlations were found between expectation of newly acquired operator knowledge and skill and training influence perceptions. As the training was focused on providing operator training, results would suggest that trainees' expectations were met.

It was also identified that there was an expectation that performance outcomes required a maintainer capability and, according to the trainees the perceived knowledge and skill to perform the new tasks was considered significant ($73.38 \pm 9.7\%$). However, the training programme was neither intended nor designed to provide training to support problem solving or maintenance capabilities. Thus, one would expect correlations between expectations of the amount of newly acquired maintainer knowledge and skill and perceptions of training influence. Only a significant negative correlation was found with informal training aids ($p= <.05$, $r_s= -.375$, Table 4). This finding would suggest that the greater the provision of maintainer knowledge and skill within training the less reliance there was on informal training aids to achieve expected performance outcomes. No significant correlations were found between training influence expectations (Table 4).

6.2.4 Summary of Perceptions and Expectations

In summary, no relationships were found between the pre-training factors of training aids, instructor characteristics and informal and formal training aids, and statistical comparisons could not be made with training principles. These findings can likely be attributed to the lack of power due to the small sample size. However, questionnaire responses and qualifying statements from interviews would suggest that RN trainers' capability and self-confidence to provide training, and perceptions of competency by the trainees, would be based upon and strongly influenced by the prior training received by the instructors.

Detailed historical review of prior training has shown the Canadian Navy training platform, to include the training content, tools, aids and methods of evaluation, that were based upon and very closely reflected the RN historical training that the instructors received. Although, current training for the CF reflected that of the historical training of the RN, the learning opportunities gained during the observation and discussions during the building of the submarines was not of course available. The exclusion of this portion of the historical training and the further lack to identify and include the information gained during this informal learning process within the Canadian Navy training platform, could account for the trainees' perception that further knowledge was needed, and thus could account for the trainees' attempts to seek out the information informally during their training.

The significant positive correlation found between training content and training methods, suggested a satisfaction that the training platform would provide the necessary knowledge and skills was directly connected to the methods used to assess the knowledge and skill of trainers and trainees. The correlation further suggests, with corroboration from interviews, that confidence in the training programme was also based upon the self-confidence of trainees to achieve expected outcomes. Moreover, no significant differences were found between crews, further suggesting there were no significant changes in confidence to achieve expected outcomes as training progressed.

No significant correlations were found between formal and informal aids, but a significant correlation was found between formal training aids and training content. This finding suggests the more useful the training aids the less likely intervention was needed. The significant differences of informal aids used between crews (two more so than crew one) suggests that crew twos' greater reliance on informal aids occurred either because changes to the training platform had not occurred as yet, or changes were not considered sufficient to meet expected training outcomes.

Instructor characteristics positively correlated with training content and negatively with informal training aids. These findings suggested that changes in training content (*e.g.* instruction) were directly related to instructor capabilities, and as instructor capabilities improve there was less of a need to employ informal training aids. There were no significant differences between crews, however, over the course of training successive crews all agreed in the growth of the knowledge and skill of trainers over time. These findings would suggest that although knowledge and skill of trainers increased with successive courses, informal methods to gain knowledge and skill continued within and between successive crews. This would suggest a global commitment from trainees to seek out and mutually support passing on of information outside of the training programme so as to achieve performance outcomes. These findings would then further suggest a commitment to achieve higher-level organisational goals rather than just achievement of personal performance goals- vertical transfer.

Findings from the perceived impact to learning identified a positive correlation with training methods and a negative correlation with both formal and informal aids. This intercorrelation suggests that learning improves with the ongoing confirmation of knowledge and skill of both trainers and trainees, and as formal aids improve there is less of an effect to learning and less reliance on informal aids. Trainees were provided an opportunity to suggest changes to the curriculum and training aids. However, negative correlations with both training content and formal training aids with training interventions not surprisingly suggests that as training content and formal aids improve there is less of a need for intervention.

Training outcomes can also be affected by training and performance expectations. Although no correlations were found between expectations, training content expectation negatively correlated with both training content and formal training aids. As training content and formal training improve and provide the expected knowledge and skill there is less of a requirement for further changes to the training platform to meet training expectations. Trainee performance expectations positive correlation with formal training aids and negative correlation with learning indicated the expectation for performance and how the training platform affected that outcome. Again a common theme emerged, as formal training aids improve and become more helpful in improving learning the more likely expected performance outcomes will be achieved.

Trainees identified there were very different expectations for the percentage of new knowledge and skill needed for operators (32.63 $\pm$ 5.31%) and maintainers (73.38 $\pm$ 9.7%) (Appendix E). As the training platform was intended to provide operator training, it was not surprising to find no significant correlations with perceptions or operator knowledge and skill expectations. This would suggest that expectations were met for operators, but they were achieved utilising informal methods to gain knowledge and skill. However, that was not the case when stakeholders were asked if maintainer knowledge and skill expectations were met. A negative correlation with informal training aids suggested that the greater the training platform provided the knowledge and skill to meet expected performance outcomes the less reliant trainees were on informal aids.

But findings indicated that the training platform did not provide all of the knowledge and skill needed for maintainers, thus there was a continued reliance on informal aids over successive crews' training. Differences in maintainer knowledge and skill expectations were found between crews, with crew three having lower expectations than crew one (Appendix E). This finding suggests that crew three had lower maintainer expectations from training than crew one, which was lower than the other interviewed stakeholders. Interviews revealed the reason for the lower expectation was that crew three expected that changes to the training platform should have occurred at this point, and more training was expected for maintainers. Therefore, one could conclude from the correlation that there was a heavy reliance on informal aids to meet expected performance outcomes for maintainers (*e.g.*, amplifying the knowledge and skill for marine engineers and electricians). It would also suggest that expectations for maintainer training were not being met from the training platform.

As data collection of perceptions and expectations were only determined once at various stages of completion of the training for the successive crews, pre and post training perceptions of the effects of any changes to the training platform and potential changes of performance expectations could not be evaluated. It was also unfortunate that performance measures could not be obtained to measure learning, and due to lack of power (low number of subjects) regression analysis could not be reliably performed to test the relative effects of these independent variables.

Although performance measures could not be taken, the indication that each crew was able to sail successfully back to Canada provides the ultimate indication that overall crew performance outcomes were achieved. Also, performance during sea-trials and certification of capability from the RN Captain would indicate the crews' capability to successfully complete emergency operating procedures. Sea-trials are considered a training opportunity as well as a method to evaluate capabilities. Sea-trials are progressive in nature, providing initial practise of operating and emergency manoeuvres under controlled conditions at sea, progressing to more intense and complex multiple emergency sequences as assessors confirm capability. The RN policies, procedures and guidelines for sea training and certification are pre-defined and very specific and detailed to include the requirement for ongoing feedback of progress (Royal Navy, 1999a). Thus, certification would reasonably assure a crews' capability to deal with multiple emergency failures consistent with those that may be experienced as a result of collision (Royal Navy, 1999a).

Although findings suggest that performance expectations were met for operators but not met for maintainers, all crews successfully completed and achieved certification of capabilities during sea-trials. Thus, performance outcomes were achieved for functional operations, and as a crew they achieved the capability to perform emergency procedures even with significant delays in the training programme.

The significant findings between training factors and between crewmembers suggest specific training factors influence training effectiveness and outcomes from training. These correlations would include training content and methods, instructor characteristics, and formal and informal aids impacted both learning and performance. These exploratory findings also suggest a link between pre-training and training influences from the organisation, individual and training design that combine to influence this complex, interdependent team training to achieve personal and higher-level organisational objectives.

Thus, results have supported the theory that individual outcomes emerge upward through teams to achieve organisational objectives. This case study has thus provided the empirical evidence to support the theory of interdependent vertical team transfer. Common correlations between informal training aids with learning and expectations for maintainer knowledge and skill, and between formal aids with content and performance expectations would also suggest that intervention measures taken by individuals upward through the team, and across teams, has enhanced training outcomes. Thus, efforts by individuals upward through to teams, and across teams has impacted organisational effectiveness. Chapter 7 provides further detail the on the integration and impact of the case study findings within the aims of this thesis.

7. Discussion

The objective of this case study of complex team-training was threefold: 1) to provide empirical evidence to support the theory of interdependent team vertical transfer; 2) to identify the links and influences of training effectiveness factors from pre-training and training organisational, situational and individual variables, with a focus on the training design, to broaden the scope of multilevel training effectiveness on vertical transfer; and, 3) to provide foundation evidence to support the theory linking training effectiveness to organisational effectiveness.

The existing literature in training effectiveness research has evolved and proven that learning and transferring what has been learned in training to the workplace is influenced by a complex multi-factorial interaction of individual, organisational and training factors. However, although training is intended to support the achievement of organisational objectives and strategies, training effectiveness research has focused primarily on the influences to the outcomes on the individual in the horizontal plane (Kozlowski *et al.*, 2000; Kraiger & Aguinis, 2001; Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992). Research and modelling has thus far only assumed the upward linkage and emergence of individual training outcomes and organisational objectives (Kozlowski *et al.*, 2000). It has also been postulated that validation and delineation of this vertical transfer linkage would strengthen the link between training effectiveness and organisational effectiveness (Kozlowski *et al.*, 2000).

This dissertation builds upon current training research by providing empirical support to the theory of multilevel approaches to training effectiveness from research findings obtained while the Canadian Navy performed complex team-training of successive crews for each of the four newly purchased submarines. Although the research focused on the performance of safety-critical elements of operations, this training platform was ideal to identify multilevel approaches to training effectiveness, as real-world training presents the many and often varied interactions, capabilities, complications, and interventions that training effectiveness research hopes to understand and address from a system perspective. Also, historical concerns of past training research were addressed.

Training was linked and integral to organisational objectives (Kozlowski & Salas, 1997) and, thus, the training platform did not limit or exclude the potential many and varied influences that higher-level contexts (team, unit, and organisation) can exert on training effectiveness and outcomes (Baldwin & Ford, 1988; Cannon-Bowers *et al.*, 1995; Kozlowski, 1998; Kozlowski & Salas, 1997).

Training is predicated on contributing to higher-level group and organisational outcomes and objectives. However, although there is a research base indicating that training contributes to individual effectiveness (Kozlowski *et al.*, 2000), to date it is only assumed that training contributes to organisational effectiveness. Furthermore, although assumed, training effectiveness is ultimately determined by the degree to which training outcomes contribute to organisational objectives and strategies. To provide empirical exploratory evidence to the theory of vertical transfer and link training effectiveness and organisational effectiveness, this case study focused its efforts on the pre-training and training influences within the training platform that influence achievement of higher-level goals. The rationale for this approach was that the training platform is central to the foundation of the theories, an effective training platform will provide outcomes that meet organisational objectives to achieve organisational effectiveness, and training effectiveness will identify the multilevel influences to prepare and implement an effective training platform that contributes to organisational effectiveness.

7.1 Multilevel Approaches to Training Effectiveness

This case study provided a unique and yet to be explored approach to broaden the scope of multilevel approaches to training effectiveness, simultaneously identifying and examining the link between individual through to team influences, training outcomes and organisational effectiveness (Salas & Cannon-Bowers, 2001) across the horizontal and vertical platform (Kozlowski *et al.*, 2000). The existing training and transfer literature has indicated many individual, organisational, training and situational constructs that can influence training and outcomes. Moreover, certain variables have been shown to relate to perception, expectation and satisfaction within a training platform, which together would provide broad indications of support and success over the course of crew training. Although these constructs have not been studied together, or approached within a multilevel framework, pre-training influences such as individual characteristics and experiences (Tannenbaum, 1993), perceptions of organisational climate (Noe *et al.*, 1997; Rouiller & Goldstein, 1993), perception of trainees on instructors and vice versa (Kraiger & Aguinis, 2001), perceptions of organisational support and input, training medium, training design and quality of delivery (Kraiger & Aguinis, 2001), and expectations from training (Cannon-Bowers *et al.*, 1995; Mathieu & Matineau, 1997; Tannenbaum, 1993) have all been shown to influence training and transfer. Using these constructs together in the research and writing of this thesis has provided the unique capability to identify the multilevel influences and interactions within a training programme that have influenced both horizontal and vertical transfer over successive crew training.

The additional background history and in depth Hierarchical Task Analysis of Emergency Operating Procedures provided additional supportive exploratory evidence to support the notion that multilevel influences can have either supported or moderated both learning and performance outcomes that have emerged upward in the achievement of organisational objectives.

7.1.1 Implied Training Process for Undertaking Training

It is well acknowledged that one of the most important steps in training development is conducting a training needs analysis (Salas, Cannon-Bowers, & Kozlowski, 1997; Tannenbaum & Yukl, 1992). This process focuses on who should be trained, what should be trained, and what may affect the delivery of the training. A training needs analysis therefore identifies where training is needed in an organisation, what needs to be taught and who needs to receive the training. This in turn identifies the learning objectives, and shapes the design, method and process of delivery of the training intervention. Training effectiveness follows on from this to identify why training did or did not achieve its objectives and what factors influenced the training and successful transfer.

However, the Canadian Navy did not complete a training needs analysis. Rather, as the RN controlled training, analysis was limited to discussions with the RN who suggested depth of training and currently available RN courses for each occupation. Thus, the training programme to integrate the Canadian Navy to a new working platform was not developed to identify individual needs or interdependent team needs for the tasks in this new platform. This was evident in the presumption that the basic certification for systems in one platform was a suitable and sufficient pre-requisite for training to the new platform. The additional workload in the new platform for technicians and changes to the system functioning would, as an example, identify that the pre-requisite from a prior platform would not be adequate unless the training programme addressed the differences. The training programme also did not take into consideration the varied levels of experience and inexperience (less than two years) of the trainees, or lapse in experience.

With no training needs analysis, the Canadian training program remained a very close reflection of the RN historical training platform provided by the RN for this submarine. The RN had decommissioned the Upholder class submarine six years prior to initiating training for the Canadian Navy, thus there was a significant lapse since the instructors obtained any training or actively served on this vessel. Although instructors had significant submarine experience, most also had little active service on this class of submarine prior to decommissioning. Training at that time also consisted chiefly of systems knowledge obtained informally through the building and activation of the system. So, instructors had little to no experience, with a significant lapse since they were involved with the submarine, and there was no training package made for this system, the training lectures were considered very scant, and supporting documentation were either non-existent or incomplete. Thus, the instructors had to re-familiarise themselves with the platform and bring themselves up to speed, with very little to aid them besides memory. Beyond sketchy documentation, there was also no other experts to seek guidance from and access to the submarines was a continuing problem and not within their control.

With no direct knowledge of the strengths or weakness of the trainees, or what specific training needs were required to meet Canadian objectives, all training was provided to one proficiency level. Within a military platform, operational duties and responsibilities within a submarine are divided, and responsibilities vary with increased rank. That is, technicians do not perform the same duties as managers. Technicians thus felt they were not receiving sufficient training. The first crew presented this deficiency and dissatisfaction to the training managers, and it was agreed that the training had an operational focus, rather than a technical one. As the first crews' training was considered a pilot course, discussions of this shortcoming in the post training, lessoned-learned meeting resulted in changes to the knowledge portions of training for successive crews. Specifically, it was agreed that certain occupations (mostly technical) were not receiving sufficient training to perform their duties and courses were added to alleviate this shortfall. It was further identified in the meeting that insufficient time was given in simulator training for individuals and teams to be proficient in performing the emergency operating procedures. The result was an extension of simulator training from one week to two weeks of training.

It was further noted by the trainees that knowledge training was specific for the systems that each occupation was responsible for but no formal knowledge was provided to gain an understanding of how the systems were connected and the potential multi- or cascade consequences that could occur in an emergency. There was also no formal knowledge training for the sequencing or systems involved in EOPs during phase-one training. Although individual and team simulator training was provided, time constraints did not allow all permutations of each emergency to be practised in simulator training. This deficiency was also presented in the post training, lessoned-learned meeting. From this, the training management completed a cursory survey with both crew one and two to determine if they felt confident to do their jobs safely at sea. To which each crew replied they were. Training management also noted that a balance between the knowledge and skill training was needed, they considered there was a balance but would continue to track the capability of ongoing crews training and satisfaction. As trainees were not provided EOP systems sequencing training during the knowledge phase, for any of the three crews training, trainees felt they needed to take it upon themselves to learn the multi-system linkages and the actions required during any of the 31 emergency sequences. They did this through an informal process, individually, between crews, and seeking support from subsequent crews who had completed this phase of training.

Throughout training it was also noted that EOPs and supporting documents were not complete and contained errors, especially for the first crews' training. During the initial training, availability and access to documents were also considered a problem, which was noted by the trainees but also acknowledged by the managers. The RN were the owners of the documents, but it is likely that some of the documents were not complete. As well, it is likely that original documents and subsequent requests for changes had not received formal approval for distribution while a crew were receiving their phase one and two training. This resulted in appearances that request for changes to documents were not acknowledged or accepted. However, although formal changes to documents took time, most suggestions for changes to documents as a result of errors or omissions were changed unofficially by the instructors, throughout training. Upon successive crews training the issue of access to documents was alleviated, however the issue of completion of the documents, errors and omissions continued, although to a lesser extent.

It was also noted that the EOP procedural document was not written to support learning. Rather, it was identified that the document assumed all procedures were known, and thus the document acted as a referral or reminder of the process. As systems knowledge was not taught, nor were the EOPs taught prior to simulator training where memorisation was expected, trainees had to learn the procedures informally on their own time. For the inexperienced members, learning the procedures through this method was found to be difficult. As a result, more senior members took it upon themselves to mentor the younger crew members.

Delays in re-activating the submarines also had a cascading effect on training. As crew one could not complete sea-trials, with no available submarine, they could not continue with training. The result was a degradation of knowledge and skills, and subsequent re-training was required in the simulator. Further crews training were delayed as there were insufficient instructors to complete the knowledge and skill phase training for crew three, USQ for crew two and concurrent sea-trials for crew one. This deficiency could not be resolved within the training program as there was insufficient staff to complete all that had to be done. The result was that each crew continued with training on an informal basis, seeking advice from builders, contractors, supporting documents, and gaining access to a submarine when available to try to maintain knowledge and skill, and keep on track.

Testing measures were in place in this training platform to identify knowledge and skill attainment, however, trainees were not given any feedback of strengths, weaknesses or confirmation of progress. Trainees thus had to presume their own and their crewmembers capabilities. Requests were made to address this perceived shortcoming; however, it was not addressed to the satisfaction of the crewmembers, for any of the successive crew training. There was therefore an uncertainty as to whether the required knowledge and skills would be obtained through the formal training process.

The alternative was to seek out the perceived required information informally. This method of information retrieval was considered the norm as both nations supported and endorsed a training philosophy that included and expected both a formal and informal mechanism for learning. Although there were identified deficiencies in the training platform (*e.g.*, lack of expertise of instructors, incomplete state of supporting documents, no feedback, and an operational focus), rather than succumb to the barriers and limits of the training platform all trainees accepted that the training platform would not meet expectations and informal mechanisms of learning were sought as compensation.

The misunderstanding of the training goal further fuelled the mechanism of informal learning. Trainees, especially technicians, expected they would receive sufficient training to achieve the same knowledge and skill state as that from the previous operating system. This misinterpretation of the training goal further cascaded into perceptions that the training content would not meet the performance outcome expectations. The lowered expectation was seen from technicians, but operators also felt the training content was not sufficient, although not to the same degree. Trainees thus perceived a greater level of knowledge was needed to achieve performance outcomes in the new working platform than that provided formally in the training programme.

These combined factors resulted in informal methods of learning. The informal method of learning and support from other crewmembers within a crew and from previous crews continued throughout the training programme. Over successive crew training, crews continued to believe that further knowledge was needed to perform their duties. Their dissatisfaction was also related to their frustration that changes that were present at the start of the training programme had not been remedied at this point in the training programme. This resulted in a continuation of retrieving information informally.

Assessment of the influences of this training programme has shown that when a person analysis is inadequate and details of who should be trained, why, and what should be trained are not sufficiently completed, individual strengths and weaknesses are not identified. The result was the provision of training at a level that resulted in sub-optimised training effectiveness.

7.1.2 Vertical Transfer

The findings from this case study have indicated that even with the considerable obstacles and challenges incurred by the trainers and trainees, operation performance outcomes were achieved (as they sailed safely back to Canada), and the crew of each submarine achieved the functional capability and was certified 'safe' to perform emergency operating procedures. Findings further identified that the process was achieved through individual outcomes that emerged upward through the interdependent teams to achieve organisational objectives. Using the VIE theory identified by Vroom (1964) (cited in Mathieu & Matineau, 1997; Salas, Cannon-Bowers, & Kozlowski, 1997), this approach can help to explain result findings and verify the theory of interdependent team vertical transfer (Kozlowski *et al.*, 2000).

Motivation was seen as a compelling driving force to learning the knowledge and skills for the new working platform(although not measured), but as well, there was a strong motivation and persistence to ensure knowledge and skills were considered sufficient for performance in the new working platform. This motivation to successfully achieve performance outcomes from the conversion training was seen to stem from the inherent risk of the working platform of the trainees, as the potential consequence of an accident or ineffective dealings with an emergency in a submarine, individually or as a team, could be catastrophic. With the inherent risk, isolation and confinement of the working environment of a submarine each individual is required to fully understand all safety aspects, and thus there is a requirement for all submariners to achieve a basic submarine certification for the submarine they are employed prior to active service.

However, beyond the requirement for each crewmember to have achieved a safety qualification, there is a further requirement for specific positions to collaborate in the performance of interdependent tasks to deal with any emergency to ensure the safety of the crew and the submarine (*i.e.*, performance of EOPs). Thus, the safety of all crewmembers is dependent upon the crews' capabilities as a whole, but the capability to perform the safety-critical systems operation for any emergency is dependent on the capabilities of the interdependent team on duty. The consequence of not doing well in training for an individual or the team could be disastrous. Thus, there was a collective expectancy that training outcomes would provide the knowledge and skills necessary to successfully perform in the new working platform. Additionally, the consequence within the platform was also an extreme motivator to assure all crewmembers achieved the perceived knowledge and skills for this working platform. Thus, the consequences for lack of skill in the working platform was seen to shape the belief that training would provide the perceived necessary skills, but also is an important factor for the lengths the trainees would go to achieve that perceived capability, individually, within a crew and between crews.

This case study has shown that expectation and satisfaction with training content are associated with performance outcome expectations, although a direct link was not identified. However, the associations with subunits in the training platform identify that specific areas within a training programme influenced both learning and expectations. Further, the subunit associations in the training programme also provide more explicit answers to the rationale for the approaches taken to ensure successful achievement of vertical transfer.

Significant correlation findings have shown that the greater the improvement of training content and formal aids the less need for changes to meet training expectations ($p<.05$, -.354), and as formal aids improve and become more helpful in learning the more likely performance outcome expectations would be met($p<.05$, –368). These common formal training aids negative correlation findings from this case study would suggest that the support supplied from the tools from training (*e.g.*, individual and team simulator training) were expected to support the knowledge and skills to achieve performance outcomes from training. As no inter-group differences were found, this would further identify this sentiment was felt by all trainees, trainers and managers. Further, a significant negative association was found between learning and formal training aids ($p>.01$,-.394) and with performance expectations ($p>.05$, -.374). These case study findings would identify the benefit of formal training aids to improve learning (Hitt II *et al.*, 2001). This common formal aid negative association with performance expectation would also identify the value and expectation from the training tools to support team performance outcomes (Allen *et al.*, 1985). However, although formal training aids were found to be very beneficial (*i.e.*, individual and team simulator training), case study findings would further identify that formal training aids were not considered sufficient enough to overcome other training platform influences on learning or to meet the expectations for maintainers.

Even though intervention opportunities were provided and changes were instituted through successive crew training, informal training aids were used as identified by the negative relationship with learning ($p>.05$, -.313) and with maintainer knowledge and skill expectation ($p>.05$, -.375). The significant group difference on influences to learning ($x^2=10.373$, $df=4$, $p=.035$) would identify that informal methods continued to be used by crew three to support learning.

This continual heavy reliance on informal aids through successive crews was influenced by a number of factors from pre-training and within the training platform. Pre-training assumptions that determined the training design can be considered as a key influence. Interview corroboration and consistent significant differences between CF managers and RN trainers' perceptions of the influence of various training platform factors from trainees has identified the disparate view that the qualifications were considered sufficient. These consistent and significant differences between trainees and both CF managers and RN trainers for the degree of influence for training content, training methods, instructor characteristics, and formal training aids identified that there was an expectation and a belief by managers and trainers that prior training and certification would provide the background needed for this training. The mangers and trainers applied this belief and expectation to both the capability to instruct by the trainers and the capability of the trainees to achieve performance outcomes.

These pre-training influences would moderate the expectations and satisfaction with the training platform, specifically, the interrelationships with training content. The case study has shown that there was also a significant positive relationship between training content and formal training aids, training methods and instructor characteristics that together influenced the satisfaction with the training programme. With corroboration from interviews these training content interrelationship findings, in concert with the significant negative association with perceptions of intervention changes, can be considered together as the drive for informal mechanisms to retrieve and share information. Confirmation of knowledge and skill (for both instructors and trainees) was not provided, as there was no feedback during training. The responsibility for this deficiency was then transferred to instructors, which also influenced the opinion of the ability of the instructors and influenced perception of the value of formal aids (*e.g.*, incomplete state of documentation) to achieve the expected knowledge and skill.

This research has also identified the perception of the value of training was also significantly influenced by the inherent training philosophy of both nations, which supported and endorsed both formal and informal components to training that included gaining of knowledge from outside sources. The significant relationship between instructor capabilities, training content ($p= <.01$, $r_s= .442$) and informal aids ($p= <.01$, $r_s= -.397$), support the existence and significance of this philosophy. The overall agreement by all successive crews, especially the technicians, was that the trainers did not have the in-depth knowledge or skill for this working platform, but considered this an acceptable style as it forced trainees to search for answers. As a result informal training aids were sought, shared, and accepted and expected within and between crewmembers. This informal support network can be considered a compensation mechanism to assure knowledge was gained and thus performance outcomes were achieved.

Together the results have revealed that even with all of the obstacles in the training platform, trainees believed they would achieve the knowledge and skills necessary to perform their future required duties, and there were no changes in confidence to achieve expected performance outcomes for successive crews during training. Even so, this case study identified that expectations were met for operators but were not met for maintainers within the training platform. However, functional operational performance outcomes were still achieved despite the challenges, delays, and shortcomings in training. This does not suggest that the successful performance outcomes were achieved solely because of the informal retrieval and distribution of information. Rather, achievement of performance outcomes was attributed to the dedicated informal efforts put forth by the trainees.

The case study has thus shown there was a strong support climate and an interdependence of teams both in learning and in achieving performance outcomes, within and between crews. Specific and unique individual learning outcomes were required for the success of team performance outcomes, to both functionally operate the vessel and to effectively perform emergency procedures. Moreover, significant informal interventions were taken individually to assure personal achievement, but they were also transferred between individuals, upward to teams, and across teams. This was seen in the informal mechanisms to gain and transfer information, mentor and support fellow team-mates, within and between crews. The successful achievement of crew functional operational performance outcomes thus indicate that individual outcomes from training have transcended to emerge as successful interdependent team and crew outcomes that have achieved organisational objectives. These results would concur with Baldwin and Magjuka's (1997) thoughts, that a favourable context can enhance even sub-optimal training interventions.

Therefore, these case study findings provide empirical evidence to support the theory of interdependent team vertical transfer. The analysis has also identified that success of interdependent team emergency management to achieve organisation objectives relies upon technical knowledge and skill, teamwork and taskwork skills identified in Kozlowski and Salas' (1997) multilevel framework. This case study also supports the notion that interdependent team training must achieve individual horizontal transfer and that performance capability transcends upward to support the interdependent team to achieve the organisation's objective.

7.1.2.1 Vertical Transfer- Team Compilation Influences

This thesis has thus far provided empirical evidence to support the theory of vertical transfer, however, confirmation of what successfully links lower-level training to higher level-objectives has yet to be verified and delineated. The multilevel model proposed by Kozlowski and Salas (1997) has provided a theoretical framework to expand training and transfer research from an individual-level focus to emphasis on an organisational system, that addresses vertical, horizontal and top-down organisational links (Figure 2). Kozlowski *et al* (2000) further elaborated on this multilevel approach model to propose a framework that recognises and elaborates the different training and transfer implications for independent and interdependent teams. However, they (Kozlowski *et al.*, 2000) have indicated that the compilation, interdependent team, vertical transfer framework has not been modelled to date, and one of the primary concerns in formulation of the model for compilation is to identify the linkages between individuals, team and higher-level outcomes across levels. The analysis of findings from this thesis is able to build upon the interdependent team theory of Kozlowski *et al* (Cannon-Bowers & Salas, 1997a; Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997). Utilising the multilevel framework of Kozlowski and Salas (1997) (Figure 2) findings from this research are able to identify individual and team-training components that support team compilation vertical transfer. Specifically, the results from this research have identified the supporting training tools, sequences and timings that can aid in vertical transfer. Within this section only team emergent findings are discussed, and results of the specific training effectiveness factors and their vertical influence to training outcomes are discussed later in this chapter (Section 7.1.2).

7.1.2.1.1 Technostructural Factors

Through various data collection methods, this case study has provided evidence to empirically support the general team content requirements identified in Kozlowski and Salas' (1997) multilevel level model as an application for interdependent team training (Figure 12). The HTA results identified that for emergency management in this platform, specific, non-redundant individual technological knowledge and skills were needed to fill the requirement for specific jobs that would form the interdependent team in the new working platform. As an example, the merging of two previous and distinct occupations into one in this new working platform, and the functional operating changes of the new system from a manual to semi-automated operations to the perform emergency procedures, would confirm that specific individual knowledge and skill requirements were necessary for team effectiveness in the new working platform. These findings are in keeping with the theoretical framework for interdependent teams, in that the case study identified that the target and sequence for training would require training for both the individual (for task-specific skills) and for the intact team (for integration) for achievement of horizontal and vertical transfer (Kozlowski *et al.*, 2000). The findings have further revealed (and are supported by past research) that individual skill was founded on, is required, and important for team success (Kozlowski, Toney *et al.*, 2001; Salas *et al.*, 1992; van Berlo, 1996) in learning and in achieving performance outcomes. The methods through which the individual knowledge and skill were obtained was not ideal as there was a lack of control of what was learned (Chao, 1997). However, Chao (1997) provides a plausible explanation for why an informal approach can be successful. Attitudes and behaviours, and this case study would also suggest knowledge, that are implicitly learned contribute to a wealth of knowledge that is used to evaluate and make sense of new information acquired through implicit or explicit means (Chao, 1997).

Thus, these empirical findings further support Kozlowski and Salas' (1997) multilevel framework approach for integration of interdependent teams, as results have shown that each member has unique contributions that are critical to the outcome. The results have revealed the criticality that training must first focus on the individual but it must also focus on the fit and distinctive contributions of each individual to meet higher-level outcomes (Kozlowski *et al.*, 2000). The significant performance benefits from individual simulator training to support learning of individual skills, prior to interactive team training, further corroborates and supports the compilation theory that individual delivery of technical skills is appropriate and supportive initially (Kozlowski *et al.*, 2000). These case study findings also align with the literature on teams, which has indicated that individuals must develop some proficiency on their task before they can devote attention and skill in team-based activities (Kozlowski *et al.*, 1996; Salas *et al.*, 1992). Proficiency is critical for this high-tech environment characteristic of a modern submarine. So, for compilation training outcomes to be successful, each member must possess the requisite knowledge and skills for his or her role in the team (at the individual level), but team members must also learn to function as a whole.

Results within this case study have further shown that interdependent teams also considered team training, as intact teams, extremely beneficial to learning when interactive training included an accurate representation of the task technology, structure and interdependence of task completion, as identified in Kozlowski and Salas' (Kozlowski & Salas, 1997) multilevel model (Figure 12). Meaning, the benefit of team, task training was found to be dependent upon the reflection of the training to the work related task and environment (Cannon-Bowers & Salas, 1997b). Consistent with prior research on the value of simulator training, this case study has revealed that simulation training that reflected the working platform benefited both learning and performance (Allen *et al.*, 1985; Mumaw & Roth, 1995; A. Schaafstal, 1993), but also, creation of a learning environment that closely resembled a real-world situation supported effective training (Hitt II *et al.*, 2001). Training within this case study reaffirms the importance of simulation training that is representative of the working platform, as training occurred in a simulator that mimicked both function and response of the working platform. Additionally, further benefit was obtained from training simulations performed within the working platform under controlled, monitored conditions. To provide credence to this body of work, case study findings are therefore also consistent with *Identical Elements Theory*, as satisfaction and outcome from training have been influenced by the reflection of the training content and programme to the physical workplace (Baldwin & Ford, 1988).

Kozlowski *et al* (2000) have suggested that training results will be ineffective, as will organisational effectiveness, if the training process does not address the combination of differing KSA content of individuals in interdependent teams. They further acknowledge that opportunities should be taken to use and expand the workflow models to make a workable compilation-based model for vertical transfer (Kozlowski *et al.*, 2000). This case study's empirical findings of training interventions for interdependent teams permits the validation of Kozlowski and Salas' (1997) multilevel model for use with interdependent teams, as individual knowledge and skill proficiency was found to be a critical antecedent to the formation and development of team-task performance (Figure 12, technostructural transfer). Results from this case study also allows other models such as those for team competencies (Cannon-Bowers & Salas, 1997b; Cannon-Bowers *et al.*, 1995) to be evaluated for inclusion in Kozlowski and Salas' (1997) multi level model to enhance the framework for design and training interventions for interdependent team emergency management.

This case study's findings are consistent with Cannon-Bowers and Salas' (1997b; 1995) teamwork competencies model; that team competencies are differentially applicable depending on the nature of the task and environment in which the team perform. However, results of this thesis confirm van Berlo's (van Berlo, 1996) criticisms of this model, in that the categorisations for the nature of their team competencies (*i.e.*, Context drive, Team-Contingent, Task-Contingent, and Transportable) do not address teams and tasks that do not fit exactly into one category, to include this military platform that also deals with emergency management.

According to the categorisation presented by Cannon-Bowers and Salas (1997b; 1995) the team in this working platform would fall under Context Driven, as there is a high task interdependence under stressful conditions. The team membership is also fairly stable, but the performance of emergency procedures requires quick adaptation but not to a strategic, problem-solving level. Teams must perform a variety of unexpected tasks as a team (thus falling under Team Contingent), and the procedures, sequence, and team interaction and coordination for each emergency are defined and must be followed (thus falling under Task Contingent). Further, reallocation of workload between team members performing an emergency procedure is not possible as members have unique skills and capabilities and the entire team is interactively required as a whole to successfully, and safely complete the task. Team members do however monitor each other's performance, which fits within their Context Driven category. This relationship is possible in this working platform because there is a shared, accurate knowledge of the task and environmental demand, achieved through the qualification for the platform and an in-depth understanding of the specific emergency procedure sequence and the responsibilities for each task.

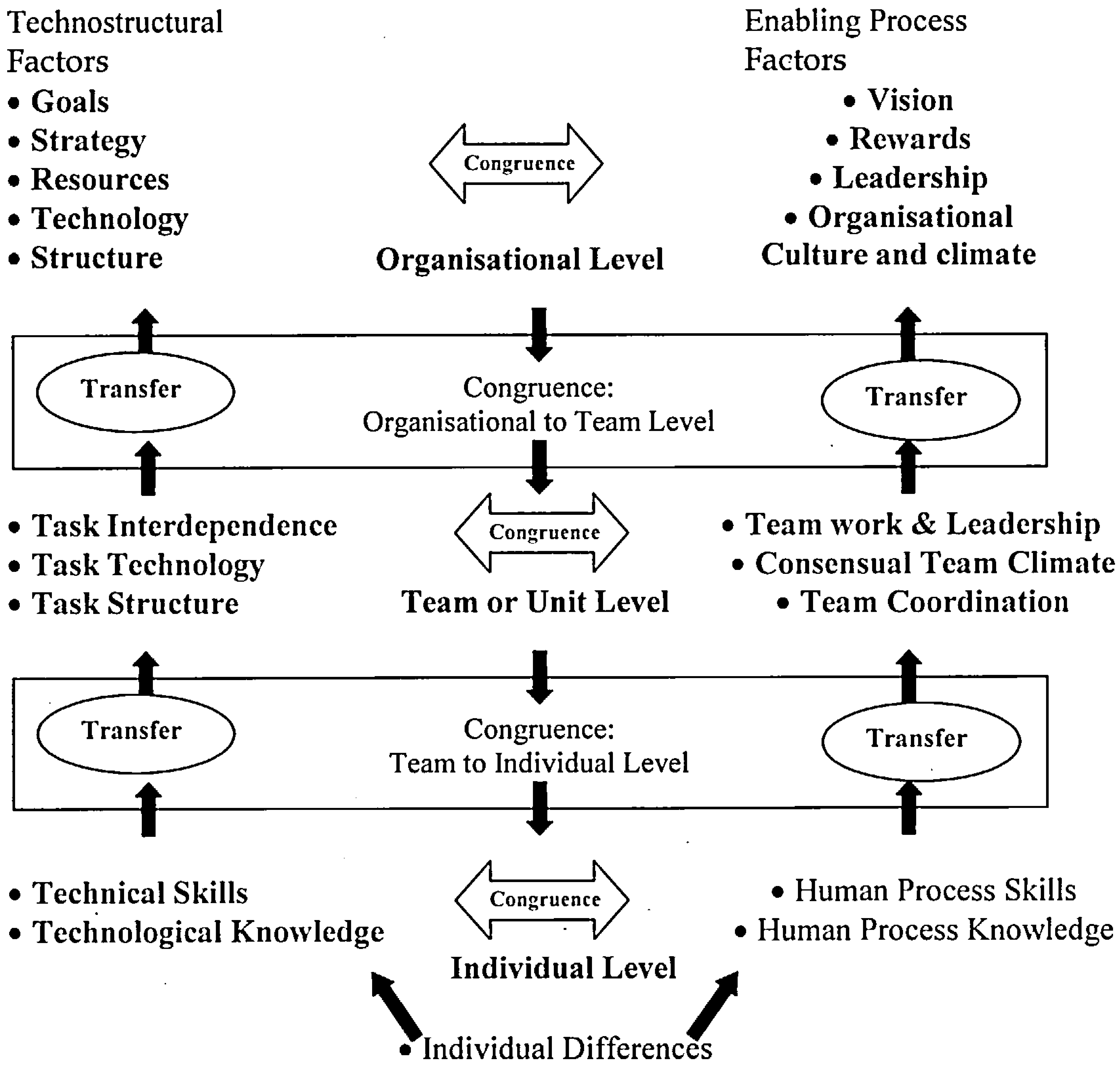
Thus, case study findings have revealed that this interdependent team has team and task specific knowledge and skill competencies that blend across the identified categories of Cannon-Bower and Salas' (1995) framework. Although most of the knowledge and skill competencies in the Context Driven category fit for this interdependent team, reallocation of function does not. Findings further suggest that the critical consequences of performing a task incorrectly and the infrequent nature of the emergency procedures required knowledge and skill competencies that are not identified in this Context Driven category. They include explicit task structuring; procedures for task accomplishment; an accurate specific detail of the task, not just a shared concept of the task models; information exchange; and, intra-team feedback (Cannon-Bowers *et al.*, 1995). This case study concurs with past findings that there are challenges and difficulties in identifying common task and team competencies that must be identified and addressed for interdependent team vertical transfer (Cannon-Bowers *et al.*, 1995; Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997). Cannon-Bower and Salas' (1995) model for team and task knowledge and skill competencies did not entirely fit with the team requirements for this platform. However, this case study's findings have shown that some of their modelled competencies are supportive of common interdependent team and task competencies that can be used to expand Kozlowski and Salas' (1997) multilevel framework.

Empirical findings from this team training platform have identified that complex, interdependent teams require team knowledge competencies that ensure team members have an accurate, detailed knowledge of the team member capabilities and their strengths and weaknesses. As shown in this training platform, and further supported within the literature, knowledge of team members capabilities, deficiencies and challenges provided opportunities for team leaders to shape the degree of transfer through informal reinforcement (Cannon-Bowers & Salas, 1997b; Smith-Jentsch *et al.*, 2001). Also, findings have identified that peer, subordinate and supervisor support all play a critical role in successful team training (Riemersma, 2001), including training interdependent teams for emergency management (A. M. Schaafstal *et al.*, 2001). This finding was most apparent in the informal support provided to team members as an aid to learning. Thus, findings enforce the contention that a shared knowledge of the task and environment demand is also critical, as is a clear understanding of individual role responsibility and interdependency between team roles and task organisation.

The findings have also identified that a shared cue-strategy association is important for the successful achievement of interdependent team tasks (Cannon-Bowers & Salas, 1997b), as explicit and controlled communication in an emergency situation requires continual updates of the state of the emergency and the system for effective management. Therefore, findings would suggest the inclusion of cue/strategy associations from Cannon-Bower *et al's* (Cannon-Bowers & Salas, 1997b) model as a subunit of task interdependence in Kozlowski and Salas' (1997) model for interdependent team design and delivery support.

The findings further suggest that beyond teams sharing the knowledge of team mission, objectives and resources (Cannon-Bowers & Salas, 1997b), to ensure that training integrates into the system within an organisational context, organisational contextual factors must also be understood and addressed within the training design (Baldwin & Magjuka, 1997). The problems that result in designing and performing training when organisational goals are misinterpreted have been exemplified in this case study. Further, findings have also identified the importance and value of training that is designed and implemented to incorporate individual and interdependent team knowledge and skill competencies that fit and support the workflow configurations within the organisation, based upon the organisational resources and working platform technology and configuration (structure) (Figure 12). The HTA for this case study identified resource and system issues that when not addressed result in sub-optimised training and dissatisfaction when training does not fit the requirements for the workflow configurations. This was apparent in the insufficient number of personnel available to successfully complete certain emergency procedures for all of the tasks (*e.g.*, EOP 28.1, insufficient personnel available to fight a fire should it occur). The issue is allocation of personnel within the working platform, but the issue is not so simple as reallocation as all personnel have specific duties already. Thus, the impact to personnel in training (while at sea) is that simulations for these specific EOPs with personnel shortcomings would not be reflective of a true emergency.

Figure 13. Data Collection Variables for the Multilevel Model for Training Implementation and Transfer (Green = data collection and comparisons through questionnaires and HTA confirmation. Blue = data collection through historical data, interview detailing, and where possible HTA confirmation. Red = no data collection or comparisons were possible).



Taken from Kozlowski and Salas (1997) A Multilevel Organisational Systems Approach for the Implementation and Transfer of Training

Case study findings support the notion that the technostructural factors indicated at the organisational level in Kozlowski & Salas' (1997) multilevel model could be applied to interdependent team vertical transfer. The case study has shown that technostructural factors in this model also fit the team compilation vertical transfer model (Kozlowski *et al.*, 2000), in that lower level training targets the delivery at the appropriate level and is in alignment with higher-level contents from a system perspective. Findings have shown that the derivatives of the technostructural factors are based upon the higher-level concrete considerations within an organisation identified by Kozlowski and Salas (1997). Thus, the findings would support the use of Kozlowski and Salas' (1997) multilevel framework as a foundation, as all of the levels, factors and congruence collected during this case study were seen as necessary for training intervention. Results would further support the notion that preparing individuals to accept training-induced change and encouraging them to express their new capabilities in the work environment requires training that is delivered at the appropriate level and is in alignment with contextual support (Yamnill & McLean, 2001).

7.1.2.1.2 Enabling Process Factors

The findings from this case study have shown support for the general enabling process factors studied in Kozlowski and Salas' (1997) multilevel model as an application for interdependent team training (Figure 12). The enabling process factors of Kozlowski and Salas' (1997) multilevel model refer to the human interactions, perceptions, and shared expectations that allow the technical knowledge to be usefully applied in the work setting. The process specifically focuses on the behavioural components, identifying the social and human interaction processes that allow the operation of a system, and the dynamics of human behaviour that can influence organisational settings. Thus, findings from this research platform used in this thesis are able to identify some of the behaviours and attitudes, at each level, that have either been shown to be supportive elements for interdependent teams, or have been shown to hinder training effectiveness and the achievement of vertical transfer. Findings have also identified enabling process training interventions that should be considered to achieve system effectiveness in emergency management of safety-critical systems.

Findings have shown the importance and necessity of the enabling factors found in Kozlowski and Salas' (1997) multilevel model as a requirement for interdependent teams, as the success of integration required that each team member must be able to perform their individual skills but they also had to integrate as a unit into the system. To achieve this, training design and implementation must also consider and integrate the attainment of individual technical knowledge and skill with human processing of knowledge and skills that are constrained by individual variations in ability (i.e. experience and lapse in experience), behaviour (i.e., motivation) and attitude (i.e., commitment) (Figure 12). The success of integration has been postured by theorists, who hypothesise that training that fosters development of a shared mental model has the potential to improve team performance (Cannon-Bowers & Salas, 1998). This case study's findings concur with the shared mental model view capability to support team performance outcomes from training (Cannon-Bowers & Salas, 1998), as the working platform for this case study implements a shared understanding and support of tasks for both the interdependent teams and all crewmembers.

The requirement for each crewmember to have obtained the working platform certification (dolphins) prior to any active service is an important example of an effective shared mental model. This self-study, on-the-job training, and oral board exam process can be seen as a method of cross-training (Blickensderfer *et al.*, 1998) to achieve a shared mental model, as each team member achieves the basic knowledge of all systems and their function and operation, and is capable of performing any of the basic tasks in an emergency to ensure the safety of the crew and the submarine (*e.g.*, shutting of valves in a flood). Therefore, basic emergency actions can be taken by any crewmember that discovers an emergency, without waiting for direction. Thus, in emergency management the achievement and assurance of a system shared mental model for this platform has helped to mitigate the risk of errors (Dobson *et al.*, 2001) and also assures the effective dealing with an emergency, as prediction of system behaviours is possible (Cannon-Bowers & Salas, 1998), with the appropriate follow-on action.

However, although this shared mental model has been shown to be effective and necessary for the working platform, this case study's findings have shown that the certification to obtain the shared mental model is only truly effective for the specific platform or system for which it was developed. Results have shown that consideration must be given, in the form of a needs assessment, whether the basic understanding of systems in one platform (certification and a shared mental model) is sufficient for application to another platform. There were similarities in some of the systems and function, but this new working platform has some very distinct system differences (*e.g.*, semi-automated vice manual, and three hydraulic plants vice one in the previous platform) that require different actions. The presumption of pre-requisite certification suitability has been shown to influence training effectiveness. The case study findings would further speculate whether sufficient and accurate individual knowledge was obtained through informal mechanisms that were not tested, because of this presumption.

A more positive influence of the development of a shared mental model in training was identified in this case study in the delivery of sequential individual and team simulator training. There was a resounding support to the benefit of initial individual simulator training as it provided both opportunities for development of individual level skill proficiency and understanding of each team members' tasks and the integrative role and fit within the system prior to integration with the team. Trainees considered individual simulator training of such value that they suggested greater time should be allotted in training to assure this fundamental building block for team integration was achieved. Although the delivery sequence in this case study supported the development of interdependent teams, the achievement of skill proficiency was uncertain due to lack of feedback. Thus, although performance objectives were achieved, the true proficiency of individual skill level and its effect will only be known when tested in real scenarios in the working platform (Kozlowski & Salas, 1997). This stresses the importance of testing and confirming capabilities in training. Although the findings are consistent with the literature in that interdependent team alignment between individual level skill proficiency and collective enabling process skills are critical to ensure cohesion in performance (Kozlowski *et al.*, 1996), the findings have further identified that the training content and methods must both support and determine the achievement of individual required skills.

Following individual simulator training, the training platform provided team training that integrated the task linkages, role expectations and goals of safety-critical procedures. This sequencing of training was found to be extremely beneficial as the progress to team training provided an integration of individual task components, but also allowed the practise and development of integrating and coordinating the required teamwork enabling components (Figure 12). Team training thus provided an opportunity for the adaptation and adjustment between team members in real-time to the emergency task demands to ensure seamless coordination of the tasks. Case study findings would therefore agree with the literature, that even with all the challenges and obstacles in the training programme, that positive outcomes are seen when a shared mental model for the interdependent teams is developmentally progressed from an individual orientation to a team orientation (Cannon-Bowers *et al.*, 1991; Driskell *et al.*, 2001; Kozlowski *et al.*, 1996). These case study findings also add to the existing literature which has determined that a training platform that has been designed to implement both technical and processing (coordination and communication) skills is required for interdependent teams in high demand and high threat situations (Driskell *et al.*, 2001) and will also mitigate the risk of error (Dobson *et al.*, 2001).

Case study findings further support the necessity of incorporating both the enabling factors of leadership and climate in Kozlowski and Salas' (1997) multilevel framework for design and delivery of interdependent team training as they can both improve, hinder and compensate training effectiveness. The case study's supporting evidence of the strong leadership (*e.g.,* mentorship, guidance, discipline and reinforcement) and organisational training philosophy that was inherent in the working platform of both nations which also transferred to the training programme, is an example that application of philosophies can vary in effectiveness depending on how they are applied.

Within the working platform all of the leadership roles are needed to achieve performance outcomes, but a particularly effective form of leadership that transferred to the training platform was the guidance and continued mentorship to expand both subordinates' capabilities and those of colleagues who had less knowledge and experience. These supportive informal actions in the form of informal peer, subordinate and supervisor support (at many levels), and when asked for, the additional informal support from the instructors was identified to be beneficial in learning. But as well, the findings that team composition was considered important because of the relative support it provides, would further reveal that exchanges between crewmembers also provided opportunities to clarify material that was obtained, either formally or informally (Chao, 1997). This very supportive and cohesive climate is an integral part of the behaviours and attitudes in this high-risk working platform that requires an effective response to emergency situations. The military provides leadership training for various levels in the hierarchy structure. However, within a training platform that supports and endorses informal retrieval of information, leadership training in itself would not be considered sufficient to pass on technical expertise. Although informal support definitely has value, when applied in a training platform that lacks assessment standards to confirm that knowledge and skill were obtained, questions then arise as to the accuracy, detail and quality of the informal information exchanged, as the degree of the colleagues' technical expertise (Klein & Ralls, 1997) and the instructional skills to pass on technical information (Kozlowski *et al.*, 1996) were uncertain. The effect to performance outcomes on transfer could also be further influenced by the leadership policy to deal with any individual shortcoming within the new working platform.

Thus, the findings have determined that Kozlowski and Salas' (1997) multilevel framework can identify and address enabling factors that are necessary for interdependent team training design and delivery. But as well, the findings have also identified that enabling factors in Kozlowski and Salas' (1997) multilevel framework can also help to proactively identify and address those moderating influencing factors, such as working platform philosophies, that may alter the effectiveness of training. The findings further support and justify the requirement for alignment of the task and role responsibilities and fit between levels for interdependent teams to develop proficiency. Although this training programme was fraught with problems that influenced the training effectiveness, the approach to train this interdependent team in teamwork skills, of coordination and communication in concert with the practise of integrated skills was key to the achievement of successful performance outcomes. These findings clearly identify that the overall skill training style (not including assessment methods) was effective for dealing with an emergency (A. M. Schaafstal *et al.*, 2001), high demand and stress (Driskell *et al.*, 2001), and mitigated the risk of errors (Dobson *et al.*, 2001). These results would further suggest that the success of training intervention also relies upon a training programme that incorporates the culture, climate and leadership values of the organisation (Figure 12). This case study revealed that organisational support for training (Cheng & Ho, 2001), informal reinforcement (Cannon-Bowers & Salas, 1997b; Smith-Jentsch *et al.*, 2001) and values placed on training (Kraiger & Aguinis, 2001), all improve the likelihood of success of the training platform and facilitate successful training transfer if they are applied in a manner that supports training effectiveness.

These findings would further support the notion that training that fosters development of a shared mental model of the situation and the task environment, roles and abilities of team members has the potential to improve team performance (Cannon-Bowers & Salas, 1998; Serfaty, Entin, & Johnston, 1998). In dynamic, complex environments such as that of emergency management, training to develop a shared mental model of the interdependencies of the team should be considered where timely, error-free performance is required.

7.1.2.2 Summary

The case study findings therefore support the use of Kozlowski and Salas' (1997) model as it identifies and addresses historical deficiencies in the development of a training design, taking into account, albeit broadly, the multilevel linkages to consider and implement to assure training outcomes (Ostroff & Ford, 1989) that meet organisational objectives. This case study has revealed that when integration of interdependent teams to a new system employs the merging of both the technostructural and enabling factors in both individual and intact team training, the result is an aid to learning and performance. Additionally, the informal approach taken by trainees to obtain the foundation knowledge to develop the required skills has identified that individuals must first acquire knowledge before some proficiency can be developed in their tasks. Individuals, specifically the technicians, could then devote attention to the processing skills necessary to enable team performance (Kozlowski *et al.*, 1996; Salas *et al.*, 1992). The case study findings have determined the importance of training to include the concrete requirements within a system (knowledge and skill), but as well, training delivery must also consider the informal social interactions, interdependencies, expectations and perceptions (Kozlowski *et al.*, 2000) within, between and across levels, to ensure alignment (Yamnill & McLean, 2001).

Findings from this case study have thus identified, although broadly, that the multilevel theory of Kozlowski and Salas (1997) can provide a framework to answer the key organisation questions in training effectiveness- how, where and when - to deliver interdependent team training to enhance training outcomes (Cannon-Bowers *et al.*, 1995; Ostroff & Ford, 1989). Assuming an organisational focus, case study findings have also identified and supported the inclusion of some of the general teamwork (*e.g.*, task structuring and intra-team feedback) and taskwork (*e.g.*, cue/strategy associations, role responsibilities, and accurate task models) competencies to additionally support the achievement of interdependent team vertical transfer. Thus, consideration should be given to include these competencies in Kozlowski and Salas' (1997) multilevel framework.

The deficiencies and resulting misalignment of the training platform to provide expected knowledge and skills also identifies the importance and necessity of performing training needs analysis prior to the design of the training programme. The importance of conducting a thorough needs analysis is well established and accepted in the literature, and the findings further justify that an organisational analysis, task analysis and person analysis should not be considered in isolation (Salas, Cannon-Bowers, & Kozlowski, 1997; Tannenbaum & Yukl, 1992). Further, the results have revealed the requirement for both the traditional individual-level analysis, as well as, a team-task analysis prior to designing and initiating a training programme (Bowers *et al.*, 1995; Kozlowski *et al.*, 2000). The additional workload in the new platform for technicians and changes to the system functioning would, as an example, identify that the pre-requisite from a prior platform would not be adequate unless a personnel analysis indicates otherwise. Thus, findings would concur with the literature that a personnel assessment for the tasks are needed, and the assessment requires the addition of the appropriateness of the background knowledge individuals bring to training (Rogers *et al.*, 1997). Assessment of the influences of this training programme has shown that when a person analysis is inadequate and details of who should be trained, why, and what should be trained are not sufficiently completed, individual strengths and weaknesses are not identified. The result was the provision of training at a level that resulted in sub-optimised training effectiveness.

This case study has provided an empirical foundation which corroborates the use of Kozlowski and Salas' (1997) multilevel model as an aid in design and delivery for use in interdependent teams to support vertical transfer, although this case study was only able to provide a foundation for the general categories. The complexities of this training platform and the approaches and interventions taken within this platform have also provided an indication of the real-world complications in achieving vertical transfer. The findings have also identified that different combinations of factors can exert an influence on pre-training that will transgress to influence the effectiveness of training delivery. This further supports the requirement to develop a detailed model to support the design and delivery of training for interdependent teams. Although this platform required both individual and team training, this sequence of training may not be necessary for upgrading of individual skills or behaviour integration. Although team performance models and team-driven performance strategies have begun to address these issues, further research and empirical evidence is still needed to address specific team skill-set requirements, and how, when, how long, and whom should be trained for training to be effective.

7.1.3 Training Effectiveness Factors

To provide further support and advancement to the theory of interdependent vertical transfer, this dissertation has identified that Kozlowski and Salas' (1997) multilevel model can be used as a framework for design and delivery of training for interdependent teams. This dissertation has also identified that some of the teamwork and taskwork competencies from Cannon-Bower and Salas' (Cannon-Bowers & Salas, 1997b; 1995) should be included in their (Kozlowski & Salas, 1997) framework for interdependent team vertical transfer as these components were found to be integral to the successful achievement of performance outcomes. However, Kozlowski and Salas' (1997) multilevel model does not include or address training design influences in their model. As factors within training are known to influence training effectiveness, then training design could also impact vertical transfer outcomes and thus potentially influence the impact training could have on organisational effectiveness. To further advance the knowledge of factors that can influence interdependent team vertical transfer this dissertation further identifies some of the pre-training and training influences of the training platform on interdependent team learning and performance. This dissertation also further explores training design elements within this case study training programme to identify the influence of the techniques and tools on training interdependent teams. This case study thus provided the opportunity to advance support to the theory of interdependent vertical transfer by expanding upon Kozlowski and

Salas' (1997) multilevel training interventions approach model with pre-training, training design and team training influences (Figure 14).

7.1.3.1 Pre-training Influences

Accumulating evidence in the literature has shown that the impacts of pre-training fall into three general categories: 1) what characteristics an individual brings to training; 2) variables that engage trainees to learn and participate in developmental activities; and, 3) how training can be prepared to maximise the learning experience (Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992). For ease of discussion findings will be discussed within this framework.

7.1.3.1.1 Individual Demographics

Demographic information about the individuals involved in this training platform was taken to identify the potential mitigating influence of prior experience and lapse of experience on ability to learn, manage and instruct within this training platform (Figure 14). The findings concur with past research suggestions that experience has not been found to be directly related to training effectiveness (Tannenbaum, 1993), as the training platform design did not take individual experience into account nor was the lapse in experience. However, the literature has suggested that experience can be a useful predictor of training expectations, perceptions, motivation and self-efficacy (Mathieu & Matineau, 1997; Tannenbaum, 1993). The case study identified that although there was a balance of experience and inexperience between crews, which would balance itself in the working platform, each crew also had individuals with very little experience (less than two years). Based on this past experience, trainees would develop disparate perceptions of their ability, or lack thereof, and based on their experience they would also develop perceptions of the training needs for the new working platform (Noe *et al.*, 1997). These pre-training perceptions then translated to personal expectations and expectations from training (Figure 14)..

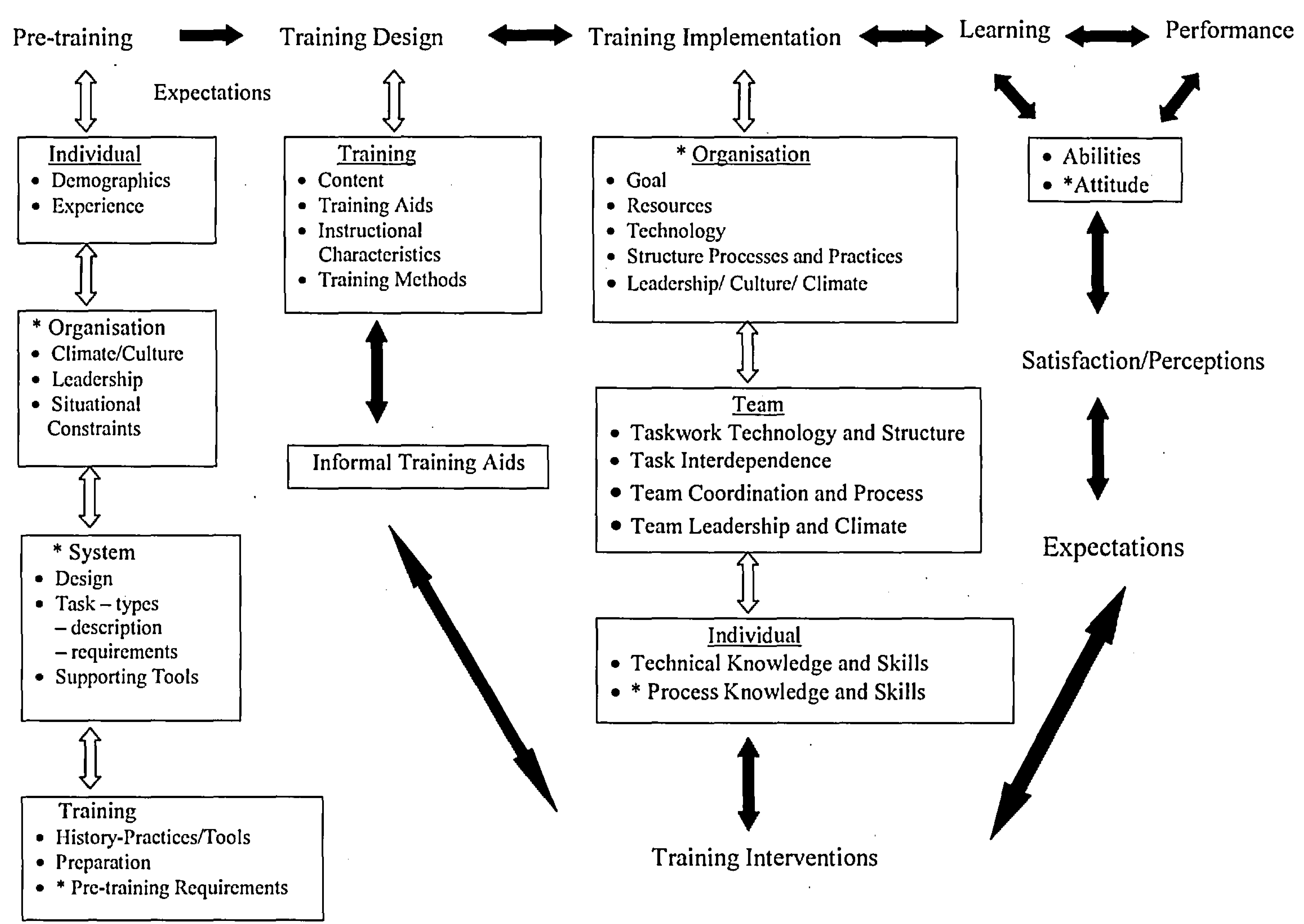
The case study findings have shown that individuals have drawn from the varied levels of past experience and developed an expectation that the training programme would provide the necessary knowledge and skills to allow equivalent performance to the new working platform. The Hierarchical Task Analysis has further identified that task emergency management within the new working platform required a similar capability to perform the sequences by rote, but to perform the tasks and ensure future and on-going capability of the system, further technical knowledge was needed of the systems and their integration for all who would perform those tasks. Thus, the findings have identified that there was a perceived mismatch, especially for technicians, between the organisational goal of training and perceptions of required performance outcomes (Figure 14). Those with extensive expertise would have superior knowledge of relevant facts and procedures (Pokorny *et al.*, 1996), albeit of the original working platform. Those with a greater breadth of task experience would also have a greater recognition of the necessity and value of training (Ford *et al.*, 1993), recognising the cultural norm of a formal and informal process. This was evident in the informal support provided during training by experienced members to the less experienced who were having difficulties achieving expected knowledge (Figure 14).

It can be said with certainty that characteristics that an individual brings to the training programme and the compensations derived from more experienced team members and crew were all-important factors to the success of the training programme and ultimate transfer. Moreover, the findings further suggest that requisite knowledge and skills are important considerations for learning (Smith *et al.*, 1997), as case study findings identified the entry pre-requisites were considered insufficient for the level of technical knowledge and skill required for performance outcomes. Although motivation was not specifically measured in this case study, the inherent risk of the environment; the future system requirements for personnel; the significant deliberate informal mechanisms chosen during training as compensation; and, corroboration from the comments in interviews would suggest that motivation was a driving factor in this training platform. Goal setting theory can help explain the motivational efforts of the trainees; as the intentional effort and persistence, above that expected, would suggest a motivation and commitment to achieve the goal (Yamnill & McLean, 2001). It can then be projected that the direction, effort, intensity and persistence of individuals and teams was motivationally driven by pre-training and training situational factors and individual perceptions.

These exploratory findings suggest that future research is needed to simultaneously investigate the pre-training influences and potential links of individual's ability and perceptions of their ability, perceptions of training needs, and the impact to effort-performance perceptions and resulting behaviours. This interaction has not been explored on an individual front, let alone that of complex, interdependent teams and the effect to vertical transfer. Further, team-driven strategies using a shared mental model approach have been shown to have a positive influence on team performance (Boland & Tenkasi, 2001; Entin & Serfaty, 1995; Garbis & Waern, 1999; Smith-Jentsch *et al.*, 2001; Tannenbaum *et al.*, 1998). If a shared mental model has an effect on team performance, then it can be further postulated that a shared mental model could also influence individual and team attitudes and behaviour towards emergency management training, which could influence training outcomes.

The commonly used phrase 'young man's game' for this working platform suggested age might influence learning, as older workers have been found to be less likely to participate in development activities and accept new technologies (Noe *et al.*, 1997). However, the reasons for the phrase were related to lack of agility as one gets older, but as well, with age there was less of a willingness to take risks. The relationship could be related to social influences (*e.g.,* family and community responsibilities), while it could also be related to maturity with aging, life experiences, and recognising one's own limitations. Trainee characteristics, such as the behaviours taken to overcome the challenges in training, and the conditions and requirements of the work environment have previously been shown to influence training effectiveness (Tannenbaum & Yukl, 1992). Thus, training preparations and the effectiveness of a training platform could be. This potential relationship is worth exploring, especially for emergency management. influenced by the combined components of the risk of the working platform, situational mitigating influences, and the attitudes and behaviours that result.

Figure 14. Multi-level Training Effectiveness Influences for Interdependent Teams (Filled in arrows represent the relationship between training effectiveness categories and training outcomes. Clear arrows represent the contextual factor relationships within categories. Those items identified with an * have only been explored through historical data collection, HTA and interview comments).



7.1.3.1.2 Training Preparations

The training platform for this working environment required considerable preparation prior to delivery that included both instructor and training plan preparation. To identify the pre-training influences that might have an impact, perceived impacts of lapse in operational experience to recall and train and the influence of the imposed principles and the supporting aids were investigated. Although no significant correlation differences were found between the pre-training factors of training aids, instructor characteristics and informal aids, and no statistical comparisons were possible with training principles, discussion is worthy as many pre- training factors together influenced the quality and delivery of the training platform which influenced expectations and learning style. These factors together have suggested an influence on the effectiveness of the training programme.

Historical background on the prior training of the instructors indicated there had been a significant lapse since any training or active service on this platform, and although instructors had significant submarine experience, most had little active service on this class of submarine prior to decommissioning. Systems knowledge was mostly obtained informally through the building and activation of the system. Further, no training package had been made for this system, the training lectures were considered very scant, and supporting documentation was either non-existent or incomplete. It would then be expected that there would be some difficulties in recalling that previously learned, as mere passage of time causes forgetting (Wickens & Hollands, 1999). But as well, there would be a requirement to recall, if developed, previously learned procedural skills (EOPs) in order to instruct. Recall of procedures can be accurate and effortless, but only if the skill was thoroughly learned in the first place as procedures that require a sequence of steps are more rapidly forgotten (Wickens & Hollands, 1999).

Surprisingly, lapse in operational experience was not considered an influence to recall when the question was presented to Canadian Navy managers and RN trainers. This response was also consistent with that given for the perceptions of growth of knowledge and skill of the trainers and their development with time. However, trainees' response that they agreed there was growth, interview corroboration, and the significant relationship with informal training aids would reveal that was not the sentiment of the trainees, as they believed there was either difficulty in recall or the knowledge and skill was not present in the first place.

Although no pre-training correlation was found with instructor characteristics, the likely reason that lapse was not considered an influence for CF managers and RN trainers was that there was a strong belief, by both nations, that the method of prior training was sufficient and the aids available (*i.e.,* technical documents, simulator training and access to the working platform) would have overcome any memory loss that may have occurred. Findings would further suggest that the training platform in support of the formal and informal training philosophy would overcome any deficiencies (Figure 14).

The findings have shown that for trainees learning was supported by the similarity and reflection of the training environment to the working platform. Thus, it was not surprising that representative simulation training was considered a benefit to their learning (Allen *et al.*, 1985; Mumaw & Roth, 1995; A. Schaafstal, 1993), as did access to the working platform (Hitt II *et al.*, 2001). However, although most of the prior documentation was incomplete, their resounding support that the documents were of value can be attributed to the fact that the documentation supplied retrieval cues to information stored in long-term memory (Wickens & Hollands, 1999). Even though they may not have been able to recall the information, the literature suggests that often information is recognised as familiar once it is seen (Wickens & Hollands, 1999), even if the information was not complete or detailed.

Extensive informal methods were also sought by the RN trainers to extend their knowledge and skill over and above that available from the original training programme. Although informal training was part of the historical training programme and an inherent training philosophy, there was no requirement to seek external aid nor was there guidance as to what was needed to be learned to be an effective instructor. The Royal Navy instructors chose informal mechanisms to ensure currency of knowledge and skills to assure credibility with the trainees. Using goal setting theory as the framework to approach the rationale, this intentional effort and persistence, above that expected, would suggest a motivation and commitment to achieve the goal (Yamnill & McLean, 2001). The contractors were not involved in the re-training process and it was also perceived that their knowledge and skill was not adequate. Thus, the motivation and drive to achieve a capability to train was not equally distributed among all trainers. The reason for the select military instructors' commitment is not likely attributed solely to an understanding of the inherent risk of the working platform, as the contract instructors were also at one time submariners for the working platform of this training programme. Therefore, one could conclude that a reason for the military instructors' selective commitment relates to their mutual current profession and working platform (*i.e.*, as active military members and submariners). A culture exists within the submarine community that traverses across nations, in which there is an *esprit-des-corps* to ensure all that can be done, will be, to assure fellow submariners have the capability to perform their duties and keep safe.

However, if skills were not thoroughly learned originally and skills have been forgotten or not used, there can be significant disadvantages to gaining information informally. Informal mechanisms to learning can result in lack of control for what actually gets learned, lack of uniformity across trainees, problems with incompetent trainers, and there are hidden costs to informal training (*e.g.,* time engaged with questionable value, engaged work delays and suffering) (Chao, 1997). Questions then arise, or should, as to whether the material had been adequately learned and understood for this application.

Thus, findings seemed at odds between the perceptions of influence from lapse in operational experience and capability to train, as lapse was considered to have some effect, as seen through informal mechanisms, but there was a resounding agreement of capability to train. As identified with individual demographics, experience can be a useful predictor of expectations (Mathieu & Matineau, 1997; Tannenbaum, 1993). It can then be concluded that past experience has likely shaped the perception of capability to train and expectations from training (Figure 14). It is likely that expectations were strongly weighted upon the informal and formal components of the training philosophy observed by both nations. Therefore, there was a subjective perception of the formal developmental needs, which were likely under-rated because of the informal learning expectation. Leadership expectations from the receiving nation could also have played a significant part in the lowered expectations from training as the working platform culture expects leaders to deal with deficiencies.

The training programme was also self-regulated by the military instructors for the technical content, level of detail and assessment style, as there was no outside body with equal or greater knowledge and skills of this working platform. Although the instructors measured their knowledge and skill against the qualification of the working platform, the level of competency to train for a specific skill set was not measured, nor was it possible.

Thus, although no correlations were found between pre-training influences, and performance measures were not possible, this case study suggests that different combinations of training design elements could exert a cumulative effect on the effectiveness of training and pre-training factors were shown to play a major influence on the attitude toward the training platform and actions taken to assure that performance outcomes would be achieved. The exploratory pre-training factors identified within this case study would therefore confirm the necessity to broaden the approach of training effectiveness to include pre-training individual characteristics, organisational influences and design elements in combination (Figure 14).

7.1.3.2 Training Influences

The influences of training design at the individual level are well represented by the literature (as seen in reviews by Baldwin & Ford, 1988; Ford & Weissbein, 1997). Design and delivery of training involve the selection of appropriate media, training content, sequencing and learning principles to achieve objectives (Baldwin & Ford, 1988). The multilevel model proposed by Kozlowski and Salas

(Kozlowski & Salas, 1997) has been shown to address the issues of team-based tasks and delivery of team outcomes (Kozlowski *et al.*, 2000; Salas *et al.*, 1992), and this dissertation further provided empirical evidence to support its use for interdependent teams and vertical transfer. However, the framework has not incorporated training design components as factors that could influence vertical transfer and organisational effectiveness, although training design is known to influence training effectiveness. This dissertation provides further support to the multilevel level framework for interdependent teams by identifying the training platform factors that have influenced learning and performance, as well as, the specific techniques and tools that have hindered or enhanced interdependent team outcomes (Figure 14).

7.1.3.2.1 Training Design Influences and Learning

The findings have shown that factors within this training design influenced both learning and performance. Training methods were found to positively influence learning ($p= <.05$, $r_s= .307$), using assessment methods as the identifier as to whether knowledge and skills had in fact been learned (Figure 14). This suggested that learning would improve with ongoing confirmation of knowledge and skill capabilities provided by the instructors and attained by the trainees. This correlation would further suggest that knowledge and skill confirmation would instil a confidence in the capability of the trainers, as well as, corroborate the progression and attainment of knowledge and skills for the trainees. This case study identified a distinction between testing of knowledge and skill and confirmation that the skills had in fact been obtained. Although unusual, when no debriefings on progress and capability are provided, trainees question whether they have attained what is needed, even though they have been tested. As testing was performed, this distinction between testing and confirmation identifies that the lack of feedback was considered influential to learning. This further altered the trainees' expectation that performance outcomes would be attained (Figure 14). The literature would support these findings, as training effectiveness has been shown to improve when all available sources of relevant feedback are used, and feedback is accurate, credible, timely and constructive (Redmill & Rejan, 1997; Tannenbaum & Yukl, 1992). Further, these case study findings are consistent with the literature that positive feedback is especially critical for stress management. In extremely high demand performance environments individuals will develop positive or negative expectations regarding their capacity to perform in the environment (Driskell *et al.*, 2001).

The concern of whether knowledge and skill were obtained was also directly linked with training content ($p= <.05$, $r_s= -.378$), and this finding can further explain the influences of confirmation of skill on learning development. Testing of learning outcomes for technical and motor skills, which was of most concern for technicians, evaluated skill development using traditional and accepted methods of observing trainee performance in role-play (*i.e.,* simulation) and in the working platform (Kraiger *et al.*, 1993). However, these observations are only an appropriate evaluation tool when the evaluation method has been deemed appropriate through a needs assessment using theoretical conceptualisation of skill development (Kraiger *et al.*, 1993). This is relevant to this case study as it provides a possible explanation for the expected performance outcomes and the lowered expectation from the training platform. The literature has shown learning outcomes begin with declarative knowledge (what) which is then organised and compiled into procedural (how), and with greater experience becomes strategic (which, when and why) (Kraiger *et al.*, 1993). Skill acquisition involves the transition from knowledge that is declarative to knowledge that is procedural (Neves (1981) as cited in Kraiger *et al.*, 1993). Part of the difficulties can be explained in that declarative knowledge encourages memorisation (Rogers *et al.*, 1997), while procedural knowledge is often considered to be directly reflected in successful performance outcomes (Kozlowski, Gully *et al.*, 2001). Herein was part of the potential problem, dissatisfaction with the training content, and reason for seeking informal aids as support. The emergency procedures required memorisation, but errors are reduced, verbal rehearsal is eliminated, and behaviour is more-task focused with levels of learning that are higher than declarative (Kraiger *et al.*, 1993). Trainees believed that they required further knowledge of how a system functions in order to adequately perform the functional tasks, rather than just memorisation. They also expected the training programme to provide higher-level learning than declarative. The resulting lack of feedback and confirmation of progression resulted in significantly greater negative expectations from the training programme content ($p = <.05$, $r_s = .335$). But rather than developing a negative expectation of their capacity to perform in the environment, as suggested in the literature (Driskell *et al.*, 2001), informal methods were sought to ensure performance expectations were achieved. Thus, the positive influence of training methods on learning makes sense and it was not the evaluation method that was the issue, but rather that learning improves with the confirmation that knowledge and skill had been obtained. This would also confirm one of the significant disadvantages of an informal learning process to gain critical knowledge (Chao, 1997), but it would also suggest (although not measured) a motivation to achieve performance outcomes and a commitment to higher-level goals.

Not surprisingly, findings also indicated relationships with both formal and informal training aids. However, both negatively correlated with learning (formal, $p = <.01$, $r_s = -.394$, and informal, $p = <.05$, $r_s = -.313$), indicating that as formal aids improve there is less of an effect to learning and less reliance on informal training aids (Figure 14). As identified in Section 7.1.1.1.1, the formal training aids of individual and team simulator training were found to be extremely beneficial to learning, as was access to the platform and technical documents. Although considered very beneficial, trainees desired more timely and lengthy simulator training, thus the negative correlation with formal aids. Therefore, sequential individual and team training that reflects the task and environment can be considered supportive of interdependent teams and vertical transfer (Cannon-Bowers & Salas, 1997b).

The findings have also revealed that team composition influenced both learning and job performance, which members qualified to mean that there is interdependence between team members for support that is relied upon to complete the tasks within this training platform. They also identified that this interdependence was also necessary in the working environment. These findings further support Kozlowski and Salas' (Kozlowski & Salas, 1997) framework for interdependent team training to achieve successful outcomes in both the horizontal and vertical plane. Successful performance of interdependent teams has also been identified to be critically dependent on the integration of both technical knowledge and skills and the enabling processes. As identified in this case study, simulation training provided opportunities to practise and develop a mutual adaptation and adjustment among team members in real-time to shifting demands, uncertain cues, and time compression (Salas *et al.*, 1992). Thus, it was also not surprising to find that performance expectations were also significantly linked to both learning and formal training aids (learning, $p= <.05$, $r_s= -.374$, and formal aids, $p= <.05$, $r_s= .368$). There was reliance and thus, an expectation from training to provide the formal training opportunities. As formal training aids improve and become more helpful in improving learning (such as greater time and length for individual and team simulator training and sea-trials) the more likely expected performance outcomes will be achieved. This would identify the multi-level link between training design components, expectations, and the combined achievement of both technostrutural and enabling team performance outcomes (Figure 14).

Even the emergency procedure documents were found somewhat supportive. Therefore, the formal aids negative correlation with learning was further reflected in the learning effects caused from the lack of accuracy and detail of the documents and lack of changes over successive crew training. Although changes were made to the documentation and training content over the course of successive crews training, crew twos' greater reliance on informal aids ($x^2 =16.54$, $df=4$, $p=.002$) would confirm that the changes were not considered sufficient. There was also a significant negative relationship between informal training aids and expected maintainer knowledge and skill ($p= <.05$, $r_s= -.375$). As training was not intended to provide knowledge and skill to a level to allow maintenance or problem solving, this correlation was not unexpected. However this finding suggests that even through successive training, and interventions, a multi-dimensional link exists between formal and informal training aids and expectations (Figure 14).

The technicians also found lack of experience made it more difficult to learn the emergency procedures, as the training programme did not provide systems integration knowledge. The explanation for the difficulties can be found in Duffy *et al* (Duffy & Curran, 1983) who identified that there is a different comprehension skill for documents prepared for 'reading to learn' and 'reading to do'. For performing a task (reading to do), information is gathered for immediate use and the text is simply interpreted as it pertains to the specific task. However for learning, the sentences and comments must be related and integrated with preceding text, as clarity and organisation are far more critical to comprehension.

The findings of this case study have revealed that the training programme influences that have significantly influenced learning in this complex, interdependent team training include training methods, and both formal and informal training aids, and that performance expectations were significantly linked to formal aids and learning. It can thus be seen that even within the training design there is a complex interaction of factors that influence learning and ultimate successful performance outcomes (Figure 14). Case study findings further identify the benefit of individual and team simulator training. There was a reliance on documents, although they were not as supportive as they could have been. Thus, documents for training should be prepared so that they aid in learning. The case study has also shown the benefits of interdependent team training that reflects the working platform that further includes training within the platform.

What again becomes apparent is the need for training needs analysis to first identify organisational objectives from training, and further to delineate the individual and team task components so that training can be designed to meet, and perhaps exceed higher-level objectives. These interactive training design influences that influenced both learning and subsequent performance also identify the need for further empirical research to clearly delineate the degree of influence of these factors. The findings also identify the need to further explore the level, sequencing, timing and alignment between individual and team training, for both technical and behavioural processes.

7.1.3.2.2 Further Training Design Influences

Other training factors were found to influence perceptions and expectations from training, and although they were not found to be directly linked to learning the factors are interlinked as they are part of the training design, and therefore could moderate learning and influence training outcomes. This intercorrelation was found with training content, as it significantly correlated with both formal training aids ($p= <.01$, $r_s= .440$) and training methods ($p= <.05$, $r_s= .378$). This relationship again draws attention to the perceived completeness and lack of sufficient interventions to the training curriculum, contents and documents over each crews' training, and over successive training (Figure 14). Although the trainees believed they would receive the knowledge and skill needed, the lack of feedback and confirmation of progression would significantly lower expectations from the training content, and thus there was a greater reliance on informal mechanisms. Training content expectations reflected this as there was a negative correlation with both training content and formal aids ($p= <.05$, $r_s= -.335$ and $p= <.05$, $r_s= -.354$, respectively).

As there was always an expectation from trainees that knowledge and skill would be gained as well as a capability, by whatever means, this would suggest both an individual and team confidence (Ford *et al.*, 1992). Additionally, the effort and persistence taken to assure successful outcomes, as a team, would also suggest a motivation to learn (Mathieu & Matineau, 1997) and a motivation to transfer (Noe & Schmitt, 1986). Although these attitudes were not specifically measured, the evidence for their existence is strong within this platform. There was also a strong perception of confidence held by others (Kraiger & Aguinis, 2001), but what was unique in this platform was that confidence was also required between fellow team-mates as each individual must be able to perform their duties in dealing with an emergency. Interdependent simulator and onboard system team training supported and developed this confidence, but as expectations were not seen to be met by the training platform, additional informal learning mechanisms were sought throughout successive crew training. Consequently, exploratory evidence provided in this case study would suggest that future research should explore the influence of required confidence between team members and its influence to learning and performance outcomes, especially in stressful, emergency management,. This attitude or cohesiveness could also be linked to the perceived or real risk of the working platform, or an emergency state, and thus the combined states should be studied in a realistic platform.

The trainers' and managers' view of the influence of the training content, methods and formal aids were not that of the trainees. Although their perceptions did not influence the correlation significance of the relationships, there was a significant variance in their views with either the CF managers or the RN trainers having the most opposing view to that of the trainees (training content, $x^2 = 15.58$, *df*=4, p=.004, methods, $x^2 = 18.81$, *df*=4, p=.001 and formal aids, $x^2 = 11.90$, *df*=4, p=.018). Their differences in perception are related to their knowledge of higher-level planning and preparations for the training platform. Their perception of training content completeness was based upon the expected success of the entire programme, while their view of the value of the formal training aids was based upon the objective of the programme and the belief that the prerequisites were sufficient. The differing opinion that methods were in place to test and confirm knowledge and skill, specifically for the trainees, was likely based upon the belief that the historical methods of achieving the aim would be successful.

Intervention capabilities in the form of providing changes to the training content and training aids would alter the training platform and therefore, although not directly, influence the potential to learn. Again there was a common theme and an integrative influence, as training content intervention negatively correlated with both training content (p= <.01, r_s= -.424) and formal training aids (p= <.01, r_s= -.443) (Figure 14). These findings were not surprising considering the deficiencies in the training programme. Part of the dissatisfaction with the programme, was although changes could be suggested, and were strongly supported, the implementation of the changes was usually not seen during a crews' training. Informal changes were made to emergency procedures, but formal document and content changes required a lengthy formal approval process. The informal changes made by the RN trainers when suggestions were made, was not a requirement. Therefore, one could conclude that RN trainees provided a facilitating climate for learning. Also, capability to provide changes and the belief that suggestions are considered could also moderate the motivation of individuals to learn, as trainees' interactions with others will likely influence their motivation (Mathieu & Matineau, 1997). It has also been reported that pre-training participation is related to trainee motivation when participative input was reflected in the training received (Baldwin & Magjuka, 1997). The findings suggest that participation and reflection of input would also apply during training, thus suggesting a further motivational influence for the trainees. However, rather than detracting from motivation, as seen by Baldwin and Magjuka (1997), trainees were more motivated and chose additional avenues to support the achievement of performance outcomes. Thus, the findings have confirmed that opportunities to provide changes to the training programme and the implementation of those changes influences the training design, but opportunity to provide changes can also be presumed to have moderated the attitudes and beliefs of those attending training.

Instructor characteristics were also looked at to identify the perceived capability of the instructors, both military and contractors, and their ability to pass on knowledge and skill based on their prior training and preparation. Although instructor characteristics was also not linked to learning perceptions, their capability, instructional style and even their personality characteristics can influence the perceptions of trainees and the outcomes from training. Although trainees were not aware of all the preparation and planning of the training programme prior to its initiation, it is still likely that preconceived notions of capabilities, and thus expectations, were made prior to initiating training. This initial perception and resulting expectation would set the tone, as motivation to learn and receptivity to training content has been found to be a function of identification with and respect for the instructor (Kraiger & Aguinis, 2001).

However, the perceptions of the instructors' capability over the course of the training programme was not equal between the RN trainers and the contractors, and the opinions varied significantly among the various groups and between crews (x^2 =11.63, *df*=4, p=.020). It was the CF managers then the RN trainers who indicated the instructors' developmental change over time had the least detrimental impact, as they believed the instructors had the capability from the beginning. The trainees also agreed that the knowledge and skill of the RN trainers had progressed over time, but felt there was very little growth from the contract instructors. They also perceived that the contract instructors were not receptive to suggestions of change, nor implemented any changes. This was not found to be the case, but findings would project that the lack of perceived support from the contract trainers moderated the trainees' view of the capability of these instructors. A possible explanation can be found with Kraiger and Aguinis (2001) who suggest that social categorisation processes may influence trainees' perceptions of the credibility of the trainer and relevance of the training material. They indicate the bias can be based on whether the trainer comes from outside the organisation or has not held the same job as the trainee. This perception could have moderated the view of trainees, but as the RN trainers reviewed all of the contractors' lectures and all course critiques, this bias of credibility to a select group is not substantiated. However, the historical review of the training preparation identified, that beyond lapse of experience with this working platform, criteria were not specified for training content or level of capability required for instructors. There was also no outside body with the knowledge and skill to judge the accuracy of completeness of documents, or the capability of the instructors. Although the RN trainers took on a greater role in developing currency of their knowledge and skill, the level of expertise of all of the instructors was not known. This was not considered in developing the training programme. It was also not considered an issue during training by the managers or trainers as there was a training philosophy and cultural behaviour common to both nations that accepted and expected informal mechanisms to assist in learning and dealing with deficiencies in capability.

The trainees did however have strong views of the lack of improvement of the training programme over time to deal with the deficiencies, and placed this blame on the instructors who they believed had the responsibility to make the changes. Successive crews thought the training programme changes should have been implemented at this point in the training programme. As such, although it was not perceived as the most effective method of learning or clarifying what was learned, successive crews continued to rely upon informal mechanisms within and between crews to retrieve and clarify information. Consequently, there was a significant influence between instructor characteristics and training content ($p= <.01$, $r_s= .442$) and a negative correlation was found with informal aids ($p= <.01$, $r_s= -.397$) (Figure 14).

Although only exploratory in nature, the link between these factors would suggest that perceptions and expectations from the training design have impacted not only a judgement of the effectiveness of training-related processes, but also based upon the perceived capability to deliver expected performance outcomes, a judgement of the effectiveness of training was transferred, by some trainees, onto the instructor (Kraiger & Aguinis, 2001). Although this case study did not directly measure the capability of the instructors, from a training effectiveness point of view, it can again be seen that there is a complex interaction between the training design factors, attitudes and behaviours of all those involved in the programme that interactively impacts learning and the achievement of performance outcomes.

7.1.3.3 Organisational Influences

Research and modelling has sufficiently established the knowledge that group and organisational factors have direct and moderating effects on individual learning and transfer (Kozlowski *et al.*, 2000; Kraiger & Aguinis, 2001; Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992). Furthermore, the multilevel model proposed by Kozlowski and Salas (1997) has expanded upon the traditional individual, horizontal transfer focus to identify a multilevel approach to training effectiveness that addresses the vertical, horizontal and top-down organisational links within an organisational system. This dissertation has shown that Kozlowski and Salas' (1997) model can be an effective training tool to support design and delivery for interdependent teams in the horizontal and vertical plane. However, to broaden the scope of the factors that have the potential to impact the success of interdependent teams and vertical transfer, it is of value to discuss the organisational influences that have influenced this case study training design and training platform. Discussion of the influences from the organisation downward through to the individual will also provide further empirical support of Kozlowski and Salas' (1997) model as a framework for use in design and delivery considerations for interdependent team vertical transfer.

There were many organisational factors that were repeatedly identified during this case study. Although not specifically measured for their influence, case study findings strongly suggest that organisational factors moderated training effectiveness. One of the key organisational influences found in this case study was that the goal of training was not specific and the meaning was not clearly communicated to the trainees. This resulted in trainees' interpretation of the training goal that was much broader than that intended, which then also created an expectation from training that was inconsistent with the training goal (Figure 14). Consequently, the misinterpretation created considerable uncertainty for the trainees of how this training content and objectives would contribute to the perceived future needs of the organisation (Hall (1984) cited in Baldwin & Magjuka, 1997), and what they would receive from training in order to successfully meet those needs. Interviews identified that the misinterpretation of the training goal, which was most profound for the technicians, further cascaded into perceptions that the training content would not meet the performance outcome expectations. This perception was seen in the finding that maintainer performance knowledge and skill expectations were not met from this training platform, for all successive crews. The lowered expectation was solely seen from technicians, operators also felt the training content was not sufficient, although not to the same degree. However, trainees were not deterred, as they perceived a greater level of knowledge was needed to achieve performance outcomes in the new working platform.

From interview corroboration it can be seen that the drive to seek information informally was further fuelled by the cultural training philosophy, by both nations, that supported and endorsed this mechanism for learning (Figure 14). Although there were identified deficiencies in the training platform (*e.g.*, lack of expertise of instructors, incomplete state of supporting documents, no feedback, and operations focus), rather than succumb to the barriers and limits of the training platform all trainees accepted that the training platform would not meet expectations and informal mechanisms of learning were sought as compensation. Thus, this misinterpretation of what the training programme was expected to provide resulted in informal methods of learning with no confirmation of suitability or accuracy. The literature suggests this may have resulted in unnecessary efforts for what was thought to be important (Chao, 1997).

However, as the findings have identified, those with more experience supported and mentored those with less experience. In later crew training, those who had completed the training supported learning to those still in training. This would have somewhat controlled unnecessary efforts, but as identified in the post training lessons learned meeting, deficiencies in meeting capabilities were identified (*e.g.*, need to improve the overall operator skills of the crews prior to the conduct of sea-trials), and training courses were identified as deficient, not applicable to the platform, or not supplied but there was a requirement. Although some of these deficiencies were corrected, it was not possible to address all of the training deficiencies as the RN controlled the training and the contract limitations would not permit changes in the timeframe allocated. This would have further fuelled an informal drive to achieve the observed deficiencies, but the efforts would have been more focused. Thus, these findings would add to the literature that not only have team leaders shaped the degree of transfer through informal reinforcement (Cannon-Bowers & Salas, 1997a; Smith-Jentsch *et al.*, 2001), in an environment where the risk is very high, the inherent leadership philosophy within the working platform instils a supportive network whereby all members are driven to assure performance capability from all crewmembers.

Although it cannot be confirmed from this research, it is worth considering that although there was a supportive climate to encourage learning, the acceptance, endorsement, and support to informal learning could have impeded the belief and desire for changes that could have improved the training programme. Also, the leadership philosophy to deal with individual shortcomings within the working platform, whether identified in training or otherwise, could also have influenced the organisation's expectation and satisfaction with training. Thus, the combined leadership and training philosophy intrinsic in the working environment of both nations together could have further discouraged any changes that might have been considered important without them.

Thus, findings would suggest that organisational goals, leadership and training philosophy have moderated both learning and training effectiveness. Also, findings would further suggest that policies, procedures and directives, and common practices from the host-training nation greatly influenced the training design and delivery, which then influenced and directed the behaviours and attitudes of the trainees. It could again be seen that although only influences from the training platform were assessed in this case study, findings would suggest that many different organisational factors in combination have additionally influenced training effectiveness (Figure 14). The organisational influences identified would further suggest that there is a cumulative effect from these influences that have directly effected training, but they have also moderated individual perceptions and expectations. In short, organisational influences have influenced training effectiveness. It is important to therefore consider and address organisational factors and their direct and moderating influence on interdependent team performance outcomes meeting organisational objectives. These exploratory results have shown that Kozlowski and Salas' (1997) framework can be used to guide design and delivery of training to identify the potential organisational technostructural and enabling influences that may impact training effectiveness (Figure 13).

7.1.4 Summary

In investigating the influences within an organisation's training programme to achieve interdependent team vertical transfer, the findings have shown that multiple factors from the individual, organisation, working platform and training design that have influenced individual learning and vertical transfer are really no different than those that have been previously identified (although either singly or with few combinations) on individual learning and outcomes (Kozlowski *et al.*, 2000; Kraiger & Aguinis, 2001; Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992). The findings have further shown that multiple factors and cumulative events prior to training (*i.e.*, individual, organisational, and situational) will influence training design and subsequently training effectiveness. This case study would coincide with the assumptions made by Baldwin and Magjuka (1997) that all things are not equal between trainees (*e.g.*, experience) and that organisational contextual factors have a significant influence on a training programme design and delivery. Situational factors also played a significant part in pre-training influences to training design.

This case study has also identified that various factors within the training platform have influenced interdependent team learning and performance outcomes, to include the training content, methods, formal training tools, and instructor capabilities. These training programme elements were seen to have a cumulative effect on training effectiveness. However, the effectiveness of training was also seen to be moderated by the perceptions of the organisational climate (Noe *et al.*, 1997; Rouiller & Goldstein, 1993), policies and practices for training, and leadership and training philosophies. The significant degree of informal peer, subordinate, supervisor and instructor support also played an important part in the perceived degree of influence of the training programme, as does the informal mechanisms to gain knowledge. This support was to be important and necessary for learning and performance in the working environment of interdependent teams.

Thus, this empirical case study has demonstrated that real-world training presents a very complex mix of factors that influences training effectiveness. The empirical findings from this research have also identified that training effectiveness is truly multilevel in that it spans downward from an organisation, upward through the team to an organisation and across individuals and time. The findings further suggest that various components within the training programme were considered to have more of an effect on training than others (*i.e.*, significant positive influence of formal tools, significant negative influence of lack of feedback). This would also suggest that further empirical research is needed to explore not just the multilevel influences on training effectiveness, there is a further need to explore the cumulative effect of the multilevel influences and how that impacts those involved in the training process.

7.2 Organisational Effectiveness

The impetus for training for the Canadian Navy was the move to a new and somewhat similar platform that required each member of the team with unique skills and roles to perform effectively as an individual. These individuals must also integrate their duties and interact to effectively operate the working platform, and when necessary, effectively and accurately perform emergency procedures to ensure the safety of the crew and the submarine. The consequence of not achieving performance outcomes could be disastrous. Although the interdependent team members had prior experience, this new platform required additional knowledge and skills to effectively perform the duties. Therefore, there was a collective requirement and expectancy that training outcomes would provide the knowledge and skills necessary to successfully perform in the new working platform.

The detailed HTA identified that specific and unique skill-set contributions were required by individuals to collectively and cooperatively be able to functionally operate the submarine and to perform the emergency procedures. The achievement of these skill-sets from the training programme, albeit unconventionally provided team members both a capability to perform emergency procedures and a capability to functionally operate the submarine, thereby supporting higher-level operational functions. The achievement of interdependent performance outcomes and the indication of interdependent team skill requirements from the task analysis have revealed that individual outcomes emerged upward through teams to achieve performance objectives from the organisation. However, significant questionnaire findings, corroborated with interviews, have further identified that the success of vertical transfer in this working platform relied not only on an individual skill-set outcome for interdependent team emergency management. The findings have shown that a complex integration of multilevel influences, as that suggested by Kozlowski and Salas's (1997) multilevel framework, collectively influenced training effectiveness and the achievement of vertical transfer, that together identify that organisational effectiveness was achieved.

It has been identified that a complex interaction of training effectiveness factors within the training platform has influenced training effectiveness and performance outcomes. Trainees could have accepted the status quo from the training platform, but the duties within the platform require unquestionable confidence from all team members that each member is capable of performing their assigned duties. Thus, although there were many challenges, difficulties and shortcomings in this training programme, the underlying achievement of organisational effectiveness can be related to the perceptions, expectations and satisfaction from this training platform derived from the powerful influence of the inherent risk of the working platform. The outcome from this was a drive and persistence to achieve the perceived knowledge and skill requirements to effectively perform their duties in new working platform.

As identified by the significant relationship between informal training aids with learning and expectations for maintainer knowledge and skill, there was a lack in confidence of the knowledge and skills that would be obtained formally through training to achieve the expected capability to perform the duties. Rather than develop a negative expectation of their capacity to perform, measures were taken by the trainees through informal mechanisms to retrieve, distribute and support the achievement of performance outcomes. Examples of their efforts to gain greater knowledge and skills include their seeking out contractors who had installed the systems; countless hours spent in the platform understanding the systems; searches through all available documents; contacting manufacturers; and, asking for more courses and time in the simulators which was implemented for successive crews. Also, the continued reliance on informal mechanisms was present for all successive crews' training, and those who had completed the training supported those still in training.

There also remained a reliance on formal training aids, but although beneficial it was not found to be sufficient, as seen by the common correlation between formal aids with content and performance expectations. Insufficient knowledge and skills provided by the training platform, specifically, the formal training aids, were not helpful enough in learning to meet performance expectations. One can conclude then that to achieve the expected capability, there had to be a global commitment from all trainees within and between crews.

Therefore, the intervention measures taken by individuals upward through the team, and across teams, have resulted in greater knowledge and skill than that provided or intended from the training platform. Conclusions can be drawn from this exploratory case study that the efforts by individuals upward through to teams, and across teams has enhanced training performance outcomes. Albeit unstructured, this approach and effort resulted in performance capabilities that were greater than what would have been provided solely from the original training platform. Therefore, there was an impact to organisational effectiveness. Furthermore, these complex multilevel influences within this training programme were proven to be effective (although sub-optimised) and have impacted the greater effectiveness of training and the outcomes from training. Therefore, one could conclude from this case study that training effectiveness is linked to organisational effectiveness.

8.0 Study Strengths, Limitations, Future Research and Conclusions

8.1 Study Strengths and Limitations

Strengths

This case study pioneered a unique approach to broaden the scope of multilevel approaches to training effectiveness by examining the links between individual through to team influences; learning; training outcomes; and, organisational effectiveness.

This approach was made possible because the research was performed while an organisation conducted training for complete crews, of various experiences and occupations, to learn the performance of safety-critical operations for a new working platform. The benefits to this approach were that research was conducted as training proceeded naturally, and training was linked and integral to organisational objectives. This training procedure allowed the influences that an organisation can exert in design and delivery of training to be readily observed. This training platform also provided the opportunity to examine the combined influences that the organisation, individual, training programme and situational variables from pre-training through to training contributes and influences training effectiveness across multi-levels. The case study has addressed past concerns that training effectiveness research has only focused on selective influencing factors and the complexity of tasks studied have not been representative of an organisation (Baldwin & Ford, 1988; Ford & Weissbein, 1997). Further historical criticisms and limits of the value of past training effectiveness research were also addressed as this research could incorporate training as a multilevel system embedded in an organisational context (Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997; Tannenbaum & Yukl, 1992). This case study was also able to observe and examine individual and team simulator training as it occurred. Thus, detailed observations of the training regime were possible, rather than making determinations from only self-reporting measures.

Limitations

Several limitations were present in this case study that constrain the conclusions that can be drawn. Although conducting research while an organisation performs training is a plus in many respects, this research could not interfere with the conduct of the training process or impose any perceptions that might influence outcomes. Thus, the protocol design was restricted, and many of the variables known to influence training effectiveness (*e.g.*, attitude and behavioural variables) could not be included in this work. Pre-training perceptions could only be identified from managers and trainers to avoid the potential development of negative perceptions of the value of training or the capability of the instructors. For greater weight of the conclusions drawn from this study it would have been preferable to distribute the pre-training questions to all involved, but this was not possible because distribution of some of the questions to trainees could have altered the perception of the value of the training programme. Further, assessment of the constraints and perceptions of the organisation was not possible as this could again undermine the value of training. Although a great deal of data was obtained for the historical background, the RN trainers and Canadian Navy management provided this information, along with its own institutional biases.

Distribution of questionnaires and conduct of interviews with the various groups (*e.g.*, managers, trainers and the three crews) over a period of time could be considered a limitation as this time lag could have altered perceptions of intervention changes that should or could be implemented. However, as crew one had completed all portions of training when interviewed, and all members of the crew were interviewed within a period of two days, the skewing of results from discussions or pressures from other members in this crew is therefore unlikely. This data was therefore used as the baseline conditions of the original state of the training programme. Interviews have identified that individuals actively sought information from crews who had already had the training and had participated in this research. Therefore, interviews and questionnaires could have prompted perceptions of training and the need for change. However, as the questions only related to the perceptions of the effect of the programme to learning or performance; significance of the various training programme support in achieving that aim; and, the current state and changes to the training programme, this study did not reveal any concepts or perceptions that were not already present. This can be said with some confidence as the training programme was receptive to review any suggestions for changes, and the post lessons learned meeting from crew one identified and collated the concerns and deficiencies in the training platform (Detachment, 2001).

As this research was conducted during successive training of four crews, at various stages of training, pre- and post-testing were not possible, nor was this study able to complete testing at the same completion phase for each of the three crews examined. The availability of the participants during this training controlled the timing of the interviews. It was not considered desirable to distribute the questionnaires without the researcher present, as skewing, or group consensus responses were likely to result. Although data collection over a period of time can be considered a limitation, the information gathered and the conclusions drawn were able to sufficiently identify the perceived effectiveness of the training and the effects to perceptions and expectations from training interventions. Also, no performance measures could be taken or obtained to identify the degree of progress made from this training (beyond the indication of a pass), or the measurement of the true success of this training to achieve the expected transfer outcomes. As all contributing influencing factors could not be measured (*e.g.*, organisational factors and individual characteristics), erroneous conclusions would have been made to attribute the influence of performance solely on those factors examined. As the objective of this thesis was to provide empirical evidence to identify interdependent team vertical transfer and the multilevel training effectiveness factors that could impact outcomes, performance measures would not have added greater value to the outcomes of this thesis. Although the only real performance measure was that the submarines sailed safely and intact to Canada. Another unexpected performance measure was the effective transfer of training that occurred among crews, and among crewmembers of various experience. It is the depth and accuracy of what was learned informally that is of question

There were also potential measurement limitations within this case study. This case study had limitations in the statistical analysis that was possible because of the small sample population size (maximum 42 participants of a possible 71). Thus, although there were sufficient numbers to proximate a normal distribution, power was considered insufficient to perform parametric statistics. However, non-parametric tests did provide the association between influencing factors and the association between groups (Shavelson, 1988). Also due to the low power, reliability testing of the questions was not possible. Although questions were tailored for the unique training environment, questions were circulated prior to their use within academia and within the Canadian Navy non-involved personnel to identify relevancy, clarity, detail, and completeness (J. R. Wilson, 1998).

8.2 Future Research Recommendations

1. One of the key future recommendations that has been identified in this case study is that organisations need to understand the relevance and value of training effectiveness research. More importantly they also need to understand the practical implications and benefits that can be achieved from research findings and models developed for training effectiveness design and delivery. Reciprocally, greater empirical research needs to be performed to understand operational problems and the training approaches taken, to link research to practice. These case study findings emphasise the importance for future training research to identify and explain the implications of multilevel influences to training effectiveness and how that can be applied in training practice (Salas, Cannon-Bowers, & Blickensderfer, 1997).
2. The findings from this case study have also identified the importance of further empirical research that takes into account real-world training and all of the multiple influences that could impact the achievement of interdependent team vertical transfer. This research has determined that training is bound by organisations' objectives, and individual outcomes: emerge upward through the

team to the organisation. Thus, training effectiveness is not based on individual outcomes rather they emerge upward to effect an organisation (Kozlowski *et al.*, 2000; Kozlowski & Salas, 1997). If future research is to aid organisations in achieving organisational effectiveness, efforts need to expand beyond an individual level orientation of training and broaden the approach to consider training as a system within an organisation (Kozlowski & Salas, 1997) and include all of the multi-levels of influences that can impact its success.

The research from this case study has identified and confirmed at a cursory level that Kozlowski and Salas' (1997) multilevel model framework will aid in the design and delivery of interdependent team training, and will provide even greater support with the inclusion of more defined teamwork and task work competencies (Cannon-Bowers & Salas, 1997b; Cannon-Bowers *et al.*, 1995). As this research was exploratory it broadly identified how, where and when to deliver training and gaps in models to support interdependent team vertical transfer. Research is still needed to further detail the requirements for a supportive model to aid in emergency management. For instance, this case study has shown that both the technical knowledge and skills and the enabling behavioural skills must both be provided together for effective performance, and individual skill proficiency is necessary prior to team delivery. This was identified through deficiencies however and not level of performance. To further validate Kozlowski and Salas' (1997) multilevel model further research is needed to identify what is the optimum sequence, timing and allocation of training between individuals and teams. When should the technical and enabling components be delivered? In developing the answer to these questions, determining the acceptable performance level would seem to be the way to proceed. Risk analysis of error would also assist in determining the level of skill proficiency required.

Therefore, in environments where the consequence of lack of ability or error could be disastrous, at what level of skill is the team and individual considered proficient? Guidance in performance outcomes for behaviour can be given by theories that pose there are three stages of skill level: initial skill acquisition (novice rudimentary skills); skill composition (advanced skill); and, skill automaticity or mastery (Yelon & Ford, 1999) that encompasses situational awareness, prioritisation and implementation of task strategies (Kozlowski, Toney *et al.*, 2001).

3. This case study's findings have identified that a complex mix of factors and cumulative events prior to training (*i.e.*, individual, organisational, and situational) have influenced the training design, which has impacted training effectiveness. Although, organisational situational factors (*e.g.,* leadership and training philosophy) greatly impacted the design of this training programme, their influence was still seen during training. Taking into consideration the impact of the pre-training influences, the insignificant findings are likely due to the low number of respondents. Thus, further research is needed to measure the pre-training and training influence of organisational constructs within a multilevel approach to identify the influence of such things as workplace culture, leadership, and training philosophy on training effectiveness. The impact from these organisational constructs also influenced the behaviours and attitudes of the trainees. Although behaviours and attitudes were not measured in this case study, it can be assumed with some confidence that the inherent risk of the working platform created a motivation and commitment to achieve performance outcomes. This assumption was clear in the dedicated informal efforts by all crewmembers, within and between submarines to support and assure performance outcomes would be achieved. Confidence would also come into play in the scenario, as the working platform requires each crewmember to have complete confidence that members can perform their respective duties. Interdependent teams could also influence this interrelationship of attitudes and behaviours. Thus, further research should explore if work related attitudes (*e.g.*, commitment) of interdependent teams alters training effectiveness.

Additionally, case study findings have identified that various components within the training programme were considered to have more of an effect on training outcomes than others (*e.g.*, because there are likely more components than those shown here). This finding was likely again related to the pre-training and training leadership and training philosophy. Moreover, there was likely a cumulative effect from the various multilevel factors on learning and performance, but to what degree has this influenced training effectiveness and training outcomes? Leadership influences and training philosophies, practices and procedures are present in any organisation. Thus, future research should also explore if there is a difference in the perception of importance of training between managers, instructors and trainees, and what influence this difference has on training effectiveness. Will the characteristics composition of an interdependent team (*e.g.*, their occupation, hierarchy of importance, and individual characteristics) be influenced or counteracted by these them? Answers to these questions provide practical relevance to research. These answers and their implications will allow research to be incorporated into training practice.

4. Another key finding from this case study was the presumption of the suitability of the pre-requisites for this training. This presumption, in part determined the training content, but there was also a significant follow-on effect to the trainees in learning. The distinct system and function differences between the two working platforms required different actions, especially for the technicians. The new working platform also merged the duties that were performed by two occupations in the prior working platform into one. Although this pre-requisite is not solely responsible for the sub-optimal training effectiveness, prior consideration of a detailed needs assessment would have identified the details of what should be trained, why, and who should be trained for performance of the operational duties. These findings have identified the importance of a traditional needs assessment, but as well, team-task analysis would also be required prior to designing and initiating a training programme (Bowers *et al.*, 1995; Kozlowski *et al.*, 2000). Although team performance models and team-driven performance strategies have begun to address these issues, further research and empirical evidence are still needed to address specific team skill-set requirements, and how, when, how long, and whom should be trained for training to be effective.

Informal mechanisms for learning also played a significant part in this training platform. The informal support network between trainees was considered very beneficial for the team in performance of their duties as the experienced supported and balanced the weak. However, this case study's lead to speculation as to speculate whether sufficient and accurate individual knowledge was obtained through informal mechanisms that were not tested. It also questions whether this informal mechanism to learn would have been required had the presumptions of pre-requisite training been different. To answer these questions further research should explore the pre-training categories that can impact training effectiveness. Specifically, further research is needed to identify what an individual brings to training and how and what variables and techniques combine and emerge in interdependent teams to learn and how training can maximise learning.

8.3 Conclusions

In summary, this case study has provided the empirical evidence to support the theories of interdependent team vertical transfer and the link between training effectiveness and organisational effectiveness. This empirical case study has shown that interdependent team training to achieve vertical transfer was influenced by a multitude of factors and cumulative events that occurred prior to training and during training. It was also determined that influences to training effectiveness were exerted from multilevels. Although this case study has identified multilevel influences and interactions that can have an effect on both horizontal and vertical transfer, further research is still necessary to expand on this foundation. In particular, the model proposed for use in this exploratory research needs much development and expansion to support interdependent team training design and delivery. What has become evident from this body of work is the need to employ a multilevel approach when designing training or performing research to examine training effectiveness. It is anticipated that the findings of this study will enrich existing training programmes and result in improved vertical transfer knowledge.

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21 October 1999

Distribution List

PROPOSAL FOR HUMAN FACTORS REVIEW AND ASSESSMENT OF CURRENT SUBMARINE EMERGENCY PROCEDURES

Reference: A. Email, Col D. Salisbury, CO CFEME, MAO-Bio OSS Sponsor /Capt Y. Severs, U of Loughborough (ATL), 17 Sept 99
B. Telecon, LCdr D. Davis, Sub Advisor, CDLS London / Capt Y. Severs, U of Loughborough (ATL), 7 October 99

1. As a BioScience officer in the CF, I have done considerable work in the field of Occupational Health and Safety (OHS) identifying hazardous environments and producing strategies to prevent or reduce risks to operator health and safety by developing policies, recommending changes to SOPs, and training. I believe we can further expand the provision of operator health and safety through the proactive assessment of the interactions between man, machinery, and the environment to produce optimal system performance and efficient use of manpower, resulting in the desired CF goal, effective operations.

2. I am currently on PG training to complete a PhD in the field of Ergonomics, and would like to continue research in the field of OHS, specifically dealing with issues of health and safety in a submarine. In an effort to continue the pursuit to support and augment operations I would like to take advantage of the unique and rare combination of current circumstances. Canada is about to bring a new class of submarines into the CF; submariners are currently training in the UK; and, there is an opportunity to determine if current training and procedures ensure personnel can effectively operate the submarine and achieve desired outcomes.

3. Aware of the time-line constraints and training requirements, the enormity of reviewing all systems and tasks would be impossible to complete under these circumstances at this time. Thus, in an endeavour to ensure optimum system reliability, efficiency, and safety when critical, I propose at this time a study to ergonomically review and assess the current emergency procedures. To determine if the procedures effectively allow personnel to continue to carry out there tasks as intended and trained.

4. An evaluation of the demands of the submarine on the operator with the capability of the submariner would identify Human Factor issues that are affecting or could affect the safety or operational effectiveness of our submarine fleet, and if required, provide solutions to alleviate these factors. A task analysis process would examine all emergency tasks and evaluate the influence of system design, submariners' limitations (physical and cognitive), and environmental constraints to determine if alterations could be made to improve procedures and/or training to reduce the risk of human operator error.

5. Laboratory simulation of events in a submarine is not ideal, as an accurate assessment of procedures requires evaluation of all coexisting mitigating factors

(systems, submariners, and environment), which cannot truly be recreated. Consequently, it is proposed that following familiarization with training, documentation and procedures the following protocol and access requirements are suggested:

a) Describe in detail all emergency tasks as directly observed from personnel, based upon desired goal, resources, constraints and preferences.
   Access: During training, Observation, Walk-through/Talk-through tasks

b) Examine training and identify influencing factors, to compare capability with expectations.
   Access: During training, Observation, Questionnaire

c) Compare and examine training with task descriptions and personnel performance results
   Access: No access to submarine or personnel required

d) If necessary, rectify problems, adjustment of standard, training recommendations, job aids.
   Access: No access to submarine required

e) Personnel performance check against recommended changes (i.e new version of standard) to confirm acceptability.
   Access: Training and/or Sea-trials, Observation, Questionnaire

6. I would like to reassure you that the proposed study will not interfere with the regular scheduled events of training, nor will it affect the scheduled time-line of expected sea-trials. To ensure this is achieved, prior to initiation of study, I will liase directly with submarine advisor CDLS London, and as so directed appropriate support staff, to determine a suitable schedule, and access to needed documentation.

7. Proactive application of Human Factors principles to emergency procedures prior to commissioning of the fleet can remedy inefficient interactions before they become ingrained, and from the outset optimise individual and overall system performance as well as advocating and promoting health and safety.

I therefore request this proposal be given reasonable consideration and endorsement

Y.D. Severs, CD, MSc
Captain
Research Student
for
Director Human Sciences
Loughborough University

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Informed Consent Form Appendix B

As I'm sure you are aware I am currently in the United Kingdom doing a PhD in Ergonomics. My research involves the potential performance effects of Canadian Forces submariners' integration to a new class of submarine. Specifically, my interest lies in what knowledge and skill is needed to perform complex, team-oriented tasks in the new working platform, the value of the training platform, and what support and value interaction with other individuals (co-workers, and trainers) and resources assists in performing or enhancing those duties. My eventual aim is to provide guidance for the development of tools, which will aid learning and subsequent job performance.

In order to ensure the research accurately reflects conditions and identifies the needs of submariners, I am interviewing Canadian submariners and those directly involved in the training process (Royal Navy Trainers (UTT), BAE contract team members, and Canadian Upholder management team). This questionnaire and interview will provide you the opportunity to voice how you feel the process/training has affected submariners' ability to perform their duties, to identify interactions that have been supportive and as well, the opportunity to express your opinions on what improvements you think can be made.

During this interview to ensure there are no misinterpretations, and so comparisons can be made with other interviewees, I would like your permission to record the interview and to ask if you would occasionally indicate on the papers provided the degree of your reaction to specific questions. I can assure you that your identity and all information supplied in this interview will be treated confidentially, and used solely for this study. The personal details provided will only be used to identify and categorize responses to determine if specific groups have a unique view or requirements.

Before you begin I would like to thank you for your participation. You will be supporting me in the short term to complete my PhD and, I hope, in the long term your candour will identify means of easing learning and enhancing the influences training can support operations to the Canadian Navy.

Sincerely,

Yvonne Severs, CD, MSc
Captain

I freely give consent to participate in this investigation

____

Print Name Provide Signature Date

Questionnaire, Interview Questions and Category Divisions[4]

Appendix C

Please indicate your name; rank; occupation;

1. Years of military service;
2. Highest level of education;
3. Years qualified as a submariner;
4. Years of operational experience on submarines; and on which class,
5. Years lapsed in submarine experience.

Collated Questionnaire and Interview Questions for Management and Trainers

Responses unless identified otherwise were to the Likert scale of 1-5 (1= strongly agreed, agreed, neutral, disagreed, to strongly disagreed).

6. While the RN was actively serving on the Upholder class submarine do you know if you/they were provided with the training needed to perform the required duties? Interview question: Explain.
7. Do you think the documents provided were an aid to learning the required duties?
8. Once the RN was notified they would be training the CF, do you/they know if the RN trainers had the knowledge and skill necessary to train the CF to operate the Upholder submarine, specifically, emergency procedures? Interview question: Explain what was missing.
9. Once the RN was notified they would be training the CF, do you/they know if Flagship had the knowledge and skill necessary to train the CF to operate the Upholder submarine, specifically, emergency procedures? Interview question: Explain what was missing.
10. Do you know if the trainers received any guidance regarding how the training programme should be set up (Entirely, Some, Barely, Not at all) Interview question: If so, what information, and from who (*i.e.* content, form, style, length)?
11. Do you know if the trainers received any guidance regarding the training syllabus content (Entirely, Some, Barely, Not at all)?
12. Do you know if the trainers received any guidance regarding required depth of subject matter (Entirely, Some, Barely, Not at all)?
13. Do you know if the trainers received any guidance on the standards for assessment of knowledge and skill? (Entirely, Some, Barely, Not at all)?
14. Did the lapse in active service onboard the Upholder class submarine have an influence on your/their ability to recall what was previously learned?
15. Did the lapse in active service onboard the Upholder class submarine have an influence on your/their ability to train? Interview question: What operational and

[4] This appendix is a collation of the questionnaire and interview questions provided to all groups in this case study. When distributing questionnaires, each group or individual were provided with the questions appropriate for the group. The sentence structure was also changed, if necessary, to reflect the group and phase of training. To control for misinterpretation and thus contamination of data, each distinct question was placed on a separate page. Simultaneous interviews with questionnaire completion provided respondents an opportunity to expand upon responses, and also provided the researcher an opportunity to tease out the reason for the response. Any reference of you/they or a slash in this appendix is only present to identify the sentence structure change for a particular group (*i.e.*, you/they refers to RN trainers with you and CF managers with they).

training knowledge and ability was required of the RN trainers and Flagship, and what level of expertise was expected?

16. Did the lapse in active service onboard the Upholder class submarine have an influence on the RN trainers' ability to assess the trainees for knowledge and skill?
17. Did the original documentation assist the RN trainers in retrieving the information needed? Interview question: Why?
18. Did the training simulator provide assistance? Interview question: Why? Was it used to upgrade/retrain?
19. Did access to the Upholder class submarine provide any assistance to the RN trainers? Interview question: Why?
20. Did the RN trainers use any other method to extend their knowledge and skill other than what was originally provided when the Upholder was in active service? Interview question: from what or whom? Interview question: Why?
21. Did Flagship use any other method to extend their knowledge and skill other than what was originally provided when the Upholder was in active service? Interview question: from what or whom? Interview question: Why?
22. At the time that training began, do you believe the RN trainers had the level of knowledge and skill to train and assess the CF? Interview question: If not, how did you believe they compensated?
23. At the time that training began, do you believe Flagship had the level of knowledge and skill to train and assess the CF? Interview question: If not, how did you believe they compensated?

Collated Training Questionnaire and Interview Questions Provided to RN Trainers, CF Management and CF Trainees

24. Do you believe the CF submariners have formally received and retained the set out knowledge and skills to perform emergency operating procedures based upon the formal training to date? Interview question: If not, identify what was missing.
25. Will the CF submariners have the knowledge and skills to perform the set out emergency tasks on completion of training/sea-trials? Interview expansion: To what level?
26. Did you find the Emergency Operating Procedure document, in its current format, aided the CF trainees in learning? Interview question: Were they complete, or was it necessary to refer to other documents (*e.g.*, SOPs, technical documents) in order to learn and memorize each procedure?
27. Did the original technical specifications aid in the CF trainees in their studies? Interview question: Did you find the content, format and style was helpful in aiding learning of Upholder systems? Were they complete?
28. Did individual simulator training assist the CF submariners in learning? Interview question: Was it of value? Interview question: Why?
29. Did team simulator training assist the CF submariners in learning? Was it of value? Interview question: Why?
30. Did access to the Upholder class submarine assist the CF submariners in learning? Interview question: How and why?
31. Did the CF submariners use any other method to extend their knowledge and skill other than that provided formally in the training platform (*e.g.*, informal aids)? Interview question: Did they need to, how did they know or recognize what was missing, what specific information was sought, and where did they get it from?
32. Were the training material and lectures and contents in all documentation accurate, and were the display consoles and the training simulator a true reflection of the

submarine at the onset of training? Interview question: Was the training a reflection of the tasks and working platform? Are there significant differences between submarines?

33. Has the training curriculum changed since the CF training programme initiated? (Entirely, Some, Barely, Not at all) Interview question: If so what, do you know why, and by whom? Are there significant differences between crew one's training, as a pilot course, and subsequent crew training?
34. Has the training content changed since the CF training programme initiated? (Entirely, Some, Barely, Not at all) Interview question: If so what, do you know why, and by whom? Are there significant differences between crew one's training, as a pilot course, and subsequent crew training?
35. Has the training supporting documentation changed since the CF training programme initiated? (Entirely, Some, Barely, Not at all) Interview question: If so what, do you know why, and by whom? Are there significant differences between crew one's training, as a pilot course, and subsequent crew training?
36. Has the accuracy of the training material, lectures, documentation, and accuracy and reflection of the simulators affected your ability to learn? Interview question: Has the training programme changed to be more reflective of the working platform?
37. Has the training curriculum changed since the CF training programme was initiated?
38. Has the course content changed since the CF training programme was initiated?
39. Were you able to provide suggestions to the training curriculum and content along the way?. Interview question: Are there any differences to the training crew one received and subsequent crews? If so what are they?
40. Were you able to provide suggestions for changes to documentation along the way? Interview question: If so what and why.
41. If changes were made to the training curriculum, content or documentation, did that negatively affect your ability to learn? Interview question: Why?
42. If changes were made to the training curriculum, content or documentation, did that, or will that negatively affect your ability to perform during sea-trials? Interview question: How so?
43. Does the process have measures in place to test and confirm the knowledge and skills of trainees? Interview question: If so, what measures are in place, what is the acceptable standard and what has it been based upon?
44. Does the process have measures in place to test and confirm the knowledge and skills of the RN trainers? Interview question: If so, what measures are in place, what is the acceptable standard and what has it been based upon?
45. Does the process have measures in place to test and confirm the knowledge and skills of the Flagship trainers? Interview question: If so, what measures are in place, what is the acceptable standard and what has it been based upon?
46. Have the RN trainers' depth of knowledge and skill changed over time? Interview question: What, and how have they expanded their depth and capability (with whom or what)
47. Have the Flagship trainers' depth of knowledge and skill changed over time? Interview question: What, and how have they expanded their depth and capability (with whom or what)
48. Have the trainers ((1) RN trainers and (2) Flagship) continued to gain knowledge and skill during the training process? Interview question: Is that achieved through sharing with others (*e.g.*, other training staff, trainees)? (Great Deal, Somewhat, Barely, Not at all)
49. Has this change in trainers' knowledge and skill detrimentally affected how the RN trainers train and assess?

50. Will the changes in information and knowledge detrimentally affect how the trainers will train and assess subsequent crews?
51. Has previous submarine experience detrimentally affected the trainees learning capability for the Upholder class submarine? Interview question: Do you believe age might be a factor in the ability to learn, as suggested in the submariner community "young man's game"? Do you believe there may be any other reason why the saying "young man's game" has been attached to the submariners?
52. Does team composition of crews affect learning? Interview question: How?
53. Will team composition affect subsequent job performance? Interview question: How?
54. Do you believe changes could still be made to the training curriculum? Interview question: Why?
55. Do you believe changes could still be made to the supporting documentation? Interview question: Why?
56. What do believe is the percentage of new operator knowledge and skill needed in order for the CF to adequately perform their assigned tasks and sufficiently operate the Upholder class submarine?
57. What do believe is the percentage of new maintenance knowledge and skill needed in order for the CF to adequately operate their assigned tasks and sufficiently run the Upholder class submarine?

Pre-training and Training Effectiveness Question Category Division

Pre-training Influences		Training Influences			
		Perception		Expectation	
Training Content	6	Training Content	24, 32, 33, 34, 35, 37, 38	Training Content	50*, 54, 55
Training Aids	17, 18, 19	Training Aids	26, 27, 28, 29, 30	Trainee Performance	25,42*, 53
Instructor Characteristics	8, 9, 14, 15, 16	Instructor Characteristics	22, 23, 46, 47, 49*	Operational Knowledge and Skill	56
Training Principles	10,11, 12, 13	Informal Aids	31, 48	Maintainer Knowledge and Skill	57
Informal Aids	7, 20, 21	Training Methods	43, 44, 45		
Participants Characteristics	1, 2, 3, 4, 5	Training Content Intervention	39, 40		
		Learning	36,41*, 51*, 52		

* Denotes reverse scaled questions as degree of negative impact. For statistical purposes, reverse coding was completed for those questions denoting a negative impact.

Training Effectiveness Questionnaire Responses (Parentheses indicates number of individuals or number of questions for each category)

Pre-training Influences	**Training Effectiveness Questionnaire Category Responses**					
	CF Managers (4)	RN Trainers (5)	Crew One (12)	Crew Two (10)	Crew Three (11)	Total Mean and SD
Training Content (1)	2.13 ± 1.03	1.85 ± 0.86				2.42 ± 1.10
Training Aids (3)	1.40 ± 0.43	1.50 ± 0.75				1.45 ± 0.62
Instructor Characteristics (5)	2.80 ± 1.44	2.33 ± 1.44				2.58 ± 1.44
Informal Aids (3)	1.79 ± 0.53	1.87 ± 0.70				1.83 ± 0.62
Training Influences						
Expectation						
Training Content (3)	2.04 ± 1.05	2.08 ± 0.75	1.78 ± 0.86	1.99 ± 0.85	1.97 ± 0.47	1.98 ± 0.76
Trainee Performance (3)	1.63 ± 0.71	1.93 ± 0.35	2.12 ± 1.25	2.19 ± 0.85	2.34 ± 0.74	1.94 ± 0.51
Trainee Performance % New Ops KS (1)	40 ± 14.14	37 ± 4.5	31.25 ± 4.83	32 ± 4.83	31.36 ± 3.23	32.63 ± 5.3
Trainee Performance % New main KS (1)	70 ± 14.14	79 ± 2.24	70.42 ± 8.91	81 ± 8.76	67.73 ± 8.17	73.38 ± 9.7
Perception						
Training Content (4)	1.86 ± 1.13	1.55 ± 0.35	2.54 ± 0.95	2.71 ± 0.80	2.67 ± 1.01	2.44 ± 0.63
Formal Training Aids (5)	1.26± 0.44	1.33± 0.43	1.72± 0.88	1.81± 1.06	1.76± 0.87	1.66± 0.87
Instructor Characteristics (5)	1.96 ± 0.91	1.72 ± 0.38	2.54 ± 1.66	2.63 ± 0.90	3.12 ± 1.03	2.6 ± 0.91
Informal Aids (2)	3.25 ± 1.51	2.25 ± 0.46	1.85 ± 0.91	1.38 ± 0.54	2.66 ± 1.03	2.17 ± 1.1
Training Methods (3)	1.75± 1.22	2.18± 1.39	3.74± 1.25	2.98± 1.29	2.93± 1.14	2.97± 1.39
Training Content Intervention (2)	2.5 ± 1.29	3.29 ± 1.68	2.02 ± 0.84	2.0 ± 0.63	2.3 ± 0.70	2.3 ± 0.95
Learning (4)	3.55 ± 1.54	2.96 ± 1.08	3.42 ± 1.44	3.06 ± 1.16	2.66 ± 1.08	3.15 ± 1.05

* Those questions denoting a negative impact were reverse coded for group mean and standard deviation responses for training effectiveness categories.

Hierarchical Task Analysis Representation for Emergency Operating Procedures[5]

Appendix D

Examples are provided for EOPs 1, 2, 4, 7, 8, 10, 11 and 14

EOP 1 – Emergency Stations
EOP 1.1: Emergency Stations at Sea

Task preceded by the discovery of the emergency, and the raising of the alarm.

Duties of the SCOOW

1. Hearing the alarm order "Stop snorting/Stop ventilating, Do Not lower masts, Do Not flood the induction system" if at PD, if not then " Go to safe depth (55m), 6 down".
2. Press General Alarm 3 times, pipe on FMB "Emergency Stations, Emergency Stations, ...".
3. Helmsman then ordered to reduce speed to 4 knots.
4. View panel to assure orders have been followed, assure communication received from crew of successful completion of orders.
5. Await advisement from crew of conditions.

Duties of the SCC 1 and 2

Task preceded by OOW gives order "Stop snorting/Stop generating, then, pipe "Emergency Stations, Emergency Stations", provides awareness.

1. Immediate response- as the pipe is given press Emergency Stop Engine Indicator Push Button (IPB).
2. Rotate Engine Telegraphs from 'Start to Stop'
3. Shut Snort Drain one, select Induction Hull valve IPB, communicate, "Shutting the Induction Hull valve", direct SCC_2 to site induction valve.
4. SCC_2 - Prompted to site induction hull valve shut, communicate, "Induction Hull valve sited shut"
   - Shut, communicate, "Shutting the Emergency flap valve"
   - Flood the Induction System, communicate, "Induction system flooding up"
5. Shut Ventilation Exhaust Hull valve, if open, select IPB, communicate, " Shutting the vex Hull valve"
6. Select Emergency shut down - communicate, Emergency shut down as each valve is selected (left to right, down):
   a. Diesel Generator (DG) fuel isolate
   b. Ships ventilation shutdown
   c. Battery agitation/ventilation shutdown
7. SCC_2- directed to "Make all stations on the VCS and report", communicate, "All stations VCS"

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[5] Appendix D provides a representation of the Hierarchical Task Analysis for eight of the Emergency Operating Procedures for the Upholder class submarine (now renamed as the Victoria class upon commissioning by the Canadian Navy). This research was approved and supported by the Canadian Navy, and as such the Hierarchical Task Analysis for all of the Emergency Operating Procedures was supplied to the Canadian Navy to assist in the development of the CF submarine training programme, and policy and procedural development. Thus, the task description, style of presentation, and use of terms and acronyms are reflective of the Canadian Navy style and format as they are used today.

8. Scan surveillance, gauges and panel

9. Await further direction

Duties of the MCC 1 and 2

1 Immediate response- as the pipe is given press Emergency Stop Engine Indicator Push Button (IPB) for running Port and Starboard engines.
2 Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.
3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. Secure compressors, Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.
5. Shut down battery agitation, turn battery agitation pump selector switch from run to stop.
6. Shut down activated battery ventilation, turn battery exhaust fan selector switch to off
7. MCC_1 directs MCC_2 "Stop axial flow fan"
8. MCC_2 prompted to switch off axial flow fan controller, communicate to MCC_1 "Axial flow fan off"
9. MCC_2 to ensure shutdown of 56 bulkhead door, and man 56 bulkhead door
10. Man damage control net, reset panel
11. Advise SCC_1 of status, communicate, "Stop achieved, ventilation shutdown"

Duties of Helmsman

Task preceded by OOW gives order "Stop snorting/Stop generating, go to safe depth (55m), 6 down (if at PD remain at PD)". Then, pipe "Emergency Stations, Emergency Stations".

1. Likely will be on auto pilot, disengage auto pilot, select manual "Course avail engaged" and "Depth avail engaged" switch Indicator Push Button (IPB), usually port unless otherwise directed.

Note: auto pilot does not need to be manually disengaged (selection of IPB), selection of manual course and depth control automatically disengages auto pilot.

2. Almost simultaneously, dive on the plane to 6°.
3. Eyes travel to central panel to depth gauge, first to pitch angle – no more than 6°, communicate to OOW, " 6 down and current depth"
4. Continue to communicate depth change every 5-10 m with pitch angle to OOW.
5. Eyes remain on central panel rotating between gauges for pitch angle, depth rate, pitch rate, 'Keeping the bubble'.
6. Change new depth order (safe depth 55 m) into computer Awaits direction from OOW.

EOP 2 Collision
EOP 2.1: Collision Surfaced

Duties of SCOOW

Note: OOW on the bridge has control of the emergency, SCOOW below carries out his orders.

Task preceded by OOW on the bridge pipe "Emergency Stations, Emergency Stations, Stand-by Collision", usually indicated port or starboard, then orders, "Do Not lower masts, Man compartment blow", if necessary "Blow main ballast".

1. SCOOW below then pipes FMB, "Shut bulkhead doors, Shut all hatches".
2. Press General Alarm 3 times, pipe on FMB "Emergency Stations, Emergency Stations, Stand-by Collision.....(port or starboard), Shut bulkhead doors, Shut all hatches, Man compartment blows, Brace, Brace, Brace".
3. Orders then given to "Shut conning tower upper lid", unless Captain on way to bridge, "Stop generating, Do Not lower masts, Shut the induction hull valve", if OOW on the bridge has directed "Blow main ballast".
4. View panel to assure orders have been followed, assure communication received from crew of successful completion of orders.
5. Await advisement from crew of conditions

If collision occurs then Press General Alarm 3 times, pipe on FMB "Emergency Stations, Emergency Stations, Loud bang heard external to the Submarine. All compartments carry out phase one damage control checks, and report to DCHQ".

Duties of SCC1 and 2

Task preceded by OOW pipe "Emergency Stations, Emergency Stations, Stand-by Collision", usually indicated port or starboard, "Shut bulkhead doors, shut all hatches, Man compartment blow".

1. Immediate response- as the pipe is given press Emergency Stop Engine Indicator Push Button (IPB).
2. Rotate Engine Telegraphs from Start to Stop
3. Shut Snort Drain one, select Induction Hull valve IPB, communicate, "Shutting the Induction Hull valve", Direct SCC_2 to site induction valve.
4. SCC_2 - Prompted to site Induction Hull valve shut, communicate, "Induction Hull valve sited shut"
   - Shut Emergency Flap valve, communicate, "Shutting the Emergency flap valve"
5. Shut Ventilation Exhaust Hull valve, if open, select IPB, communicate, " Shutting the vex Hull valve"
6. Select Emergency shut down - communicate Emergency shut down as each valve is selected (left to right, down): a. Diesel Generator (DG) fuel isolate
   b. Ships ventilation shutdown
   c. Battery agitation/ventilation shutdown

7. SCC_2- directed to "Make all stations on the VCS and report", communicate, "All stations VCS"
8. Scan surveillance, gauges and panel
9. Await further direction and brace for collision

Note: Blow main Ballast tanks as required to ensure submarine remains surfaced

Duties of MCC1 and 2

Task preceded by OOW General Alarm, then pipe "Emergency Stations, Emergency Stations, Stand-by Collision", usually indicated port or starboard, "Shut bulkhead doors, shut all hatches, Man compartment blow".

1. Immediate response- as the pipe is given press Emergency Stop Engine Indicator Push Button (IPB) for running Port and Starboard engines.
2. Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.
3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. Secure compressors, Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.
5. Shut down battery agitation, turn battery agitation pump selector switch from run to stop.
6. Shut down activated battery ventilation, turn battery exhaust fan selector switch to off
7. MCC_1 directs MCC_2 "Stop axial flow fan"
8. MCC_2 prompted to switch off axial flow fan controller, communicate to MCC_1 "Axial flow fan off"
9. MCC_2 to ensure shutdown of 56 bulkhead door, and man 56 bulkhead door
10. Man damage control net, reset panel
11. Advise SCC_1 of status, communicate, "Stop achieved, ventilation shutdown"
12. Brace for collision

Duties of Helmsman

Task preceded by OOW pipe "Emergency Stations, Emergency Stations, Stand-by Collision", usually indicated port or starboard, "Shut bulkhead doors, Shut all hatches, Man compartment blow".

1. (Lower left panel, Monitor selection panel) If on auto pilot, disengage auto pilot, select manual "Course avail engaged" and "Depth avail engaged" switch IPB, usually port unless otherwise directed.
2. Likely will be ordered to change course to avoid collision, and alter speed (group down)
3. Awaits direction from OOW.
4. Brace for collision.

EOP 2.2: Collision Dived

Duties of SCOOW

Task preceded by periscope OOW order "Go Deep, Go Deep, Go Deep, keep safe depth"

1. SCOOW then pipes on FMB "Stop snorting, Stop snorting, Stop snorting, Shut bulkhead doors".
2. Then order "Full ahead main motor", if in SSMG then order "Group up, full ahead", followed by " Full dive on the planes, 10 down, keep 55 m, wheel amidships".
3. Press General Alarm 3 times, pipe on FMB "Emergency Stations, Emergency Stations, Stand-by Collision.....(port or starboard), Shut bulkhead doors, Shut all hatches, Man compartment blows, Brace, Brace, Brace".
4. Observe panel to ensure full dive on the planes, correct emergency stop snorting achieved, and communication received from crew that orders performed successfully
5. Check to see echo sounder is on, if not, direct it be turned on.
6. If no chance of collision, boat is safe, provide direction for adjusted speed and trim.
7. If collision occurs, Press General Alarm 3 times, pipe on FMB "Emergency Stations, Emergency Stations, Loud bang heard external to the Submarine. All compartments carry out phase one damage control checks, and report to DCHQ".

Duties of SCC 1 and 2

Task preceded by OOW pipe "Go Deep, Go Deep, Go Deep, Emergency Stations, Emergency Stations, Stand-by Collision", usually indicated port or starboard, "Shut bulkhead doors, shut all hatches, Man compartment blow".

Note: error in current EOP, SCC indicates Stop: generating/ventilating. Generating = surface/engine running, ventilating = surface or dived to PD, engines operating dived. Thus, generating is incorrect.

1. Immediate response- as the pipe is given press emergency stop engines IPB.
2. Rotate Engine Telegraphs from Start to Stop
3. Shut snort drain one, select Induction hull valve IPB, communicate, "Shutting the induction hull valve", direct SCC_2 to site induction valve.
4. SCC_2 – prompted to site Induction Hull valve shut, communicate, "Induction valve sited shut"
   - shut Emergency flap valve, communicate, "Shutting the Emergency flap valve"
   - flood the induction system, communicate, "Induction system flooded up"
5. Up panel: Lock down search and attack periscopes
6. Move up: Emergency down all masts switch
7. Move right: Shut Ventilation Exhaust Hull valve, if open, select IPB, communicate, " Shutting the Vex Hull valve"
8. Select Emergency shut down - communicate, "Emergency shut down..." as each valve is selected (left to right, down): a. Diesel Generator (DG) fuel isolate
   b. Ships ventilation shutdown
   c. Battery agitation/ventilation shutdown
9. Eyes travel to periscopes – report to OOW, "all masts indicate fully lowered"
10. SCC_2- directed to "make all stations on the VCS", communicate, "all stations VCS"
11. Brace for collision

Duties of MCC 1 and 2

Task preceded by OOW order "Go Deep, Go Deep, Go Deep, followed by the General alarm, pipe "Emergency Stations, Emergency Stations, Stand-by Collision", usually indicated port or starboard, "Stop snorting, Stop snorting, Shut bulkhead doors, shut all hatches, Man compartment blow".

1. Immediate response- as the pipe is given press Emergency Stop Engine Indicator Push Button (IPB) for running Port and Starboard engines.
2. Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.
3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. Secure compressors, Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.
5. Shut down battery agitation, turn battery agitation pump selector switch from run to stop.
6. Shut down activated battery ventilation, turn battery exhaust fan selector switch to off
7. MCC_1 directs MCC_2 "Stop axial flow fan"
8. MCC_2 prompted to switch off axial flow fan controller, communicate to MCC_1 "Axial flow fan off"
9. MCC_2 to ensure shutdown of 56 bulkhead door, and man 56 bulkhead door
10. MCC_2 to check propulsion panel to ensure full ahead achieved, if not communicate to MCC_1 who will forward to control room.
11. Man damage control net, reset panel
12. Advise SCC_1 of status, communicate, "Stop achieved, ventilation shutdown"
13. Brace for collision

Duties of Helmsman

Task preceded by OOW "Go Deep, Go Deep, Go Deep, keep safe depth" then pipe "Emergency Stations, Emergency Stations, Stand-by Collision", usually indicated port or starboard, "Shut bulkhead doors, shut all hatches, Man compartment blow". Then OOW will order "Telegraphs to full ahead, 10 down, keep 55 m, wheel amidships".

1. Immediately, push wheel in full to 10 down, full dive on the plane, ensure rudder amidships, then communicate to OOW, "Full dive on the plane, rudder amidships".
2. If on auto-pilot, disengage auto pilot, select manual "Course avail engaged" and "Depth avail engaged" switch IPB, usually port unless otherwise directed.
3. Eyes travel to central panel to depth gauge, first to pitch angle – full 10°, communicate to OW " 10 down and current depth"
4. Then to bottom right 'ordered panel', change depth (safe depth 55 m) into computer
5. Continue to communicate depth change every 5-10 m with pitch angle to OOW
6. Eyes remain central panel rotating between gauges for pitch angle, depth rate, pitch rate, 'keeping the bubble'.
7. Standby to change course and speed. Likely OOW will order group down, or group up battery and change speed (slow ahead, half ahead, slow astern, half astern).
8. Upon direction rotate battery and speed switch as ordered, communicate, "Main motor telegraph i.e. half ahead" once selected IPB will flash until selection is achieved, once achieved report to OOW "Main motor telegraph indicates i.e. half ahead".

9. Observe revolutions LED, adjust as necessary (increase or reduce revolutions). Then, as a reminder to what revolution has been ordered, set revolutions on 'Propulsion telegraph switches'
10. Once speed steadied communicate to OOW, " Set 180, full ahead".
11. Await direction and brace for collision

EOP 4 Flooding
EOP 4.1 Flooding Accident Dived * sequence not as suggested in training

Duties for the SCOOW

Note: Notice can be given by verbal pipe, Manual flood alarm (each compartment) or float flood alarm activated (high bilge alarm 1st, then if water high enough flood alarm activated).

Task preceded by verbal pipe from person discovering the emergency, activation of manual flood alarm, or float alarm

1. Order "Stop snorting, Stop snorting", then "Full ahead main motor, midships, 20° up" if in SSMG then order "Group up, full ahead"".
2. Then order SCC_1 "Blow fwd and aft Main Ballast Tanks (MBT) in emergency and normal, Blow D tank, Emergency shut down switch to auxiliary"
2. Pipe on FMB "Shut bulkhead doors"
3. Press General Alarm 3 times, pipe FMB " Emergency Stations, Emergency Stations, Flooding in ...., Man compartment blows, Shut bulkhead doors.
4. If notified flooding uncontrollable, and confirmation received bulkhead doors shut down, then pipe FMB "Open ....compartment blows"
5. Observe panel for depth, speed, and bottle group pressure, when ½ depth achieved, consider ordering "stop blowing 1, 2, 3, 4,, Stop QA blows" if upward velocity is good, or bottle group pressure drop below 100 psi.
6. At 60 m advise helmsman to "ease 6 up ", if flooding forward advise helmsman "ease 10 up until surfaced".
7. When advised by SCC_1 that D-tank is empty, order "Emergency shutdown switch to all".
8. When surfaced order "blow main ballast" to maintain maximum buoyancy, if sinking order SCC_1 "Rapid de-ballast, pump out internal tanks".
9. Pipe on FMB "Report on flood state and isolation"
10. Order SCC_1 "Revert Emergency shut down to auxiliary, normal bilge and ballast", helmsman "Full rise on the planes".
11 Await advisement from crew of conditions, if still flooding consider abandon ship.

Duties of SCC 1 and 2

Note: Notice can be given by verbal pipe, Manual flood alarm (each compartment) or float flood alarm activated (high bilge alarm 1st, then if water high enough flood alarm activated).
Task preceded by OOW: if snorting will give order "Stop snorting, Stop snorting", then..."Blow fwd and aft Main Ballast Tanks (MBT) in emergency and normal, Blow D tank, Emergency shut down switch to auxiliary"

1. Immediate response- if snorting press emergency stop engines IPB.

2. Rotate Engine telegraphs from start to stop
3. Shut snort drain one, select Induction hull valve IPB, communicate, "Shutting the induction hull valve", direct SCC_2 to site induction valve.
4. SCC_2 – prompted to site Induction Hull valve shut, communicate, "Induction valve sited shut"
   - shut Emergency Flap Valve, communicate, "Shutting the Emergency Flap Valve"
   - flood the induction system, communicate, " Induction system flooded up"
5. Shut ventilation exhaust Hull valve, if open, select IPB, communicate, " Shutting the vex Hull valve"
6. Open: Fwd and aft Emergency blow selectors (STAND UP pull both levers out and down for fwd and aft quick acting (QA) blows)
7. Open: 1, 2, 3, 4, main ballast IPB, communicate, "Blowing 1, 2, 3, 4"
   (Note panel indicates 4321, not 1234)
8. Move right: Emergency Ventilation Hull shut down valve, hull valve switched from normal to auxiliary, communicate, "Ventilation Hull valve to auxiliary"
9. Select emergency shut down - communicate, "Emergency shut down…" as each valve is selected (left to right, down): a. Diesel Generator (DG) fuel isolate
   b. Ships ventilation shutdown
   c. Battery agitation/ventilation shutdown
10. Move down panel: Blow "D" tank, select vent IPB, communicate, "Blowing D"
11. Observe gauges for HP bottle groups, make sure pressure not below 110 bar, communicate, to OOW pressure status every 10 bar.
12. Wait for order from OOW, stop blowing if good upward velocity maintained or bottle group pressure drops to 100 bar then: "Stop blowing 1, 2, 3, 4, Stop QA blows, Stop blowing D"
13. Shut 1, 2, 3, 4 blow, select IPB, communicate, "Stop blowing 1, 2, 3, 4 main ballast and tanks"
14. Stand up, lock unlock switches at Emergency blow stations, communicate, "Stop emergency (QA) blows"
15. Stop blow to D, select IPB, communicate, "Stop blowing to D", do not vent D's
16. When on the surface, rotate hull valve emergency switch to all, communicate, "Emergency hull valve to all"
17. Await OOW orders and line up for "Rapid deballast, pump out internal tanks".
18. SCC_2- directed to "Make all stations on the VCS and report", communicate, "All stations VCS"

Duties of MCC 1 and 2

Note: Notice can be given by verbal pipe, Manual flood alarm (each compartment) or float flood alarm activated (high bilge alarm 1st, then if water high enough flood alarm activated).

Task preceded by OOW FMB pipe "Shut bulkhead doors", followed by the General alarm, then pipe FMB, "Emergency Stations, Emergency Stations, Flooding in…., Man Compartment blows, Shut bulkhead doors".

1. Immediate response- as the pipe is given press Emergency Stop Engine Indicator Push Button (IPB) for running Port and Starboard engines.

2. Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.
3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. Secure compressors, Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.
5. Shut down battery agitation, turn battery agitation pump selector switch from run to stop.
6. Shut down activated battery ventilation, turn battery exhaust fan selector switch to off
7. MCC_1 directs MCC_2 "Stop axial flow fan"
8. MCC_2 prompted to switch off axial flow fan controller, communicate to MCC_1 "Axial flow fan off"
9. MCC_2 to ensure shutdown of 56 bulkhead door, and man 56 bulkhead door.
10. Fire red grenade from After Submerged Signal Ejector (SSE)
11. Man damage control net, reset panel
12. Advise SCC_1 of status, communicate, "Stop achieved, ventilation shutdown, Red grenade fired from After SSE."

Duties of Helmsman

Note: Notice can be given by verbal pipe, Manual flood alarm (each compartment) or float flood alarm activated (high bilge alarm 1st, then if water high enough flood alarm activated).

Task proceeded by OOW: if snorting will give order "Stop snorting, Stop snorting", then "Full rise on the planes, rudders up".

1. Immediate response, full rise on the planes (pull into stomach)
2. If on auto-pilot, disengage auto pilot, select manual "Course avail engaged" and "Depth avail engaged" switch IPB, usually port unless otherwise directed.
3. Eyes go to pitch angle-20° up, keep eye on the plane, advise OOW every 5-10 m of current depth status.
4. Stand by to change speed, likely full ahead.
5. Prompts turning speed switch to full ahead, communicating to OOW "Main motor telegraph to full ahead", when IPB stops flashing communicate, " main motor telegraph indicates full ahead"
6. OOW will ask for change in revolutions (+/-). Await orders, observe revolution LED wait until revolutions steady. OOW will order " set revolutions to 180"
7. Then, as a reminder to what revolution has been ordered, set revolutions on 'Propulsion telegraph switches'
8. Once speed steadied then increase or decrease revolutions as necessary, communicate to OOW, " Set 180, full ahead".
9. OOW will likely give orders for pitch angle and course.
10. Await direction.

EOP 7.1: Hydraulic Burst

Tasks preceded by notification of person discovering the burst, gauge indication on the panel, and/or alarm of system/plant hydraulic failure, or systems affected by hydraulic system.

Duties of the SCOOW

1. Immediate response, order "Stop snorting, Stop ventilating, Do not lower the masts, Do not flood the induction system, Auto pilot to manual, Midships the rudder, Centre the Foreplanes".
2. Press General Alarm 3 times, pipe FMB " Emergency stations, Emergency stations, Hydraulic burst in ...compartment, on ...system".
3. Following report/update indicating burst might be on the After-plant, and MCC's indication that it is safe to select emergency on rudder, then order Helmsman "Select air emergency on the After planes, select emergency on rudder".
4. Check status all is secure, scan panel and confirm via communication from panel crew, ensure diesel generator back-up valve and snort induction hull valve shut, and trim system lined up for fire fighting.
5. If at PD, order helmsman, "Remain at PD, reduce speed, slow ahead, 4 knots" if no periscopes raised then order Helmsman, "Go to safe depth, dive on the planes, keep 6° to 55 m, slow ahead, 4 knots".
6. If Helmsman indicates emergency rudder control is not available, indications show burst is on main hydraulic system, have SCC_1 contact MCC to operate systems in hand-control.
7. Pipe on FMB, "Stand-by to operate Ships systems in Hand-control".
8. Await advisement from crew of conditions.

Duties of SCC1 and 2

Tasks preceded by OOW orders "Stop snorting, Stop ventilating, Do Not lower the masts, Do Not flood the induction system, Auto pilot to manual, Midships to rudder, Centre the Foreplanes"

1. Immediate response- as the pipe is given press emergency stop engines IPB.
2. Rotate Engine telegraphs from start to stop
3. Shut snort drain one, select Induction hull valve IPB, communicate, "Shutting the induction hull valve"
4. SCC_1 directs SCC_2 – Do Not flood induction system
5. SCC_2 prompted to: site induction hull valve shut, communicate, "Induction valve sited shut" shut Emergency Flap Valve, communicate, "Shutting the Emergency Flap Valve"
   (does not flood induction system).
6. Move right: Shut ventilation exhaust hull valve, if open, select IPB, communicate, " Shutting the vex Hull valve"
7. Select emergency shut down - communicate, "emergency shut down..." as each valve is selected (left to right, down): a. Diesel Generator (DG) fuel isolate
   b. Ships ventilation shutdown
   c. Battery agitation/ventilation shutdown
8. Line up trim system for fire fighting –, Shut M port vent, open M port blow, forward trim pump to run
   (below garbage-center trim panel)
9. Direct SCC_2- shut m-port vent – to blow on .....
10. Secure bilge and ballast system – shut off bilge pump, turn off valves
11. Secure any hull valves open

12. If forward of 56 Bulkhead
a) Switch: External Hydraulics pump to off Fire Isolation Valve (FIV) IPB off.

b) Switch: Main Hydraulics pump to off pump to and FIV IPB off.

If burst Aft of 56 bulkhead
a) Switch: External Hydraulics and pump to off and FIV IPB off

b) Switch: Switch: Main Hydraulics off, and FIV IPB off

c) Switch: Steering and Hydraulic pump to off, and FIV IPB off

13. Monitor hydraulic gauges for drop in pressure, determine where leak/burst is situated
14. Communicate to OOW position of pump and FIV lineup ".... valves and FIV shut"
15. Radar mast valve to off, Communicate to OOW, "Radar mast valve off"
16. Await direction of re-commission of hydraulics by DCHQ.

Duties of MCC 1 and 2

Tasks preceded by General alarm, then FMB " Emergency stations, Emergency stations, Hydraulic burst in ....Compartment, on.......system".

1. Immediate response- as the pipe is given press Emergency Stop Engine Indicator Push Button (IPB) for running Port and Starboard engines.
2. Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.
3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. Secure compressors, Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.
5. Shut down battery agitation, turn battery agitation pump selector switch from run to stop.
6. Shut down activated battery ventilation, turn battery exhaust fan selector switch to off
7. MCC_1 directs MCC_2 "Stop axial flow fan"
8. MCC_2 prompted to switch off axial flow fan controller, communicate to MCC_1, "Axial flow fan off"
9. Advise SCC_1 of status, communicate, "Stop achieved"
10. MCC_2 to ensure shutdown of 56 bulkhead door, and man 56 bulkhead door.
11. MCC_2 directed to prepare Sub fire fighting unit 90 (SFU 90) and break out extinguishers.
12. Shut down main blowers from propulsion switchboard, lower panel, select Blower 1 motor and/or Blower 2 motor selector switch and rotate from auto to off.
13. Monitor computer screen for changes in main motor temperature.
14. Upon MCC_1 return directs MCC_2 to investigate Starboard aft motor room, to ram assembly to see if any mechanical problems preventing putting rudder to emergency control
15. MCC_2 also investigates rudder electronic enclosure to see if powered
16. MCC_2 then reports to MCC_1, communicate, "Safe to operate rudder in emergency control"

17. MCC_2 directed to investigate hydraulic problem, check After plant and rep tank levels, if burst on After plant then opens the plant by-pass valve, and communicate to MCC_{1}, "Plant by-pass valve open"
18. MCC_1 relays information to SCC_1, communicate, "Stop achieved, Ventilation shut down, and Safe to operate rudder in emergency control"
19. If burst is on the After plant communicate to SCC_{1}, "Plant by-pass valve open"
20. Await direction.

Duties of Helmsman

Tasks preceded by OOW orders "Stop snorting, Stop ventilating, Do not lower the masts, Do not flood the induction system, auto pilot to manual, midships to rudder, Centre the Foreplanes" Then, OOW FMB pipe " Emergency stations, Emergency stations, Hydraulic burst in ...compartment, on ...system".

If indication shows a burst might be on the After-plant then OOW orders "Air emergency on the After planes, select emergency on rudder (if safe to do so).

1. If on auto pilot, disengage auto pilot, select manual "course avail engaged" and "depth avail engaged" switch IPB, usually port unless otherwise directed.
2. If at PD, will remain at PD, if no periscopes raised then OOW will order "go to safe depth (55 m), then follow orders as directed (dive on the planes, keep 6° to 55 m).
3. Maintain course, midships the rudder, and centre the Foreplanes (o position), check gauges to ensure correct, and burst has not affected steerage and hydroplanes.
4. Communicate to OOW status, if gauges indicate problem report " i.e. after planes jamm"
5. If report indicates burst is in the After plant then OOW will order "Air emergency on the Afterplanes", and if safe to do so, "Select emergency rate control"
6. Put Afterplanes in air emergency, stand up, pull down air emergency valve, rotate quarter turn, and release, communicate, "Afterplanes in air emergency".
7. Select rudder switch, adjust from normal to emergency, and communicate, "rudder in emergency control"
8. If "off the bubble", manually adjust to port or starboard with rudder in emergency control
9. If control achieved maintain, if not, emergency control not available, advise OOW "Emergency rudder control is not available, rudder at ie.10° port, I have no control"
10. MCC will be advised, await direction, Await direction.

EOP 8: HP Air Burst at Sea
EOP 8.1: HP Burst at Sea

Tasks preceded by notification of person discovering the burst, alarm indications, or panel gauges indicate problem

Duties of SCOOW

1. Initially order "Stop snorting, Stop snorting, Stop snorting".
2. Press General Alarm 3 times, pipe FMB "HP air burst, HP air burst in .... "
3. View panel to assure orders have been followed, snort is off, assure communication received from crew of successful completion of orders and

update of status, affected bottle groups, and which Group Isolator Valves (GIV's) have been shut.

4. Pipe on FMB "Man emergency blows in hand".
5. If all GIV's shut order Helmsman "Maintain depth and course", if speed is up, reduce speed, "slow ahead, 4 knots".
6. Await advisement from crew of conditions

Duties of SCC 1 and 2

Tasks preceded by OOW FMB pipe "HP air burst, HP air burst in .... ", then "Stop snorting, Stop snorting", then " Man emergency blows in hand".

1. Select stop snorting alarm – not emergency
2. Rotate Engine telegraphs from start to stop
3. Shut snort drain one, select Induction hull valve IPB, communicate, "Shutting the induction hull valve", direct SCC_2 to site induction hull valve.
4. SCC_2 – prompted to site induction hull valve shut, communicate, "Induction valve sited shut"
    - shut Emergency Flap Valve, communicate, "Shutting the Emergency Flap Valve"
    - flood the induction system, communicate, " Induction system flooded up"
5. SCC_2- directed to "make all stations on the VCS and report", communicate, "all stations VC
6. Move right: Shut ventilation exhaust hull valve, if open, select IPB, communicate, " Shutting the vex Hull valve"
7. Monitor HP air pressure gauges and ring mains, communicate pressure readings:
    A) if all gauges fall (both ring mains), shut all group isolation valves (GIV), communicate to OOW, "all GIV's shut"
    B) if only one side ring main drops, shut affected GIV's, communicate to OOW, "GIV's port or starboard shut"
    C) if no indication of pressure drop leave GIV's alone, communicate to OOW, "no pressure drop of GIV's".

Duties of MCC 1 and 2

Tasks preceded by General alarm, then FMB pipe "HP air burst, HP air burst in .... ", followed by FMB "Stop snorting, Stop snorting", then " Man emergency blows in hand".

1. If snorting/generating, as non-emergency, proceed with normal shutdown for running Port and Starboard engines. Select engine telegraph selector switch and rotate from start to stop for each engine.
2. Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.
3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. If HP air compressors running then shut down. Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.

5. Advise SCC_1 of status, communicate, "Stop achieved"
6. Await direction.

Duties of Helmsman

Tasks preceded by OOW General alarm pipe "HP air burst, HP air burst in .... ", then FMB pipe "Stop snorting, Stop snorting, Man emergency blows in hand".

1. If on auto pilot, disengage auto pilot, select manual "course avail engaged" and "depth avail engaged" switch IPB, usually port unless otherwise directed will likely give orders for pitch angle and course
2. Maintain depth, course and speed
3. Observe log to ensure correct speed, compass for correct course, rudder, Foreplanes to maintain bubble
4. Await OOW direction.

EOP 10: 140KW MG Failure
EOP 10.1: Single MG Failure with both MG's Running

Note: Loss of Fwd MG will result in Fwd and After battery flood alarms being activated

Tasks preceded by activation of battery flood alarms – B class, depth and heading indicators are lost, if After MG, or loss of all gauge indications, if loss of Fwd MG.

Duties of SCOOW

1. Initially order "Stop snorting, Stop snorting, Do Not lower masts, Do Not flood the induction system".
2. Press General Alarm 3 times, pipe FMB "Electrical failure, Electrical failure, loss of Fwd/Aft MG, electrical repair parties and DCHQ close up".
3. Order Helmsman " Man helm, Select manual control, Centre the Foreplanes" if deep then "Keep safe depth, 55m".
4. If forward MG failure, remind Helmsman to view Arma Brown, – back up compass
5. If After MG failure order MCC, "Obey telegraphs in Manual mode 1", then pipe on FMB, "Make telegraphs in hand control"
6. Pipe on FMB, "Do Not start any AC machinery without contacting the MCC".
7. View panel to assure orders have been followed, snort if off, assure communication received from crew of successful completion of orders.
8. Await advisement from crew of conditions

Duties in SCC 1 and 2

Note: Loss of Fwd MG will result in Fwd and After flood batteries being activated
Loss of Fwd MG results in Propulsion failure on changing group

Tasks preceded by OOW order "Stop snorting, Stop snorting, Do Not lower masts, Do Not flood the induction system". Then, General alarm FMB "Electrical failure, Electrical failure, loss of fwd/aft MG, electrical repair parties and DCHQ close up".

1. Immediate response- as the pipe is given press emergency stop engines IPB (alarm? As MG failure not considered emergency).
2. Rotate Engine telegraphs from start to stop
3. Shut snort drain one, select Induction hull valve IPB, communicate, "Shutting the induction hull valve"
4. SCC1 directs SCC_2 – Do Not flood induction system
5. SCC_2 prompted to site induction hull valve shut, communicate, "Induction valve sited shut" shuts Emergency Flap Valve, communicate, "Shutting the Emergency Flap Valve"
   (do not flood induction system).
6. SCC_2- directed to "make all stations on the VCS and report", communicate, "all stations VCS"
7. Move right: Shut ventilation exhaust hull valve, if open, select IPB, communicate, " Shutting the vex Hull valve"

8. Loss of Fwd MG

a) Advise OOW "Loss of fwd trim, Steering and hydraulics, Main hydraulics, LP bilge."
b) Switch After plant DC pump to line
c) Switch AC pump to off
d) Direct SCC_2 "make override switch for ballast pump water sensitive probe
e) Monitor all systems and panel

Loss of aft MG

a) Advise OOW "Loss of External hydraulics, After trim pump, After trim not available."
b) Switch Main hydraulic pump to off
c) Direct SCC_2 "make override switch on HP bilge pump water sensitive probe"
d) Monitor all systems and panel

Duties of MCC 1 and 2

Note: Loss of Fwd MG will result in Fwd and Aft flood batteries being activated
Loss of Fwd MG results in Propulsion failure on changing group

Tasks preceded by General alarm, then FMB "Electrical failure, Electrical failure, Loss of fwd/aft MG, Electrical repair parties and DCHQ close up"

1. If snorting/generating, as non-emergency, proceed with normal shutdown for running Port and Starboard engines. Select engine telegraph selector switch and rotate from start to stop for each engine.
2. Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.
3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. Secure compressors, Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.
5. Note panel alarm indications to determine which motor group affected (Fwd/Aft MG), disengage audible alarm.

6. Advise SCC_1 of status, communicate, "Stop achieved" relay motor group affected "Fwd/Aft MG failure"
   Check MG control and AC distribution panel, scan up the panel, check Aft and Fwd AC switchboard to see if indicators tripped, check to see if MG contactor switch tripped, check MG gauges. Select affected MG AC breaker selector switch rotate from closed to off
7. Check DC supply, shut down affected MG, turn affected DC contactor switch from start to off.
8. Check Buss couplers (BS), ensure BS_1 and BS_2 breakers are open and tagged (normal state at sea is off)
9. Report to DCHQ for recovery action, communicate, "Fwd or Aft MG breaker shut down and isolated, BC contactors open and tagged".
10. Await direction from DCHQ.

Duties of Helmsman

Tasks preceded by OOW order "Stop snorting, Stop snorting, Do Not lower masts, Do Not flood the induction system". Then, General alarm FMB "Electrical failure, Electrical failure, loss of Fwd/Aft MG, electrical repair parties and DCHQ close up". OOW then orders " Man helm, Select manual control, centre the Foreplanes.

1. If on autopilot, disengage auto pilot, select manual "course avail engaged" and "depth avail engaged" switch IPB, usually port unless otherwise directed.
2. OOW will order if deep "Keep safe depth, 55m"
3. Centre the Foreplanes to centre hold
4. If forward MG failure OOW will remind to view "Arma Brown" – back up compass
5. Maintain course via Arma Brown, keep depth and speed
6. Eyes remain on central panel rotating between gauges for pitch angle, depth rate, pitch rate, 'keeping the bubble'.
7. Await direction.

EOP 11: 24 Volt Failure
EOP 11.1 Total 24 V DC Failure

Note: Control panel ineffective, remote control lost. Hydraulic plants may be available for local operation, all hull valves fail shut.

Task preceded by sudden loss of all power, complete darkness, loss of communication.

Duties of SCOOW

1. Initial order, "Stop snorting, Stop snorting, Do Not lower any masts. Do Not flood the induction system".
2. Order Helmsman "Keep safe depth, After-planes in air emergency", if deep, come to safe depth, order "Go to safe depth, 55m".
3. With no internal communication, delegate 2 runners, each with a whistle, one foreward one aft to shout "24 Volt failure, 24 volt failure, Diving stations, Diving stations"

4. Direct SCC_2 prior to going aft, " Advise MCC to obey telegraphs in Manual mode 2, pass all telegraph orders via VCS net, MCC to man and operate rudder by operation of the distributor valve".
5. If indication by Helmsman hydroplanes are not available send runner aft, upon his return to centre the Foreplanes.
6. Assure communication received from crew of successful completion of orders.
7. Await advisement from crew of conditions

Shipwide implications:

1. Complete loss of remote control and indications of all hydraulically operated valves from SCC and MCC.
2. Loss of all alarm indications and all audible warning outposts.
3. Complete loss of vices
4. Complete loss of automatic propulsion control and telegraphs
5. Complete loss of OMC
6. Loss of all mast and periscope control
7. Loss of automatic control of all hydraulic plants

Duties of SCC 1 and 2

Note: Control panel ineffective, remote control lost. Hydraulic plants may be available for local operation, all hull valves fail shut.

Task preceded by OOW pipe "Stop snorting, Stop snorting, Do Not lower any masts. Do Not flood the induction system".

1. Immediate response- as the pipe is given press emergency stop engines IPB (emergency? Or press stop snorting alarm).
2. Rotate Engine telegraphs from start to stop
3. Shut snort drain one, select Induction hull valve IPB, communicate, "Shutting the induction hull valve"
4. SCC1 directs SCC_2– "Do Not flood induction system"
5. SCC1 directs SCC_2– "Site induction hull valve shut, shut Emergency Flap Valve and report, Do not flood induction system"
6. With no external control SCC_2 required to manually:
   a) Site induction hull valve shut, communicate, "Induction valve shut";
   b) shuts Emergency Flap Valve, communicate, "Emergency flap valve shut"
   c) Sites the vex hull valve, shuts, and shuts backup, communicate, "Vex hull valve and backup shut"
7. SCC_1 shuts all hydraulics off, External, Main, and Steering and Hydraulics, communicate to OOW, " All hydraulics shut"
8. SCC_1 directs SCC_2– "make all stations on the VCS", communicate, "all stations VCS".
9. SCC_1 orders AMS Watchkeeper (individual duty yet to be determined), "Run up the Main and External hydraulic plants in local control"

Shipwide implications:

1. Complete loss of remote control and indications of all hydraulically operated valves from SCC and MCC.

2. Loss of all alarm indications and all audible warning outposts.
3. Complete loss of VICES
4. Complete loss of automatic propulsion control and telegraphs
5. Complete loss of OMC
6. Loss of all mast and periscope control
7. Loss of automatic control of all hydraulic plants

Duties of MCC 1 and 2

Note: Control panel ineffective, remote control lost. Hydraulic plants may be available for local operation, all hull valves fail shut.

Task preceded by sudden loss of all power, complete darkness, loss of communication. Runner will pass through the boat with whistle piping "24 Volt failure, 24 volt failure, Diving stations, Diving stations".

1. If snorting/generating, as non-emergency, proceed with normal shutdown for running Port and Starboard engines. Select engine telegraph selector switch and rotate from start to stop for each engine.
2. Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.
3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. Secure compressors, Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.
5. Direct MCC_2 to "Man propulsion switchboard, Obey telegraphs in Manual mode 2".
6. MCC_2 selects Fwd and Aft motor breaker selector switch, rotates switch from closed to off.
7. Using Mode selector switch rotate switch to Manual mode 2 from Primary, communicate "Manual mode 2 selected".
8. Go to Start and Group Camshaft motor selectors, rotate Start Camshaft selector from start to stop, and Group Camshaft selector from on to off
9. Turn ACU to off, select auto control toggle and switch from on to off.
10. Close Main Motor breakers, select Fwd and Aft motor breaker selector switch rotate switch from off to closed. Selector switch will spring to on.
11. Send runner to control room to communicate, "Ready to obey telegraphs in Manual mode 2"
12. MCC_2 to man hydraulic plant, run the AC pump in local control.
13. Send runner to control room to communicate, "Hydraulic pump in hand"
14. Extra body, then delegated by MCC_1 to "Man and operate rudder using distributor valve", communicate to OOW via runner, "Rudder manned".
15. Await direction.

Ship wide implications:

1. Complete loss of remote control and indications of all hydraulically operated valves from SCC and MCC.
2. Loss of all alarm indications and all audible warning outposts.
3. Complete loss of VICES

4. Complete loss of automatic propulsion control and telegraphs
5. Complete loss of OMC
6. Loss of all mast and periscope control
7. Loss of automatic control of all hydraulic plants

Duties of Helmsman

Note: Control panel ineffective, remote control lost. Hydraulic plants may be available for local operation, all hull valves fail shut.

Task preceded by OOW pipe "Stop snorting, Stop snorting, Do Not lower any masts. Do Not flood the induction system". Followed by internal communication, "24 Volt failure, 24 volt failure, Diving stations, Diving stations"

1. OOW will order if deep "Come to safe depth, 55m, select After planes in air emergency"
2. Put Afterplanes in air emergency, stand up, pull down air emergency valve, rotate quarter turn, and release, communicate, "Afterplanes in air emergency".
3. OOW will remind to view "Arma Brown" – back up compass
4. Maintain course via Arma brown, maintain depth
5. Eyes view upper panel rotating between gauges for pitch angle, depth rate, pitch rate, 'keeping the bubble', communicate to OOW continuing status.
6. MCC to man and operate rudder by operation of the distributor valve
7. If indications hydroplanes are not available OOW will send runner aft to centre the Foreplanes.
8. Await direction

Ship wide implications:
1. Complete loss of remote control and indications of all hydraulically operated valves from SCC and MCC.
2. Loss of all alarm indications and all audible warning outposts.
3. Complete loss of vices
4. Complete loss of automatic propulsion control and telegraphs
5. Complete loss of OMC
6. Loss of all mast and periscope control
7. Loss of automatic control of all hydraulic plants

EOP 14: Fire General
EOP 14: Fire at Sea

Initial indication of fire will be a Minerva alarm, then FMB pipe 'Minerva alarm , Minerva alarm, Minerva alarm in ...... investigate compartment and report to ship control". Emergency stations not to be presumed until investigation completed.

Duties of SCOOW

1. Initial order "Stop snorting, Stop snorting"
2. Press General Alarm 3 times, pipe FMB "Emergency Stations, Emergency Stations, Fire, Fire, Fire in ...compartment".
3. Order Helmsman " Go to safe depth, 55 m", if at PD, remain at PD.

4. When assured safe and clear advise Helmsman to reduce speed, "slow ahead, main motor".
5. View panel to assure orders have been followed, snort if off, assure communication received from crew of successful completion of orders.
6. Prepare to come to PD to clear smoke from submarine.
7. Await advisement from crew of conditions

Duties of SCC 1 and 2

Task preceded by OOW "Stop snorting, Stop snorting", then General alarm "Emergency Stations, Emergency Stations, Fire, Fire, Fire in ...". (if fire alarm goes off)
Note: if Minerva alarm then pipe is" Minerva alarm, Minerva alarm in.... investigate and report"

1. Immediate response- as the pipe is given press emergency stop engine IPB. Do not wait for order to stop snorting
2. Rotate Engine telegraphs from start to stop
3. Shut snort drain one, select Induction hull valve IPB, communicate, "Shutting the induction hull valve"
4. SCC_2 - prompted to site induction hull valve shut, communicate, "Induction valve sited shut"
   - shut Emergency Flap Valve, communicate, "Shutting the Emergency Flap Valve"
   - flood the induction system, communicate, " Induction system flooded up"
5. Shut ventilation exhaust hull valve, if open, select IPB, communicate, " Shutting the vex Hull valve"
6. Select emergency shut down - communicate emergency shut down as each valve is selected (left to right, down):
   a. Diesel Generator (DG) fuel isolate
   b. Ships ventilation shutdown
   c. Battery agitation/ventilation shutdown
7. Trim system for fire-fighting, open M-port, switch forward trim pump to run
8. Direct SCC_2 to "Shut m-port vent, Blow to M port, Pull out EBS"
9. SCC_2 shuts m-port vent, communicate, "M-port shut, pulls out EBS for control room.
10. SCC_2- directed to "Make all stations on the VCS and VICES", communicate, "All stations VCS and VICES"
11. Scan alarms, and panel

Duties of MCC 1 and 2

Task preceded by OOW "Stop snorting, Stop snorting", then General alarm "Emergency Stations, Emergency Stations, Fire, Fire, Fire in ...". (if fire alarm goes off)
Note: if Minerva alarm then pipe is" Minerva alarm, Minerva alarm in.... investigate and report"

1. Immediate response- as the pipe is given press Emergency Stop Engine Indicator Push Button (IPB) for running Port and Starboard engines.
2. Shut Port and Starboard engine seawater inlet and outlet hull and backup valve controllers, press port SW Hull valve controller IPB and backup IPB. If open, press Starboard SW Hull valve controller IPB and backup IPB.

3. Open exhaust interspace drain and silencer drain for both port and Starboard stopped engines, select exhaust interspace IPB and silencer drain IPB
4. Secure compressors, Stand up, Stop running port and Starboard compressors, select port and Starboard switch from run to off.
5. Shut down battery agitation, turn battery agitation pump selector switch from run to stop.
6. Shut down activated battery ventilation, turn battery exhaust fan selector switch to off
7. MCC_1 directs MCC_2 "Stop axial flow fan"
8. MCC_2 prompted to switch off axial flow fan controller, communicate to MCC_1, "Axial flow fan off"
9. MCC_2 to ensure shutdown of 56 bulkhead door, and man 56 bulkhead door
10. MCC_2 directed to prepare Sub fire fighting unit 90 (SFU 90) and break out extinguishers.
11. Shut down main blowers from propulsion switchboard, lower panel, select Blower 1 motor and/or Blower 2 motor selector switch and rotate from auto to off.
12. Man damage control net, observe and reset panel
13. Advise SCC_1 of status, communicate, "Stop achieved, ventilation shutdown"

Duties of Helmsman

Initial indication of fire will be a Minerva alarm, then FMB pipe 'Minerva alarm , Minerva alarm, Minerva alarm in ...... investigate compartment and report to ship control. Emergency stations not to be presumed until investigation completed.

Task preceded by OOW "Stop snorting, Stop snorting", then pipes "Emergency Stations, Emergency Stations, Fire, Fire, Fire in ...compartment". Followed by OOW order " Go to safe depth, 55 m", if at PD remain at PD.

1. If on auto pilot, disengage auto pilot, select manual "Course avail engaged" and "Depth avail engaged" switch IPB, usually port unless otherwise directed.
2. OOW will order if deep "Go to safe depth, 55m, maintain course"
3. Respond with rise or dive on the plane, eyes travel to central panel to pitch angle and depth gauge, communicate and confirm to OOW the pitch angle and direction
4. Continue to communicate depth change every 5-10 m with pitch angle to OOW.
5. Eyes remain central panel rotating between gauges for pitch angle, depth rate, pitch rate, 'keeping the bubble'.
6. OOW orders "slow ahead, main motor"
7. Prompts rotate speed switch as directed, communicating to OOW "Main motor telegraph to slow ahead", when IPB stops flashing communicate, " Main motor telegraph indicates slow ahead"
8. Observe revolution LED wait until revolutions steady (approx 10 rev's per knot).
9. Observe log for speed, adjust, increase or decrease, revolutions as necessary, communicate to OOW, " Set 35, slow ahead".
10. Then, as a reminder to what revolution has been ordered, set revolutions on 'Propulsion telegraph switches'
11. Await direction

Training Effectiveness Category and Statistical Comparisons   Appendix E

Average Group Training Effectiveness Questionnaire Category Responses
(Average for each category includes all questionnaire responses for each category as identified in Appendix C).

Pre-training Influences	**Training Effectiveness Questionnaire Category Responses**					
	CF Managers (4)	RN Trainers (5)	Crew One (12)	Crew Two (10)	Crew Three (11)	Total Mean and SD
Training Content (1)	2.13 ± 1.03	1.85 ± 0.86				2.42 ± 1.10
Training Aids (3)	1.40 ± 0.43	1.50 ± 0.75				1.45 ± 0.62
Instructor Characteristics (5)	2.80 ± 1.44	2.33 ± 1.44				2.58 ± 1.44
Informal Aids (3)	1.79 ± 0.53	1.87 ± 0.70				1.83 ± 0.62
Training Influences						
Expectation						
Training Content (3)	2.04 ± 1.05	2.08 ± 0.75	1.78 ± 0.86	1.99 ± 0.85	1.97 ± 0.47	1.98 ± 0.76
Trainee Performance (3)	1.63 ± 0.71	1.93 ± 0.35	2.12 ± 1.25	2.19 ± 0.85	2.34 ± 0.74	1.94 ± 0.51
Trainee Performance % New Ops KS (1)	40 ± 14.14	37 ± 4.5	31.25 ± 4.83	32 ± 4.83	31.36 ± 3.23	32.63 ± 5.3
Trainee Performance % New main KS (1)	70 ± 14.14	79 ± 2.24	70.42 ± 8.91	81 ± 8.76	67.73 ± 8.17	73.38 ± 9.7
Perception						
Training Content (4)	1.86 ± 1.13	1.55 ± 0.35	2.54 ± 0.95	2.71 ± 0.80	2.67 ± 1.01	2.44 ± 0.63
Formal Training Aids (5)	1.26± 0.44	1.33± 0.43	1.72± 0.88	1.81± 1.06	1.76± 0.87	1.66± 0.87
Instructor Characteristics (5)	1.96 ± 0.91	1.72 ± 0.38	2.54 ± 1.66	2.63 ± 0.90	3.12 ± 1.03	2.6 ± 0.91
Informal Aids (2)	3.25 ± 1.51	2.25 ± 0.46	1.85 ± 0.91	1.38 ± 0.54	2.66 ± 1.03	2.17 ± 1.1
Training Methods (3)	1.75± 1.22	2.18± 1.39	3.74± 1.25	2.98± 1.29	2.93± 1.14	2.97± 1.39
Training Content Intervention (2)	2.5 ± 1.29	3.29 ± 1.68	2.02 ± 0.84	2.0 ± 0.63	2.3 ± 0.70	2.3 ± 0.95
Learning (4)	3.55 ± 1.54	2.96 ± 1.08	3.42 ± 1.44	3.06 ± 1.16	2.66 ± 1.08	3.15 ± 1.05

Kruskal-Wallis ANOVA Test Findings for between Group Comparisons of Training Effectiveness Factors (Groups defined as: 1). Crew 1; 2). Crew 2; 3). Crew 3; 4). CF Managers; and, 5). RN Trainers).

Training Effectiveness Factors	**Group**	**Number of Responses**	**Mean Rank**
Training Content Performance	1	12	23.04
	2	10	27.75
	3	11	25.00
	4	4	13.38
	5	5	4.10
	Total	42	
Training Aids Performance	1	12	22.38
	2	10	26.70
	3	11	25.64
	4	4	7.88
	5	5	10.80
	Total	42	
Instructor Characteristics Performance	1	12	22.79
	2	10	23.90
	3	11	27.50
	4	4	11.75
	5	5	8.20
	Total	42	
Informal Aids Performance	1	12	17.88
	2	10	11.10
	3	11	27.91
	4	4	33.88
	5	5	27.00
	Total	42	
Training Methods Performance	1	12	32.21
	2	10	21.75
	3	11	19.86
	4	4	8.00
	5	5	9.70
	Total	42	
Training Content Intervention Performance	1	12	17.79
	2	10	17.00
	3	11	21.55
	4	2	26.25
	5	5	29.40
	Total	40	
Learning Performance	1	12	26.75
	2	10	21.95
	3	11	14.18
	4	4	32.13
	5	5	15.60
	Total	42	

Training Content Expectation	1 2 3 4 5 Total	12 10 11 4 5 42	18.08 21.45 22.50 22.25 27.00
Trainee Performance Expectation	1 2 3 4 5 Total	12 10 11 4 5 42	16.79 24.75 27.41 11.88 21.00
Expectations of Operator Knowledge and Skill	1 2 3 4 5 Total	12 10 11 2 5 40	17.75 19.55 18.59 27.75 30.30
Expectations of Maintainer Knowledge and Skill	1 2 3 4 5 Total	12 10 11 2 5 40	17.04 28.75 13.68 17.50 28.50

Chi-Squared Test for Relatedness for Between Group Comparisons of Training Effectiveness Factors (Group comparisons were defined as: RN trainers; CF Managers, to include the Training Managers and CO's; Crew1; Crew 2; and, Crew 3).

Training Effectiveness Performance Factors	Training Content	Training Aids	Instructor Characteristics	Informal Training Aids	Training Methods	Training Content Intervention	Learning
Chi-square	15.582	11.899	11.644	16.536	18.908	5.240	10.373
df	4	4	4	4	4	4	4
Asymp. Sig	.004	.018	.020	.002	.001	.264	.035

Training Effectiveness Expectation Factors	Training Content Expectation	Trainee Performance Expectation	Expectations of Operator Knowledge and Skill	Expectations of Maintainer Knowledge and Skill
Chi-square	2.133	7.549	6.846	12.952
df	4	4	4	4
Asymp. Sig	.711	.110	.144	.012