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The role of an education in the behavioural sciences towards contributing to the safety culture of the maritime industry

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THE ROLE OF AN EDUCATION IN THE BEHAVIOURAL SCIENCES TOWARDS CONTRIBUTING TO THE SAFETY CULTURE OF THE MARITIME INDUSTRY

By

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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Ingratitude is worse than witchcraft

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ABSTRACT

Title of dissertation: **The role of an education in the behavioural sciences towards contributing to the safety culture of the maritime industry.**

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Developing a safety culture is a prime aim of the maritime industry as spearheaded by the International Maritime Organization. For several reasons such as number of accidents and a poor public image, safety culture is seen as a way to move beyond current levels to optimum safety. However, the human factor poses a challenge to the achievement of a safety culture and the dissertation argues that this is more so due to the neglect of a holistic engagement with the behavioural sciences in devising solutions to the need for non-technical skills.

Through literature review, case studies and interviews, the dissertation explores safety culture and the factors impacting its development. A number of factors which shape performance such as fatigue, lack of teamwork and poor situational awareness were identified as needing attention. The role of MET and the STCW in contributing to effective training of the seafarers to counter the negatives of the performance shaping factors was examined. It was found that both needed to be improved. The relevant aspects of the behavioural sciences were investigated to ascertain their contribution to creating awareness and understanding of the performance factors.

It was concluded that in order to develop a safety culture there has to be a holistic approach to the human factor and that the behavioural sciences has a role to play. It is recommended that with further research, the STCW considers making mandatory, the training in the relevant aspects of the behavioural sciences that are relevant to the development of the non-technical skills in the maritime industry.

KEYWORDS: Safety culture, behavioural sciences, human factor, maritime industry, maritime education and training, STCW convention.

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LIST OF ABBREVIATIONS

ATSB	Australian Transport Safety Bureau
BRM	Bridge Resource Management
ERM	Engine-room Resource Management
FSA	Formal Safety Assessment
HEAT	
HRA	Human Reliability Assessment
IFSMA	International Federation of Shipmasters' Associations
INSAG	International Nuclear Safety Advisory Group
IMO	International Maritime Organization
ISM	International Management Code for the Safe Operation of Ships and for Pollution Prevention (International Safety Management Code)
ISPS	International Ship and Port Facility Security Code
MAIB	Marine Accident Investigation Branch
MARCOM	Maritime Communication
MET	Maritime Education and Training
MRM	Marine Resource Management
NTSB	National Transportation Safety Board
METNET	Thematic Network on Maritime Education, Training and Mobility of Seafarers
PSC	Port State Control
PSF	Performance Shaping Factors
SOLAS	International Convention for the Safety of Life at Sea

STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978, as amended.
SMI	Swedish Maritime Inspectorate
STW	Standards of Training and Watchkeeping Sub-Committee

A little Learning is a dang'rous Thing;
Drink deep, or taste not the Pierian Spring:
There shallow Draughts intoxicate the Brain,
And drinking largely sobers us again.
Fir'd at first Sight with what the Muse imparts,
In fearless Youth we tempt the Heights of Arts,
While from the bounded Level of our Mind,
Short Views we take, nor see the lengths behind,
But more advanc'd, behold with strange Surprize
New, distant Scenes of endless Science rise!
So pleas'd at first, the towring Alps we try,
Mount o'er the Vales, and seem to tread the Sky;
Th' Eternal Snows appear already past,
And the first Clouds and Mountains seem the last:
But those attain'd, we tremble to survey
The growing Labours of the lengthen'd Way,
Th' increasing Prospect tires our wandering Eyes,
Hills peep o'er Hills, and Alps on Alps arise!

Excerpt from: "An Essay on Criticism" by Alexander Pope

CHAPTER 1
INTRODUCTION

ENGAGING THE SCIENCE OF MAN

> I have one gnawing concern which embraces the whole question as to why intelligent, well trained, highly-skilled and experienced professional seafarers make critical mistakes despite the advances in technology which have been designed to make them more efficient and, by inference safer in the way they operate. **It is extremely important that we should get to the root of this question so that we can introduce corrective measures**. [author's emphasis] (O'Neil, 2001).

At the turn of the 21st century when reflections are taking place as to the past and paths for the future, the maritime industry found itself at a cross roads of safety measures that were not bearing the expected fruits. The concern articulates a burgeoning realization that *something more* was needed in the industry to stem the number of accidents which were inimical to the International Maritime Organization's (IMO) goal of safer ships and cleaner oceans. The *more* that was needed turned the spotlight onto the **human factor** and that *something* has been translated into the establishment of a **safety culture.** This concern remains relevant as the industry seeks to understand and devise solutions to the role of the human factor in accidents (Barnett, 2005; Pekcan, et. al., 2005; IMO 2006a, 2007a, 2008). It is the subject of this dissertation that the behavioural sciences can assist in getting to the root of the question by offering insights into the human condition and suggesting areas for education and training.

This chapter introduces the subject of this dissertation by presenting an overview of the issues to be explored such as the human factor challenges as regards the establishment of a safety culture; behavioural factors that shape performance; a review of the maritime education and training regulatory regime and possible areas

within the behavioural sciences which may be incorporated to develop personal skills and abilities to contribute to safety culture as a whole.

The purpose of the opening question was to focus on the need to foreground the seafarers. Crucial aspects of their lives are not fully addressed – "certainly fatigue, boredom, health …family problems, pressure to meet schedules, shipboard living conditions…can all play a part" (O'Neil, 2001) in the seafarer contributing to accidents. Indeed fatigue, the most studied of those factors, has been implicated in many accidents (UK P & I Club, 1996; MAIB, 2004; Hetherington et. al., 2006; Lützhöft, et. al., 2008). However, fatigue is addressed mainly in physiological terms and the psychological dimensions are neglected (Smith 2007). These human factor variables are the "softer" non-technical skills, the nature of which needs a multi-disciplinary approach to solutions that include the behavioural sciences, which are currently peripheral in the maritime education and training regulatory regime and applied in an *ad hoc* way in the industry as a whole.

1.1 SAFETY CULTURE IN THE MARITIME INDUSTRY

Shipping faces negative perceptions as regards its safety and pollution record (Clayton, 2005; Kristiansen, 2005; Sohmen, 2005;). Although it is said that generally the total number of accidents are declining (Baker & McCafferty, 2005; Barnett, 2005; Owsley, 2005), a recent article in the ISM Code magazine (Reportism, 2008) laments the many collisions despite the existence of electronic aids to navigation, rules, and safety management procedures. Solutions to the problems of safety had focused primarily on the technological (Schager, 1998; Psaraftis, 2002; Eriksson & Mejia, 2003), a fact admitted by former secretary general of the IMO (O'Neil, 2002). The spotlight has now turned on the people leading to increased work in the industry (Eriksson & Mejia, 2003; Arthur D. Little Ltd. 2004; MAIB, 2004; Barnett, 2005), and the IMO where Members made submissions regarding understanding the human factor (IMO, 2003a; IMO, 2003b; IMO 2003c).

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) 1978 and the International Management Code for the Safe Operation of Ships and for Pollution Prevention (International Safety Management (ISM) Code), are the two instruments considered to address the human factor aspect of a safety culture (O'Neil 2001, 2002; Veiga, 2002; IMO, 2003a; Winbow, 2003; Bhattacharya, 2007; Fuazudeen, 2008). The STCW addresses the actors at the sharp end, the seafarers, while the ISM Code addresses the actors at the blunt end, management in the shipping companies. The success of these two instruments is in question (Pekcan, et. al. 2005; Bhattacharya, 2007; Fuazudeen, 2008) due to lack of global implementation (Veiga, 2002), and a lack of provisions for relevant aspects of the human factor (Pekcan, et. al., 2005; Barnett, et. al. 2006).

The STCW Convention focuses primarily on the technical competence (Gauw, 1994) and provisions regarding human and social competence are limited (Pekcan, et. al., 2005; Barnett, et. al. 2006). There are mixed perceptions regarding the ISM Code as, while it is viewed positively in some quarters, it is believed that it is most helpful to those at the middle of the safety continuum rather than those at the poles (Arthur D. Little Ltd., 2004).

Establishing a safety culture involves deliberate and sustained orchestration (Reason, 1997; Cooper, 2000; Hudson, 2001; Sudhakar, 2005), the cultivation of the correct mindset and behaviours (Veiga, 2002; IMO, 2003a; Manuel, 2005; Bhattacharya, 2007) and these two safety culture instruments do make substantial provisions in this regard. As has been confirmed, technological advancement does not automatically make operators more efficient, responsible or inculcate any of the behavioural imperatives necessary to ensure safe operations (Schager, 1998; O'Neil, 2001; Broadbent 2006; Reportism, 2008). Likewise, focus on organizational policies and procedures without equal focus on the people will not bear much fruit. The behavioural and attitudinal imperatives are developed through education and training with the appropriate content (Asyali, et. al., 2003; Barnett, 2005; Barnett, et. al.,

2006) and the industry has to be willing to fully engage all aspects of the human factor which cannot be accomplished without an engagement with the behavioural sciences – "The human factor, how people function, belongs to the domain of psychology." (Schager, 1998, p.63).

1.2 HUMAN FACTOR CONTRIBUTION TO MARITIME ACCIDENTS

Although only one of the sources that contribute to accidents (the others being technical and organizational), the human factor is seen as the main source in shipping (UK P & I Club, 1996; IMO, 2001; Baker & McCafferty, 2005; Barnett, 2005; Owsley, 2005; Hetherington, et. al., 2006). Yet the IMO's human element strategy (IMO, 2006a) does not include any provision for education and training, neither direct reference to welfare or working conditions. It may be extrapolated that areas of focus in the strategy such as a safety culture, safety management systems, incorporating ergonomic approaches and more inclusion of human element expertise in IMO's deliberations, may eventually lead to a full engagement with the more complex "human condition," but as with the experience of the STCW Convention, what is not explicitly stated is left to wide ranging interpretations (IMO, 1996; Fuazudeen, 2008). Other areas of neglect which influence safety are welfare and rights of seafarers. Job satisfaction and positive perceptions of rights may be viewed as defences against accidents. However, seafarers' rights have become a contentious issue in the industry (Gold, 2005; Mukherjee, & Mustafar, 2005; ITF, 2006; Donner, 2008; Zhang, 2008; Mukherjee, n.d.).

1.3 MARITIME EDUCATION AND TRAINING

Maritime education and training (MET) is seen as an important defence in accidents if training is adequate and relevant (Pekcan, et. al., 2005; Barnett, et. al. 2006). The STCW convention is the standard bearer for education and training and therefore has a critical role to play in the quest for a safety culture. It is instructive that an article in Lloyd's Ship Manager in 1992, (Seafarers' training needs…1992), called for a focus on basic skills and human factors. The discussion introduced the notion of the

"seafarer of the future" where it noted that education and training had to be conscious of the technical as well as the social-psychological dimensions, stressing the importance of understanding human behaviour. The article also noted that seafarers were "socially poor" and modern shipboard management required a broader set of skills. Yet, years later the discussion of providing a more holistic education remains on the table (Schröder, et. al., 2003; Ho, 2004; Manuel, 2005; Solanki, 2007). This is the role of MET to respond to the training needs of the industry. A more holistic approach to education would contribute to empowering the seafarer, making him more prepared to take on the demands of contemporary shipping as well as preparing him for roles in the shore-based maritime sector (Schröder, et. al., 2003; Solanki, 2007). Education in the behavioural sciences also promises to impart survival skills as regards welfare and health issues. It is believed that this kind of empowerment could also benefit the industry in terms of recruitment and retention of seafarers (Solanki, 2007). As such, a long term human resource strategy for the industry is seen as the prudent course of action (Solanki, 2007; Graveson, 2008).

1.4 THE BEHAVIOURAL SCIENCES

The maritime industry has been engaging the behavioural sciences evidenced by the proliferation of such concepts as leadership, power distance, fatigue, teamwork, communication, attitudes, complacency and destructive obedience, to name a few (Schager, 1998; MARCOM, 1999; MAIB, 2004; Kristiansen, 2005; Manuel, 2005; Sohmen, 2005; Horck, 2006, 2008a; Kahveci, 2007). The term *behavioural sciences*, as used in this dissertation, will be limited to psychology and social psychology as the concepts of interest stem mainly from these disciplines. Social psychology is seen as a branch of psychology which stresses the social nature of man as distinguishable from the individual focus of psychology (Hayes, 1993). The foregone discussion has revealed human factors as being of importance to the maritime industry's quest for a safety culture, noting the need for an engagement with the behavioural sciences as the area concerned with people.

The behavioural sciences have a rich tradition of research and theories that my assist in explanations and applications of strategies to the human factor challenge to safety culture. For example, theories and practical applications in perception (Zebrowitz, 1990) that may assist in the area of situational awareness; group dynamics (Brown, 2000) for areas such as team work, leadership and multi-cultural interactions on board. Figure 1-1 is an illustration of the relationship between the behavioural sciences and areas of a seafarer's life. This is not comprehensive but gives an example of where the behavioural sciences may be useful.

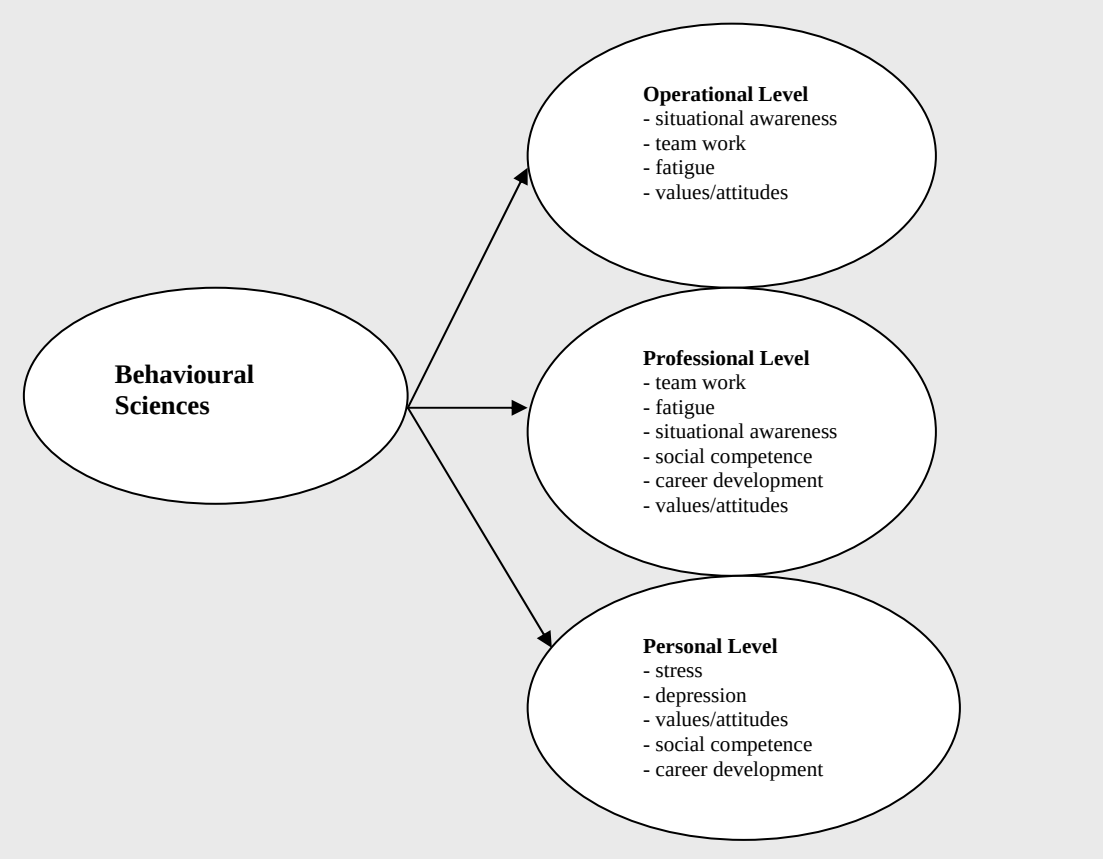

Figure 1-1: Relationship of the behavioural sciences to the three important areas of a seafarer's life. Source: Author

1.5 SUMMARY/STATEMENT OF THE PROBLEM

The discussion may be summarized as follows:

- There are problems in the maritime industry as regards safety.
- The human factor plays a substantial role in accidents.
- Many aspects of the human factor are behavioural, that is, belonging to the psychological and/or social-psychological realm.
- The IMO has opened the topic for debate and finding solutions, yet the regulatory regime is lacking in addressing it holistically.
- Maritime education and training has a role to play in transferring skills and knowledge that resides within the behavioural sciences so as to enhance the human factor contribution to a safety culture.

These are the ideas for exploration in the reminder of the dissertation. The dissertation does not discount the value of the technical approach of the STCW, neither the work of the IMO in safety. The wish is to point to other areas that may be of benefit to the industry if such strengths are harnessed. The human factor is complex and the way to access to any degree such complexities towards understanding and possible solutions is to engage the science of man. It is against this background that this dissertation explores what education in the behavioural sciences can contribute to meeting the challenges towards achieving a safety culture.

1.6 OBJECTIVE

The objective of the dissertation is to identify and explore the human factor challenges in developing a safety culture and the potential benefits of an education in the behavioural sciences towards achieving the same.

1.7 METHODOLOGY

The study is exploratory. As such a qualitative approach was taken using maritime casualty cases and the literature as the main sources of information. A limited number of interviews and discussions were held with persons from the seafaring

profession and MET institutions as well as one professional body. Special focus was given to the STCW Convention as the regulatory training regime and therefore extensive use was made of IMO papers.

Arising from background reading, the following research questions were developed:

1. What are the human factor challenges to arriving at a safety culture?
2. What provisions are there in the STCW to address these challenges?
3. What is the role of MET in meeting these challenges?
4. What can education in the behavioural sciences contribute towards meeting these challenges?

1.7.1 Cases

Accident analyses provide valuable sources of information on human factor contribution to casualties. As such it was thought that the use of cases would benefit the research process by substantiating the human factor challenges to safety culture. Five cases were selected for detailed exploration and five as supporting evidence. This however did not preclude the mention of other cases where relevant. The sources of cases were Horck (2006), Sampson (2003) and accident reports of the Marine Accident Investigation Branch (MAIB) and the internet. Original cases were read and selected on the basis of the investigators' analysis of the human factors. Therefore, accidents reporting fatigue, situational awareness, and teamwork were selected. These are the factors which shape performance and will be the focus in the dissertation. Human factor issues were grouped as per Table 1-1.

Table 1-1: Performance shaping factors identified in maritime accidents

PERFORMANCE SHAPING FACTORS		
Situational Awareness • perception • complacency • distraction • violations[1]	**Teamwork** • leadership • communication • destructive obedience • power distance	**Fatigue** • health • stress • welfare issues

Source: Author – compiled from accident reports and the literature.

[1] Violations are grouped here for convenience.

1.7.2 Literature review

The literature review served a two fold purpose; firstly, for generally guiding the research process, and secondly, as a source of data. As such the literature will be referred to throughout the dissertation. The literature was drawn from a number of sources: peer reviewed journals, books; conference proceedings; research reports; seminars; periodicals, class handouts and the internet. Sources were selected for their relevance to the topic and currency of information. This however did not preclude the use of sources that were dated but the information was relevant. The aim was to acquire a wide range of information from a variety of sources to achieve as global a picture as possible on the issues in keeping with the exploratory approach.

1.7.3 Interviews

This took the form of online discussions where questions were sent via email and responses returned and follow-up discussions, for clarification, took place where necessary via email. This was necessary as persons were either in another geographical location or indicated they preferred that method. One personal interview was done. A visit was made to one professional body, the Swedish Club to participate in a seminar in Maritime Resource Management (MRM). Discussions were held with the presenter and participants on the course who were from a popular cruise line.

1.7.4 Other Sources

Use was made of observations and notes taken on field trips to MET institutions in Europe as part of the WMU's curriculum for its students pursuing the MET specialization.

1.8 THEORETICAL CONSIDERATIONS/DEFINITION OF CONCEPTS

The dissertation explores and utilizes a number of theories as dictated by the four main concepts under discussion: safety culture, human factor, MET and the behavioural sciences. Each concept carries its own theoretical perspective(s) as

purported by practitioners and detractors alike. This section draws attention to the theories governing the concepts to be used as well as definitions of concepts to be introduced by the writer.

1.8.1 Safety Culture

Theories of safety culture surround its nature as an organizational approach to risk management. It rests on theories of culture and therefore has its foundation in anthropology (Cox and Flin, 1998; Cooper, 2000). Theories surround for example components: shared values, attitudes, commitment; management: such as top-down or bottom-up; its nature: whether it is something the organization *is* or something the organization *has*.

An accompanying concept is safety climate which, by its existence has contributed to the development of safety culture theories. Climate is seen as being on the surface and reflects perceptions of safety at a moment in time whereas culture lies below the surface (Cooper, 2000). The debate is divided on disciplinary lines. From a management perspective culture is something the organization *has* (Cooper, 2000; Reason 1997), meaning it can be orchestrated and is malleable (Reason, 1997). The contending perspective from the social scientists and academics sees culture as something the organization *is* (Cooper, 2000; Reason 1997) as it emerges as a property from the values, attitudes, and ideologies of all the members of the organization (Reason, 1997). Approaches to the achievement of safety culture is influenced by the view one holds and Reason is inclined towards the *has* theory. Although it may be rationalized that what an organization *has* may and does lead to what it *is*; and what it *is* drives what it *has*, as Reason (1997) comes to acknowledge at the end of his discussion on safety culture.

The dissertation operates on the premise of the mutual influences between the concepts but also takes the position that safety culture is something the organization *is*, in keeping with its anthropological influences. This position provides the basis for

later discussions on the maritime safety regime of rules and regulations as belonging to the realm of safety climate, what the organization *has*, which at best fosters a compliant culture. To achieve a safety culture, the dissertation argues, a holistic approach engaging the human factor as social-psychological beings has to be among the strategies, to create what the organization *is*.

1.8.2 Behavioural sciences

This is a general term used to refer to disciplines concerned with people and their place and behaviour in the social world, whether as individuals or as groups. Disciplines such as Sociology, Psychology, Anthropology and branches thereof fall in the realm of the behavioural sciences. For this dissertation the term *behavioural sciences* refers particularly to psychology, but also social psychology as a branch of psychology. Psychology is concerned with the individual while social psychology is concerned with social interactions (Hayes, 1993; Brown, 2000). Theories of salience to this work are cognitive theories such as perception and information processing explaining issues of situational awareness, and group theories for explanations of leadership, teamwork, and power etc.

1.8.3 Human factor

The concept human factor is largely an ergonomic term. The term human element is also used, both terms are taken to mean the same thing for the purposes of this dissertation. Using Hawkins' (1993) definition, human factor is about people in their working and living environment. "It is about their relationship with machines and equipment, with procedures and with the environment about them. And it is about their relationship with other people." (Hawkins' 1993, p.20). The area of concern for this dissertation is human factor highlighting the factors that shape performance as they are discussed in risk management analysis. The dissertation also takes some liberty and uses the term loosely in general reference to people and related issues.

1.8.4 Other Concepts

The dissertation has coined a number of concepts which are explained below:

- *Safety triad* – this concept is used to refer to the interrelationship of the technological, the organizational and the individual factors in safety-critical systems. Chapter 2.
- *Psycho-socio-technical system* – this concept refers to the elements of the *safety triad*. It is an extension of the socio-technical space to emphasize the place of the people in safety-critical systems. Chapter 2.
- *Idiosyncrasies* – this word, meaning a behavioural attribute that is distinctive and peculiar to an individual,[2] is used as a concept in the dissertation to refer to distinctly human behaviour and disposition such as those lying in the cognitive domain as peculiarities in perception or those mediated by culture such as power distance.

1.9 CHAPTER SUMMARY AND CONCLUSION

The chapter introduced the ideas surrounding the main concepts of safety culture, human factor, MET and behavioural sciences. The basic premise is that safety culture is seen as a desirable pursuit for the maritime industry to promote safer operations, improve public image and protect the marine environment. However, there are human factor challenges that are not solved solely by regulations or technical means. To devise appropriate solutions, the human factor must be understood on its terms. The behavioural sciences, as the science of man, have been underutilized in the maritime industry. It is suggested that a holistic approach is needed which entail training and education, but the STCW Convention needs to strengthen its provisions for the non-technical skills.

The remaining chapters develop on the ideas introduced in this chapter. Chapter 2 looks at safety culture in detail highlighting the place and role of the human factor and emphasizing the need for the behavioural sciences. Chapter 3 examines the

[2] Oxford Advanced Learners Dictionary.

factors that shape human performance as the source of erroneous acts and the target of intervention strategies. Chapter 4 is divided into two parts. The first section looks at MET and its role in developing the non-technical competence. The second section is a review of the STCW Convention to ascertain its provisions to address the human factor. Chapter 5 introduces the behavioural sciences *vis-à-vis* the accident cases and discusses their potential for contributing to a safety culture. Chapter 6 is an overall discussion bringing the whole together. It presents the aviation industry's CRM as an example of lessons to be learnt for the maritime industry. Chapter 7 concludes the arguments highlighting the contributions of the study and makes recommendations.

CHAPTER 2

SAFER SHIPPING DEMANDS A SAFETY CULTURE

2.1 INTRODUCTION

The three legged stool – the most important leg is the one that is missing (Patraiko, 2007).

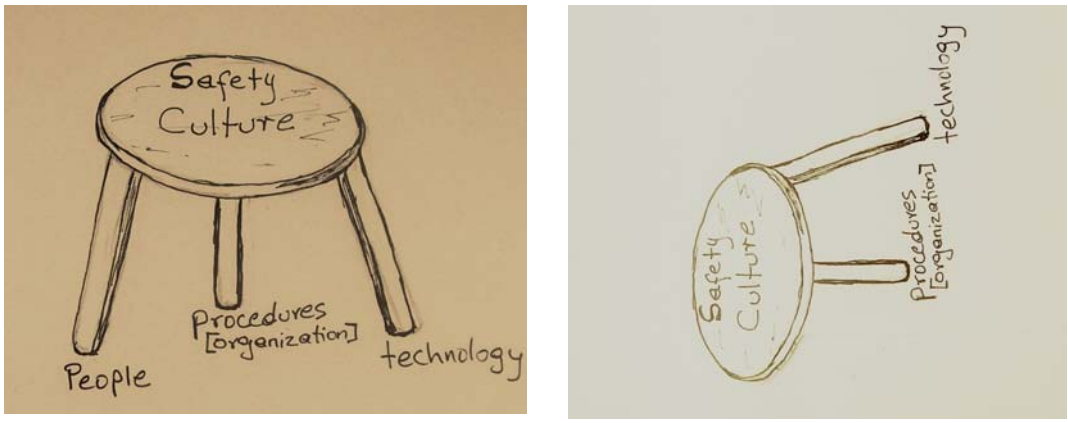

Figure 2-1: The three legged stool
Source: Patraiko (2007)

> *…while reflecting on the gains which have been made, a look to the future is also made to determine which areas offer the greatest opportunities for further advances….it has been recognized that there have been marked improvements in the casualty records… than was the case a decade ago. The records also show that there has been a concurrent decline in the amount of pollution entering the marine environment…These successes have been achieved mainly through improved standards and an enhanced regulatory regime… accompanied by the introduction of technologically advanced navigational systems.*
>
> ***However, it has also been recognized that the one area to which most accidents have been attributed – namely the human factor – while not being totally neglected in the past, was in need of greater attention.*** (O'Neil, 2002, p.1). [Author's emphasis]

The title for this chapter was adopted from the 2002 World Maritime Day message by former Secretary General of the IMO, William O'Neil where he unequivocally declared the need to focus on human behaviour as an intrinsic aspect of any quest towards a safety culture. It is instructive to note that this focus refers to actors both at the sharp and blunt ends "… the importance and advantages of creating a genuine safety culture in the people involved in all components of the shipping industry." (O'Neil, 2002, p.1). Leading players in the maritime industry have also acknowledged the importance of involving the people on ship, ashore and at the ship-shore interface (Arthur D. Little Ltd., 2004). This is not to suggest that such an approach is entirely new, but the decade of the 2000s has seen much more focus on the people as indispensable to the safety goals of the maritime industry (Veiga, 2002).

The focus of this chapter is safety culture and the place of people in defining and achieving a safety culture. On the one hand, safety culture is an organizational or industry approach to engender safety in the very being of the organization or the industry so that nothing is done without thinking safety (INSAG[3], 1991; Veiga, 2002). On the other hand, humans pose a challenge to this approach if they are not factored in all aspects; the human factor is the centre (Mathiesen, 1994; Arslan, & Er, 2006). People can be the champions of a safety culture or as equally, its adversary. So whereas the organization is the embodiment of safety culture, the people are the drivers, both as individuals and as groups and therefore conscious and deliberate actions should be taken to "engineer"[4] their place in the overall system.

There are many issues being discussed regarding safety culture. Chief among them are a lack of a common definition, contentions between safety culture and climate and the lack of consensus on the "cause, the content and consequences of safety culture" (Cooper, 2000; Guldenmund, 2000; Hale; 2000; Wiegmann, et. al., 2002; Zhang, et. al. 2002; Manuel, 2007). These discussions will be mentioned so far as

[3] International Nuclear Safety Advisory Group
[4] As used by Reason (1997) to suggest focused actions at developing.

they have implications for the human factor focus of this dissertation and are explored on the basis of: What is safety culture? Why the need for a safety culture? How is a safety culture achieved? (looking at a number of models); and whether the human factor is a challenge to safety culture. A brief discussion on the relationship of safety culture with security is presented as the two impacts each other and is a contentious issue within the maritime industry.

2.2 WHAT IS SAFETY CULTURE?

The term safety culture is said to have been introduced in the "Summary report on the post-accident review meeting on the Chernobyl accident" (INSAG, 1991). The term was further developed in a follow-up publication "Basic safety principles for nuclear power plant" (INSAG, 1991) bringing the term into "authoritative" usage (Reason, 1997; Cox & Flin, 1998). The dangers to life, property and the environment posed by high risk industries, such as shipping, were contrary to the demands of a modern society that had evolved beyond basic needs. Corporate society had to develop a social conscience and therefore the need to engender a safety culture in their organizations emerged as the *sine qua non* of responsible corporate operations.

The literature has revealed that safety culture is a complex multi-dimensional, multi-disciplinary concept which, for high risk industries, involves the dimensions of the *psycho-socio-technical*. Figure 2-2 is borrowed from Hollnagel (1998), to demonstrate the relationship among the three components of the system which this dissertation refers to as the *safety triad*. The term socio-technical has its foundation in ergonomics and is used in the literature, particularly in discussing the environment as created by the organizational and the technical aspects of the system. The addition of the psychological dimension, seeks to make obvious the need to focus on the people as feeling, sensing beings who should be understood within their domain as well as within an overall socio-technical system.

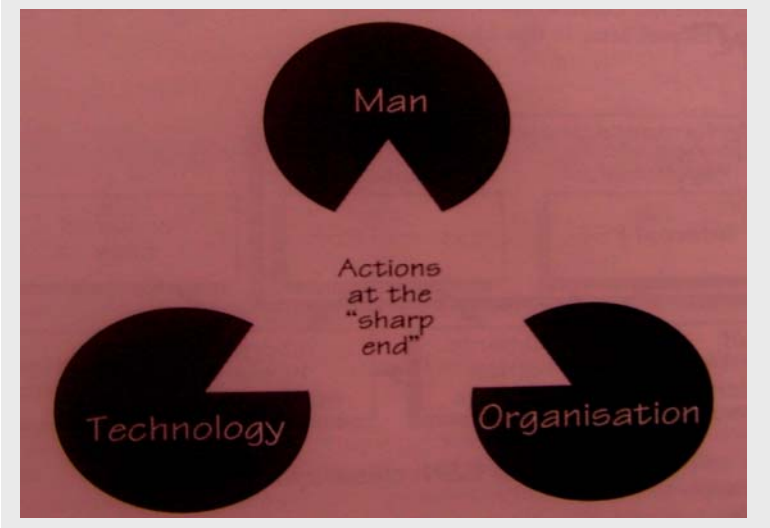

Figure 2-2: The relationship among the three components of the psycho-socio-technical space. Source: Hollnagel ,1998.

In the *safety triad*, *man* represents the people as individuals or groups within the system both at the blunt and sharp ends. The *organization* provides the social environment in terms of policies, rules and procedures, creating the socio-cultural milieu within which people meet each other and the technology. The *technology* provides the machinery (hardware and software) where man interfaces as an operator, or a monitor, depending on the nature of the technology. Actions at the sharp end are influenced by all actors within the system although they have significant implications for those in the immediate environment as the "inheritors" (Reason, 1997) of the actions of the others, but also as creators of their own actions. These three dimensions form the *safety triad* that has to operate in harmony if the quest for a safety culture is to become a reality.

2.2.1 Definition

Definitions of safety culture encompass its organizational genesis as well as the place of people in its realization. As such, its definitions have impacted methodologies to measure, assess and ultimately manage safety culture (Cooper, 2000; Guldenmund, 2000; Hale, 2000; Zhang, et. al. 2002; Human Engineering, 2005). However, one of the criticisms is the lack of a common definition (Cooper, 2000; Hale, 2000;

Wiegmann, et. al., 2002; Zhang, et. al. 2002). What may be arguably the first attempt at a definition of safety culture was by INSAG (1991, p.1) as "…that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance." As explained by INSAG, the aim was to reflect the attitudinal and structural composition of safety culture relating to the individual and the organizational respectively, and that the appropriate perceptions and actions were comparable with the importance of the concept (INSAG, 1991).

Since then, many other definitions have emerged as the concept gained currency which provide evidence that safety culture is not easily articulated (Cooper, 2000; Guldenmund, 2000; Hale, 2000; Human Engineering, 2005; Bhattacharya, 2007; Manuel, 2005, 2007). Turner's definition, as quoted by Cooper (2000) attempts to account for the organizational, the technical and the human factors – "the set of beliefs, norms, attitudes, roles and social and technical practices that are concerned with minimising the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious."

The definition that is arguably most widely used (HSL, 2002), and seemed to have gained favour in the maritime industry, as echoed by the ISM Code, is the UK's Health and Safety Commission's definition:

> The safety culture of an organization is the product of individual and group values, attitudes, competencies and patterns of behaviour that determine the commitment to, and style and proficiency of, an organization's health and safety programmes. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety, and by confidence in the efficacy of preventive measures." (As quoted in Reason, 1997, p. 194).

This definition seeks to capture the human aspects both as individuals and groups which are necessary to culminate in a desirable outcome of safety consciousness for the organization, through commitment.

Despite the criticism of lack of a common definition, there are common elements that have been identified which give direction to the concept as a whole. In their review of the safety culture literature Zhang et. al. (2002, pp.2-3) identified a number of common elements as to what constitutes safety culture:

- Safety culture is a concept defined at group level or higher, which refers to the *shared values* among all the group or organization members.
- Safety culture is concerned with formal safety issues in an organization, and closely related to, but not restricted to, the management and supervisory systems.
- Safety culture emphasizes the contribution from everyone at every level of an organization.
- The safety culture of an organization has an impact on its members' behaviour at work.
- Safety culture is usually reflected in the contingency between reward system and safety performance.
- Safety culture is reflected in an organization's willingness to develop and learn from errors, incidents, and accidents.
- Safety culture is relatively enduring, stable and resistant to change.

These points of convergence suggest that there is some agreement as to what the contents of safety culture are. Perhaps the approach is to focus on the elements of salience as was done by the Human Engineering (2005) when faced with the task of developing as safety culture tool kit following two rail accidents.

2.2.2 Safety Culture and Safety Climate

A brief exploration of safety culture versus safety climate is necessary as this is another area of contention associated with definition, measurement and management. The distinction between the two concepts has been an ongoing debate (Cox & Flin, 1998; Guldenmund, 2000; HSL, 2002; Wiegmann, et. al., 2002; Zhang, et. al., 2002: Ek, 2006; Manuel, 2007). Safety culture and climate were at times used interchangeably (Cox & Flin, 1998); the general preference however is to separate both concepts. The debate between the concepts may have arisen because, as Cox and Flin (1998) explained, both terms developed in parallel but have distinct etymologies arising from separate theoretical roots. They noted that earlier ideas of climate had a social psychological background and was used later on for the measurable characteristics of organization, therefore the use of quantitative measurement tools such as questionnaires. Safety climate is seen as a "snapshot" (Glendon & Stanton, 2000; Wiegmann, et. al., 2002; Sudhakar, 2005) reflecting the perceptions of the employees in an organization at a particular point in time (Guldenmund, 2000; HSL, 2002; Zhang, et. al. 2002). Figure 2-3 is the iceberg metaphor used to demonstrate the distinction between the concepts (Manuel, 2007).

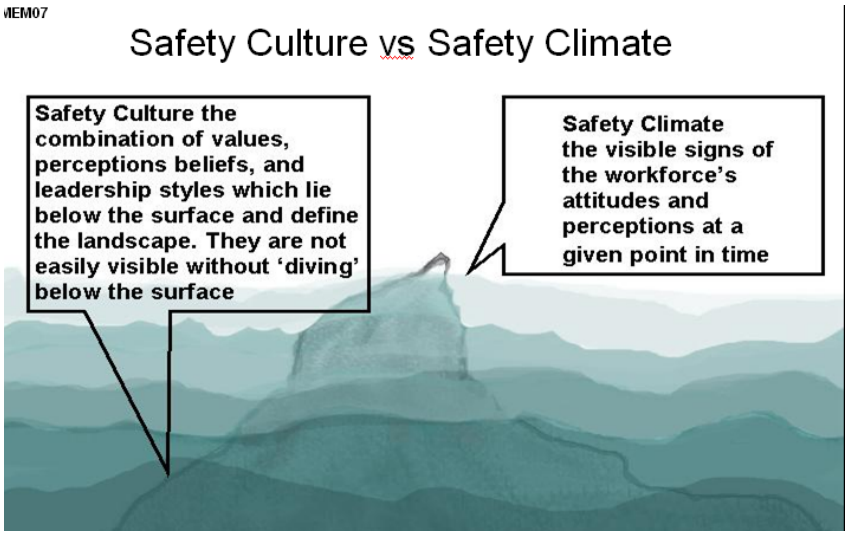

Figure 2-3: The iceberg metaphor of safety culture and safety climate
Source: Safety Culture Bulletin 2002 as quoted in Manuel, 2007

Culture has its roots in anthropology (Cox & Flin, 1998; Ek, 2006). The emphasis on culture initially "…was on uncovering deeper organizational values, underlying assumptions and symbolism associated with artefacts[5], rituals, norms and rites of passage" (Cox & Flin, 1998 p. 191). This perspective has informed subsequent approaches to safety culture as seen in the definitions discussed. Culture is pervasive (Zhang, et. al. 2002) lying at a deeper level than climate, "below the iceberg" (Manuel, 2007); its measures are therefore qualitative (Cox & Flin, 1998).

The dissertation takes the position of Mearns, et al. (1998) who believe that theoretical distinctions should be drawn and empirical investigations should be clear on which concept is being measured. Such distinction is helpful because, whereas climate may be indicative of the underlying conditions and hence culture (Wiegmann, 2002), people's "real" attitudes and perceptions are not easily captured through "snapshot" quantitative methods, for a number of reasons – fear, job security etc. Climate indicators need validation to be interpreted in a cultural framework (Glendon & Stanton, 2000).

This writer sees the usefulness of climate as a desirable stage in the progression towards a safety culture (Guldenmund, 2000). Mathiesen (1994) identified three types of culture in the maritime industry: evasive, compliant and safety culture, to which Sudhaker (2005) has added uninformed culture. These are explained in Section 2.5.1.4 (Figure 2-8). Climate measures may be valuable for diagnosing an organization's state of compliance and therefore becomes a useful audit tool. Having a climate may be the final step in a "have to" (compliant) culture and steps may be taken to move to a "want to" (safety) culture. Climate may be achieved through rules, regulations and compliance with safety systems which is helpful towards a safety culture. This distinction is necessary to reflect the complexity of the main element, the people, who may present a desirable picture for a "snapshot" yet disguising the picture below the surface - safety culture is "a way of life" (Veiga, 2002).

[5] Language, technology, products etc. (Ek, 2006)

2.3 WHY A SAFETY CULTURE FOR THE MARITIME INDUSTRY?

The fervent engagement with safety culture in the literature, across high risk industries such as aviation, nuclear and transportation, compels one to coin the maxim *safety is a virtue*. Safety culture emerged as an organizational approach to understanding and managing health and safety issues at work (Cox & Flin, 1998; Cooper, 2000; Batteau, 2001; Zhang, et. al., 2002; Ek, 2005; Wiegmann, et.al. 2007). For the maritime industry, human factor is said to be the major contributor to accidents. A review of major[6] accident databases by Baker and McCafferty (2005, p.70) reveal that management practices, failures of situation awareness and risk taking/risk tolerance account for 25% of accidents. Also 80 to 85% of accidents were either directly initiated by human error or were associated with human error. It is believed that a safety culture will contribute towards a reduction in such figures. Although cautioned by Cox and Flin (1998) that expectations of safety culture may be overinflated, it is nonetheless a desirable goal for the maritime industry as there is no denying the need to protect life, property and the environment which is the promise of a safety culture if it is realized.

Safety remains one of the fundamental objectives of the IMO, but an "over-riding" challenge is "how [to] improve global maritime safety still further?" (Mitropoulos, 2004). The IMO's efforts at promoting a safety culture are evidenced by the development of the ISM Code and the STCW convention (Veiga, 2002; Manuel, 2005; Bhattacharya, 2007; Fuazudeen, 2008), but good intentions do not make sensational headlines. Shipping has a poor image which makes a safety culture even more urgent. Figure 2-4 are a few headlines which demonstrate the public's attitude towards shipping. Additionally, names such as the *Torrey Canyon*, *Amoco Cadiz*, *Exxon Valdez* and the *Prestige* have gone down in infamy for causing extensive environmental damages. Likewise, when the vessels' management contravene the

[6] United States Coast Guard, Marine Accident Investigation Board (UK), Transport Safety Board (Canada), Australian Transportation Safety Board, The Nautical Institute's Marine Accident Reporting Scheme (MARS), The Det Norske Veritas Worldwide Offshore Accident Database (WOAD)

rules and regulations, as in the case of the *Herald of Free Enterprise*, and the *Erika*, or the *Exxon Valdez* where the master was said to be under the influence of alcohol, the public demand for "heads" increases.

Prestige captain on $3m bail	**Chirac hits at 'gangsters of sea'**	**Cancer fears over oil spill**
MADRID, Spain (CNN) -- The Greek captain of the sunken oil tanker Prestige left a Spanish jail after nearly three months following the posting of a $3 million bond. http://edition.cnn.com/2003/WORLD/europe/02/07/prestige.captain/index.html	PARIS, France (CNN) -- President Jacques Chirac has blamed the "gangsters of the sea" for the millions of oil pellets that are beginning to float onto France's beaches. http://edition.cnn.com/2003/WORLD/europe/01/03/prestige.chirac/index.html	Volunteers who helped clean oil spilt by the tanker, Erika, which broke up off north-west France in December, have been told they could be at risk from cancer. http://news.bbc.co.uk/2/hi/europe/677180.stm
Human error led to the sinking of the "Bow Mariner"		
The final report by the US Coast Guard on the explosion and sinking of the 1982-built, chemical/product tanker "Bow Mariner" on February 28 last year in the Atlantic, is grim reading and bears witness of human error and inadequate operational management. http://www.shipgaz.com/magazine/issues/2006/02/0206_article.php		

Figure 2-4: headlines to news items.
Source: various sources online as per websites.

In addition to the corporate need, many other issues of health and safety, welfare and rights of the seafarers also hinge on the development of a safety culture. According to Broadbent (2006, p.1), "optimal safety cultures typically provide the necessary support for employees to strive beyond minimal efforts." It is said that morale in the industry is low and seafarers' welfare, health and safety are neglected (Stevenson, 2002; Nielsen & Panayides, 2005; ITF, 2006; Kahveci, 2007). A safety culture therefore offers many promises of safer, cleaner oceans, protection of the environment and a more people-caring industry.

2.3.1 Safety in Shipping

Of all the high risk industries, the maritime industry has had the longest history of establishing a safety regime. This can be traced to ancient laws governing various aspects such as construction, use of ships and cargo carriage. These laws were mainly to protect property and commercial interests, rather than for safety as a

virtue[7]. Other more substantial laws were developed overtime throughout antiquity and into modern society (Zhang, 2008)[8].

For modern society, the establishment of a safety regime through rules and regulations had been tumultuous arising from excessive loss of lives in the British merchant navy and resistance to the establishment of laws to govern safe shipping (Veiga, 2002; Jones, 2006). Although these were national laws, they ultimately had influence of international proportions due to Britain's position and impact in maritime history and as a colonial power where it bequeathed its laws to its colonies. Table 2-1 provides a listing of international efforts at regulating maritime safety. The approach to safety has been reactionary to major accidents, such as the *Titanic*, *Herald of Free Enterprise*, *Estonia* etc., with strong technical components and neglect of the non-technical skills.

Table 2-1: Milestones in maritime safety

Year	Initiative or regulation
1914	• Safety of Life at Sea (SOLAS): Ship design and lifesaving equipment
1929	• First international conference to consider hull subdivision regulations
1948	• The International Maritime (Consultative) Organization (IMO) is set up as a United Nations agency
1966	• Load Line Convention: Maximum loading and hull strength • Rules of the road • The International Association of Classification Societies (IACS): Harmonization of classification rules and regulations
1969	• Tonnage Convention
1972	• International Convention on the International Regulations for Preventing Collisions at Sea (COLREG)
1973	• Marine Pollution Convention (MARPOL 73)
1974	• IMO resolution on probabilistic analysis of hull subdivision
1978	• International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW 78)
1979	• International Convention on Maritime Search and Rescue (SAR)
1988	• The Global Maritime Distress and Safety System (GMDSS)

Source: Kristiansen, 2005 p. 10

[7] See for example, Code of Hammurabi, paragraphs 234-240

[8] For example The Rhodian Sea Code, 7th or 8th Century; The Rôles of Oléron, 13th Century; The Judgements of the Damme, 13th Century; The Rules of Wisby, 13th Century; The Black Book of the Admiralty, 14th Century; The Ordonnance de la Marine, 1681; and the British Merchant Shipping Act, 1850.

2.3.1.1 Can safety culture be regulated?

"…Although the behaviour of individuals may be influenced by a set of rules, it is their attitude to the rules that really determines the culture. Do they comply because they want to, or because they have to?" (O'Neil, 2002 p.1).

The safety regime of the maritime industry rests on international conventions and regulations (Psaraftis, 2002; Veiga, 2002). It is the position of this dissertation that the regulatory regime (eg. ISM and STCW) and the enforcement regime through port state control (PSC) facilitate compliance at best, but more is needed to develop a safety culture (Mathiesen, 1994; Broadbent, 2006; Bhattacharya, 2007). This is not an indictment on the regulatory regime, its success lies in effective implementation in the right environment that would allow the founding principles to flourish.[9] This environment has to be "engineered" as Reason (1997) puts it. For example, in the United States it was discovered that regulations do not instil desirable attitudes for voluntary compliance as regards road traffic (Foss, 2007). Compliance was achieved with sustained and deliberate actions, including enforcement. The international nature of shipping necessitates voluntary compliance, and this is more challenging with substandard shipping. It is recognized in the ISM Code that "In matters of safety and pollution prevention it is the commitment, competence, attitudes and motivation of individuals at all levels that determines the end result." (IMO, 2002, p.5). Internalized values, manifesting themselves through appropriate attitudes and behaviours are the hallmark of a safety culture (Guldenmund, 2000; Cooper, 2000). Safety culture for Manuel (2005) is associated with ethics. On their own, rules and regulations do not make people ethical, except they are mediated by affect (Nichols, 2002), which requires deliberate actions.

The existence of sub-standard shipping (Mathiesen, 1994; Lang, 2001; Arthur D. Little Ltd., 2004; ITF, 2006) is evidence that not all players in the industry are ethical

[9] Bhattacharya (2007) in his study on the influence of the ISM Code on safety culture, demonstrates that its principles are defeated by autocratic environments that engender fear.

hence there is a role for the regulators to fill the gap where there is not the organizational consciousness or will to develop a safety culture. To circumvent the organizational deficiencies, the dissertation sees a possible solution in targeting the education of the seafarers to instil the desirable values and attitudes that will be tapped regardless of employer (Manuel, 2005). Regulations and enforcement strategies are features of a compliant culture where the necessary actions are taken to avoid the consequences (Mathiesen, 1994; Manuel, 2005; Foss, 2007). A safety culture goes beyond to an advanced stage (Bhattacharya, 2007) of thinking and *doing* safety. Safety systems may be robust but they are insufficient if they are merely applied mechanically (Hudson, 2001; INSAG, 1991), or if they are founded on wrong principles (Foss, 2007). Safety systems "… need an effective safety culture to *flourish*" (Hudson, 2001, p.3).

2.4 HUMAN FACTOR: A CHALLENGE TO SAFETY CULTURE?

Accidents are usually the starting point to question an organization's safety culture or lack thereof (eg. Chernobyl, *Herald of Free Enterprise*) (Glendon & Stanton, 2000; Ek, 2006). It has been said throughout the literature that the human factor contributes to a large percentage of accidents. Although it is realized that such figures lie in the complex interrelationship of technological, organizational, individual and group factors (Perrow, 1999; Ek, 2006), the operators at the sharp end are usually the focus of an accident for the maritime industry.

In looking at causal factors, Kristiansen (2005) identified from an analysis of 419 groundings, that core causal factors involve "soft" problems of work conditions, human performance and neglect. Neglect is sub-divided into "failure in watch performance" and "individual human conditions." Others have identified such causes as communication, language and cultural diversity (MARCOM, 1991; Hetherington, et. al., 2006; Horck, 2006), teamwork, stress and health issues (Stevenson, 2002; Hetherington, et. al., 2006). These factors may be aligned with Kristiansen's "human conditions." The most dominant contributory factor has been identified as lack of

situation awareness and fatigue (MAIB, 2004; Baker & McCafferty, 2005; Barnett, 2005; Hetherington, et. al., 2006; Owsley, 2005). Barnett (2005) and UK P & I Club (1996) have also found violations as another common factor in accidents, possibly stemming from attitudes to risk (and some amount of male machismo - ego)[10]

As a contributory factor to accident, Kristiansen's (2005) "human conditions" could also been seen in terms of neglect of seafarers' welfare that may affect job satisfaction which is important in developing a safety culture. According to the UK's submission to the IMO (2003a), job satisfaction is one of the key indicators of a safety culture, a lack of which can thwart any safety strategy as management is viewed with mistrust and suspicion. Poor welfare may also lead to depression and isolation (Kahveci, 2007; Thomas, 2003) affecting mental health and performance. The UK P & I Club (1996) acknowledges the role of "states of mind" in accidents.

Addressing the root of factors that shape performance, which many see as lying in the organization (Reason, 1997; Dekker, 2006), is not disputed, but the human condition is complex and its influence should not be denied (Foss, 2007). As Broadbent (2006, p.1) sees it "safety [culture] requires people to adopt a set of habits and ways of thinking that are often difficult and unnatural (eg. reporting one's own mistakes…)," "*it is human nature to cover things up. There is a fear of criticism and reprisal from the company*" (Arthur D. Little Ltd. 2004, p.63). Solutions to such primal responses lie in education of the individual to impact the relevant attitudes and behaviour formation.

Further, the maritime industry has unique challenges that necessitate an engagement with the sharp end, at the same time it attempts solutions directed at the organization. These challenges include sub-standard shipping, an open register regime which

[10] In investigating the *Bow Mariner* casualty, the investigator had an interview with the Chief Officer of the sister ship, the *Bow Transporter*, regarding operational procedures as outlined in manuals the investigator noted "…the Chief Officer of the Bow Transporter scoffed at suggestions that the Cargo and Ballast Operations Manual was governing stating that his '30 years of chemical tanker experience' was all he needed to perform his job.

spreads the company's responsibilities across organizations and countries; it is sometimes difficult to identify a company, more so to police its operations; management is outsourced, seafarers are on relatively short term contracts and therefore time to instil company's values and attitudes, if these exist, is not sufficient. Challenges such as these make the development of a safety culture difficult as it must be admitted that not all owners are interested. In brief, those at the sharp end are left to learn by trial and error many aspects of the human-human interface. For example the *Crimson Mars* grounding where it was reported that the pilot had a "one-on-one" communication with the helmsman to put him at ease so he could offer challenge if any orders given appeared "stupid" but this made the situation more tense, and was interpreted as an "inappropriate joke" by the others on the bridge. Therefore, intervention at the level of maritime education and training is recommended (Arthur D. Little Ltd. 2004; Sudhakar, 2005; Manuel 2005, 2007; Horck, 2006, 2008), where the lessons are learnt to create mental models of appropriate responses before they are needed.

2.5 HOW IS SAFETY CULTURE ACHIEVED?

Commitment of the people at all levels to the safety goals and principles has been a consistent theme throughout the literature. As said before, safety culture is an organizational response to risks. Yet individual actions cannot be separated, although writers such as Reason (1997) thinks from an organizational perspective on the premise that one cannot change the human condition, but one can change the conditions under which people work. At times the conditions are right, but humans in all our complexities also pose a risk (Foss, 2007). For INSAG (1991), safety culture operates in a framework where management and policy provide the direction and individuals provide the appropriate responses to those policies. An individual approach is also evident where maritime education is discussed as one of the strategies towards a safety culture (Manuel, 2005, 2007; Sudhakar, 2005). Manuel, (2005) offers an alternative definition for culture:- "The cultivating or development (of the mind, faculties, emotions) - improvement or refinement by education and

training – the result of such refinement." – which may be adapted for the purposes of this dissertation to suggest an educational approach as one of the strategies to achieving a safety culture. Such a definition of safety culture may be:- *The cultivating or development (of the mind, faculties, emotions) of the safety imperatives within the individual through appropriate education and training.*

2.5.1 Approaches to Achieving Safety Culture

2.5.1.1 Social Engineering

Reason (1997) sees the development of safety culture as "social engineering," where deliberate actions are taken by the organization to instil safety in all aspects of its operations. An organization with a safety culture possesses the following characteristics (Reason, 1997, pp. 195-196):

- an informed culture – continuously collects data regarding the "many entities that may penetrate its barriers" and uses these constructively to ward off complacency. The organization must not forget to be afraid.
- a reporting culture – the people at the sharp end are willing to report their errors and near-misses without fear of punishment.
- a just culture – an atmosphere of trust where people are encouraged when behaviours are appropriate and contribute to safety, and they are also aware of unacceptable behaviours.
- a flexible culture – adaptability to changing demands, as such power and authority does not interfere with the safe procedures. Control of a hazardous situation passes to the person with the knowledge on the spot and reverts when the situation is returned to normal.
- and a learning culture – where lessons are taken from the system and a willingness to make major reforms if these are needed.

For Reason, safety culture equals an informed culture and the others are seen as subcomponents. These must be "engineered" through deliberate actions on the part of the organization.

2.5.1.2 Evolutionary Model

Hudson, (2001) stresses the development of solid individual and organizational safety management skills that have to be cultivated: "skills have to be developed, and require practice; they do not suddenly appear just because you read the manual" (p.6). Writing from an aviation perspective, Hudson (2001) combines Reason and Westrum to develop this approach. Reason's categories have been summarized into the following:

- A safety culture is informed at all levels
- A safety culture exhibits trust by all parties
- A safety culture is adaptable to changes in conditions
- A safety culture worries

Figure 2-5 is the adapted Westrum's model which shows the movement with increasing trust and "informedness", from a pathological stage to the highest level of a generative stage which is the place of safety culture. The rationale for an evolutionary model is that it gives direction, where the organization is going (Hudson, 2001). The development of good safety management skills which is learnt and practiced is the mainstay of this approach.

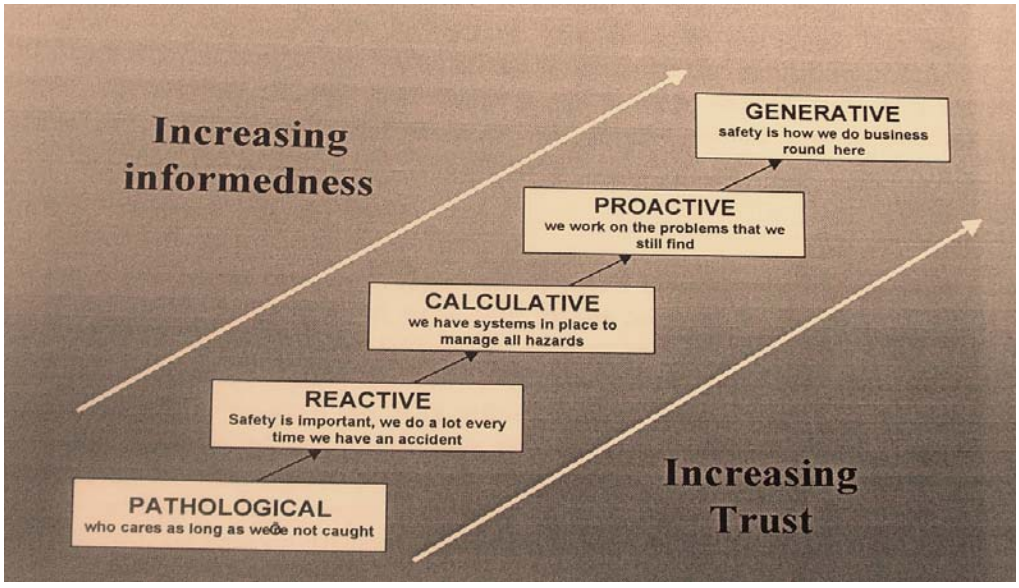

Figure 2-5: Hudson's evolutionary model of safety cultures
Source: Hudson (2001)

Both the social engineering and evolutionary models involve the development of skills, attitudes, mutual respect for members in the organization, they involve flexibility, willingness to change, commitment, and learning. Both Hudson (2001) and Reason (1997) admit that safety culture is not necessarily an easy pursuit but it is a desirable pursuit.

2.5.1.3 Reciprocal Safety Culture Model

Cooper (2000) proposed a goal making model whereby safety culture is seen as a super-ordinate goal. This model is an adaptation of Bandura's model of reciprocal determinism. Cooper (2000 p.116) believed "the creation or enhancement of a safety culture is dependent upon the deliberate manipulation of various organisational characteristics thought to impact upon safety management practices", hence a theory of action. Each characteristic is viewed as a sub-goal, the antecedents, leading to a safety culture, the behaviour and consequences which are the goal-achievements. The model (Figure 2-6) emphasises the "reciprocal relationship" among the behavioural, situational and psychological and therefore sees a holistic engagement to successfully arrive at a safety culture as imperative.

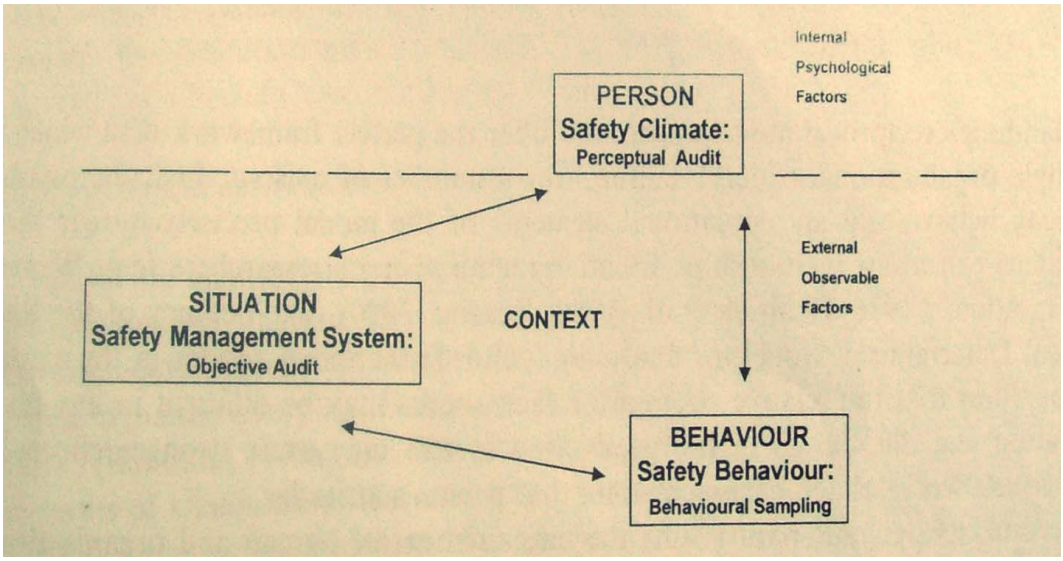

Figure 2-6: Cooper's Reciprocal safety culture model
Source: Cooper (2000)

2.5.1.4 The Convergence Model

Sudhakar (2005) proposed a convergence model where the top-down and bottom-up approaches to safety culture are merged, Figure 2-7. Writing from a maritime industry perspective, Sudhakar presents his model in the ambit of safety as a risk management tool. The top-down approach sees safety culture as a sub-set of organizational culture and the bottom-up approach sees safety culture as learned behaviour. Safety culture existing in the industry takes four possible forms as outlined by the road map to safety culture (Figure 2-8) (Sudhakar, 2005). It is therefore suggesting that to move from an uninformed culture to a safety culture the "interactive relationship" (Cooper, 2000) among the stakeholders must be "engineered" (Reason, 1997), which is also a reciprocal relationship of another kind, but necessary to achieve the goal of a safety culture.

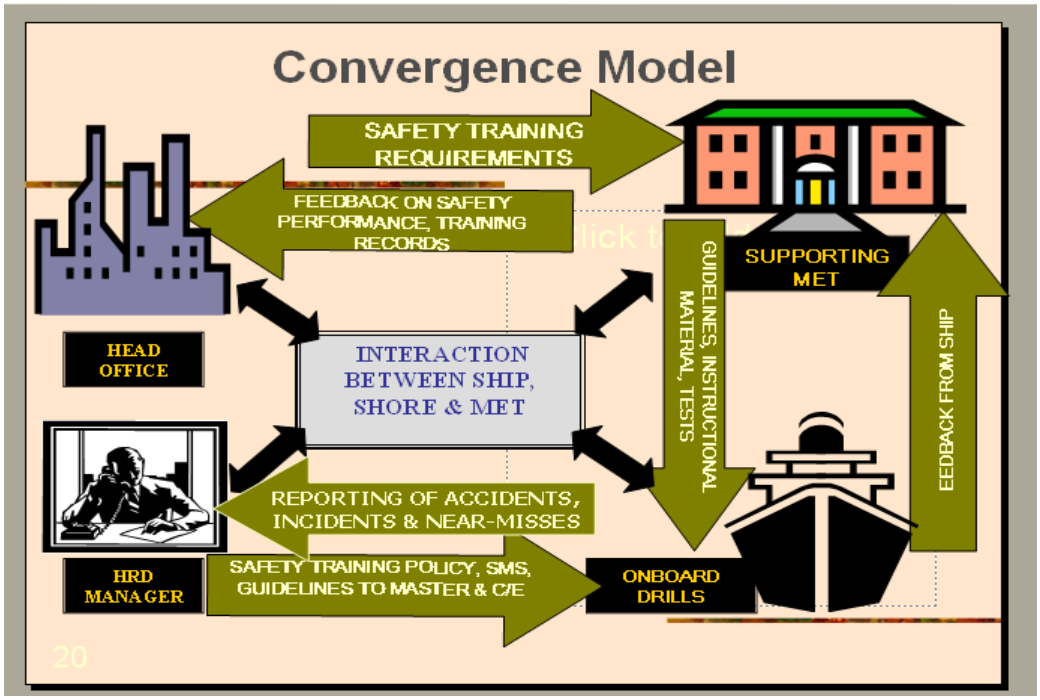

Figure 2-7: Convergence Model
Source: Sudhakar (2005).

UNINFORMED CULTURE Symptoms	EVASION CULTURE Symptoms	COMPLIANCE CULTURE symptoms	SAFETY CULTURE symptoms
-gaps in knowledge and skills needed for safe operations -poor emergency preparedness -lack of training -absence of exercises	-perfunctory approach -focus on paperwork -appearances are most important -inadequate training -poor emergency response	-focus on compliance -conversant with rules -flawless records -safe practices a routine -extensive checklists -inability to deal with unforeseen emergencies	-safety awareness visible throughout -collective approach -proactive risk identification -high degrees of preparedness -cohesive team
Culturally driven beliefs	**Culturally driven beliefs**	**Behaviour pattern**	**Behaviour pattern**
.fatalism **.safety measures increased accident risk** **.no matter what you do, accidents will still occur**	**.excessive safety is "bookish"** **.'smart' operations involve cutting corners** **.the chief objective is not to get into trouble with authorities**	**.discipline** **.obedience to rules** **.clear role definition** **.pride in doing things right** **.group commitment** **.clean record matters most**	**.clarity of objectives** **.positive group dynamics** **.professionalism** **.sure support** **.confident in emergencies**

Figure 2-8: A Road Map to Safety Culture
Source: Sudhakar (2005).

The models demonstrate that safety culture rests on the people. Reason (1997) and Cooper (2000) presented general organizational models, with Reason presenting from a managerial/leadership perspective, while Cooper's model is based on a more social psychological view. Hudson wrote from an aviation perspective, presenting an organizational psychology model and Sudhakar's model is an organizational/ educational model. What these models offer are differing perspectives on addressing the human factor that may be adopted according to the nature of the organization or the industry within which one is operating. The point of convergence for the models is that achieving a safety culture arises from deliberate efforts at engineering (Reason), cultivating (Hudson), developing by deliberate manipulation (Cooper) and fostering linkages (Sudhakar); they stress the need for a holistic approach to the human factor in safety culture predicated on behaviour modification. Therefore to reiterate the adapted definition of safety culture: *The cultivating or development (of the mind, faculties, emotions) of the safety imperatives within the individual through appropriate education and training.*

2.6 SAFETY AND SECURITY

Any discussion of safety in shipping necessitates, at the very least, a mention of security as it impacts the seafarer's performance. A quote from Benjamin Franklin "The way to be safe is never to be secure" (quoted in Schröder, et. al.) sums up the tensions between the concepts.

In Jamaica (my home country) it has become standard procedure in certain parts to construct homes with burglar bars as a means of access control due to crime problems. These ensure security but present direct threats to safety in the event of dangers such as fires. Persons have been known to die in fires because they could not leave the house as the keys to the burglar bars could not be found (possibly a case of panic), or they lie unconscious from smoke inhalation and nobody could get in… secure, but not safe.

The IMO's commitment to security is firmly embedded in the amended motto of "safer, *secure*, efficient shipping on cleaner seas." The maritime industry's security regime has been adequately documented by a number of researchers in the area (Mejia, 2007; Mensah, 2005). The most recent addition to the security regime, the International Ship and Port Facility Security (ISPS) Code, has given rise to tensions between safety and security. The background and rationale for the implementation of the ISPS Code are well known (Franson, 2005; Wright 2006). Safety and security have been at logger heads since the implementation of the Code. At the very minimum, it has added to the administrative responsibilities aboard, hence increased workload (Schröder et.al. 2006; ITF, 2006) amidst concerns of fatigue and lack of situational awareness (Barnett, 2005; Hetherington, et. al. 2006) which are implicated in weakening the system's defences against accidents.

Additionally, seafarers' right to shore leave has become a contentious issue since the increased attempts at security (ITF campaigns…2004; Mukherjee & Mustafar, 2005; Grey, 2006; ITF, 2006). Lack of shore leave exacerbates health issues, particularly

mental health such as stress, isolation and boredom, (Kahveci, 2007) and compounds the possible negative effects on performance (Schröder, et. al. 2006). Issues of conflicts of interest (Schröder, et. al. 2006), and overall mistrust in the industry surrounding perceptions of unfair treatment at ports (ITF campaigns…2004; ITF, 2006; Joshi, 2004; Grey, 2006) have impacted on an amicable union between safety and security. An attempt at addressing possible conflicts is found in provisions of the ISPS Code section 11.11 (IMO, 2003d), where it is the duty of the company security officer (CSO) to ensure consistency between security and safety requirements. Additionally, Regulation 8 of Chapter XI-2 of the International Convention for the Safety of Life at Sea (SOLAS) 1974, gives the master power to prioritize safety over security where such conflicts arise during operations, but such jurisdiction does not go beyond the guard rails of the ship and may of the issues are with border personnel (ITF campaigns…2004; Joshi, 2004; Grey, 2006; A question of balance, 2007).

The relationship between safety and security does not have to be acrimonious as both are affected by similar complexities and human idiosyncrasies. Harmonization is necessary to reduce the tensions and increase the scope for cooperation (Schröder, et. al. 2006; A question of balance, 2007). Despite the separation of security and safety in maritime studies (Mejia, 2007), there are grounds to subsume security under an overall safety regime, as vulnerabilities to security threats also compromise safety. It would therefore be useful to strike a balance and engage the human factor issues for both safety and security simultaneously so there is not a reinvention of the wheel when it is discovered that *more* is needed to ensure persons not only comply with security measures but internalize them as well, as is the current challenge with safety. The term security culture has already been mentioned in the human element strategy, MSC/MEPC 7/Circ. 4 (IMO, 2006b).

2.7 CHAPTER SUMMARY AND CONCLUSION

A number of issues were looked at in this chapter. It was ascertained that although the genesis of safety culture is organizational, it places great emphasis on the people as their responses and attitudes towards safety culture is key to its realization. It was shown that there are many definitions for safety culture but there are points of convergence which gives guidance in identifying workable approaches to achieving a safety culture. Culture and climate are differentiated on the basis of compliance versus an advanced response to safety. Although climate may be an indication of culture, it measures perceptions at a particular moment in time whereas culture is more pervasive. This distinction has implications for the maritime industry's safety regime. The chapter makes a distinction between the maritime industry's safety approaches which, while being robust, does not necessarily engender a safety culture, and may, at the most achieve a safety climate, as the key ingredient, the people, have been left out of the loop in a holistic way.

Safety culture is a necessary goal for the maritime industry to stem its accident and near miss records through addressing the human factor in all aspects of the *safety triad*. A number of approaches exist that are useful in guiding the development of a safety culture but the maritime industry has additional challenges that are unique to its nature. Challenges such as sub-standard shipping, an open register regime, differences in the vigilance of PSC regime, make it difficult for this industry, more than any other industry, to pilot the development of a safety culture. Having safety systems in place without the commitment of the people at all levels is tantamount to not having a system. As demonstrated in this chapter, the human factor is essential to the successful achievement of a safety culture and as Manuel (2005, p.46) puts it "If the core of a safety culture is human element, then the source of this element, how they are educated and how they perform is critical."

CHAPTER 3

HUMAN PERFORMANCE IN SAFETY-CRITICAL SYSTEMS

"*To err is human…*" Alexander Pope

3.1 INTRODUCTION

Understanding the dynamics of human performance in safety-critical systems is a crucial aspect of any safety culture agenda. Humans at the sharp and blunt ends are regarded as the dominant risk factor in safety-critical systems (Baron, 1988; Reason, 1990; Barnett, 2005) and as noted in Chapter 2, is a major challenge to achieving a safety culture. The root of this challenge lies in the performance shaping factors (PSFs) as they are the link to erroneous acts and therefore influences safety. It is the domain of risk management to understand and devise solutions to risks in safety-critical systems including those pose by humans.

Table 3-1 gives a summary of major accidents that have come to epitomize what can go wrong in safety-critical systems with devastating consequences. These accidents have become fodder for the safety culture quest in all high risk industries. These accidents have also been used to illustrate the point that no major accident is caused by a single direct action at the sharp end, but organizational factors, management decisions and designers of equipment and technology are intricately involved (Watson, 1988; Reason, 1990; Perrow, 1999; Barnett, 2005; Dekker, 2006).

This chapter focuses on the human factor as a source of risks in safety-critical systems. In so doing it explores the dynamics of human erroneous acts and factors shaping those performances, an understanding of which is key to risk management, which involves training and education. Although the dissertation focuses on the people at the sharp end, it maintains in principle that actions at the blunt end are extremely critical towards overall effective functioning of safety-critical systems, as is proven in the literature. As such, actions at the sharp end cannot be discussed in isolation and as is appropriate for this chapter, the blunt end is incorporated.

Table 3-1 Accidents Involving Human Error

INDUSTRY	YEAR	ACCIDENT	CAUSES IDENTIFIED	CONSEQUENCES
Nuclear	1979	Three Mile Island	operator error, latent failure, maintenance error	No direct deaths but it assumed people died years later from radiation poisoning
	1986	Chernobyl	Deliberate, systematic and numerous violations of safety procedures by operators, design failures	31 lives lost. 400 sq. miles contaminated. Increase in risk of cancer deaths over a wide area of Scandinavia and Western Europe
Petrochemical	1984	Union Carbide, Bhopal	Operator error, poor maintenance, failed safety systems, design support problems.	2500 died
Maritime/Offshore	1988	Piper Alpha	Technical and organizational causes.	167 persons died
	1987	Herald of Free Enterprise	Commercial pressures, poor management, operator error,	150 passengers & 38 crew died
Space Programme	1986	Challenger	Faulty O-ring, Organizational failure, conflicting goals, maintenance management problems.	All 7 astronauts died
Railway	1987	King's Cross	Management failures,	31 died
	1988	Clapham Junction	Technician failed to remove a wire, bad workmanship, poor supervision and poor manangement.	35 died 500 injured
Aviation	1989	Kegworth M1 Air Crash		47 persons died

Source: Compiled from Watson, 1988; Reason, 1990; Senders & Moray, 1991; Redmill & Rajan, 1997

3.2 THE SAFETY CRITICAL SYSTEM

The term safety-critical system borrowed from Redmill and Rajan (1997) is useful. A safety-critical system is defined as one which may present a hazard to human life or well-being, or the environment. Their theory on human factors in safety-critical systems highlights the central position of humans in such systems, and supports the concept of the *safety triad* where the *psycho-socio-technical* variables interact to either promote or undermine safety.

Redmill and Rajan (1997), as indicated in Figure 3-1, show a total system and the place of people within that system. The system has three parts, 1) the equipment under control (for example a nuclear plant), 2) the control and protection systems

which are computer[ized] elements for monitoring, controlling and providing protection and 3) the humans.

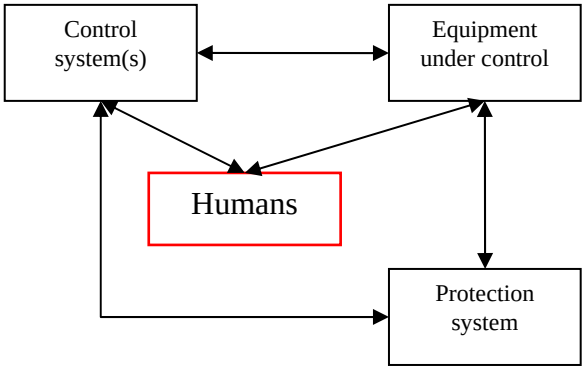

Figure 3-1: The total system according to Redmill and Rajan.
Source: Redmill and Rajan (1997)

Humans in this context include all the people. Applied to the maritime industry, the diagram would indicate the equipment under control as the ship; the protection system consisting of elements that are technological/computerized (warning systems, navigation systems); and organizational systems such as safety management; and the control systems also entail organizational policies and procedures as well as the wider regulatory regime, for example conventions and port state control. Humans are the point of convergence where the various elements meet each other at the apex of the *safety-triad*.

The purpose here is to demonstrate that shipping is a safety-critical system and that humans pervade the entire system and a balanced and holistic approach towards understanding such dynamics is indisputable. Further, acknowledging the pervasiveness of humans in safety-critical systems should ensure that risk management aggressively adopt a variety of approaches to solutions, which is the shortcoming of the maritime industry. Solutions, particularly for education and training, do not reflect the human complexities that exist in shipping (Arslan, & Er, 2006; Kristiansen, 2005). Pekcan, et. al. (2005) thus conclude that approaches to the

non-technical aspects in the maritime industry are comparatively (with aviation) immature. Redmill and Rajan (1997, p-7), underscore the importance of the human factor, their view is still relevant for today and is instructive for the maritime industry:

> The human component should be the subject of hazard analysis and careful, verified design to the same degree as the other components of the system. That it often is not, is the cause of many otherwise avoidable accidents. … people have freedom of choice and, while this is a strength …it also renders their behaviour unpredictable and its analysis more complex and difficult.

This attempt to balance the scales by giving due regard to the role of humans at the sharp end is not a popular position to take as the prevailing perspectives focus on the organization (such as Reason, 1997) or take a systems approach (such as Perrow, 1999 and Dekker, 2006). However this dissertation, also sees the need to consider the human component of safety critical systems as the subject of hazard analysis in their own right as feeling, sensing beings with their own human mechanisms for action and/or inaction.

3.3 HUMAN ERRONEOUS ACTS

Human error analysis, is an integral part of human factor theory, discussing the what, when, where, why and how of errors (Reason, 1990; Senders & Moray, 1991; Perrow, 1999). However, the term *human error* has proven problematic within safety culture, as it connotes blame, whereas the situation is usually more complex. To demonstrate:

> A man has a protracted argument with his wife. He stamps out of the house to the nearest bar and drinks four highballs. He then decides to go for a ride. It is night-time, there is a skim of snow on the ground, and the tyres on our victim's car are smooth. In rounding a poorly banked curve at excessive speed, the right front tyre blows out; the car leaves the road and is demolished. What was the cause of the accident? The argument? Drinking? Speed? The weather? The smooth tyres? The blow out? The poorly designed highway? (Chapanis as quoted in Barnett, 2005, p.132)

Any one of the reasons listed above could be taken as the cause depending on the perspective and motivation of the investigator, as well as how far in retrospect the analysis of the chain of events goes (Barnett 2005). As such, Hollnagel (1998) sees attributing a cause for an accident to human error as a judgment in hindsight and is in itself erroneous. Likewise, Reason (1998) makes a strong case for human erroneous acts to be seen as consequences rather than causes. In so doing he emphasized the role of organizational conditions in shaping the performance of the people, and therefore cautions the human impulse to lay blame on those at the sharp-end. This is a major step towards fostering a no blame culture, an important sub-component of a safety culture (Reason 1997; Manuel, 2005). Causes are attributed to failures within the organization (Watson, 1988; Reason, 1997; Dekker, 2006), or the system as a whole (Perrow, 1999).

The organizational perspective is one approach to understanding error. Others have been the technological approach and the human approaches. The technological paradigm viewed the technology as the source of errors and attempts were made at improving the technology (Senders & Moray, 1991; Redmill & Rajan, 1997). The human perspective saw people as the weak link in an otherwise safe system and attempts were made to design people out of the system (Senders & Moray, 1991; Dekker, 2006). These polarities, while useful in their own right, have been detrimental to a holistic approach to risk management. The dissertation is not proposing a return to the old paradigm of a blame culture but as the human factor is the least understood of the systems, they are to be brought into the loop, which is the focus of this work.

3.4. HUMAN PERFORMANCE IN SAFETY-CRITICAL SYSTEMS

Risk management may be to safety culture what a waypoint is to a navigator. Safety and safety culture must consider risks (O'Neil, 2000; Kristiansen, 2005). It is in the consideration of risks associated with humans that PSFs arise. Gyles and Salmon (1978) as quoted in Barnett (2005, p.134) illustrate by what they describe as the

frustration that those responsible for safety may feel in the face of an accident when they thought all defences were in place:

> There was no gross negligence, no recklessness or stupidity, no drunkenness or fatigue, no question of the ship being without enough trained personnel; no lack of equipment. But there were mistakes. Mistakes of the kind that all men are liable to make on occasions. Seeing what they expect to see; not seeing what they should see, failing to recognise a mistake in a colleague, reacting too late, or not at all, in the face of the unexpected.

Such an understanding of the human capacity to commit erroneous acts, and viewing humans as a system in its own right, would lead to a full engagement with the human *idiosyncrasies* making them an integral part of the risk analysis, without the blame.

Humans have their own built in mechanisms for protection (flight or fight), restoration (sleep), for information processing as well as mechanisms that are sometimes seen as inadequacies such as boredom, distraction, loss of concentration, (Redmill & Rajan, 1997) and susceptibility to fatigue. Although Reason (1990, p.173) extols an organizational perspective, he acknowledges the role of the human element:

> Rather than being the main instigators of an accident, operators tend to be the inheritors of system defects created by poor design, incorrect installation, faulty maintenance and bad management decisions. Their part is usually that of adding the final garnish to a lethal brew whose ingredients have already been long in the cooking.

The argument is, human actions contribute to accidents; there is merit in addressing the "garnish," without which the meal is not appetizing. For the maritime industry, Baker and McCafferty (2005) have found where seafarers have been direct instigators of accidents. Reason (1990) also acknowledges that humans commit violations. These violations he sees as occurring in a social context where rules, codes of conduct and procedures exist. Violations are described as "…deliberate – but not necessarily reprehensible – deviations from those practices deemed necessary

(by designers, managers and regulatory agencies) to maintain the safe operation of a potentially hazardous system." For example, the master of the *Attilio Ievoli*, of his own volition, used the west Solent, against company instructions, where the vessel ran aground. This dissertation refers to these human related threats to systems as human *idiosyncrasies*, as explained in the Chapter 1.

Human threats to system failure are said to stem from two sources, erroneous acts and violations. Rasmussen's categorization of performance is commonly referred to in explaining erroneous acts. These types of performance are skilled-based, rule-based and knowledge-based (Reason, 1990). Skill-based actions are prone to slips and lapses; rule-based and knowledge-based actions are pone to mistakes. In brief planning failures are termed *mistakes* while execution failures are termed *slips* and *lapses* (Reason, 1990).

The sequence of performance is for skill-based actions to precede rule and knowledge-based actions (Reason, 1990; Redmill & Rajan, 1997). It is subsequent to an erroneous act at the skill-based level, if such error is detected, that rule and knowledge based performance is activated (Reason, 1990). However, as Reason (1990) explains, the nature of man is such that the tendency is for the actor to resort to rule-based actions (separate from written rules), seeking a pre-determined solution from his database of cognitive scripts and schemas. These are human mechanisms for decision making short cuts but may sometimes lead to inaccurate information and poor decision. It is at this juncture that the behavioural sciences are evident where concepts such as availability heuristic and confirmation bias surface. The notion is that stored scripts and schemas are activated to pair with the existing situation to find solutions. Information that is readily available in memory is used (availability heuristic) and such information confirms what the person wishes (confirmation bias) (Zebrowitz, 1990). It is after these mechanisms have failed to satisfactorily resolve the situation that knowledge based performance is activated (Reason, 1990).

3.4.1 Assessing Performance

Human reliability assessment (HRA) methods have been developed to analyze the risk posed by humans to systems. Here, factors that shape performance are investigated. HRA approaches involve three stages of 1) identifying the possible errors that can occur, 2) determining the likelihood of their occurrence and 3) improving human reliability by reducing the likelihood of their occurrence (Redmill & Rajan, 1997).

Hollnagel (1998) noted that at different periods in the development of HRA methods the focus was altered. Initially such human risk assessment was categorized according to errors of omission and commission. Such categorization was behaviour based. Taking their cue from Skinnerian stimulus-response behavioural theory, the categories proved useful for observable actions. It was however discovered that account had to be taken of the internalized (endogenous) actions and therefore other HRA methods focused on human cognition (Hollnagel, 1998). One of the major premises of the cognitive approaches is that "…any attempt of understanding human performance ***must*** [Author's emphasis] include the role of human cognition…particularly in the study of humans at work." (Hollnagel, 1990, p. 15).

3.4.2. Nature of Human Performance

Reasons (1997) Swiss cheese model (Figure 3-2) of active and latent failures in organizations may be used to apply a similar analysis to human erroneous acts. This writer is of the view that similar to the organization, humans have internal mechanisms that may be seen as active and latent failures. Such mechanisms lie in the cognitive [11] and behavioural domain. Therefore cognitive heuristics [12] that manifest themselves in perceptive biases such as confirmation bias may be viewed in the sense of a latent failure (although it must be said that these are built in mechanisms that have their usefulness). Active human failures may be seen a as a

[11] This use of cognitive refers to mental programming and not the reference to knowledge gained through education.
[12] Mental shortcuts

mistake, a slip or a lapse which manifest themselves in observable behaviours. Both active and latent failures shape performance. The relationship between the two types of human failures can be seen as failing to act or acting incorrectly as driven by cues from the cognitive dimension.

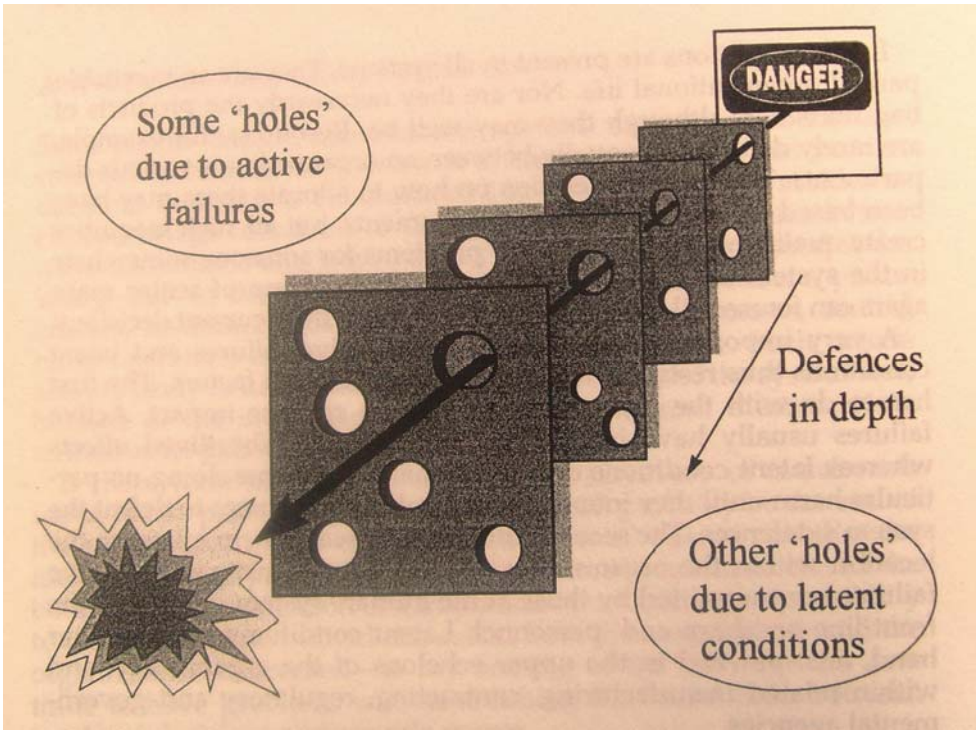

Figure 3-2: An accident trajectory passing through the holes and defences in a system
Source: Reason (1997).

The figure shows Reason's (1997) accident trajectory to which a parallel may be drawn. Using the *Royal Majesty* accident as an example, the holes in the system due to latent conditions can be compared with the human *idiosyncrasies* such as confirmation bias. Active failures may be seen as overreliance on automation (diffusion of responsibility)[13], defences in depth can be referred to as knowledge and skills gained from training. For the *Royal Majesty*, the accident trajectory was activated when at the skill based level, an execution failure occurred; that is, course was not changed. Due to latent conditions the cues to indicate that something was

[13] Less vigilance in the presence of others or an automated system. This is discussed further in Chapter 6 on the Behavioural Sciences.

wrong were used instead to confirm that the vessel was on the planned route, as the officers had over-relied on the automated system; as there was no training on the human biases, these could not be activated as further defences in the system and therefore the error led to the grounding.

3.4.3 Performance Shaping Factors in the Maritime Industry

A number of factors shaping human performance have been discussed for the maritime industry. The UK P & I Club (1996) found that deck officer error was the highest among its main causes of major P & I claims, accounting for 25%. This justifies a focus on the factors that shape their performance. In a review of the literature relating to the human factor in the maritime industry, Hetherington et. al. (2006, p. 403-409) discussed a number of PSFs; those of relevance to this work are listed below:

- Personnel issues: Fatigue, stress, health and wellbeing
    - Non-technical skills: situation awareness, decision-making and cognitive demands, communication, language and cultural diversity, teamwork.

Issues of health, stress and welfare will be discussed under fatigue, while issues of leadership, power, communication and culture will be discussed as a part of teamwork, situation awareness is discussed separately.

3.5 REDUCING HUMAN ERRONEOUS ACTS

Senders and Moray (1991) suggest a dichotomous taxonomy of erroneous acts that is suitable for this dissertation as it relates to internal and external influences - exogenous and endogenous erroneous acts. Exogenous acts are caused by factors external to the person and endogenous within the person, which is similar to Reason's (1990) intrinsic (cognitive biases, attentional limitations) and extrinsic factors (structural characteristics of the task, context effects) as well as Hollnagel's (1998) internal and external view of PSFs. Since the focus is primarily actors at the sharp end, this taxonomy is useful to distinguish active failures that arise in the social

system (exogenous/context) - team-work, leadership, communication - and those that arise in the individual (endogenous/intrinsic) - perception, cognition. It is said that most erroneous acts are exogenous in keeping with other writers who foreground the organization, and the situations in which this is not true are said to result from among other things, poor quality of training. It stands to reason therefore that education and training is a strategy to combat such erroneous acts.

Accidents have many causes and it is considered that interrupting the causal linkages at any point would prevent the error (Senders & Moray, 1991) although there are opposing views to this notion (Reason, 1997; Dekker, 2006). The rationale is that, for the maritime industry it is easier to access the seafarers than companies for regulatory purposes. The training regulatory regime is in place, what is needed is to strengthen its provisions taking a holistic, systematic and focussed approach to training that would engage the science of man.

Maritime education and training is a combination of knowledge and skills to ensure competence in carrying out the on board tasks. Competence currently does not include human behaviour. A comparison can be made with the aviation industry where the behavioural sciences are embraced holistically at every level of the pilots life. Manuel (2005) points out maritime education and training needs to go further to instil the correct attitudes to ensure that the requisite mindset is present to carry out tasks with integrity and professionalism. While this is so, the curriculum has to contain the correct content as well. Such content has been discussed in terms of communication and cultural awareness (Horck, 2006, 2008a), leadership and teamwork (Sampson, 2003; Arthur D. Little Ltd., 2004; Pekcan, et. al., 2005), but content concerning perception and how these affect judgment and decision making are yet to be discussed in the maritime industry.

3.6 CHAPTER SUMMARY AND CONCLUSION

The premise of this dissertation is that safety culture is a desirable goal for the maritime industry that promises to enhance safety. The human factor is a challenge to this goal. The challenge lies in the performance on board in areas such as teamwork, situation awareness and fatigue. PSFs are usually the domain of risk management. Risk management strategies to address human performance have utilized the behavioural sciences. It has been shown that human factor theory and the behavioural sciences are inextricably linked (Reason, 1990; Senders & Moray, 1991; Redmill & Rajan, 1997; Hollnagel, 1998). This is the missing ingredient in the training regime. What is needed is a focus on the actors at the sharp end as psychological beings. Although the IMO Conventions do not preclude individual Member States developing higher standards, the industry in general and MET, use such standards of the IMO as a benchmark and look to the regulatory regime for guidance and cues towards their action. Hetherington et. al. (2006) indicate that the provisions for the non-technical training in the STCW Convention do not suggest what the human behaviour skills are, or what is an adequate level of competence.

The importance of education and training to grasp the aetiology of such conditions and how they come to influence performance will assist in building defences against their occurrence. It is proposed that the behavioural based training that has been recommended (IMO, 2003a) to influence attitudes through behaviour, considers such cognitive human “failings” in its content. Developing the right attitudes necessitates the inclusion of the right content.

CHAPTER 4

EDUCATION AND TRAINING OF SEAFARERS PART I

The Role of Training Institutions in Safety Culture

4.1 INTRODUCTION

> In this multi-dimensional, multi-disciplinary and flexible environment, aim of MET is not only [to] give trainees basic technical knowledge to perform pre-designed, routine and standardized objectives or briefly "training" but also to improve their critical thinking, decision making and problem-solving skills, leadership, social intelligence, moral motivation or briefly "education." (Asyali, et. al. 2003).

Training and education is seen as one of the critical mitigating strategies for the risks associated with the human factor (Arthur D. Little Ltd., 2004; Pekcan, et. al., 2005; Barnett, et. al., 2006). Seafaring has evolved beyond traditional education and training requirements of a purely technical nature to the need for the "soft" skills such as leadership, communication, cultural awareness, group dynamics (MARCOM, 1999; Benton, 2006; Horck, 2006, 2008a). As Ho (2004, p.14) rightly says: "what we need is to develop the Seafarer of the Future who is mature, responsible, well-rounded, has a fundamental strength of character, is empowered and aware of how his actions affect the whole." Such a seafarer is essential to the achievement of a safety culture. A seafarer of this nature would be empowered to say no to substandard shipping, would be averse to violations, and would seek to do the right thing at the right time (Manuel, 2005) displaying the level of professionalism that would suggest an internalization of such principles. It seems that a few shipping companies have found a formula, an organizational culture that reinforces as well as "goes beyond" the formalized training to the development through shipboard life the "unwritten" rules of professionalism (Lane, 1999; Hernqvist, 2008). But what

becomes of the seafarer when he leaves this company, are the skills sufficiently ingrained to have continuity?

Professionalism is considered as competence by Lane (1999), demonstrating that a seafarer's competence goes beyond the technical. But such companies are few. What is needed is the kind of empowerment that would instil this "professionalism," strength of character; it is believed by this writer, as others have indicated (Sampson, 2002; Ho, 2004; Barnett, 2005; Manuel, 2005), that it is through education and training that such traits are developed and more so, education and training in the behavioural sciences to augment the technical, and this should be pursued by the STCW Convention to ensure that the standards are spread globally.

This chapter has two parts. Part I looks at MET and the state of education and training in the non-technical areas, which the industry now demands. Part II is a review of the STCW Convention relative to its human factor provisions. The chapter is predicated on two assumptions that, since MET institutions are fixed then enforcement of standards are possible. It is also assumed that unlike with people, compliance may lead to excellence when given no other choice. There are institutions that go beyond the basic requirements, however to have global uniformity in standards the STCW has to prescribe these for MET.

4.2 THEORIES OF LEARNING

It is helpful to explore a few theories of learning to substantiate the need to engage the science of man at the MET level. Theories of learning are divided into basically two camps, the behavioural and the cognitive. Bigge and Shermis (1992, p.3) define a learning theory as:

> …a systematic, integrated outlook in regard to the nature of the process whereby people relate to their environments in such a way as to enhance their ability to use both themselves and their environments more effectively.

What is suggested here is that learning is deliberate and orchestrated by those responsible for the process. A holistic approach, systematically applied based on notions of how humans absorb information and relate to their environment. Such deliberate orchestration is the purview of educational institutions.

Learning theories were developed to make the teaching process more effective and efficient (Bigge and Shermis, 1992). Early approaches viewed learning as "mental discipline" where the mind had to be exercised, as such, much learning was based on repetition and recall. Subsequently, theories based on behaviourism and cognition emerged (Bigge and Shermis, 1992).

The behaviourists saw learning as a "change in observable behaviour" which was conditioned through stimulus and response (Schellenberg, 1978; Bigge and Shermis 1992; Muirhead, 2008a). The behavioural approach was seen as an improvement on the early repetition and recall method. The behavioural approach to education has its roots in the work of B. F. Skinner and his theory of operant conditioning (Schellenberg, 1978; Bigge and Shermis, 1992; Conway, 1997). It is reflected today in behaviour modification that has been a popular approach to instil attitudes and correct behaviour as regards safety and is commonly recommended for use in the maritime industry (IMO, 2003b; Manuel, 2005; Pekcan, et. al., 2005; Barnett, et. al. 2006). Behaviour modification rests on the ABC process where antecedents, behaviour and consequences are "engineered" to elicit desired responses.

Dissatisfaction with behaviourism in terms of problem solving and learning strategies led to the development of the cognitive approach (Bigge and Shermis, 1992; Conway, 1997). The cognitive approach saw learning as a process of "gaining or changing insights, outlooks, expectations, or thought patterns" (Bigge and Shermis, 1992, p.10), as the learner actively participates in his/her learning. Thus individual factors such as personality and motivation, as well as social context influence the learning process (Bigge and Shermis, 1992; Conway, 1997; Muirhead, 2008a). The

cognitive approach has its roots in the work of educational psychologists such as Vygotsky, Piaget and Bruner (Bigge and Shermis, 1992; Conway, 1997).

4.3 TEACHING METHODOLOGIES

Delivery methods developed can be viewed from the behavioural influences to the cognitive/information processing method known as constructivism (Conway, 1997; Arends, 2000). The methods used by MET varies and may be seen as directly related to the philosophy that drives the school. The lecture mode is still a common method of delivery. It is a passive method (Muirhead, 2008a). However, technology has impacted the delivery of lectures by introducing the use of multi-media and other such teaching aids, thus increasing the opportunities for use of a behaviour based approach. As such the ABC behaviour based model has been incorporated into the use of simulators as an innovative method at Warsash Maritime Centre (Pekcan, et. al., 2005; Barnett, 2006). This will be discussed further.

Constructivism utilizes collaborative/cooperative and problem-based learning (Conway, 2007) providing more opportunities for internalization of learning objectives. The terms collaborative and cooperative learning are used interchangeably, and refers to cooperation in the learning process as against competition where students work together to find solutions to a problem rather than compete individually for grades. Problem-based learning may involve collaboration and is geared at the student finding solutions to real problems; as such, this delivery method is deemed suitable for andragogy (the teaching of adults) as against pedagogy (teaching of children). The problem based approach has been recommended for application to the STCW requirements as it is seen as a valuable and reliable method of achieving learning objective of knowledge, skills and attitudes (Asyali, et. al. 2003). It was concluded that the competence demanded of the seafarer will not be gained through traditional teaching methods, therefore Dokuz Eylul University School of Maritime Business and Management in Turkey, changed its curriculum to one that utilizes problem based learning (Asyali, et. al. 2003).

4.3.1 The use of simulators

Simulators have become a ubiquitous teaching tool in MET. If their advantages are harnessed they can be a very effective delivery method combining both behaviour and cognitive based approaches. The industry has embraced the use of simulators as evidenced in the STCW Convention Section A-I/12, being mandatory for Radar and ARPA training. It is debated whether simulators are more efficient than onboard training and the conclusion is that it is in many regards (Muirhead, 2008b) as multiple learning objectives may be covered in a shorter time without the risks; confidence of the cadet is developed; hands-on experience is gained in decision making and operational procedures in difficult situations, which would be impossible on board (Muirhead, 2006, 2008c).

The use of simulators has been observed by the writer on field trips to training institutions in Europe (France, Netherlands). Both approaches were evident. If the Warsash behavioural approach is used as reference, aspects of the ABC were present in the use of simulators at these institutions: A-ntecedents were the class room lectures; B-ehaviour was the practical exercises on the simulators and C-onsequences were the debrief. Additionally, the fact that the situations required critical thinking and problem solving by working as a team, introduced the problem-based approached of the cognitive theory. The writer was however uncertain that these methods were exploited to their fullest potential. It was clear that the focus was the technical. On inquiry, at one location, the writer was told that human factor issues were mentioned in debrief; yet these could have been incorporated in existing simulation exercises to account for the need of the soft skills.

4.4 CONTEXT

One of the demands of the industry is to address its accident record. This is predicated on the development of a safety culture. A restructuring of MET to respond to the contemporary demands of the industry for well-rounded seafarers has been seen as an imperative (Asyali, et. al., 2003; Kanev, 2003, Asyali, et. al., 2006). The

attitude to safety culture varies across institutions. Interviews reveal that such attitudes range from conscious and deliberate actions to incorporate the "softer" skills to not having any such programmes. The importance of the non-technical demands that not just some, but all seafarers become beneficiaries. Training institutions have their own philosophies and worldview that influences their approach to such topics. Although dated, Rosengren, & Bassis (1976) provide valuable research on the social organization of maritime education and training which illustrates how the different philosophies and national interests drive the MET curriculum. The system of training is as varied today with universities, colleges and vocational training and different curriculum, such as those offering dual purpose training as against the traditional separation of departments (Schröder, et. al. 2003). MET curriculum is also affected by the realities of economics and politics (Prasad, 2008a).

Manuel (2005) also found that MET may be driven by similar cultures as the industry ranging from evasive to those with a safety/excellence culture. He noted that by far those with a compliant culture are greatest in number. However, unlike with people, compliance in this instance may lead to a culture of excellence as the mechanisms can be instituted to drive this development. The nature of the global regime is such that the STCW Convention governs the curriculum so far as the provisions are mandatory. The provisions for accountability were strengthened in the 1995 amendments, which are to be further strengthened in the current review (IMO, 2008). It is assumed that since MET institutions are fixed then they are easily identifiable and may be subjected to the regulations to ensure standards are kept. There are those in the evasive group that may avoid detection, but it is believed that improvements will at least be made within the compliant group.

An outcome of the METNET programme was that the quality and employability of seafarers was mainly the task of MET institutions (Schröder, et. al., 2003). A similar conclusion from a global perspective was arrived at (Kanev, 2003) in looking at the

seafarer labour market challenge and implications for MET. The “soft” skills courses that are the concern of this dissertation would fit into the framework as developed by Schröder et.al. (2003) for the enrichment of the seafarer. If the seafarer is to see seafaring as a career path and he is to be prepared adequately for employment ashore, leadership, teamwork, cultural awareness and other social-psychological skills apply to all careers. Such courses could become part of the enrichment process (Schröder et. al. 2003).

4.5 CONTENT

The “soft” skills that shape performance are more and more coming to the fore as casualty investigations begin to take account of human factors in accidents. The need for education and training in these areas is also gaining momentum, however the approach remains *ad hoc* as topics are introduced as reactive approaches to accidents.

There needs to be an understanding among the regulators of the need for a holistic approach as evidenced during the deliberations of the current STCW review (IMO, 2008) where a delegation proposed a combination of BRM, Engine-room Resource Management (ERM), communication and leadership as they all address human behaviour and human resources; however, this proposal was not supported. Additionally it was proposed that the requirements for communication, language etc. should be only for deck and engineer officers. This writer is of the opinion that all should benefit from such education. It may be made appropriate to the ranks and function of the seafarer, however all crew members, including ratings need to be aware of aspects of shipboard life such as the responsibility of leadership, beyond their perceptions of the one who gives orders; its role and function, and how they (the ratings) fit into the team in general. Issues such as obedience to authority (Sampson, 2003) and its destructive nature may be discussed in a course on leadership and taught in such a way as to develop the ability to “challenge” authority respectfully. The provision as it is currently stated in the STCW Table A-II/4 “ability to understand orders…” may be perpetuating power relations that are

counterproductive (Sampson, 2003) and the ability to "challenge" that is being discussed, may not be fostered in such an "order taking" atmosphere. A holistic top-down and bottom-up approach is prudent.

4.5.1 Culture

Culture affects both context and content. The seafarer is a product of his culture which influences the attitudes by which he views the world and through which he operates. This impacts both the operational procedures and the social interaction with fellow shipmates on board. Cultural differences are a challenge for the safety of shipping (Dzugan & Renping, 1999; Benton, 2006; Horck, 2006, 2008a). Such differences lie in the national/ethnic cultures from which people come (Hofstede & Hofstede, 2005). However, such dimensions are not easily influenced and therefore the need to incorporate into the curriculum at all levels. As one institution indicated that courses developed to address safety culture are taught at every level throughout the seafarer training programme, "*from first year step by step*" (Appendix 4). This approach, strengthened by a cognitive and behaviour based delivery method, would ensure enculturation of the values and principles embedded in such courses and there is a greater likelihood that seafarers who are so educated and trained would exhibit a higher level of ethics and professionalism than those who were not exposed in this way.

Hofstede and Hofstede (2005) is useful in describing some of the impacts of culture. Culture is seen as mental programming resulting from socialization. Culture is learned. As such any effort at mitigating cultural influences has to tap into mind (and hearts) of individuals. Issues of power and authority and leadership, how these are perceived and the responses to these are culturally based (Hofstede & Hofstede, 2005) and impact interactions. The concept of power distance which is becoming a common concept in the maritime industry, is defined as "the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally." (Hofstede & Hofstede, 2005, p.46). The

impact however is in its influence on behaviour where expectations and acceptance manifest themselves in dependence, that is, the subordinates are afraid of disagreeing with the superior and expect an autocratic style of leadership and decision making. Hofstede & Hofstede (2005) also noted that counter-dependence is another likely outcome of power distance, where the subordinate rejects the power but complies in practice. This may also result in destructive obedience as the subordinate would comply with any order given.

Whereas Hofstede's and Hofstede's view may be debated, it does provide food for thought with regards to categorizing behaviours on board. It may be that national or organizational or shipboard culture is operating to foster power distance which has implications for intervention (an important area to be researched). Power distance is associated with destructive obedience (Sampson, 2002; 2003) (obeying a wrong command, or keeping silent due to the authority of the person giving the orders). For example the *Domiat* and the *Green Lily* accidents were possibly due to power distance where the masters' decisions were not "challenged" by any of the officers which led the *Domiat* to run aground, and which exacerbated the situation for the *Green Lily* leading to the death of a rescue operator Appendix I).

4.5.1.1 Cultural Awareness

Cultural awareness is being discussed increasingly as it is seen as a possible factor affecting shipboard operations. Investigations into casualties such as the *Bow Mariner* suggest that stereotypes may have been operating. The senior officers were Greek. It was reported that the Filipino officers were given almost no responsibility, and were closely supervised in every task." Such behaviours reveal lack of trust in the abilities of the Filipino crew which may have been motivated by stereotypes of the abilities of Filipinos in general. As such Horck (2006; 2008a) advocates that MET be proactive as the need for cultural diversity training is evident. Benton (2006) also agrees with the need to make the study of "cultural difference" a core component of the curriculum of maritime institutions. The reality of multinational

crew demands that for greater cohesion and safety, seafarers must become culturally literate (Benton, 2006).

4.5.2 Communication and Language

The tradition in the maritime industry has been to discuss communication primarily as language difficulties arising from multi-nationality onboard, perhaps because this was easily identified. The solution has been to develop communication phrases to be used in specific occasions and stressing the importance of a common language giving rise to Maritime English as an area of study (Benton, 2006). Communication is however much more than language - grammar and vocabulary - (MARCOM, 1991; Dzugan & Renping, 1999; Kahveci et. al. 2002; Badawi & Halawa, 2003; Sampson & Zhao, 2003; Horck, 2006, 2008a) as culture, non-verbal communication, aspects of social interaction and meaning are critical aspects that would not be solved by having a common language.

4.5.3 Leadership and Teamwork

The operational imperatives onboard demand teamwork (Østreng, 2001; Asyali, et.al., 2006); effective teams have good leaders; lack of teamwork and poor leadership have been cited as contributory causes in a number of accidents, for example *Domiat* and *Dole America*. The organizational structure of a ship is steep in hierarchal traditions which seemingly give rise to autocratic styles of leadership (Kahveci, et.al. 2002).

Organizations ashore have long moved on to more horizontal structures where teamwork is encouraged. Whereas it may be necessary to maintain a vertical structure, “teamship” (Sampson, 2002) must be encouraged and autocracy discouraged, this is best done through holistic application via education and training. Recalling that one of the “principles” of safety culture is flexibility (Reason 1997), the ability to defer authority according to the exigencies of the situation, such flexibility has to be “cultivated.” Asyali, et.al.(2006 p.9) noted that coordination on the bridge requires the ability to work together which in turn requires “…people

skills such as communication, teamwork, leadership, the ability to learn, and ability to adapt to changes." But has been said by others, (Kahveci et. al., 2002; Sampson, 2002; Arthur D. Little Ltd., 2004) "the existence of these necessary skills among seafarers is questionable" (Asyali, et.al., 2006 p.9). Although speaking specifically to the issue of destructive obedience and authority Sampson's (2003, p.7) observations may be applied generally to the non-technical requirements of seafarers' competence:

> [these] are likely to require considerable training and re-training for masters [and crew] who may not currently have the skills required…simulators may assist in this process but to address the problems…requires that the training policies of companies and indeed maritime training establishments become more innovative.

4.6 AN AMALGAMATION OF CONTEXT AND CONTENT

Two cases from the industry were selected to demonstrate the possibilities to enrich the MET experience by impacting both context and content.

4.6.1 School of Maritime Business Management

A conscious decision was made by the Dokuz Eylul University School of Maritime Business Management, Kaynaklar Campus in Turkey to change the context of learning by changing from the conventional delivery to the student-focused problem-based delivery method. This change was in response to the realization of the need to promote teamwork and less hierarchal structures according to global organizational trends, and the demands of the maritime industry (Asyali, et. al. 2006). The education strategy of the institution was stated as:

> "…to provide the students with certain proper knowledge, supported by desired skills and profound attitudes that they will need in their future professional careers and also give then the ability to respond quickly to changes in technology, operations, practices and procedures on board. (Asyali, et. al. 2003)

The procedure is to provide students with problem based scenarios similar to what practitioners would face. The students define the problem and are given guidance, resources and are left to solve the problem. Learning objectives are embedded in the scenarios which require an inter-disciplinary approach working in teams. Appendix 6 graphically presents the process. The outcome has been rated as an effective tool for the requirements of the STCW Convention.

4.6.2 Warsash Maritime Centre

Using the ABC behaviour modification model and adapting the contents of the aviation industry's crew resource management (CRM), the Warsash Maritime Centre, Southampton Institute, developed a programme to address the need for the non-technical skills in the maritime industry (Table 4-1) (Pekcan, et. al., 2005; Barnett, et. al. 2006).

Table 4-1 Types of skills that are taught on the CRM course.

SOCIAL SKILLS	COGNITIVE SKILLS
Co-operation	**Situation Awareness**
• Open communication • Consideration for others • Team working	• Situation awareness • Risk assessment
Leadership and Managerial Skills	**Decision Making**
• Situational leadership • Assertiveness • Planning and coordinating	• Problem diagnosis • Option generation • Option selection

Source: Pekcan, et. al. (2005).

The course emphasizes social and cognitive skills while presenting the students with new ways of thinking and problem solving. The new ways of thinking are said to be the antecedents to safe behaviour developed in the lectures and the behaviours practiced and through debrief receive feedback, which are seen as the consequences. More details are given in Appendix 7.

EDUCATION AND TRAINING OF SEAFARERS

PART II

STCW 1978 Convention
Human Factor Provisions

4.7 THE NEED FOR THE STCW CONVENTION

This section looks at the STCW Convention 1978 as amended as one of the four pillars in the maritime safety regulatory regime.[14] The Convention is tasked with providing minimum mandatory training standards to ensure that seafarers possess uniformity in competence to carry out their duties safely and efficiently while protecting the marine environment. The Convention's effectiveness as regards the soft skill has been questioned (Pekcan, et. al., 2005; Barnett, et. al., 2006). This section reviews the Convention, and current comprehensive review to ascertain the human factor provisions.

The uniformity of training standards became necessary with increased internationalization of maritime labour. The spirit of the convention is enshrined in the following principle and embodies the consensus of the parties that education and training is critical to the pursuit of safety:

> THE PARTIES TO THIS CONVENTION,
>
> DESIRING to promote safety of life and property at sea and the protection of the marine environment by establishing in common agreement international standards of training, certification and watchkeeping for seafarers…,
>
> CONSIDERING that this end may best be achieved by the conclusion of an International Convention on Standards of Training, Certification and Watchkeeping for Seafarers. (IMO, 2001, p.7).

[14] The others being SOLAS, MARPOL and the ILO's Maritime Labour Convention, 2006.

In the absence of any standards, the promulgation of STCW 1978 was laudable and seen as reflecting the highest standards which could be practicably agreed on at the time (Agbakoba, 1994; IMO, 1996; Fuazudeen, 2008). However, a number of limitations were discovered overtime (IMO, 1996, Fuazudeen, 2008; Horck, 2008b; Prasad, 2008b). The most crucial one preventing the achievement of global standards was having the provision "to the satisfaction of the Administration," (Dearsley, 1994; IMO, 1996; Winbow, 1999; Mahapatra, 2007; Fuazudeen, 2008). This resulted in subjectivity in interpretation and application of the Convention, giving rise to various standards of education (IMO, 1996; Fuazudeen, 2008; Horck, 2008b; Prasad, 2008b) and loss of confidence in the Convention; it was decided that the time was right for a comprehensive review (Dearsley, 1994; IMO, 1996; Mahapatra, 2007; Prasad, 2008b).

Other issues that were discussed included the role of the human factor in casualties and fatigue. Communication was an occasional agenda item particularly as it concerned the Sea-speak Manual and the desire to address poor communication which was also seen as a possible factor in casualties (IMO, 1986a). The IMO has therefore been discussing non-technical issues as part of the training regime for over 20 years, beginning with a submission by the Republic of Liberia on the dangers of fatigue (IMO, 1986b). The International Federation of Shipmasters' Associations (IFSMA) also submitted a Note (IMO, 1986c) highlighting concerns regarding fatigue.

Development in the understanding of fatigue was evidenced by the technical, operational and human (including the psychological) aspects that later entered the discussions (IMO, 1988, 1991). Recommendations were made that factors contributing to fatigue should be taken into account in ship design, training and also revision of the principles of safe manning. The outcome was Annex 4 to the report to MSC "Recommendations of the Sub-Committee Related to the Role of the Human Element in Maritime Casualties" (IMO, 1991). These recommendations included

communication, training, fatigue, and reporting of unsafe practices. Much emphasis was placed on fatigue. It is apparent then that fatigue became the first major non-technical issue to be considered as regards the STCW Convention. IMO Assembly resolution A. 18/Res. 772 (1993) indicated, among other things, that: "The objective is to increase awareness of the complexity of fatigue and to encourage all parties involved in ship operations to take these factors into account when making operational decisions." The annex stated explicitly the dangers of fatigue and fatigue inducing elements situated in the technical, organizational and the human domain. Those elements in the human domain included multinational crews, which may introduce language barriers leading to "social, cultural and religious isolation" and the impact these may have on safety (IMO, 1993). Resolution .772 became part of the deliberations on the first comprehensive review.

4.8 FIRST COMPREHENSIVE REVIEW

The first joint MSC/MEPC Working Group meeting discussed human factor issues that were to be taken into consideration when examining system design or recommended practices or procedures for human factor implications (IMO, 1992) as shown in Figure 4-1. Items in the call out box are further details presented in the source document that are direct subject matters of the behavioural sciences.

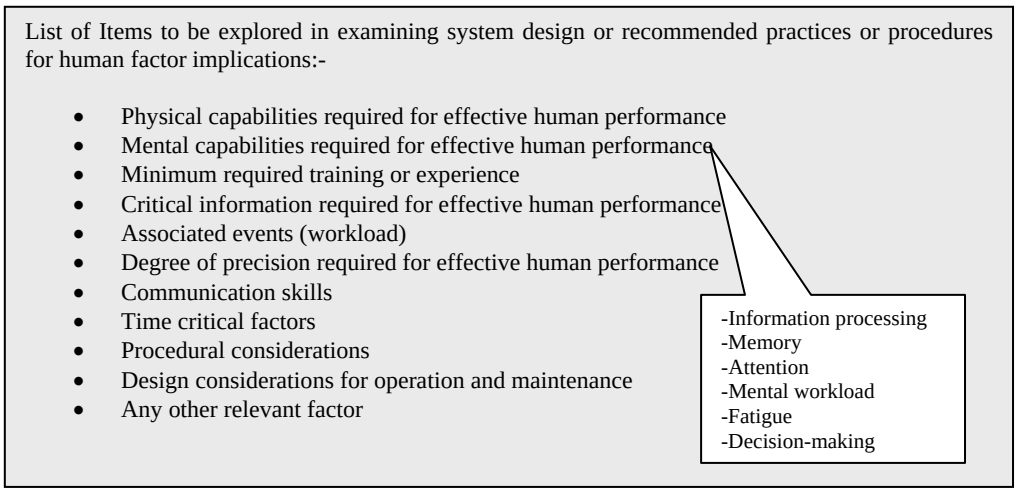

Figure 4-1: IMO Guidelines on Fatigue: List of human factor items.
Source: IMO Guidelines on Fatigue

This demonstrated a level of awareness within the IMO of the complexity of fatigue and the involvement of the psychological aspects. However the amendments made to the Convention were not commensurate with this realization.

Rightly or wrongly, the deliberations on the human factor began on the premise that "…human error is the major contributing cause of maritime casualties and pollution incidents…" which became the motivation for the comprehensive approach to examining and finding solutions to the human factor problem. However the "devil *is* in the details," as Cox and Flin (2000) said of culture. An examination of the amendments that emerged from these deliberations presents a lesser picture than the deliberations promised. The aims of the review, as listed by STW 28th, "Outcome of the 1995 STCW and STCW-F Conferences…" (IMO, 1996) are shown in Figure 4-2.

The main aims of the revision were:

1. to transfer all detailed technical requirements to an associated Code;
2. to clarify the skills and competence required and take account of modern training methods;
3. to require Administrations to maintain direct control over and endorse the qualifications of those masters, officers and radio personnel they authorize to serve on their ships;
4. to make parties to the convention accountable to each other, through IMO, for their proper implementation of the Convention and the quality of their training and certification activities: and
5. to have the amendments enter into force for all Parties to the Convention with the least possible delay.

Figure 4-2: Aims of the STCW 1978 first comprehensive revision
Source: IMO 1996, p.5

The absence of specific reference to the human factor as an aim should not be taken as trivial as it reflects the minimal attention given to the "soft" skills. The aims as laid down were achieved: technical competence was addressed (Dearsley, 1994; Gauw, 1994; Winbow, 1999); quality standard system was introduced (Regulation

I/8, Section A-I/8); enforcement and accountability were addressed (Regulation I/7), and the ensuing "white list" of complaint countries could have their systems examined by any other member state for purposes of recognition of certificates (Regulation I/10). Qualifications for lecturers and assessors (Regulation I/6, Section A-I/6 paragraph 7) were also included ensuring that not only the standards were in place, but that trainers were qualified to deliver. These provisions sought to include the major stakeholders such as the companies (Regulation I/14), strengthened by the ISM Code that was being developed simultaneously, as well as maritime education and training institutions (Fisher & Muirhead, 2005). These final provisions were necessary, and responded to the industry's call for a more robust training regime (Fuazudeen, 2008) however a training regime translated in technical terms resulting in an acknowledgment a few years later that the human factor has been somewhat neglected (O'Neil, 2002).

4.8.1. Addressing the human factor

A total of 32 papers and notes were submitted to the 27th STW subcommittee meeting (IMO, 1995), the final meeting in respect of the review. Of these, only 4 made reference to human factor relating to fatigue with one of the 4 making recommendations for provisions to be deleted on the grounds that manning level is not the purview of the STCW. The decision was to include fatigue under paragraph VIII/I Fitness for Duty in purely physiological terms. The role of human element in casualties, including casualty discussions, for example the grounding of the bulk carrier *Rose*, where factors such as communication, leadership, teamwork, and decision making were involved (IMO, 1986d) could have reflected more than a perfunctory mentioning in the final document considering the founding principle of the Code states that:

> RECALLING that a large percentage of maritime casualties and pollution incidents are caused by human error,
>
> APPRECIATING that one effective means of reducing the risks associated with human error in the operation of seagoing ships is to ensure that the

> highest practicable standards of training, certification and competence are maintained in respect of the seafarers who are employed on such ships, … (IMO, 2001, Resolution 2, p.1.)

There is a gap between this principle and the provisions made. Competence should be interpreted as also having non-technical skills (Barnett, et. al., 2006). Appendix 5 compares the provisions with the PSFs as identified in the literature. Considering the social and psychological aspects of the PSFs discussed at the time and their impact on safe performance (IMO, 1993), the provisions under Fitness for Duty, Regulation VIII/1, A-VIII/1 (IMO 2001) are insufficient (Smith, 2007). Regulation VIII, A-VIII/1 and A-VIII/2 are mostly operational while the psychological and social psychological permeates the operations but go unattended. The crew must be competent in all tasks, the master is responsible for ensuring his crew is fit for duty, not knowing the various forms fitness for duty may take and how to identify such, will compromise the master's ability to be fully effective.

Noting the existence of sub-standard ships, the impact would have also been greater to include Bridge Resource Management (BRM) under the compulsory education, making it the responsibility of MET. Although reference is made in Table A-II/1 and A-II/2 to knowledge of effective bridge teamwork, the details are absent and therefore left open to interpretation. Guidance given in B-VIII/2 calls for companies to issue guidance on BRM. BRM and personnel management, were not mentioned for officers and masters in charge of a navigational watch on vessels less than 500 gross tonnage.

Later amendments gave attention to non-technical aspects as regards passenger vessels in the areas of crisis management, crowd management and human behaviour, but these requirements do not apply to cargo vessels. The model courses are also ineffective if the provisions are not compulsory, and these model courses have also been found to be inadequate (Horck, 2006).

4.9 CURRENT COMPREHENSIVE REVIEW: HUMAN FACTOR

The provisions in the STCW convention as amended for the development of non-technical skills have been found to be deficient (Kanev, 2003; Pekcan, et. al., 2005; Barnett, et. al., 2006; Fuazudeen, 2008). Relative to other industries such as aviation, the provisions for crisis management and human behaviour are considered immature (Pekcan, et. al., 2005; Barnett, et. al., 2006). Another comprehensive review is underway which promises improved provisions in the area of the "soft" skills (Mahapatra, 2007).

4.9.1 Fatigue

Fatigue continues to be of major concern as a key PSF within the maritime industry (Lang, 2001; MIAB, 2004; Hetherington, 2006; IMO, 2007a & 2008). A step forward is imminent with the inclusion of mandatory fatigue management training for seafarers. While manning levels are still discussed, and it is proposed to revise Chapter VIII to include more explicit provisions for rest schedules (IMO, 2007b), a submission was also made on the premise that "the best means to improve understanding of fatigue is to develop and offer courses that provide tangible and practical methods of fatigue management" (IMO, 2007c, p.15). The recommendation is for new competence to be added to Table A VI/1-4 to improve personal safety and social responsibility training in fatigue management. The competence suggested were, *inter alia*, importance of obtaining necessary rest; effects of sleep on circadian rhythm; effects of schedule changes on mariners, fatigue; and effects of physical and environmental stressors on the seafarer. This proposal also saw the benefit of increasing fatigue awareness as contributing to a safety base culture on board.

The proposal was supported by the majority and is under consideration. A few Members were in disagreement as they saw fatigue mitigation only in terms of the organization of work and therefore no need for training in fatigue management. Yet it is the position of this writer that the awareness and possible impact on attitude that may be achieved through training will serve to complement the other efforts such as

work scheduling and rest periods, making for a more robust approach to fatigue and shipboard safety culture (Smith, 2007).

4.9.2 Bridge Resource Management

Accidents such as the *Attilio Ievoli* where the investigations revealed that the bridge crew was not clear on their roles and responsibilities, provide evidence for increased focus on proper BRM. This is being given attention in the current review. It was suggested and agreed that BRM is made mandatory. Therefore Tables A-II/1 and A-II/2 are to be amended to include key elements of BRM. It was proposed that key elements of engine room resource management (ERM) are also considered for mandatory inclusion (IMO, 2008). Care should be taken that the contents address the salient issues of teamwork, group cohesion and perception, and that BRM is not seen solely in terms of work allocation.

4.9.3 Communication and Leadership

Leadership, management skills, situational awareness and decision making are proposed for inclusion in a new section, A-VI/6 (IMO 2007d). The proposal saw the need for seafarers in any capacity to receive appropriate training or instructions in leadership and communication skills. These include both cognitive and social skills. Details were outlined which attempted to be comprehensive. However this dissertation is suggesting that there are additional elements which may further strengthen the provisions such as knowledge of perception and perceptive biases which play a role in situation awareness, as is discussed in Chapter 5. Cultural differences and language were also seen as a necessary inclusion in this section, as proposed by a delegation.

Additionally, another delegation recommended a holistic approach where BRM, ERM, leadership and communication should be amalgamated as they all relate to the human behaviour and human resources. However, this recommendation was not supported (IMO 2008). Instead, it was suggested that training in communication,

leadership and situational awareness should be applicable only to deck and engine officers; but as Mahapatra (2007) rightly observes, any crew member can be thrust in a leadership role depending on the situation. The decision arrived at by the sub-committee was to split the proposed Table A-VI/6 and include the major parts of leadership in Tables A-II/2 and A-III/3 at the management level (IMO, 2008). While the agreed elements are an improvement, this writer maintains that it would be beneficial for the on board safety culture, as in the case of fatigue management, to have all crew given knowledge to assist in their personal and professional development. The holistic approach proposed should be considered.

4.9.4 Other Human Factor Considerations

Alcohol limits, which appeared on the agenda in the 1980s is also under discussion. The outcome at the time was to include in Code B, B-VIII/2 parts 4 and 5, guidelines relating to alcohol and drug abuse. Recommendations are now on the table for inclusion in the mandatory section. Alcohol and other substance abuse have not been included for major discussion in this dissertation, although a PSFs this demands its own account. In one case, the *Jacki Moon*, the investigator stated that alcohol may have been a contributing factor to the watch officer falling asleep, combined with him being fatigued. The purpose of mention here is to caution the approach to alcohol as a sensitive issue as it relates to the welfare and health of seafarers and that it should be approached with understanding. A few responses from seafarers (Appendix 2) revealed that alcohol is used as a coping strategy onboard in times of stress and depression. Alcohol therefore should not be discussed in isolation of the influencing welfare factors that are a cause for concern (Kahveci, 2007).

Training for a seafarer safety representative is being discussed as one method to develop on board safety culture. Such a person would be intricately involved in aspects of the vessel operations that relate specifically to the occupational health and safety of the seafarer (IMO, 2007e). This is also an improvement on the existing situation, but reflects the tendency to compartmentalize knowledge and skills. The

presence of such a person should not preclude everyone benefitting from appropriate knowledge and skills and being informed so as to take their share of personal responsibility for on board safety culture.

4.10 CHAPTER SUMMARY AND CONCLUSION

The chapter focuses on the discussions surrounding the deficiencies in seafarer training as regards the "soft" skills. It examined learning theories and delivery methods to indicate that structures exist for effective delivery, the challenge is to harness the strengths with the appropriate content. The chapter also notes that seafarers need to become "culturally literate" (Benton, 2006); culture affects the interpersonal dynamics on board and impinge on safe operations (Dzugan & Renping, 1999; Benton, 2006; Horck, 2006, 2008a). This view was expressed much earlier when Lloyd's Ship Manager (Seafarers training needs…, 1992, p.53) quoted Martyn Dyer-Smith, psychologist and former navigating officer, as saying "In addition to focusing on technical skills, training of 'the seafarer-of-the-future' may well increasingly have to include social-psychological dimensions"

The chapter also reviews the STCW convention as one of the pillars of the safety culture regime of the maritime industry. It looks specifically at the human factor provisions in light of criticisms that the Convention was limited in that regard. A retrospective review of discussions leading to the first comprehensive review was done to ascertain provisions as regards the human factor. It was revealed that the human factor has been a longstanding agenda item in relation to fatigue and communication in particular, but also leadership. The review revealed that the outcome was not commensurate to the level of discussions that took place regarding the human factor. A current review is underway and the promise of improved provisions to develop the "soft" skills seems far greater than in the previous comprehensive review. The hope is that these receive the support of the Member States.

CHAPTER 5

THE HUMAN CONDITION
Idiosyncrasies in Action

What lies behind us and what lies before us are small matters compared to what lies within us –
Ralph Waldo Emerson

5.1 INTRODUCTION

On February 28, 2004, the vessel caught fire and exploded while the crew was engaged in tank cleaning. Of the 27 crew members aboard, six abandoned ship and made it to a life raft and were rescued. An unknown number abandoned ship to the water, three were rescued, one deceased and the other two died before reaching the hospital. The crew composition was Greek senior officers and Filipino junior officers and ratings.

*The distinctions between the Greek senior officers and Filipino officers and ratings were remarkable. Filipino officers did not take their meals in the officers' mess, were given almost no responsibility and were closely supervised in every task. The second assistant engineer reported that on arriving on the vessel for the first time he inquired of his duties and was sternly told he would be given verbal job orders daily, and was to do only as he was told and would have no administrative duties beyond making log entries. There was a lack of trust in the deck department. The surviving deck crew reported that the chief officer would not sleep beyond short naps in a chair in the cargo control room during cargo operations. When questioned as to what they would do if instructed to do something unsafe by one of the senior officers each crewman replied that they would do as they were ordered. "**Orders from the Greeks were like words from God**."*[Author's emphasis] (US Coast Guard, 2005, investigation into the explosion and sinking of the *Bow Mariner*)

The *Bow Mariner* represents a textbook case for leadership, power, authority, destructive obedience, cultural diversity, communication, teamwork and violation. These are all interrelated. Culture may have influenced the autocratic style of leadership compounded by mistrust on onboard, which impacted poor teamwork, symptoms of which are poor communication and lack of group cohesion, resulting in destructive obedience as the subordinates' response to power and authority.

This chapter, with reference to selected cases (Appendix 1), discusses a selection of the common cognitive and behavioural human factor challenges impacting safety at sea. These are described alongside the corresponding psychological theory with a view to offering insight into the human condition as well as to suggest areas for education and training. It is believed, to use the maxim, "*knowledge is power*", that an awareness and understanding of the mechanisms leading to such behaviours, will develop an appreciation in the seafarer for these human *idiosyncrasies* and provide him with the knowledge to counter the effects in his work and personal environments. There are however challenges to engaging the behavioural sciences in a holistic way such as availability of trainers with seafaring and behavioural sciences background, the commitment of MET, to name a few, however these are not insurmountable.

5.2 THE BEHAVIOURAL SCIENCES

The literature thus far has shown the importance of the behavioural sciences in understanding and finding solutions to the human factor challenges to safety culture. The PSFs explored, pertain to the cognitive and behavioural domain of psychology and social psychology. Cognitive psychology was developed in response to the need to understand cognitive limitations and capabilities of human operators of technical systems (Esgate & Groome, 2005). It involves the study of the mechanisms underlying sensory cues - sight, hearing, tasting, smelling, touching – and how they integrate with existing mental repertoires built by culture and socialization and mediated by culture and context to make judgments and therefore drive actions (Esgate & Groome, 2005; Chandler, 2008). Cognitive processes are useful

mechanisms provided by nature through which humans view and come to understand the world. Yet these mechanisms are also wrought with "*errors*" that may have negative outcomes (Esgate & Groome, 2005).

A useful book was written by Stadler (1987) some years ago on the *Psychology of Sailing: the seas's effects on mind and body*. Although it spoke about sailing, it also has relevance for merchant shipping. Stadler (1987) premised his book on the fact that "we sail with mind and body…we do not function on a boat in purely physical capacity, rather life at sea affects the entire being, behaviour and personality." He believes that recognition of the psychological and social psychological phenomena, which are encountered at sea, can enhance one's ability to identify and therefore cope with them. This has to be learnt through education and training, how to recognize these phenomena and so alerted to the need to at times seek further information, to question one's judgment or the judgment of others in times of doubt.

> *On approaching the Nab Tower, the master thought he saw the light of another vessel and ordered a starboard helm to avoid collision before going to the front of the bridge to confirm what he thought he had seen. The second officer also joined him and confirmed the red light and said he saw another to the starboard of the first. The master ordered had to starboard helm. When no further lights were seen he ordered hard to port helm. Shortly afterwards the vessel collided with the tower. The source of the red light had not been determined.* (excerpt from MAIB, (2000), investigation into the Dole America collision).

The master in this instance sought confirmation from the second officer, but then there is the matter of dealing with the *idiosyncrasies* of others and cultural influences mediating responses to leadership and authority, as Shakespeare so deftly demonstrates:

> **Hamlet**: Do you see yonder cloud that's almost in shape of a camel?
>
> **Polonius**: By the Mass, and 'tis like a camel indeed.

Hamlet: Methinks it is like a weasel.

Polonius: It is backed like a weasel.

Hamlet: Or like a whale?

Polonius: Very like a whale.

From Shakespeare's *Hamlet* (Act II, Scene II) (quoted from Chandler, 2008)

5.3 PERCEPTION AND SITUATIONAL AWARENESS

Perception is the cognitive area of interest in this dissertation. Perception is of two types, namely how we perceive objects, particularly visual perception, and how we perceive others. Perception is the first action in a sequence of actions relating to situational awareness: First the situation is perceived, that is taking in information, this leads to comprehension and then projection as to likely future developments and decision making.[15]

The study of perception alerts us to the fact that we see differently based on a number of factors such as culture, gender, moods; and that there are grounds to sometimes question what we think we see (Zebrowitz, 1990; Geller, 2001; Chandler, 2008). Figure 5.1 has been used in perception exercises to demonstrate how we might see differently depending on factors of salience to us.

Figure 5.1: Duck or hare?
Source: Chandler (2008)

[15] Maritime Resource Management seminar, August 19, 2008 at the Swedish Club.

The report on the *Dole America* noted among the contributory causes, lack of situation awareness. This is a misnomer as the captain was aware of the situation, but the situation as he perceived it. To reiterate from Barnett (2005, p.134):

> [Seafarers make] mistakes of the kind that all men are liable to make on occasions. Seeing what they expect to see; not seeing what they should see, failing to recognize a mistake in a colleague, reacting too late, or not at all, in the face of the unexpected.

It does not however have to be in unexpected situations. The master *expected* the vessel. What this writer calls human *idiosyncrasies* occur in everyday normal situations. They are a part of being human. To again repeat an earlier reference Reason (1990, p.1) notes:

> Far from being rooted in irrational or maladaptive tendencies, [*or unusual or unexpected situations – author's addition*] these recurrent error forms have their origins in fundamentally useful psychological processes. Ernst Mach (1905) put it well: "Knowledge and error flow from the same mental sources, only success can tell the one for the other."

Reason (1990) therefore makes a case for an engagement with the behavioural sciences if erroneous acts are to be understood and effectively managed. If there had indeed been a vessel, as the master perceived the situation, then his actions would have prevented a collision.

To compound the situation for the master of the *Dole America*, he was sure that there was another vessel present and the likelihood of an accident, evidenced by his helm order even before going to the bridge window to have a closer look and asking the second officer's opinion. The vessel initially had a pilot who informed the master of two other inbound vessels. The master therefore may have focused his attention on what he thought was a situation to avoid, a collision, being "primed" regarding the passage of the other vessels leading to confirmation bias. In this case the master

consulted the second officer who responded in the affirmative. The report however noted that the second officer had returned not long before from escorting the pilot out; therefore, his vision might not have adjusted to the darkened bridge; another perceptive limitation.

Priming is often used in person perception (Zebrowitz, 1990); however, it is possible to be adapted to situations such as that which obtained on the *Dole America*, in which case, priming is a phenomenon where a situation is judged based on recently activated scripts. The master, having been informed by the pilot, of the inbound vessels, was "primed" and therefore channelled his expectations in that direction and confirmed this when he "saw" the red light. Priming may therefore lead to confirmation bias in terms of seeing what is expected.

Figure 5-2 is another typical picture used in perception exercises, sometimes referred to as the wife and the mother-in-law. Depending on how one is primed one will see an old woman or a young woman.

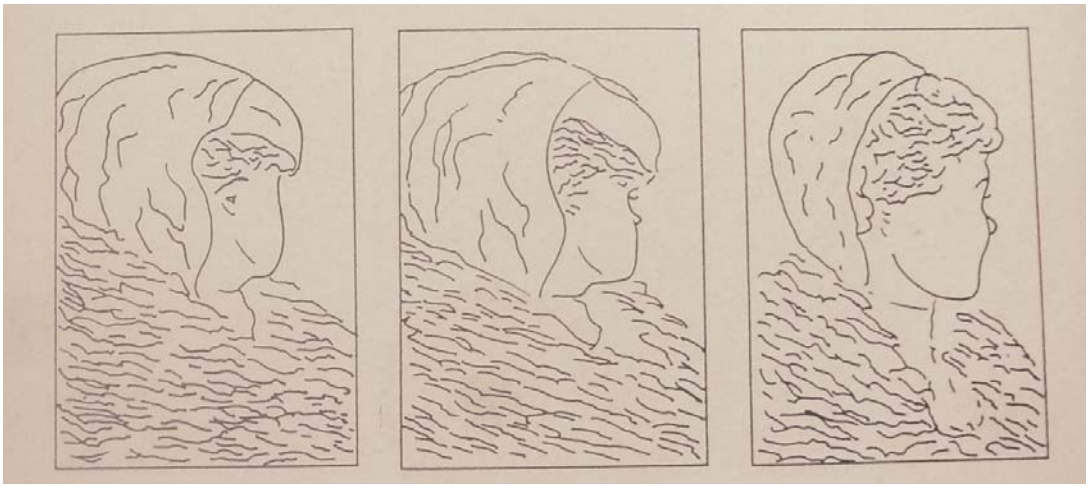

Figure 5-2: The young woman and the old hag
Source: Zebrowitz, L. (1990).

Confirmation bias is the tendency to look for information that confirms beliefs and to ignore other information that may be contradictory (Esgate & Groome, 2005). The

master of the *Dole America*, due to his expectation of the inbound vessel may have led himself to believe he saw a red light and if that light was present, he may have led himself to believe it belonged to a vessel about to collide with his.

Confirmation bias also occurs when cues are used to confirm initial hypothesis and thus markings are interpreted incorrectly (Hetherington, et. al., 2006). This may have been the case in the *Royal Majesty* grounding where the report stated that several cues indicating that the vessel was off course were present yet these did not alert the officers to that fact and the vessel ran aground 17 miles off its course.

Another concept of relevance to situational awareness as regards perception is *illusion of control*. This is the situation whereby one perceives him/herself to be in control of an uncontrollable event (Esgate & Groome, 2005). Such a perception exists in situations where earlier successes were experienced. In the case of the *Green Lily* the report indicated that the master had taken his vessel through poor weather conditions, and this may have contributed to his "over-confidence" in repeating that act. From the outset of the events the master remained optimistic about the weather conditions not deteriorating and when it did, he was optimistic about a successful outcome of the rescue. However, the result was the death of a rescue personnel.

Illusion of control is also useful in understanding perceptions of risk and therefore attitude and behaviour towards risks. Persons who feel they are in control or have an "it will not happen to me" attitude (Geller, 2001) or the machismo and confidence in the equipment, will be less likely to take precautionary measures; recall the master of the "unsinkable" *Titanic*.

None of the actions discussed as regards perception were malicious; these were genuine beliefs in the situation as was perceived at the time and actions were taken, or not taken accordingly. There is also a place for bravado and confidence in the

social world as nature's way of imprinting survival models. This is the complexity of people and what it means to be humans (Geller, 2001). Therefore, the importance of awareness as regards these human *idiosyncrasies* cannot be overemphasized.

5.3.1 Complacency and Diffusion of Responsibility

Failure to adequately assess a situation may also be due to complacency. Complacency is becoming another frequently used term in the maritime industry to describe a seafarer's lack of vigilance during watchkeeping (Hetherington, et. al., 2006). It has been named as one of the manifestations of "rogue behaviour" in the Nautical Institute's Alert newsletter (Rogue behaviour is …2008). The understanding from this label is that operators will monitor less effectively when there is automation, more so when the automation has been effective over time (Hetherington, et. al. 2006). Although speaking of the technology, Lützhöft and Dekker (2002) tell us that automation creates new error pathways. New error pathways may also be created on the part of the operator as Stadler (1987) observed, "these devices translate the psychological problems into another medium where they reappear in more serious forms." Complacency may be one of those forms where there is over-reliance on automation, as may have been the case of the *Royal Majesty*. A contributory factor in the collision between the *Skagern* and *Samskip Courier*, where both vessels, under pilotage, were proceeding at unsafe speeds for the fog condition, was cited as both masters' "over-reliance" on the pilots.

Hetherington, et. al., (2006) in search of an explanation for complacency asks the question if automation results in "some kind of cognitive lackadaisicalness? This dissertation is suggesting that such behaviour is possibly a case of *diffusion of responsibility*.

The concept *diffusion of responsibility* was developed in the early years of social psychology (the 1970s) in response to the murder of a young lady, Kitty Genovese. What prompted the foray into a series of research was that there were witnesses to

the murder yet nobody went to her assistance even after the murderer left and returned to continue the assault (Aron & Aron, 1986). The incident led to several studies in *pro-social* or *helping behaviour*. The initial research discovered that the more persons who witness someone in need, the less likely that person will be assisted, as each person is thinking the other will assist. (Aron & Aron, 1986). Other explanations have emerged for helping behaviour since then, but *diffusion of responsibility* remains a worthwhile concept.

In a modified form, *diffusion of responsibility* provides a plausible explanation for complacency on the bridge rather than the more negative "why bother" attitude that the Alert is suggesting (Rogue behaviour is …2008). In the presence of "others" such as the pilot or an automated system, perceived as reliable, some of the responsibility will be diffused. The watchkeeping officers, consciously or unconsciously will become less vigilant. However, through education along with attitude change, an appreciation for continuous vigilance may be instilled. It is believed that revelation of the underpinning mechanisms will serve to bolster the principles and provisions for watchkeeping.

5.3.2 Distraction

A similar analysis may be applied to distraction, which is another finding in casualty investigations. It is likely that those who allow themselves to become distracted also diffused their responsibilities to the automated system, or the other members of the watch team. For example, the mate who was on watch at the time of the grounding of the *Bunga Teratai Satu* (ATSB[16], 2001) was said to have been distracted by private calls his wife was making to their family home. Diffusion of responsibility is also highly likely in situations of fatigue, particularly when there is a lone watchkeeper, a possible explanation for the grounding of the *Jacki Moon* (MAIB, 2005). Watchkeepers take comfort in the presence of the automation.

[16] Australian Transport Safety Bureau

5.3.3 Violations

Violations in shipboard operations are yet another human factor contribution to maritime accidents. Except for accounts in accident investigations where rules were broken, this area has not been studied in the maritime industry. Violations include acts such as not adhering to company policies, for example the *Attilio Ievoli*, where the master chose to use the west Solent contrary to company instructions; professional misconduct such as the officer of the watch on the *Bunga Teratai Satu* or the pilot on the *Crimson Mars* who both were distracted by use of their mobile telephones. Violations stem from a complex interplay of psychological and philosophical perceptions regarding rules and risks and may therefore affect how a situation is evaluated.

5.3.3.1 Rules

Attitudes to rules may be based on whether these rules are seen to have moral underpinnings (Nichols & Mallon, 2006). Nichols (2002) distinguishes between morals and conventional violations. Moral violations, such as directly hurting someone, is associated with ethics, versus conventional violations associated more with etiquette and social acceptability, such as wearing jeans to a formal affair. Conventional rules are viewed as dependent on authority, and moral rules are seen as wrong regardless of domain. This view is instructive for the maritime industry.

The question is: Does the seafarer see it as morally wrong to violate rules? Where rules are perceived as “conventional” and their violation in the interest of commerce may be supported by the company, then there is no moral dilemma associated with their violation. Additionally, if the rules and procedures are seen negatively as creating more work and adding to the stress of the seafarer, then overlooking such rules will not be the source of any discomfort. However, if rules are seen as a matter of ethics, and the connection can be made between such violations and morality, mediated by affect (Nichols, 2002), then perhaps rules will be obeyed. Manuel (2005) has suggested education in the affective domain to develop such values and attitudes

so that a seafarer would behave ethically regardless of the company with which he works. This dissertation takes that suggestion a step further to suggest that the content of such affective education comes from the behavioural sciences. An example of a pilot who refused to fly in an unsafe situation and was fired (Dekker, 2006) represents the attitude that is desirable for the seafarer in the presence of substandard shipping. The seafarer however has to be empowered with the mindset to take such actions.

5.3.3.2 Risks

Violations are also mediated by ones perceptions of risk. Geller (2001) notes that behaviour is determined by perceived rather than actual risk and is related to *illusion of control*. Persons with lower perception of risk may also feel they have control over situations, the *Titanic* again comes to mind. Also, the master of the *Green Lily* may have been operating on perceived risks and therefore made the choice to leave port in poor weather conditions. This makes the management of safety even more challenging. At this level, rules, regulations, and procedures are no defences against such risks, the defences have to come from within where informed choices are made (HSL, 2002). Vuren (2000) as quoted in the HSL (2002) review, in a study of the Dutch steel industry found that "enormous risks" were taken and the use of personal protective equipment was not treated seriously and considered to be unnecessary burden. The opposite scenario is where protective equipment actually served to reduce the perception of risk and so the worker engages in more risk taking behaviours (Geller, 2001).

5.4 TEAMWORK, LEADERSHIP AND POWER

Many years ago there lived an Emperor who was exceedingly fond of fine new clothes that he spent vast sums of money on dress… one day two swindlers, calling themselves weavers, arrived. They declared that they could make the most magnificent cloth that one could imagine; … the clothes made from it had the special power of being invisible to everyone who was stupid or not fit for his post…

So the Emperor gave the swindlers large sums of money and the two weavers set up their looms in the palace… They demanded the finest thread of the best silk and the finest gold and they pretended to work. Now the Emperor was eager to know how much of the cloth was finished. He was, however, somewhat uneasy to look. He decided to send his faithful old minister. He will best be able to see how the cloth looks. He is far from stupid and splendid at his work. The minister saw nothing. But he did not say so... To the Emperor he said…"The cloth… is truly magnificent."

The Emperor became anxious to see the costly stuff for himself…accompanied by a number of selected ministers. He saw nothing. "What can this mean?"… Am I so stupid? Am I not fit to be Emperor?... he thought. But aloud he said, "Oh, the cloth is perfectly wonderful. They advised the Emperor to have some new clothes made to wear in the great procession the following day… And so the next day the Emperor set off at the head of the procession. All the people standing by cheered and cried, "Oh, how splendid are the Emperor's new clothes. But among the crowds a child suddenly gasped out, "But he hasn't got anything on." And the people began to whisper to one another what the child had said…The Emperor himself had the uncomfortable feeling that what they were whispering was… true. "But I will have to go through with the procession," he said to himself. (Stephen Corrin, 1964) [17]

On November 18, 1997, *Green Lily* left port Lerwick for the Ivory Coast in poor weather conditions. The vessel experienced flooding and during pumping out of the waters the main engine stopped. Attempts at rescue were hampered by severe weather conditions resulting in a fatality. In addition to lack of propulsion and failure to start the engine as the main factors leading to the grounding, the investigators also listed the master's imprudence to sail in view of the prevailing and predicted weather conditions and an overly-optimistic attitude about a successful

[17] The Emperor's New Clothes by Hans Christian Andersen (1805-75), adapted by Stephen Corrin.

outcome. The report documented an autocratic leadership style resulting in poor decision making and, not unlike the story above, at least one officer was concerned about the master's decision to sail but no one openly questioned him.

Leadership and attitudes to leaders are key aspects of any social organization and greatly affects positively or negatively subordinates' responses. Like the ministers in the story, none of the officers "challenged" the master's decision, they assisted in perpetuating a negative situation. "Face-saving" is also a likely response to leadership, one does not want to expose one's ignorance of a situation or that one does not understand, least it is construed as a personality flaw. Like the Emperor in the story, the master of the *Green Lily* made no contingency plans, optimistically expecting a successful conclusion in the face of a worsening situation and no one questioned his decisions, as they were not themselves empowered to make such a challenge; the outcome is at a minimum embarrassment when the master is "left without his clothes", or worst a casualty, loss of lives, property and damage to the environment.

Shipboard structure is rigid and maintains the traditional hierarchy (Østreng, 2001). Like an Emperor, the master is Lord of his vessel or indeed given "god-like" status "*orders from the Greeks were like words from God*." (*Bow Mariner*). Many accident reports have cited lack of teamwork as a contributory cause. Such views of leadership as just described, are inimical to healthy operational, professional and social relationships on board. Leadership impacts teamwork and accompanying factors of communication, group cohesiveness, power distance and destructive obedience. However, the gravity of power relations on board is not commensurate with the attention it gets in the maritime industry (Sampson, 2003).

5.4.1 Destructive Obedience

Destructive obedience has become a cause for concern in the maritime industry (Sampson, 2002). In 1963 at Yale University, behavioural scientists were exploring obedience and the power of social influence. It was discovered that people have a

destructive deference for authority that resulted in destructive obedience (Aron & Aron, 1986). Destructive obedience lies in obeying incorrect orders, (*Bow Mariner*) keeping quiet rather than volunteering information (*Green Lily*) to prevent a negative situation, or not "challenging" incorrect decisions (*Domiat*). Policies and procedures are weak defences against such human conditions as destructive obedience. It is assumed that no seafarer goes to sea with the intent of causing a grounding or collision and putting their lives at risk, such human responses should therefore be understood from the human perspective.

The term power distance has been co-opted to the maritime scenario to explain the power relations between the master and his sub-ordinates and the negative impact on shipboard operations. Power relations on the *Bow Mariner* is stark evidence of its destructive outcome.

5.4.2 Teamwork and Group Cohesiveness

The investigation into the *Bow Mariner* explicitly commented on the lack of cohesion onboard which also impacted communication. It may be extrapolated that this is directly related to the shipboard culture, a problem with mixed nationality crew (MARCOM, 1999; Horck, 2006, 2008a). The MARCOM (1999) project provides a list of national groupings that are incompatible onboard, although Greeks and Filipinos were not among the list, it does not preclude the development of such negative group dynamics.

The behavioural sciences begun its foray into intergroup relations influenced by the events of World War II (Aron & Aron, 1986). In a series of studies it was discovered that group cohesion may be created through the presence of a *superordinate goal*[18] (Aron & Aron, 1986; Hayes, 1993; Brewer & Miller, 1996; Brown, 2000). Yet what has been discovered since then is that social/cultural identity, is a more powerful

[18] Superordinate goals are situations affecting the groups welfare and which demand that the groups cooperate to achieve this common objective.

determinant of intergroup relations (Brewer & Miller, 1996, Brown, 2000). Social identity theory explains how a person's personal identity is intricately associated with membership in a social/cultural group and affects relationships with other groups (Hayes, 1993; Brewer & Miller, 1996; Brown, 2000). Negative intergroup relations on the *Bow Mariner* may be explained by social identity theory where the lines of group identity were clearly drawn on cultural differences. The individual identities of the Greek officers were expressed through their cultural grouping which affected relationships with the other cultural group, the Filipinos. As such communication was poor, leadership was autocratic, mistrust and apathy, and a lack of care for the crew, permeated the shipboard culture and no doubt exacerbated the disaster.

Another concept of relevance for the *Bow Mariner* as regards culture is ethnocentrism. Ethnocentrism is the belief that one's culture is superior to others. (Hayes, 1993; Brewer & Miller, 1996; Østreng, 2001). It is not unreasonable to extrapolate that this situation existed on the *Bow Mariner* resulting in mistrust of the Filipinos to perform tasks without being continuously supervised. Ethnocentrism can lead to prejudice and stereotypes. Although Kahveci et. al. (2002) did not find such tensions in their research, the hierarchy and social separations on some vessels as found by Østreng (2001) are pre-conditions for intergroup tensions.

The MARCOM project (1999) proposed the encouragement and promotion of social activities onboard to help overcome the impact of multicultural crew. Whereas this may be successful in some situations, it may not be in others. The senior officers on the *Bow Mariner* were all of one nationality sharing the same attitude towards their subordinates, therefore there was no one to initiate these activities. The company could very well give such directives, but there is no one from the company ensuring that these are carried out. Intergroup contact has to be carefully orchestrated as such contacts may lead to heightened tensions (Hayes, 1993; Brewer & Miller, 1996; MARCOM, 1999; Brown, 2000; Østreng, 2001).

Education and training in cultural diversity has also been proposed as a way to counter such negative effects (Horck, 2006, 2008). Care must however be taken to combine such education with positive mental models associated with cultural relativism, that is judging a culture by its own standards (Hayes, 1993). In agreement with MARCOM (1999), "…the idea is that there is knowledge and with further research, advances in understanding these issues can be made, companies do not have to learn by trial and error" likewise the seafarer and the maritime industry as a whole. However the challenges with companies that have been noted elsewhere in the dissertation, suggest that the place of such education is with the MET.

5.5 FATIGUE

Fatigue is the third factor affecting seafarers' performance that this dissertation explores. Issues of mental health, wellbeing and welfare are grouped under fatigue as they have implications for its development (Smith, 2007). Fatigue has been discussed elsewhere in the dissertation. The emphasis here is that fatigue is a major risk factor for stress, mental health problems such as depression and it is implicated in acute illnesses of the seafarer (Stevenson, 2002; Smith, 2007) which it is suspected may lead to premature death (Smith, 2007).

Current legislation, as said before, focuses on the physiological aspects. These legislation have been found to be inadequate in the face of commercial pressures and so seafarers or companies falsify the work and rest records (Smith, 2007), again reference is made to the grounding of the *Jacki Moon.* Education regarding the severe negative effects of fatigue is among the suggestions for solutions as part of a holistic approach. Mental health problems, depression, wellbeing have to be dealt with from a behavioural sciences perspective.

5.6 CHALLENGES TO ENGAGING THE BEHAVIOURAL SCIENCES

There is no doubt of the role of the behavioural sciences in addressing issues of safe behaviour in the actions of the people at the sharp end in the maritime industry. This has been borne out thus far in the exploration of the issues involved. The maritime industry has been engaging the sciences in a fragmented manner. Currently the call is for the introduction of fatigue, leadership, communication and cultural awareness training from separate directions. This is a piecemeal approach, as the areas are interrelated. An amalgamated course of study to holistically deliver such courses, as well as incorporating into the technical aspects would be more beneficial.

This said however, there are a few challenges facing the use of the behavioural sciences. Firstly there must be qualified persons with seafaring background or seafaring knowledge to develop and teach these courses. The integration of, and relevance to seafaring is important.

Secondly, empirical research is needed to ascertain the direct impacts of the PSFs and how the behavioural sciences can be modified to suit the situations. Cultural diversity and perceptions based on years of socialization and personality formation are difficult to impact. Such interventions will require supporting data to ensure accuracy in intervention methods.

Thirdly, the content must be combined with behaviour and cognitive based approaches to behaviour change, as discussed in Chapter 4. The traditional methods of delivery will be ineffective. As HSL (2002) notes, in a case to convince workers in a metal fabrication plant to wear ear plugs: Those who received lectures on hearing conservation and threats with disciplinary actions did not increase their usage by more than 10%. The experimental group that received behavioural based approach increased their usage by 85-90%. The challenge will probably be in gaining the commitment of the MET to adapt new ways of teaching.

Fourthly, the STCW Convention has to incorporate relevant provisions to ensure that such education and training become a part of the global standard. Problems with substandard shipping necessitate that some intervention to develop a safety culture is also directed at the seafarer who will need to take a stand in promoting safer shipping. However the implementation of provisions rests on the democratic machinery of the IMO and at times the machinery does not agree with what may seem a prudent course of action to others.

5.7 SUMMARY AND CONCLUSION

> *…there is a psychological world behind the errors to do with people's attention, perception, decision making…"* (Dekker, 2006, p.120).

The chapter presented some of the human factor challenges to safety culture from a behavioural sciences perspective. Important is the realization that how we view the world is mediated by many factors such as culture, socialization, individual differences, gender, mood, etc. A change in perspective can challenge initially held beliefs and is especially important for how others of a different culture are viewed, which may assist in multicultural relations on board. Figure 6.3 overleaf illustrates; turn the dissertation upside down and the situation appears less negative.

Cognitive interventions and behavioural changes are necessary to combat the human *idiosyncrasies*. We possess cognitive models that may be as useful as they may be dangerous. The problem is that many of us go unaware of such mental forces. Lützhöft and Dekker (2002) analysing the *Royal Majesty* accident, presented insightful explanations of the negative effects when the mental models are not fully developed for a particular situation, they however focused on the technological and omitted to see that even if the correct mental models for the automation were in place, the grounding might still have occurred, as the mental models for human *idiosyncrasies* are lacking.

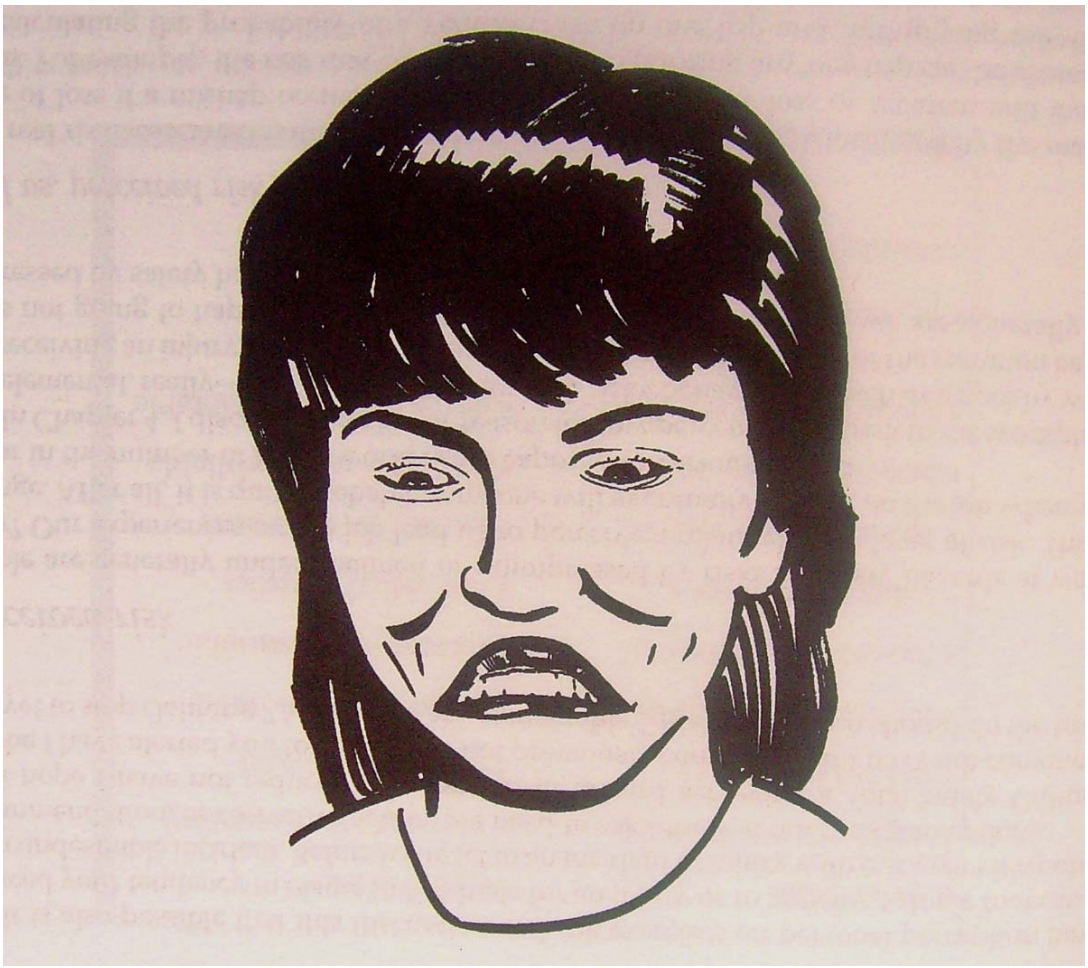

Figure 6-3: Upside down head
Source: Geller (2001)

A Behaviour based approach is the popular method of addressing attitude change as regards safety (HSL, 2002; Manuel, 2005; Broadbent, 2006; Al-Hemoud & Al-Asfoor, 2006). The premise is that behaviour is related to attitude and changing behaviour will lead to a change in attitude. However, changing attitude also involves inputting the right content, creating the awareness in the seafarer that as humans there are inbuilt mechanisms that may lead to erroneous acts. Such an undertaking belongs in the MET where these may be integrated with other courses of study to reinforce the lessons of their impact on actions.

CHAPTER 6

DISCUSSION
Part I

6.1 INTRODUCTION

This section discusses the information gathered from the responses and other sources of data. The chapter is divided into two parts. The first part is a discussion of select information according to the main concepts under exploration: safety culture, human factor (challenges to safety culture), MET, and the behavioural sciences. The second section presents a description of the aviation industry's initiative to develop and promote a safety culture with specific reference to the use of the behavioural sciences in its CRM programme.

It is recognized that the data is limited in terms of scientific rigor and therefore constrained in making generalizations, but it is adequate for exploratory purposes. The information gathered in the discussions and interviews were in-keeping with what was found in the literature. Information was gathered from sources as follows:

- 10 email interviews/discussions with seafarers, 2 were currently serving while 8 were students at the WMU.
- A personal interview with a student at the WMU in his capacity as a seafarer and as a training manager for a prominent ship management company.
- Two email discussions and one personal discussion from the perspective of training institutions.
- One seminar session on Marine Resource Management (MRM) at the Swedish Club (August 18, 2008) and discussions with the Manager, Martin Hernqvist.
- Discussions and observations on field trips to MET institutions in the Netherlands and France as part of the WMU's curriculum for its MET specialization.

Details of the topics explored in the discussions are presented in Appendices 2-4.

6.2 SAFETY CULTURE

There is no doubt that safety culture has been firmly established in the deliberations of the maritime industry. Of the three components of the *safety triad*, the technology as a factor in the performance of seafarers has received the least responses. Also, the literature has indicated that technology has improved resulting in less accidents from that domain, bringing the human contribution to accidents to the fore (Hetherington, et. al. 2006; Redmill & Rajan, 1997). The emphasis in the general discussion of safety culture in high risk industries is now the organization, however emphasizing the role of the human factor such as management and management decisions. Yet, in the maritime industry, while the organization's role is acknowledged and the actions of the people at the blunt end are not denied, the seafarer at the sharp end holds a large portion of the responsibility in the discussions of maritime accidents.

There was general agreement among the respondents that safety culture was important and should be the purview of all involved. This is seen as a way of improving the industry. One seafarer saw it as important that charterers should be involved in this discussion as well "*what kind of ship is he chartering?"* It was also seen as essential for the seafarer to have the idea about safety culture to not only protect property and the environment, but "*most importantly they need to survive and [stay] alive for their loved ones."* This comment indicates that the seafarer includes his health and wellbeing as a factor in safety. While mention is made in the discussion of fatigue and lone voices regarding occupational health (Nielsen & Panayides, 2005) are attempting to include seafarers' health and well being, there is still room for improvement. The STCW review promises to make provisions for seafarers' health awareness training (IMO, 2008), the details remain to be seen.

6.2.1 Maritime Resource Management (MRM)

MRM was developed to address the needs for the non-technical skills and to contribute towards the development of a safety culture in the maritime industry by imparting these skills to mariners as well as shore based personnel including pilots and accident investigators. MRM is an expansion of BRM which has incorporated aspects of the aviation industry's CRM. The training was instituted as part of the loss prevention philosophy of the Swedish Club, a marine insurer. The Club sees the need for a change in culture to promote the right attitudes and behaviour towards accident prevention in the maritime sector. The course contents are described in Appendix 7.

This initiative can be applauded as a step in the right direction. It seeks to be comprehensive in addressing the "soft" skills which have been established as critical to improve performance and therefore safety. It was explained by the manager, Martin Hernqvist, that not only do they teach the courses, but follow-up visits are done onboard to observe if the practices are applied. Unfortunately, it is only a few of the cruise lines that are currently sending their officers to such training.

Two points of concern arose as a result of the visit to the Swedish Club: 1) the mentality that only officers should have certain knowledge and 2) the benefits of such training are reserved for those working with more conscientious companies. These concerns run throughout the dissertation as have already been discussed in relation to the revision of the STCW Convention. The argument remains that there is prudence in exposing all seafarers to appropriate aspects of such knowledge during their cadetship to circumvent the deficiencies in the system that they encounter in their careers. Not only officers need to develop professionalism, but all crew. The crew on a vessel is a team. This view is supported by the attitude of the AB in the *Bunga Teratai Satu* where he knew the vessel was on the wrong course and did not inform the watch officer as he thought it was not his place. While power distance may have been operating here, another reason to expose all crew to such education

and training, it is also a matter of teamwork, everyone feeling a part of the team and therefore takes responsibility.

6.3 HUMAN FACTOR CHALLENGES TO SAFETY CULTURE

Both the literature and the discussions with seafarers have identified similar factors that affect performance on board. Fatigue, stress, health and wellbeing as well as non-technical performance issues such as leadership, communication and cultural differences have been shown to affect performance.

6.3.1 Fatigue

The dissertation has grouped health and wellbeing issues under fatigue as fatigue has been shown to have both physiological and psychological dimensions (Smith, 2007) affecting health and which may also be exacerbated by family issues ashore. Family problems and attempting to fix things ashore from the ship, as one seafarer pointed out, as well as home sickness, have been the "Achilles' heel"[19] of the seafarer (Thomas, 2003: Kahveci, 2007). One seafarer paradoxically explained the importance of being safe so as to return to family and simultaneously working unsafely for the family's sake. This is the explanation when asked about ever having done something that was considered unsafe on the job: *"sometimes you have to do it for the sake of others. You are forced to do it to be good in your work for giving your loved ones a good life."* The watch officer on the *Bunga Teratai Satu* (Appendix 2) was preoccupied with a private call to his family and so missed changing course and the vessel ran aground; but to re-emphasize the point, if the AB had been a team player, the watch officer would have been duly alerted.

The literature has indicated that seafarer's health and wellbeing are two areas in need of great attention in the maritime industry (O'Neil, 2001; Nielsen & Panayides, 2005; Thomas, 2003: Kahveci, 2007) and are associated with fatigue (Smith, 2007). Mental health issues, depression, possibly leading to suicide. As the training officer

[19] Area of vulnerability

interviewed (Captain X) revealed that during his time serving he dealt with three suicides on three different ships in the space of one year. There are also a number of contentious issues of welfare and rights in the industry (Mukherjee & Mustafar, 2005; Kahveci, 2007; Donner, 2008; Zhang, 2008, Mukherjee n.d.).

The consensus regarding life on board is that it is lonely, the seafarer feels isolated and it affects his mental state, although some find job on board enjoyable, which is a function of the care the company shows. As Captain X explained, he lost his father while serving and could do nothing but cry alone in his cabin. As the captain he felt there needed to be that distance [between him and the crew], so there was no emotional support. The seafarer writing in the *Nautilus* (My battle with 'the black dog' 2008) about his depression, underwent counseling and recommended that all seafarers read the book *Getting Over Depression* (cognitive therapy). Such expressions of loneliness and isolation have been verified in studies where seafarers described life on board as tantamount to being in prison (Kahveci, 2007).

The behavioural sciences may help in raising awareness regarding fatigue and its effects. It may also assist if the STCW implements the provisions for fatigue awareness training. Dealing with fatigue only in physiological terms may be undermining the gravity of the situation and influencing perceptions of being in control, being able to stay awake. It was revealed in the investigation of the *Jacki Moon* accident that hours of work were falsified and fatigue was a contributory factor. One seafarer interviewed also indicated that he has worked while tired and "*thankfully no incident happened.*" In his extensive review and research on fatigue, Smith (2007) concluded that of all the possible approaches to fatigue management: regulation, enforcement, awareness, campaigns, training and guidance – everyone is deficient in the maritime industry. A robust and holistic approach is necessary which Smith (2007) and this author believe, can lead to a culture that benefits the industry as a whole.

6.3.2 Teamwork

Issues relating to group relations, leadership, power and communication were discussed as a part of teamwork because ultimately it is a team effort that runs the ship and these factors impact the cohesiveness of the team and therefore performance. As one seafarer put its:

> *It is very important for seafarers to understand that the safety of the ship depends on the total collaboration of all on board and that safety does not only mean taking care of one's machineries or doing one's assigned duties, but looking after each other's affairs also count.*

This statement is instructive for creating a philosophy among seafarers and therefore the importance of education and training at all levels and not senior officers only, as the current STCW review is proposing; again the AB's response in the *Bunga Teratai Satu* incident emphasizes this need.

Not speaking out for various reasons, chief of which has been cited as power distance (culture) in the literature, is also a major problem on board as revealed by accident investigations. The behavioural sciences have a rich tradition of research and practices in team management, group relations and leadership that may be harnessed to instill values and attitudes where each seafarer shares the responsibility of a safe ship and is empowered with the knowledge and confidence to speak out on issues. Although the STCW makes provisions for such training, the literature and the interviews suggest that these are not enough. It was indicated that courses on leadership, group relations, communication, cultural awareness and perception (Appendix 2) were taught in the schools that the seafarers attended. However they were not all exposed to all these courses to the same degree. Only five had courses on cultural awareness and perception. This variation is also supported by the three training institutions that responded to the questions (Appendix 4).

6.3.2.1 Communication

While communication difficulties stemming from language, grammar, vocabulary, tone, pitch etc. affect performance, also important are communication problems associated with culture. Communication is essential for healthy social relationships on board which are constrained by cultural differences (MARCOM, 1999; Dzugan & Renping, 1999; Sampson & Zhao, 2003; Horck, 2006, 2008a). The responses by the seafarers support that communication problems exist and that cultural differences create problems in this regard (Appendix 2).

Power distance and destructive obedience are also associated with communication problems. One seafarer explains how communication misunderstanding operates from two sides:

> [On the one hand] *The captain is giving an order and somebody thinks, aggressive captains…do not allow anybody to speak.* [On the other hand] *bad orders are given and you keep silent not to make a problem and do it.*

Additionally, Captain X explains:

> *Sometimes the respect the master is expecting is not there. Like a junior officer from Asia or so, will stand when the master enters the bridge and walk after him but one from Europe or other developed country may not. A ship is not a democracy it is a high risk environment, and so it is necessary to have structure, but at times the master may act as a dictator and this can hinder communication, so it [power distance] has to be taken into consideration.* ***But there is no structured training for these things.***

In addition to healthy social relationships, and safe ship board operations, communication may also assist on the individual level combating psychological tensions. Simple strategies such as talking may assist in relieving some of the psychological effects (Horck, 2008a), rather than destructive coping strategies, such as drinking, smoking, becoming aggressive (Appendix 2). To repeat the saying

"knowledge is power," one has to have the knowledge in order to use it. Empowering the seafarer with such knowledge combined with the right attitude and technical skills, will go a far way in contributing to safety as sea.

6.3.3 Situation Awareness

Situation awareness is another of the important factors that impacts the performance of the seafarer. It is associated with the cognitive domain and affects how situations and objects are perceived as may be extrapolated in the cases of the *Domiat* where the master thought he saw another vessel approaching, or the *Green Lily* where the master did not perceive the gravity of the situation. Except for being named in casualty investigations, situational awareness has not been studied in the maritime industry. It is seen as important however and it is included in the CRM training course. Where it is discussed, the approach is not holistic as the cognitive elements associated with sensory perception is absent. Kristiansen (2005) has given some useful insights into the effects of being at sea on the perceptive abilities of the seafarer. Issues of autokinesis, which makes a single point of light appear to move; or refraction, when the direction of a light is interrupted on passing through different media may result in misinterpretation of the direction of other vessels or objects (Kristiansen, 2005). These phenomena work in tandem with those perceptive biases discussed in Chapter 5 and impact the decision making process. Questions that should arise to assist in correctly making a decision for visual perception is whether the object if moving or stationary?; is the source of light a marker or another vessel?; is the object moving away or coming towards my vessel? (Kristiansen, 2005). In order to effectively utilize these simple techniques on has to be aware of the phenomena which come though education. The master of the *Dole America* may have faced a similar situation when he thought he saw a light which he used as the basis of his decision to change course, leading to the collision, the report noted that the source of the light was not determined.

6.4 MET

MET varies across countries as borne out by the METNET project (Schröder, et. al., 2003). The responses given in this regard also demonstrate that seafarers are exposed to different types and levels of training in the non-technical skills, reflective of the different training regimes. The discussions with training institutions also testify to this. Two responses from training institutions indicated that their curriculum had been impacted by the discussions of safety culture whereas another had not been impacted (Appendix 4). It is as a result of such variations (both from the literature and the discussions) that the proposal is made to include education and training for the non-technical skills within the standards of the STCW.

STCW is the standard bearer for the education and training of seafarers. Some MET institutions are in a compliant stage, while others are operating at a stage of excellence, yet others are at the avoidance stage (Manuel, 2005). Making provisions mandatory in the STCW would at least ensure those in the compliant stage, which it is suspected are in the majority, are educating and training in the soft skills. There is no question as to the need for the technical skills, provisions are not questioned regarding the importance of familiarization training, **the seafarer is learning to manage all aspects of his profession except himself**. All the sources of data have provided evidence that the "soft" skills are important. The industry now demands it, the seafarers also demand it for their personal, operational and professional survival. The root of the "soft" skills lies in the behavioural sciences and therefore it is inevitable that they become a part of the curriculum of MET.

6.5 BEHAVIOURAL SCIENCES

The importance of the behavioural sciences was underscored by the cases as well as the interviews. They were seen as necessary for personal, operational and professional reasons. Captain X opines that psychology would be helpful:

> *After a while when the seafarer goes ashore he has tunnel vision, should have counselling, do a debrief before going to family…The seafarer cannot make*

full use of port chaplains because sometimes he cannot go ashore because of duties..

Captain X also believes that company personnel should be exposed to such education in diversity management and psychology. It would be useful even if persons are not professional psychologists, issues can be adequately identified and informed decisions can be made.

The other persons who responded to questions have noted the importance of courses in leadership, communication etc. mentioned above, as contributing to harmonious relationships on board as well as safety. One response from an institution was uncertain as to whether teaching the behavioural sciences would be helpful. However, the other two responded that they would be helpful, with one clarifying that such courses should be taught by professionals in seafaring and supported by proper on board training.

6.6 SUMMARY OF PART I

This preceding section presents an overview of the findings from responses and the other sources of data. All evidence points to the use of the behavioural sciences in every aspect of shipping that is non-technical. While the results from the discussions cannot be generalized, they do corroborate what was found in the literature. The MRM training has reported success in the behaviour and attitudes of personnel of Star Cruises which has been associated with a dramatic reduction in accidents and near misses since they have started using the programme (Hernqvist, 2008). This suggests that there is a place for the use of the behavioural sciences in the education and training of seafarers.

DISCUSSION

Part II

LESSONS FROM AVIATION

Parallels have often been drawn between the aviation industry and the maritime industry. There are similar discussions regarding technological development and its impact on human factor and the role of the organizations in developing a safety culture (Batteau, 2001; Hudson, 2001; Ek, 2006). Concerns also abound in the aviation industry relative to the role of the human factor in safety culture as regards issues such as violations, leadership, communication, power distance, and decision making mediated by cognitive biases and perception (Hawkins, 1993; Kern, 2001; Dahlström, 2007). However, the aviation industry is said to be ahead of the maritime industry relative to addressing human factor concerns and training in the "soft" skills in a holistic way (Pekcan, et. al., 2005; Barnett, et. al. 2006; Fuazudeen, 2008).

Similar to the maritime industry, the aviation industry has had to cope with a culture of reactive response to accidents (Kern, 2001) but have moved beyond to proactively addressing its human factor concerns. Crew resource management (CRM) is the aviation industry's human factors training programme which is defined as "the effective utilisation of all available resources to achieve safe and efficient operation" (Dahlström, 2007). The behavioural sciences are an intricate aspect of this training programme. Appendix 8 is an indication of the topics covered in a section of a CRM course[20] showing areas of basic psychology, information processing as it affects decision making, fatigue and personality theory, to name a few. CRM is mandatory training and is no longer seen as training for pilots only but for all persons involved: cabin crew, engineers, mechanics, technical staff, air traffic controllers, and in some cases dispatchers and ramp agents (Dahlström, 2008 personal communication).

[20] This was obtained in personal communication with Dahlström.

The maritime industry lags behind in this regard. Although it has embraced some of the principles of CRM into BRM, it is not compulsory. MRM which is more comprehensive, is only being utilized by a select few. Deliberations are only now underway to make aspects of BRM mandatory, and this will be limited to deck and engine officers (IMO, 2008), and the details are to be seen.

Another perspective of this dissertation, which is done in the aviation industry, is the incorporation of such "soft" skills at all levels in the training of the seafarer. The incorporation of the behavioural sciences in aviation is at all levels as regards the sharp end, that is, the pilots. Dahlström (personal communication, 2008) explains that a pilot receives basic human factors training as a student in "Human Performance and Limitations" creating awareness of the human potentials and failings in terms of cognitive and behavioural mechanisms. This course is fully incorporated into their initial qualifications for licensing. Subsequently, the student does a "Multi Crew Cooperation" course which has a significant portion of human factors/CRM training. On arriving at his first airline he again undertakes the company's full CRM training. The industry then has regulatory requirements for CRM when a pilot is changing operator, when changing aircraft type and when being upgraded to commander.

The lesson to be derived from the aviation industry is a holistic approach to the human factor. To reiterate, the suggestion to amalgamate communication, leadership and BRM at the recent STW sub-committee meeting considering the comprehensive review of the STCW convention (IMO, 2008), was not supported. Additionally, the final decision was to separate aspects of the competence table making the BRM and leadership training exclusive to engine and deck officers. This has probably been the shortcoming of the regulatory training regime. Issues concerning the human factor are approached in an *ah hoc* manner and are fragmented. As shown in the syllabus at Appendix 8, all these areas are interrelated and impact each other. Aviation has come to acknowledge the need for a holistic and integrated approach. Staff at all levels are

beneficiaries of training to enhance knowledge and awareness, providing them with suitable skills to contribute more effectively to their organizations. While it is acknowledged that there are aspects that may not be suitable for some levels of staff, there are basic elements to which all should be exposed. Courses may be tailored for appropriateness. The maritime industry would benefit from adopting a few more lessons from the aviation industry.

CHAPTER 7
CONCLUSION

BEYOND A BOUNDARY

We cannot discover new oceans unless we have the courage to lose sight of the shore. Anonymous

Beyond a Boundary is the title of an autobiographical novel by West Indian (Caribbean) writer C.L.R. James. The subject matter is the game of Cricket, famous in the West Indies. In the novel, the "boundary" is presented in its literal sense as the outer parts of the cricket field where maximum "points" are scored. It also acts as a metaphor, going beyond the boundaries of the cricket field to discuss the social and political implications of the game. The point is, there are realities beyond the boundaries we place on ourselves. While possibilities may exist, they are limited and hindered by boundaries. To quote Bertrand Russell from Hawkins (1993, p.16): "*Not only will men of science have to grapple with sciences that deal with men but – and this is a far more difficult matter – they will have to persuade the world to listen to what they have discovered."*

While the discoveries of this dissertation may not be about persuading the "world," as the literature does reveal that there are those converted to the possibilities of the behavioural sciences in the maritime industry, yet others need persuading at the junctures where global changes can be made, namely MET and STCW Convention. The objective of the study was to identify and examine the potential benefits to the maritime industry of an education in the behavioural sciences towards achieving a safety culture. Attempts to meet this objective took the form of an extensive use of the literature, case studies of accidents, discussions with persons in the industry and field trips, to ascertain the prevailing situation regarding the concepts of interest, which were safety culture, the human factor, STCW Convention, MET and the behavioural sciences. Figure 8-1 attempts a diagrammatic presentation of the key concepts and their relationships.

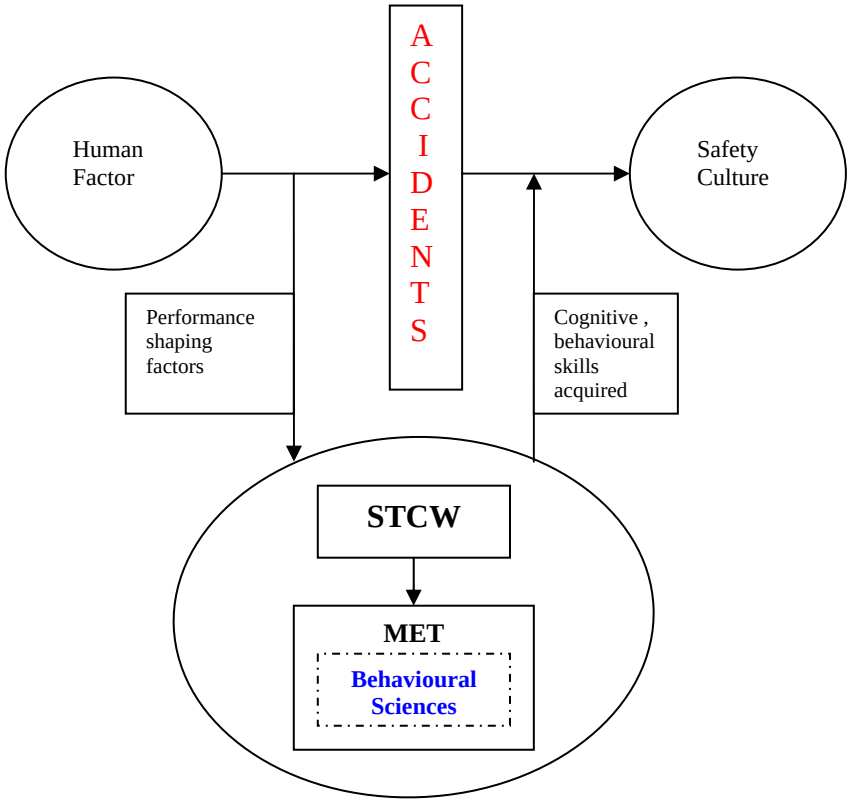

Figure 7-1: The key concepts and their interrelationship
Source: Author

The figure illustrates the path from human factor to safety culture which is thwarted by accidents resulting from PSFs. It is suggested that education and training regarding the failings of the PSFs at the MET level, utilizing the behavioural sciences as set by the standards of the STCW, will result in the necessary cognitive and behavioural knowledge and skills to complement the technical competence and therefore circumvent accidents leading to a safety culture.

The research was predicated on the following issues:

- There are problems in the maritime industry as regards safety.
- Safety culture is seen as an approach to improve safety.
- The human factor plays a substantial role in accidents.

- Many aspects of the human factor are behavioural, that is, belonging to the psychological and/or social psychological realm.
- The IMO has opened the topic for debate and finding solutions, yet the regulatory regime is lacking in addressing it substantially and holistically.
- Maritime education and training has a role to play in transferring skills and knowledge that resides within the behavioural sciences so as to enhance the human factor contribution to a safety culture.

In exploring these issues towards recommendations for action, four research questions were developed:

- What are the human factor challenges to arriving at a safety culture?
- What provisions are there in the STCW Convention to address these challenges?
- What is the role of MET in meeting these challenges?
- What can an education in the behavioural sciences contribute towards meeting these challenges?

It was found that safety culture was a concept used in all high risk industries to signify the desire to attain optimum levels of safety to ensure operations are of such standards so as to minimize the risk of accidents. However, the human factor, a key element in any safety culture agenda, also poses challenges towards achieving such a goal. The challenges lie in the PSFs associated with what the dissertation describes as human *idiosyncrasies.* While the research acknowledges the role of the organization and the technology in contributing to accidents, it also notes that human *idiosyncrasies* should not be denied. People are therefore seen as systems in their own right and should be engaged as such.

In the maritime industry, the people have been neglected on a meaningful level even though there is much discussion of the human element. The human factor is about the relationship between people and the tasks they perform at work, mental capacity for

processing information relevant to their job, their motivation, health, welfare and their relationships with colleagues (Kristiansen, 2005). Yet the science of man is absent in a holistic way from the training and deliberations regarding the human factor and its place in the overall maritime system.

Some work is ongoing in the industry by way of the IMO in terms of promoting the subject and taking steps in the current review of the STCW to strengthen the provisions. However, the current comprehensive review reveals that the provisions are still applied in an *ad hoc* way when a holistic approach would be suitable. The wider industry, in a fragmented way, is doing its part with the more forward looking institutions and professional bodies proactively developing measures to address the lack of "soft" skills among seafarers. Casualty investigation departments within States and individual researchers are undertaking studies to inform decisions. All this will however come to naught if such efforts are not channeled in the right direction.

The industry grapples with sub-standard shipping and therefore a top-down organizational strategy should be complimented by a bottom-up strategy targeting the actors at the sharp end, the seafarers. A safety culture entails more than just safe operations. The human factor needs to be committed to the cause. The "soft" skills are not fully developed in the seafarer leading him to be a victim of his *idiosyncrasies*. The current status of job satisfaction, health and welfare of the seafarers is undesirable; tensions among multinational crew are evident, culture that affects group relationships and communication, are all reasons to suggest engaging the human factor in their capacity as feeling, sensing beings.

Additionally, performance on the job is affected by factors that are purely human, as Kristiansen (2005) calls it the "human condition." Issues of perception and cognitive biases that may lead to misinterpretation of information are vital to operational safety onboard. These are all aspects of the human condition that must be understood from the perspective of people. The people skills and knowledge offered by the

behavioural sciences are also useful for personal development and are transferable to careers beyond seafaring. In brief, the behavioural sciences promise to contribute to the overall development of the seafarer, professionally, operationally and personally.

The study concludes that this is best done through the training regime of the STCW Convention to ensure that as many institutions as possible include such education in their curricula and spread the benefits widely. Companies are interested in training officers, if they train at all. Every member of the crew is a part of the team and his/her actions contribute to the overall safety culture of the vessel. Thus MET has a role to play in producing the seafarer of the future. It is believed that with awareness through education and the development of appropriate skills through training, all seafarer will learn to recognize these human conditions and take appropriate action at the necessary times. Therefore, the dissertation wishes that the role of the individuals at the sharp end is emphasized as their responses to on board culture and operations is ultimately where it matters, the system is a *psycho-socio-technical system*. HSL (2002) provides an approach to individual response with which this writer is in favour. The individual response is thus:

questioning attitude + rigorous and prudent approach + communication = safety

The seafarer would thus be empowered through education and training to elicit those responses: A questioning attitude would entail being able to "challenge" decisions or seek further information if situations appear unclear; rigorous and prudent approach involves thinking through situations, here the elements of perception would be alerted to; and communication in its many manifestations as verbal, cultural, group and social. However the obstacles to such individual responses, as the dissertation has explored, will have to be overcome. The focus of this dissertation is mainly about content being incorporated in the education and training regime, and a holistic approach to engaging the behavioural sciences at all levels of the training process among all levels of seafarers. There is evidence of much discussion on the subject

matter, there are educational tools and effective delivery methodologies available, however if the right content is missing, and the fragmented approach continues, then all these efforts are in vain.

7.1 CONTRIBUTIONS OF THE STUDY

Although there are a number of limitations, the study revealed the status of discussions and actions on the human factor in the maritime industry. Further research is needed, but as a contribution to the area of convergence for safety culture, human factor, MET and the behavioural sciences, the study is expected to:

- Create an awareness of the behavioural and cognitive limitations of humans that may contribute to accidents;
- Offer explanations to phenomena that were hitherto not discussed in the maritime industry and therefore adding these phenomena to the discussions;
- Offer an additional area for consideration in devising strategies towards developing a safety culture in the maritime industry;
- Create an awareness of the existence of theories and applications within the behavioural sciences that may be harnessed to create safer shipboard cultures;
- Highlight the need to consider a review of the content and context within which seafarer education is offered.
- Open a discussion on the holistic application of the behavioural sciences in the STCW Convention.
- Highlight the need to not only focus on officer training in the “soft” skills, but recognize that all crew are a part of the team and needs human skills.
- Point to areas for further research.

7.2 RECOMMENDATIONS

The study presents adequate evidence to conclude that the behavioural sciences are needed to develop the “soft” skills within the maritime industry. They are being utilized in other industries, and the maritime industry now demands their holistic approach. The following recommendations are therefore made, that:

- The current review of the STCW Convention considers broadening the scope of its provisions for the "soft" skills to include cognitive and perceptive elements. The aviation industry's CRM is there as a guide, or an expansion of the MRM programme.
- The current review of the STCW Convention considers the holistic approach suggested by one delegation.
- The current review of the STCW Convention considers making the provisions for the "soft" skills applicable to all crew. Model courses appropriate to each level may be developed.
- MET institutions consider reviewing their curriculum to ascertain their level of responsiveness to industry's needs. What is needed are partnerships between MET and industry, as suggested in Sudhakar's (2005) model, a top-down and a bottom-up approach to ensure all elements in the *safety triad* are addressed.
- MET institutions consider creating partnerships among themselves to share methods, resources and information. The two models of education and training presented in this dissertation may be replicated throughout other institutions.

7.3 LIMITATIONS AND CHALLENGES OF STUDY

There are a number of limitations to this study. It must be borne in mind that the study was exploratory and the main aim was to seek out the issues with regards to the key concepts. Limitations are:

- The study is an exploratory study and therefore more work is needed to include empirical data to come to more definitive conclusions;
- Interviews with seafarers were limited in number which prevents generalizations.
- Responses from seafarers included only officers. The perspective of other crew is important.

- Responses from MET institutions were poor which limited more concrete conclusions about MET.
- Lack of responses from potential participants. Participants who had initially indicated a willingness to be interviewed later abdicated.

Optimum safety culture may be an ideal for an industry as global as the maritime industry, but its principles are worth pursuing as they will lead to improvements which are needed in the system. The seafarer is a key component of this system and should be involved as human beings on their terms, this is the only way to come to a full understanding of the human factor in order to develop effective interventions.

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APPENDICES

Appendix 1 – Maritime Accident Cases

The main cases used throughout the dissertation are listed in this appendix. The first 5 case summaries were used for detailed analysis and the reminder, listed at the end of the appendix, were used as supporting material.

Green Lily – Refrigerated general cargo vessel. (MAIB,[21] 1999).

Details of the case may be found at:
http://www.maib.gov.uk/cms_resources/green_%20lily_pub_1999.pdf

Summary

The vessel left port Lerwick in the Shetland Islands on November 18, 1997 on its way to the Ivory Coast. Weather conditions were poor. Early on the 19th of November the vessel experienced flooding which was controlled but the main engine stopped during pumping out of the flood waters. Efforts to restart the engines were unsuccessful. Shetland Coast Guard was advised of the situation. Subsequently "Mayday Relay" broadcasts were made. Three tugs proceed and rescue operations commenced. Poor weather conditions exacerbated the situation and hampered the rescue operations resulting in one casualty. The members of the crew were from Croatia and the Philippines.

Analysis

The main cause of the accident was listed as grounding due to lack of propulsion and failure to start the engine in time to prevent the vessel drifting ashore.

Contributory causes were listed as the master's imprudence to sail in view of the prevailing and predicted weather conditions. He failed to make contingency plans at each stage of the incident and instead, remained overly-optimistic about a successful conclusion. The report noted that an autocratic management style resulted in decision

[21] Marine Accident Investigation Branch

making shortcomings not being identified. There was no commercial pressure from shore to leave in the weather. The master made this decision on his own. The investigator indicated that at least one officer was concerned about the master's decision to sail but no one openly questioned him.

Dole America – **Refrigerated cargo vessel** (MAIB, 2000).

Details of the case may be found at:
http://www.maib.dft.gov.uk/cms_resources/dole%20america.pdf

Summary

On November 7, 1999 the vessel collided with the Nab Tower in the eastern approaches to the Solent after departing berth at Portsmouth on her way to Antwerp. The vessel left port with a pilot, who before disembarking told the master that there were two inbound vessels. which were confirmed on radar. On approaching the tower, the master thought he saw the light of another vessel and ordered a starboard helm before going to the front of the bridge to confirm what he thought he had seen. The second officer, who was the only other person on the bridge besides the helmsman, joined him and confirmed the presence of a red light and said he saw a second to starboard of the first. The master ordered hard to starboard helm. When no further lights were seen he ordered hard to port helm. From his position at the front of the bridge he could not see the Master was unaware of the vessel's heading and her exact position in relation to the tower. Shortly afterwards the vessel collided with the tower. The crew was from Norway, India, the Philippines, Ecuador and Poland.

Analysis

The investigator indicated the immediate cause of the accident to be the master's inappropriate and unquestioned helm order to port. Contributory causes included the master's perceived need to alter course for what he took to be a crossing vessel, his lack of situational awareness and the probability that fatigue and stress might have adversely affected his perception and decision making abilities. A dedicated look

out was not posted on the bridge. The personnel on the bridge all had other duties. The lack of a predetermined pilotage passage plan was also seen as a contributing factor. Its absence let to distraction at a point when neither the master nor the second officer had time to sufficiently appraise themselves of the changing situation. Additionally, the second officer was asked to verify the light after returning from outside to the darkened bridge. The report speculated that due to power distance the second officer did not question the master's order to port. The source of the red light had not been determined. The investigator commented on an autocratic style of leadership.

Domiat **– Bulk Carrier.** (SMI[22] 2004)

Details of the case may be found at:
http://www.sjofartsverket.se/upload/listadedokument/engelska/haverirapporter/domiat-eng.pdf

Summary

The vessel ran aground on June 7, 2004 on its way from St. Petersburg to a not yet defined port in India. A passage was planned to go through the Sound via Flintrannan. The second deck officer planned the route which was approved by the master. After loading, the draft was several meters beyond the limit of the Sound. This was pointed out to the master by the chief officer and one of the third officers. The Master neglected the information and the ship ran aground. The crew was all Egyptian nationals.

Analysis

The investigator noted the circumstances to be the small draft, the master approving the route plan and a hierarchic order on board. The report noted that the manner in which the master neglected the officers' apprehensions and their adherence to his standpoint reveal that the cooperation on board was unsatisfactory. It shows a devastating respect for the opinions of a superior. The investigator reported that

[22] Swedish Maritime Inspectorate

during a visit on board an obvious hierarchic atmosphere was present where the officers seemed afraid to voice their opinions in the presence of the master. At a questioning one referred to the opinion of the master.

Reference was made to the contents of the Bridge Resource Management in relation to clear assignment of duties and responsibilities and good cooperation on board which were lacking on the *Domiat*. Comments included the use of available resources and the evaluation of new information to avoid tunnel-vision.

***Bow Mariner* – Chemical tanker.** (USCG[23], 2005).

Details of the case may be found at:
http://www.dieselduck.net/library/09%20accidents/USCG%20Bow%20Mariner.pdf

Summary

On February 28, 2004, the vessel caught fire and exploded while the crew was engaged in tank cleaning. The ship sank 45 nautical miles east of Virginia. Of the 27 crew members aboard, six abandoned ship and made it to a life raft and were rescued. An unknown number abandoned ship to the water, three were rescued, one deceased and the other two died before reaching the hospital. The crew composition was Greek senior officers and Filipino junior officers and ratings.

Analysis

The cause of the casualty was listed as the ignition of a fuel/air mixture, either on deck or in the cargo tanks. The ignition source could not be precisely determined. Contributory causes were listed as the operator and the senior officers not properly implementing the company and vessel Safety, Quality and Environmental Protection Management System (SQEMS).

[23] United States Coast Guard

The report noted that the distinctions between the Greek senior officers and Filipino officers and ratings were remarkable. Filipino officers did not take their meals in the officers' mess, were given almost no responsibility and were closely supervised in every task. The second assistant engineer reported on arriving on the vessel for the first time he inquired of his duties and was sternly told he would be given verbal job orders daily, and was to do only as he was told and would have no administrative duties beyond making log entries. The report noted a lack of trust in the deck department. The surviving deck crew reported that the chief officer would not sleep beyond short naps in a chair in the cargo control room during cargo operations. There was lack of group cohesion. When questioned as to what they would do if instructed to do something unsafe by one of the senior officers each crewman replied that they would do as they were ordered. One comment received was that orders from the Greeks were like words from God.

Attilio Ievoli – **Chemical tanker.** (MAIB, 2005)

Details of the case may be found at:
http://www.maib.gov.uk/cms_resources/Attilio%20Ievoli.pdf

Summary

The vessel ran aground on June 3, 2004 on Lymington Banks in the west Solent after leaving Fawley Marine Terminal, Southampton headed towards the English Channel via the west Solent and Needles Channel. The master, second officer and a cadet were on bridge. Neither the second officer nor the cadet was sure of who was responsible for plotting positions. The master was not paying attention to the navigation of the vessel being distracted using the ship's mobile telephone. The master instructed the second officer to remove the pilot flag, who informed the master, before departing, that the vessel was north of the planned track. The master did not hear. The crew consisted of 13 Italians, one Russian and two Ukrainians.

Analysis

The human factors analysis was carried out by QinetiQ's Centre for Human Sciences. The Centre reported that the human factor failures started with the master's decision to use the west Solent, contrary to company instructions. The crew was not clear on the roles and responsibilities of each other. Task performance were not coordinated, and there was little overt management and supervision. The report extrapolated that power distance was at work as the second officer was reluctant to question the master's authority or competence. Poor teamwork and cultural differences among team members led to role confusion among them.

Supporting Cases

- The grounding of the *Royal Majesty* on June 10, 1995. The vessel was off course by 17 miles. Human factor contribution was the officers' reliance on the automated system. (NTSB[24], 1997).

- The grounding of the *Bunga Teratai Satu* on November 2, 2000 at the north end of Sudbury Reef. Human factor contribution was listed as the mate had become preoccupied with private phone calls. (ATSB, 2001[25])

- *Jackie Moon*, general cargo vessel ran aground on September 1, 2004 at Dunoon Breakwater, Firth of Clyde, Scotland. Chief Officer who was sole person on watch fell asleep. Human factor contribution was listed as fatigue and alcohol consumption. Falsification of hours of work and rest due to commercial pressures were discovered. (MAIB, 2005).

- Grounding of the *Crimson Mars* on May 1, 2006 in the River Tamar, Tasmania. Miscommunication between pilot and helmsman. Human factor contribution was

[24] National Transportation Safety Bureau
[25] Australian Transport Safety Bureau

listed as ineffective bridge resource management and distraction caused by pilot's use of mobile telephone. (ATSB, 2006).

- Collision between *Skagern* and *Samskip Courier* in the Humber Estuary on June 7, 2006. Ships collide in dense fog. Both were going at unsafe speeds for the condition. Human factor contribution was listed as both masters' over-reliance on the pilots. (MAIB, 2007).

Appendix 2 - Responses from Seafarers

The topics discussed were to further explore the research questions as to the human factor challenges to safety culture, the status of education as regards the non-technical skills and the role of the behavioural sciences. The rationale was to discuss with the seafarers their opinions and perspectives on the concepts as they are the ones directly affected. Questions are indicated with underlining in bold and the responses follow.

Of the persons approached, ten were responsive. Two were active seafarers on the job and eight were students enrolled at the WMU at the time of the study. These took the form of personal communication via email where responses to the questions were sent and follow-up discussions done via email if clarification was needed.

Biographical Data

This information was sought to have an idea of the experience of the seafarer supporting their opinions.

	Qualification	**Current position**	**Type of vessel currently on or last employed on**	**How long have you been a seafarer**	**How long in current rank**
1	Engineer – Certification III/2 management level	Chief Engineer	Offshore supply	33 years intermittently	8 years
2	BSc	Second Engineer	Bulk carrier	10 years	4 years
3	Captain ocean going	Chief Mate	Feeder	10 years	3 years
4	Master Mariner, Maritime Pilot	Maritime Pilot	No vessel pilot for 4 years	20 years	4 years
5	Class 3 Deck Officer	2nd Officer	container	4 years	2 years
6	Master, Class I	Chief Officer	Container & LPG Gas Tanker	16 years continuous and 10 years temporary	5 years continuous and 10 years temporary
7	Deck Officer, operational	3rd Deck Officer	Bulk carrier	5 years	1 year
8	Deck Officer	2nd Deck Officer	Bulk carrier	3 years	2 years
9	Merchant Class I (inland waters)	Chief Engineer	Passenger	10 years	6 years
10	Class I Masters Licence	Masters	Container vessel	18 years	10 years

What do you think are some of the factors that affect a seafarer's performance of his duties onboard? Choose as many and you may add others not mentioned?

Factors affecting performance at sea	Number of responses
Stress	10
Fatigue	10
Family problems ashore	10
Does not understand the technology	6
Not properly trained	9
Lack of resources from company	8
Personality problems (does not get along with others)	8
Too much technology on board ships today	5

Others factors added were: one respondent each: a) stringent regulations which involve a lot of paper work and commercial pressures b) frustration c) homesickness d) alcohol and attitude of only working for the money and not caring for the profession.

Multiculturalism

The following explored the issue of multiculturalism and communication on board to ascertain the level of group interaction. Except for 2 persons they all sailed on multicultural vessels with 4 persons sailing on vessels with 3-4 different nationalities, and 4 sailing with more than 5 different nationalities.

Did you have any difficulties getting along with any of the nationalities?

Difficulties getting along with other nationalities onboard	
Yes	2
	1 Not really but the ship was very segregated, working but not socializing
No	5

Did any of the nationalities have difficulties getting along with each other?

This question was asked as it is more likely that persons feel more comfortable relating seemingly negative information about others than themselves. All 8 who have been on multicultural vessels answered yes to this question with one explaining

that it was during a time when there was national conflict between the countries of the persons onboard.

Did you personally have any communication difficulties (talking with and understanding each other) because of different languages?

The role of communication in safe operations has been established in accident cases as well as in research (Dzugan; MARCOM, 1999; Horck, 2006, 2008). Five persons of the 8 who sailed with multinational crew said yes they had communication difficulties.

Did you witness any communication difficulties (talking with and understanding each other) among other members of the crew because of different languages?

All 8 said they had witnessed communication difficulties among others in the crew.

Did you personally have any difficulties (getting along with each other) because of different cultures?

4 persons said yes they had difficulties because of culture.

Did you witness any difficulties (getting along with each other) among crew because of different cultures?

7 persons said they had witnessed difficulties among others due to culture.

Any other difficulties you can think of due to the mixed nationalities onboard?

- Other difficulties mentioned were in terms of sign language the movement of the head to signify yes or no, was different in some cultures.
- In some companies there were different salaries depending on nationality and that caused problems.
- 5 persons mentioned that meals were a problem. The type of food and difficult for the catering department to suit all the tastes.

- Culture clashes occurred when one nationality says something that another found offensive.
- One person who mentioned food as an issue also spoke of hygiene, religion, and music, as causing difficulties.

Maritime Education and Training

This section was explored to ascertain the extent to which courses geared towards the non-technical were offered in MET, how they were delivered and the seafarers' perceptions of the value of such courses.

While at training school did you do any studies on topics such as

Non-technical courses that were completed	Number of responses
Leadership	7
Group relations	7
Communication	9
Cultural awareness	5
Perception	5

The respondents were invited to name other courses but there was no indication of other courses taught relating to the non-technical. One person indicated that the communication studies he did was only for radio.

Do you think that these courses would be helpful for safety reasons onboard?

The agreement was that such courses would be helpful for safety reasons. Comments received were:

- *In my country, leadership and group relations courses are necessary because most people become officers whilst young and are made to manage older people with lots of experience on the job and if not well handled may easily lead to conflict, as there is always the "we had done it this way" syndrome.*

- *All these courses teach how to understand and deal with a micro-society, they will definitely be helpful for enhancing safety onboard. To have safety onboard in the first place you need a well functioning society.*

- *They would be helpful for safety reasons, but in an effort to reduce classroom time most of these courses have been reduced or eliminated in the UK and in training institutions elsewhere they are not even mentioned.*

- *Awareness is the key, if you have background to all of these you can probably survive onboard especially where safety is concerned.*

- *Assist in interaction with your colleagues*

- *It is very important for seafarers to understand that the safety of the ship depends on the total collaboration of all on board and that safety does not only mean taking care of one's machineries or doing one's assigned duties, but looking after each other's affairs count.*

- *It prepares you for life onboard. It does assist you in dealing with problems that will pop up from time to time.*

- *By helping to understand the situation but cannot solve the problem. I mean people will act according to their own culture especially in urgent situations when our reflexes guide our behaviours.*

In terms of such courses helping to improve safety, 9 persons agreed and one was unsure, but think it would be useful for group interaction. Comments were:

- *Yes they would be helpful but it is preferable to work with one nationality crew or at least same culture*

- *Everything which is sincerely applied can be useful*
- *Don't know if such courses improve one's safety awareness…think it helps more in the area of interaction plus man management.*

How were these courses delivered?

Methods of delivery of non-technical courses	Number of responses
Formal classes only	4
Integrated in other courses only	1
Formal classes and general discussions	2
Formal classes, general discussions, integrated in other courses	2
Not delivered	1

The method of delivery varied from formal classes only to some receiving instructions in formal classes plus informal discussions and being integrated in other courses.

Which one of the following do you think play the greatest role in safety on board?

This question was asked to ascertain the seafarer's perception as it relates to who is responsible for safety as a comparison with the different paradigms as to which of the factors in the safety-critical system is responsible for safety.

Aspects of the safety system	Number of responses
The technology only	0
The organization only	1
The seafarer only	4
The organization and the seafarer	2
All 3	3

For those believing the seafarer only plays the greatest role for safety on board, the comments were:

- *The seafarer is an element of the organization and he uses the technology, he is the most important factor*

- *It is the seafarer who uses the technology and who follows the directives of the organization. Seafarers who are safety conscious and safety aware can create working environment even for rouge organizations with little technology.*

- *He/she is responsible to follow the procedures established to safeguard against identified risks, and eventually identify hazards not foreseen.*

- *The seafarer is the whole in everything*

Persons who thought that all 3 were important had this to say:

- *Technology is no better than the user, the organization is made up of seafarers (at least partly). All are equally important but today I would say that we do have the technology and the organization in most cases but the lack of training of seafarers is the problem. Partly there is a total lack of seafarers and in addition many available seafarers are not competent.*

- *A technology which is used with capable and educated seafarers under the supervision of the highly organized/sensible organization can make a difference.*
- *Technology is been used to help in the reduction of human errors, the organization is coming up with new regulations so as to improve safety onboard; the seafarers are at the end of the chain that is they are there to implement these regulations and also meet up with the required knowledge and skill to combat the demands required to operate these technologies.*

Do you think your shipping company is serious about safety?

This question is to explore the perceptions regarding the company's approach to safety to ascertain company's involvement. Six persons indicated that their company, or the last company they worked with was serious about safety. One comment was

the company tried to make the ship a "home away from home". Another gave a general comment that some companies are not doing their best with regards to safety "*at the end of the day, shipping is all about returns. Profit. Making shareholders happy. So shipping companies will compromise safety for profit*."

Other comments were:

- *I think only from the side to comply with the regulations. Some companies do not respect their own regulations.*

- *The written procedures are mainly to satisfy the requirements for certification of the ship. Some are even "copy and paste" form other types of ships, without proper consideration with the ship's reality. For instance, procedures and checklists in a language not understood by all.*

This bears out the findings from the literature that companies vary in attitudes to safety.

In your job have you had to do anything that is considered not safe but you do anyhow?

This was a general query and not necessarily a reflection of present company or the last company with which the seafarer was employed to explore issues of violations.

Six persons said they had done things that are unsafe in their jobs. Except for one person, these acts were external to the seafarer to meet commercial pressures or the extrapolation can be made that one had to carry on to preserve ones job:

- *In an effort to keep schedule and because of commercial concerns masters have to dock vessels in small ports without pilotage assistance and to run at full speed in restricted visibility. The distance between small, island states around the Caribbean is also so small that there is very little time for the body to recover between leaving a port and arriving at another. Though companies do not explicitly say they want the ships to run at an optimum it is*

understood that a Master who does otherwise for the sake of safety may be replaced.

- *Trying to combat fire without the protective gear; anyway the reaction was spontaneous and the vessel was saved from massive destruction.*

- *Sometimes you have to do it for the sake of others. You are forced to do it to be good in your work for giving your loved ones a good life.*

- *Sailing with defective machinery form homeport under instructions from management and when you refuse to go with the ship you are thought to be incompetent and you risk your job, and being the only shipping company you had to do it anyway.*

- *As chief mate assuming the watch keeping from 04h00-08h00 after loading/discharging , which took around 12 hours at least of continuous work. I felt tired, thankfully no incident happened.*

- *For lack of appropriate material and tools.*

In your job ever seen anyone doing anything that is considered not safe but he does it anyhow

Nine persons said they had seen persons doing things that were unsafe similar to what they had done personally, such as working without proper equipment, and working while tired. One comment was that some persons worked while tired to make overtime. Others indicated that persons were ordered by officers to do things that were unsafe *"a motor man went into a partially ventilated enclosed space to work given an order by the second engineer."* One indication was that a particular person committing an unsafe act did not believe in the probably consequences.

Another indicated that a crew was working aloft without a safety belt as **he refused to wear it**.

Health Issues (Mental)

Isolation has been named as one of the factors affecting seafarers mental health and possibly leading to depression (Thomas, 2003; Kahveci, 2007). These may affect performance but are not openly dealt with in the maritime industry. Recently concerns have been raised regarding depression with one seafarer giving his experience in the *Nautilus* (My battle with the black dog, 2008). Health issues are associated with fatigue. Regarding isolation, with associated feelings of loneliness, four of the 10 said they felt lonely/isolated on board. One indicated he felt lonely on both single and multi-national vessel alike as his loneliness was homesickness. The other three indicated they felt lonely more on multinational vessels, with one commenting that "*being the only black officer amongst Eastern European officers, I sometimes felt that I was segregated from the group."* This feeling comes on mostly in the officers' saloon or at mealtimes. Similarly, the others felt lonely at social gatherings, and at the end of work period when there is time to think about the family. Drinking, recreation, entertainment (movies) going ashore and keeping busy with work were used as coping strategies.

Five persons have experienced others saying that they felt lonely on board. Reasons given were personal problems and multinational crew. Coping strategies are similar, entertainment, going ashore, keeping busy, trying to call home. One comment was "*you can even see that in their face, they are holding on just because of the money and sometimes drinking heavily*."

Eight persons said they have felt depressed on board. Job related issues, multicultural crew, homesickness, home problems, and too much work, have been given as reasons for the onset of depression. Coping strategies for depression included

focusing on work, looking forward to leave time, drinking, entertainment, quit the job, and crying.

In terms of knowing of other crew members who have said they were depressed, seven persons said yes. Coping strategies used were drinking or smoking, quitting the job, sometimes they talk to others, isolate themselves or become aggressive.

A description of life on board in general was sought to ascertain the type of environment which may affect mental health. The responses were:

- *Crew life can be fun, interesting with a busy schedule, however a supportive family is essential.*
- *Life onboard is no more fun; mostly everyone tires to do his job so as to get a clean cut for the next contract.*
- *Was fun though labouring as vessel was continuously sailing and calling in ports throughout day and night.*
- *Unique, abnormal, and sometimes fun because you can visit other places. Good experience that you could meet different people with different traits and personalities.*
- *Life onboard was very secure. Work and environment was dangerous but you were provided with most of the things… a kind of protected society away from reality. Interesting and satisfying work.*
- *Boring routine, uncomfortable, unhealthy environment.*
- *Terrible, but very good money which you will never get on shore even as a manager.*
- *Life onboard varies with the type of ship, type of trade, nationality of crew, how the company deals with its crew, area of trade. I would say it is ok.*
- *Isolated.*
- *Stress, fatigue and isolation.*

The responses vary, but show that life on board may have negative effects on health and wellbeing.

Safety Culture

There was general agreement that safety culture was important and should be discussed by all, administrations, management [companies] and seafarers, if the maritime industry is to improve. One person saw it as important that charterers should be involved in this discussion as well "*what kind of ship is he chartering?"* It was also seen as essential for the seafarer to have the idea about safety culture to not only protect property and the environment, but *most importantly they need to survive and [stay] alive for their loved ones.*

Appendix 3 – Interview with Training Manager

Interviewee: at sea for 25 years, retired 4 years ago. Training manager for ship management company.

It is said that a large percentage of accidents are caused by human factors. Do you agree with such a statement or do you see other issues?

The real problem is not investing enough in human resources, it is not valued. It's just hire and fire. If you check many companies they don't have HR policy, just short term HR.

What about issues of leadership?

You learn on the job. No course. Bridge resource management is not mandatory, it depends on the company and it is not enough.

Communication?

Communication among crew is in English but it is not mandatory, they may put together enough words to say something, but it is difficult, and sometimes communication is with body language and that can be a problem. Cultural differences can pose a problem, example some crew leave their duties and go pray (Indonesians), the captain is suppose to handle this, has anybody bother to sensitize him? There can be confrontation is captain stops them. They need education. The ship is out in the sea and is a 24hr operation cannot compromise safety that way.

Give you an example, cocoa cola, the parent company wants to set up a company in another country, he sends the person there to live for a short while to see if he likes it, get a feel of the place. Shipping is anti-social life and anti-people. As long as you are on the ship and working that is it.

What about power distance, is it a problem?

Sometimes the respect that a master is expecting is not there like a junior from Asia or so will stand when the master enter the bridge and walker after him but one from Europe or developed country may not. A ship is not a democracy it is a high risk environment so the hierarchy, it is necessary to have structure. But at times the master may act as a dictator and this can hinder communication, so this has to be taken into consideration. But there is no structured training for these things. Power distance sometimes as well between superintendent and captain. Master can divert if somebody sick and superintendent might say carry on

How would you describe life on board.

Social life onboard ship is lonely. Somebody can sit in the room and not come out and nobody enquires after him. There is no regard for culture and crew compatibility. Some crew get on well together and some do not. Desires of crew sometimes not considered, like some cultures have tea. Italian officers don't offer tea. Not sensitive to cultural needs. Or they can have pasta as meal and what about the other crew, power abuse onboard.

No regard given to emotional and psychological needs. Crew lounge is small, cabins next to smoking room, space is cramped sometimes no space. No regard, no strategic planning to take care of crew needs. Sometimes they [seafarers] go ashore there is problem to pass time, they go to pubs or go shopping. Some companies have a welfare fund and the master pockets that, others use it to organize more focussed outings.

Are there conflicts on board?

Fights occur sometimes. This is because of stress build up. A lot of time its because of food. People are working whole day and when they come to the mess room and no proper dinner, this is a cause of unhappiness and conflict. On land you go to restaurant or you have a nice dinner at home.

Have you had any experience of someone committing suicide on board?

Suicides occur. I have had 3 suicides on ships three different ships in one year that I have been on, these were for personal reasons. People don't have friends onboard to talk with. We used the fridge room where all ships vegetable and meat are stored to store the body until we got to port we let the body off and carried on. No counselling you are left to deal with it on your own.

What do you think about introducing subjects into maritime education and training regarding such matters of leadership, communication, how to deal with life onboard.

Psychology would help. After a while when seafarer go ashore they have tunnel vision, should have counselling, do a debrief before going to family. My father passed away while I was on ship, all I could do is cry in my room, no emotional support and as the captain you have that power distance.

Sometimes as well, a power struggle between captain and chief engineer. The chief engineer want to exercise power and the captain is in charge and this cause group struggle with the deck and engine. Being in the engine room for long affects their minds sometimes, being in that environment for long. The model course "personal safety and social responsibility" is there but it is not enough, need to learn how to deal with people. Need to invest in people, people are neglected. It is like you are a casual labourer, you work for today and that is it, no regard, so if somebody offers more money I go. Companies do not employ a psychologist. No company employs a psychologist. They would say the money is too much, don't want to invest.

What about the Port Chaplains?

Cannot make full use of the Chaplains because sometimes we cannot go ashore because of duties. Some ports have no chaplains.

Also the life is lonely no support, now one of my colleagues is detained, the company is still paying him, but sometimes they are abandoned. No body to support you if you are in problems.

The proposal is to have such courses from entry into school and build on the knowledge throughout each year.

I agree, but it is not the seafarer alone needs this education. Company should ensure training in diversity management undertaken by all involved in ships safety. Issues can be identified, even if the person is not a professional psychologist, issues can be identified so when they are making decisions they have information, they are aware about the things that affect seafarer. They should also make it mandatory for senior management level dealing with crew to have a degree or diploma or some qualification in human resources.

Lack of caring of seafarers affecting the recruitment, job satisfaction is important. Shipping needs an overhaul in that regard. Training is just the same, some guy come, and the white board and push the slides and thinking "when this one finishes, he will be getting more money than me." All stakeholders must be involved. Shipping is cut and dry, lack of compassion. For example, you are entering like the English channel, you are up the whole night because you take pilot, next day you have to deal with all who come to the ship and survey and check and the stores come, this come, that come, and nobody says, ok they have been up the whole night, nobody cares. It's like you have sold our soul. The thought process in the industry has to change. Awareness has changed, people want more, its like Maslow's hierarchy of needs. Small thing**s** such as designated air conditioning on bridge, or some show of care, makes a lot of difference.

What are your thought on how to arrive at safety culture?

Loyalty, build the crew loyalty, with that safety culture will come automatically, you carry out the company policy willingly. Now it is done more reluctantly and you

have to be policed. There are shipping companies with good HR policies. They map a career path for junior officers, they stay with the company, this builds loyalty. To achieve a safety culture a lot has to be done at the basic level making the seafarer a part of the team, not just hiring and firing. Root cause of ill treatment is money, don't want to invest, and attitude of owners.

Appendix 4 – Responses from MET Institutions

QUESTIONS	RESPONSES		
	Maritime Academy 1	Maritime Academy 2	Training Centre
Do you see safety culture as a challenge for the maritime industry?	yes	Yes – safety culture has never been a high priority item with maritime employees, it has been with the shipping companies	yes
Is the topic discussed in your training institution among the prospective seafarers?	Yes it is	Yes but not enough. All aspects of safety need to be discussed and applied. We need to show more by example rather than discussion. We have plenty of room for improvement.	Not really, it depends on the lecturer
Whose is responsible in the maritime industry to work towards a safety culture?	By my understanding that the logical sequence of such are: IMO – Maritime Administrations – Shipping companies - MET	Everyone, not just employers, but educational institutions as well	Companies, administrations, MET, everyone… the seafarer.
What actions relative to seafarer training has the industry taken towards achieving a safety culture?	First of all it is the implementation of all instruments where the elements of Quality Management algorithms exist (ISM Code, STCW…) as safety culture anticipates the reflections to deficiencies and projection of situation developments	I can't answer this one	Create regulations, STCW, ISM
Has the discussion on safety culture impacted on any course delivery in your institutions?	Yes it has. Every course has case studies relating to safety that is influenced by the level of safety culture of seafarers. All types of delivery methods are used and assessment is by exams. The courses are done from first year step by step	Yes, we are incorporating it into our labs and lecturers as well as our practical training aboard ship. The courses are delivered with general lecture, problem-based learning, case studies etc. All required outcomes are assessed on content knowledge. Safety is an add on that in most cases is not assessed. These courses are done primarily 1st and 3rd year.	No courses are offered that are not a part of the STCW. There are no courses on leadership, culture, communication and so on.
Do you have any suggestions as to how the industry could go about developing a safety culture	To invest in MET To develop STCW mandatory provisions for shipping companies for organization of proper on-board training.	No response	Yes, by teaching courses outside the STCW such as bridge resource management. And discuss with seafarers about safety onboard.
Do you think teaching behavioural sciences to seafarers will be helpful	Yes, I do, if these sciences are delivered by professionals in seafaring and supported by proper onboard trainng.	Unsure	Yes. But if those courses are offered nobody will take them. We used to discuss implementing courses outside the STCW in our school but if it is not compulsory the seafarers are not taking it as they have to pay and

QUESTIONS	RESPONSES		
	Maritime Academy 1	Maritime Academy 2	Training Centre
			they also don't want to be away from work too much because of the money. We don't teach to regular students.

Appendix 5 – Non-technical aspects of the STCW Code Parts A and B geared towards the human factor.

CODE Part A Column 1- **Competence**	**Human Factors**	
	CODE Part A – Column 2 – **Knowledge, understanding and proficiency**[26]	Corresponding **Performance Shaping Factors** [27]
Table A-II/1 – Maintain a safe navigational watch, p.30. - Respond to emergencies p.33	Through knowledge of effective bridge teamwork procedures. - Precautions for the protection and safety of passengers in emergency situations.	**leadership, teamwork, language, communication, cultural diversity, decision making, situation awareness, health, stress, fatigue**
- Use Standard Marine Navigational Vocabulary as replaced by the IMO Standard Marine Communication Phrases and use English in written and oral form. p.34	- Adequate knowledge of the English language to enable the officer to use charts and other nautical publications, to understand meteorological information and messages concerning ship's safety and operation, to communicate with other ships and coast stations and to perform the officer's duties also with a multilingual crew, including the ability to use and understand the Standard Marine Navigational Vocabulary as replaced by the IMO Standard Marine Communication Phrases.	**leadership, teamwork, language, communication, cultural diversity, decision making**
- Operate life-saving appliances. p. 38	- Knowledge of survival at sea techniques	**leadership, teamwork, language, communication, cultural diversity, decision making, situation awareness, health, stress, fatigue**
Table A-II/2 – Establish watch-keeping arrangements and procedures. p.45	Effective bridge teamwork procedures.	**leadership, teamwork, language, communication, cultural diversity, decision making, situation awareness, health, stress, fatigue**
- Plan and ensure safe loading, stowage, securing, care during the voyage and unloading of cargoes. p.51	- Ability to explain the basic principles for establishing effective communications and improving working relationship between ship and terminal personnel.	**communication, cultural diversity, decision making, health, stress, fatigue**
- Monitor and control compliance with legislative requirements and measures to ensure safety of life at sea and the protection of the	- responsibilities under international instruments affecting the safety of the ship, passengers, crew and cargo. - actions to protect and safeguard all persons	**leadership, teamwork, language, communication, cultural diversity, decision making, health, stress, fatigue**

[26] Where recommendatory provisions have been given in Part B of the Code this will be listed accordingly.

[27] Performance Shaping Factors compiled from the literature relating to the maritime industry, including IMO documents. Hetherington et. al. (2006) also listed safety climate and safety culture, which are important but relates specifically to the organization, although it is acknowledged that the PSFs are also affected by safety climate and safety culture.

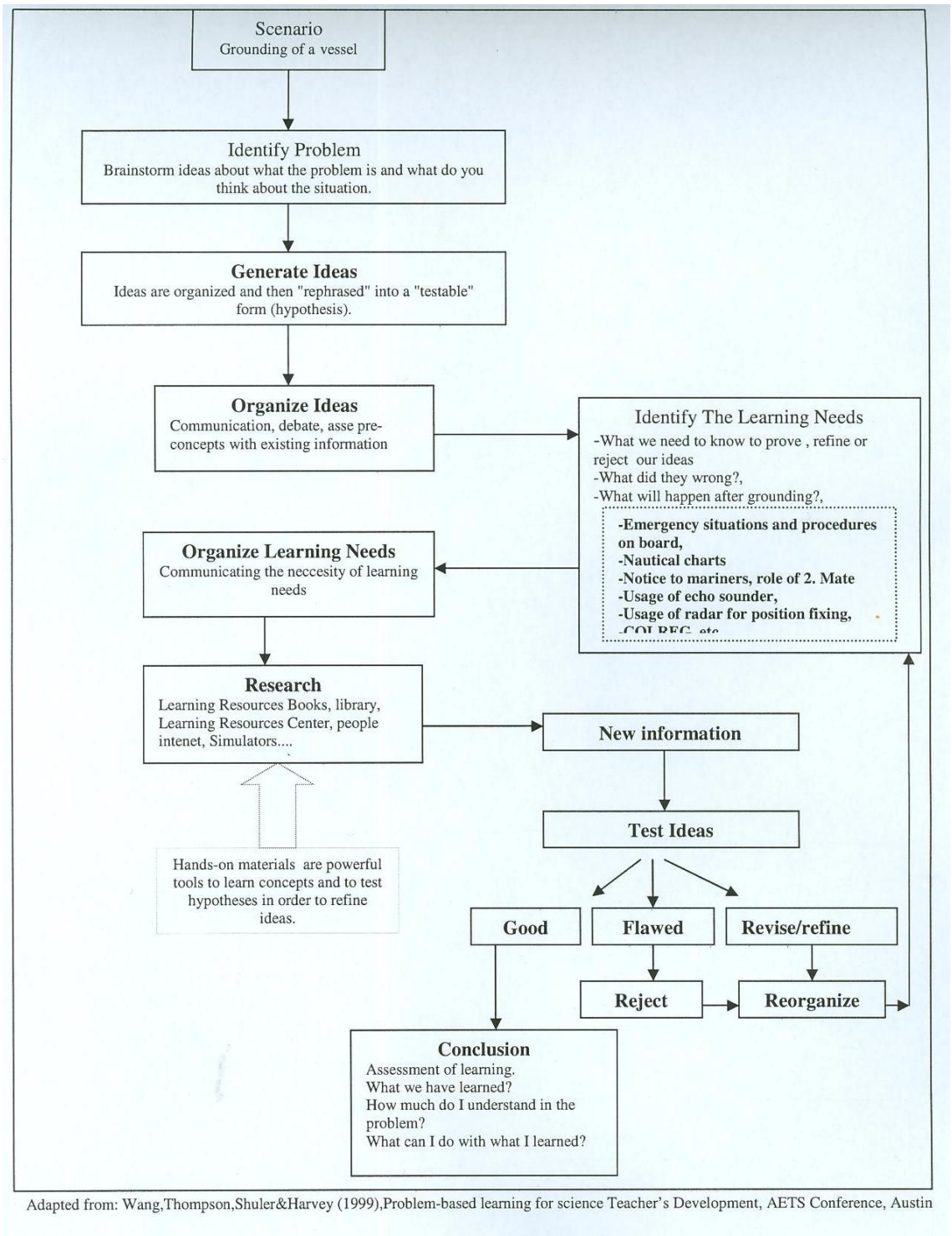
CODE Part A Column 1- **Competence**	**Human Factors**	
	CODE Part A – Column 2 – **Knowledge, understanding and proficiency**[26]	Corresponding **Performance Shaping Factors** [27]
marine environment… p.55-56 -Organize and manage crew. p. 57	on board in emergencies - A knowledge of personnel management, organization and training on board ship.	**leadership, teamwork, language, communication, cultural diversity, decision making, health, stress, fatigue**
Table A-II/3 – Respond to emergencies. p.64	- Precautions for the protection and safety of passengers in emergency situations.	**leadership, teamwork, language, communication, cultural diversity, decision making, health, stress, fatigue**
Table A-II/4 – Contribute to monitoring and controlling a safe watch. p.71	- Ability to understand orders and to communicate with the officer of the watch in matters relevant to watch-keeping duties.	**teamwork, language, communication, cultural diversity, health, stress, fatigue**
Table A-III/1 – maintain a safe engineering watch. p.76 - Use English in written and oral form. p.77	- Duties associated with taking over and accepting a watch - Routine duties undertaken during a watch Adequate knowledge of the English language to enable the officer to use engineering publications and to perform engineering duties.	**leadership, teamwork, language, communication, cultural diversity, decision making, situation awareness, health, stress, fatigue** **language, communication**
Table A- III/2 – Monitor and control compliance with legislative requirements and measures to ensure safety of life at sea and the protection of the marine environment. Maintain safety and security of vessel, crew and passengers and the operational condition of life-saving, fire-fighting and other safety systems. p. 91 - Organize and manage crew. p. 91	– Responsibilities under international instruments affecting the safety of the ships, passengers, crew or cargo. - A knowledge of personnel management, organization and training on board ships.	**leadership, teamwork, language, communication, cultural diversity, decision making, health, stress, fatigue** **leadership, teamwork, language, communication, cultural diversity, decision making, health, stress, fatigue**
Table A- III/3	as required under A-III/2	
Table- III/4 -Understand orders and be understood in matters relevant to watchkeeping duties. p.94	- Engine watchkeeping procedures	**teamwork, language, communication, cultural diversity, health, stress, fatigue**
Section A-V/2 – Crowd management training. p.108 -Safety training for personnel providing direct service to passengers in passenger spaces p.110	- Crowd management training	**leadership, teamwork, communication, health, stress, fatigue, decision-making**

CODE Part A Column 1- **Competence**	**Human Factors**	
	CODE Part A – Column 2 – **Knowledge, understanding and proficiency**[26]	Corresponding **Performance Shaping Factors** [27]
Table A-V/2 – Crisis Management and Human Behaviour Training - control response to emergencies p. 114 - Control passengers and other personnel during emergency situations. p. 115 - Establish and maintain effective communication. p.116	- Leadership skills - stress handling (ability to identify the development of symptoms of excessive personal stress and those of other members of the ship's emergency team. - Understanding the stress generated by emergency situations can affect the performance of individual and their ability to act on instructions and follow procedures. - Human Behaviour and responses Ability to establish and maintain effective communications	**leadership, teamwork, communication, cultural diversity, decision making, health, stress, fatigue** **leadership, teamwork, communication, cultural diversity, decision making, health, stress, fatigue**
Section A-V/3	Similar requirements to Section A-V/2	
Table A-VI/1-1 survive at sea in event of ship abandonment. p.123	- Principles concerning survival **CODE B**: recommends elementary first aid to be part of the early stage of basic vocational training	**leadership, teamwork, language, communication, cultural diversity, decision making, health, stress, fatigue.**
Table A-VI/1-4 -Observe safe working practices. p. 130 - Understand orders and be understood in relation to shipboard duties. p. 130 - Contribute to effective human relationships onboard ship. p. 130	- Importance of adhering to safe working practices at all times. - Ability to understand orders and to communicate with others in relation to shipboard duties - Importance of maintaining good human and working relationships aboard ship. - Social responsibilities: employment conditions; individual rights and obligations; dangers of drug and alcohol abuse. **CODE B:** Comment on the significance of communication and language bearing in mind communication needs onboard and the presence of multinational crew. Recommends the adoption of a common language as important in promoting safety by reducing error in communication.	**teamwork, language, communication, cultural diversity, health, stress, fatigue**
Table A-VI/2-1 –Manage survivors and survival craft after abandoning ship. p. 134	- Apportionment of food and water in survival craft - Management of injured persons, including control of bleeding and shock.	**leadership, teamwork, language, communication, cultural diversity, decision making, health, stress, fatigue**
Table A-VI/3 – Control fire-fighting operations aboard ships. p.139	- Communication and co-ordination during fire-fighting operations. - Management and control of injured persons	**leadership, teamwork, language, communication, cultural diversity, decision making, health, stress, fatigue**

CODE Part A Column 1- **Competence**	**Human Factors**	
	CODE Part A – Column 2 – **Knowledge, understanding and proficiency**[26]	Corresponding **Performance Shaping Factors** [27]
Table A-VI/4 – Apply immediate first aid in the event of accident or illness on board. p.142 - Provide medical care to the sick and injured while they remain on board	Details as to training requirements presented	**leadership, language, communication, cultural diversity, decision making, health, stress, fatigue**
Section A-VIII/2 parts 2, 3, 3-1. Part 3. Watchkeeping at Sea Part 3-2 Principles to be observed in keeping an engineering watch	- Principles applying to watchkeeping generally. - Principles to be observed in keeping a navigational watch. - Lookout - Watch arrangements etc. **CODE B:** Guidance regarding fitness for duty – Prevention of fatigue in relation to hours of work or rest. Administration should consider the keeping of records of hours of work or rest. - No Guidance on watchkeeping at sea. **CODE B**. Guidance on Keeping a navigational watch. Bridge resource management – companies should issue guidance on proper bridge procedures. Review use and allocation of bridge resources. Details Code B pp. 270-272.	**leadership, teamwork, language, communication, cultural diversity, decision making, situation awareness, health, stress, fatigue.**

The Table outlines those areas identified as needing human-human relations as well as operational duties where the human factors that may contribute to accidents are salient. In bold in Column 3 have been inserted the performance shaping factors (identified in the literature) that would impact those areas.

Appendix 6 – Problem Based Delivery Method Adapted by Dokuz Eylul University School of Maritime Business Management, Kaynaklar Campus in Turkey



Source: Asyali, et. al. (2003).

Appendix 7 – Aspects of the ABC approach to developing non-technical skills adapted by Warsash Maritime Centre, Southampton Institute, UK.

***A*ntecedents**
Within the Warsash training course, the lecturer inputs are descriptions and explanations of the following: • Models of human error • Error chain analysis • Situational leadership • Interpersonal influence • Cultural awareness • Situational awareness • Effective communication These teacher led activities are antecedent to student-centred activities described under the behaviours section below.
***B*ehaviours**
There have been a number of training programs produced that aim to improve the higher order cognitive skills of the students within specific context (Woods, 1983; Wales & Nardi, 1985; Resnick, 1987). These techniques have been adapted at Warsash to try and improve students' social skills such as communication and co-operation. Some of the techniques used are: • Having students justify their solutions to one another; • Having students evaluate other students solutions; • Allowing students to make and correct errors; Other studies have been directed at trying to generate training techniques to improve general problem solving skills that would be transferable into different contexts of application (de Bono, 1985; Covington, 1987; Resnick, 1987. These techniques have also been adapted at Warsash to improve the students' cognitive and metacognitive skills: • Considering multiple sides of an issue (lateral thinking); • Considering consequences; • Selecting goals and planning strategies; • Prioritizing factors involved in a situation; • Generating and evaluating evidence; • Using perceptual rather than logical thinking; • Extensive practice of solving problems; • Teaching the use of heuristic strategies; • Use of graphical representations to show the structure of problems
***C*onsequences**
"*Debriefing is the key to the entire learning process, during which trainees' knowledge and attitudes are applied, tested, analysed and synthesized." (Ellman, 1977).* A student-centred debriefing technique has been shown to be more effective because students learn better through self-discovery and self-analysis than by lecture. The student-centred debriefing technique draws upon students' professional expertise and motivation to perform well, and it helps the lecturer understand the students' performance.

Source: Pekcan, C., Gatfield, D. & Barnett, M. (2005).

Appendix 8 – Maritime Resource Management (MRM) Course Contents

Attitudes and Management Skills

The human nature and its weaknesses are discussed. The trainees learn to be aware of "hazardous thoughts", that can induce accidents, and the opposite, "safe thoughts". The concept of Common Terminology is introduced.

Cultural Awareness

Cultural differences and how to deal with them. The following characteristics are used to describe cultural differences: Group-Individual, Power Distance, Uncertainty Avoidance, Feminine-Masculine, and Short-Long Term.

Communication and Briefings

This module deals with common errors in communication, the importance of "closed loop communication" and how you achieve a good communication climate. Briefings and debriefings are mandatory in aviation and should be applied also on ships. Practical guidelines are given on how to perform briefings and debriefings.

Challenge and Response

The importance of a Challenge and Response environment is emphasised, defined as a "supportive environment", in which everybody feels free to question assumptions and actions, and in which positive responses are the norm.

Short Term Strategy

Short Term Strategy is a practical method for dealing with any type of task, but especially useful in abnormal or emergency situations when use of all available resources is necessary.

Authority and Assertiveness

In this module, behaviour in terms of authority and assertiveness is discussed. Reasons for and the dangers of extreme combinations of authority and assertiveness are analysed.

Management Styles

Different leadership styles are discussed and how to deal with them. The performance/human relation management grid is used.

Workload

The dangers of too low and too high workload are discussed and systematic ways to avoid them. Methods like task analysis, delegation and rotation of tasks are addressed.

State of the Ship

The state of the ship is generated by the combination of the team members' personal states of mind. The underlying reasons for different states of mind are discussed, as well as the importance to detect and take action on state extremes and differences between the crew members.

Human Involvement in Error

Here, underlying causes of accidents in terms of externally and internally induced errors are discussed, and the importance of responding to and learning from errors.

Judgment and Decision Making

Factors affecting judgment and decision making and the process of decision making are addressed. The importance of detecting and avoiding hidden pressure is emphasized.

Leadership in Emergencies

Transferring an emergency situation from the unanticipated, fast reaction type toward the anticipated, slow reaction type is discussed, and the necessity to apply different leadership styles in different emergency situations Attitudes & Management Skills.

Crisis and Crowd Management

Together with the above modules, this module meets the STCW requirement for theoretical training in C&C management. It covers mental and physical reactions in a crisis situation, how to deal with them, how to deal with a crowd and finally a method for personal crisis debriefing.

Automation Awareness

This module addresses the consequences of increased automation on ships' bridges. It discusses different levels of automation, characteristics, advantages and dangers with automation and some guidelines for learning to work in automated environments.

Source: http://www.swedishclub.com/mrm_main.php?id=50&menuid=61

Appendix 9 – Crew Resource Management

As part of Multi Crew Co-operation course at Lund University School of Aviation. This section presents the syllabus for 15 out of the total 25 hours of theoretical training.

Syllabus below is presented in a form equivalent to that of the teaching sessions. Each session is one or two hours and the course ends with a summary and a course evaluation. During the session lectures are mixed with practical discussions and cases, some of them mentioned in the syllabus, to analyse the implications of the theoretical knowledge. (Dahlström, 2008, personal communication).

<table>
<tr><th colspan="2">COURSE SYLLABUS</th></tr>
<tr><td>INTRODUCTION
Presentation of course contents and learning objectives
Presenting the questions and considering the facts
Conclusions through cases and discussions
Flight safety – the key in every item of the syllabus
Introduction to human factors and crew resource management
Statistics of human factor related accidents
The SHEL model
Case: British European Airways 06/17/1972; Hawker Siddeley Trident 1C (G-ARPI)</td><td>COCKPIT MANAGEMENT
Situational awareness revisited
Factors that affect SA
How to develop SA skills
Cooperation
Benefits and problems
Group dynamics
Theories of group dynamics
Group think and risky shift
Leadership
Personal traits of a leader
Leadership styles
Leadership styles in different cultures
Communication
Verbal and non-verbal communication
Levels of communication
Effective communication
Conflict
Types of conflict
Escalation of conflict
Conflict resolution</td></tr>
<tr><td>BASIC PSYCHOLOGY
Information processing
Attention and vigilance
Mechanisms of attention and vigilance
Hypovigilance
Management of attention and vigilance
Situation awareness (SA)</td><td>PERSONALITY
Personality and behaviour
Types of personality
“The big five”
Basic personality types
Behaviour which complicates communication
Behaviour which facilitates communication</td></tr>
</table>

<table>
<tr><th colspan="2">COURSE SYLLABUS</th></tr>
<tr><td>

o Definition of SA
o The three levels of SA

Human perception

o Senses and perception
o Factors that affect perception

Memory

o Memory management

The learning process

o Principles of learning
o Learning methods

</td><td>

Attitudes

o The origin of attitudes
o Components of attitudes

Case: KLM Royal Dutch Airlines and Pan American World Airways 03/27/1977 Boeing B-747-206B (PH-BUF) and Boeing B-747-121 (N736PA)

</td></tr>
<tr><td>
ERRORS

“Pilot Error
Different categories of error
Sources of error
Sources of error according to the SHEL-model
The chain of error

</td><td>
STRESS, FATIGUE AND SLEEP

Workload

o Effects of different levels of workload
o Management of workload

Stress

o Sources of stress
o Effects of stress
o Stress management

Fatigue and tiredness

o Types of fatigue and tiredness
o Effects of fatigue and tiredness
o Management of fatigue and tiredness

Sleep

o The circadian rhythm
o The sleep cycle
o Conditions for good sleep

Jet lag

</td></tr>
<tr><td>
DECISION MAKING

Information processing and human thinking
The decision making loop and CRM loop
Common errors when making conclusions

o Representation
o Access
o Confirmation

Skill-, rule- and knowledge-based decision making

</td><td>
AUTOMATION

History of automation
Benefits of automation
Problems with automation
Presentation and interpretation of warnings
Automation complacency
Future development in the field of automation
Case: Air Inter 01/20/1992 Airbus A320-111 (F-GGED)

</td></tr>
</table>