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CHANGING TACK

Defining a Strategic Direction for Innovation in the United Kingdom Shipping Industry

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Abstract

In the early 1980s technology presented the shipping community with an opportunity to offload its moribund communications infrastructure in favour of a satellite based electronic umbilical that promised to revolutionise communications with ships at sea. The development received less than enthusiastic support.

Towards the end of the last century, twenty years after satellite communications offered a viable alternative, the vast majority of ships were still using Morse code as their primary means of communication. Despite attempts to delay its mandatory introduction the Global Maritime Distress and Safety System (GMDSS) was the catalyst that ultimately led to the demise of this antiquated system of communication. A similar scenario exists in the navigation arena, where shipping organisations invariably wait for legislation to compel them to change.

This culture of innovation resistance is ubiquitous in the shipping industry and its origins seem to lie mainly in historical traditions and in the isolation that has for centuries been intrinsic to life at sea. Competitive challenges driven by shrinking innovation life-cycles, increasing globalisation, and growing demands for improved customer service creates new opportunities for flexible organisations but presents serious threats to traditionalists.

Cultural change in the UK shipping industry is an essential precursor to creating a climate in which innovation can flourish. The route to cultural change however demands a holistic approach and necessitates a fundamental understanding of the iterative processes of change. After illustrating this concept in a model I draw on empirical evidence and relevant theories to support my argument that a culture of innovation in the shipping industry can best be achieved through the development and adoption of organisational structures based on a virtual learning organisation.

Glossary of Terms and Abbreviations used in Thesis

ADSL	Asymmetric Digital Subscriber Line. Digital Subscriber Line (DSL) technology is an advanced broadband access method that uses ordinary telephone lines to carry high-bandwidth, two-way data, voice, and video communications.
ARPA	ARPA Automatic Radar Plotting Aid. An electronic system that automatically tracks radar targets and provides relevant information to aid navigation.
Barge Carrier	A ship designed to carry barges; some are fitted to act as full containerships and can carry a varying number of barges and containers at the same time.
B.P.R.	Business Process Re-engineering.
Box boat	A term used frequently in the shipping industry to refer to a container ship.
Bluetooth	A system that allows various devices to 'talk to each other'. Using a built in radio chip operating on a frequency of 2.5Ghz. A 'Bluetooth' enabled device will be able to communicate directly with any other similarly enabled device within its range.
Bulk Carriers	A vessel designed to carry bulk cargo such as grain, fertiliser, ore, or oil. This type of vessel is often referred to as a 'bulker'.
CES	Coast Earth Station. A CES is the link between an orbiting satellite, a ship at sea and the public telephone network. The Largest CES in the world is located at Goonhilly in Cornwall.
Combination	In the context of ships, a 'combination' vessel is able to carry several different types of cargo; for example, both bulk cargo and containers.
Combination Passenger and Cargo Ship	A cargo ship with a capacity to carry 13 or more passengers.
Container	A 'container' vessel is specifically designed to carry its cargo in special containers.

Deadweight (dwt)	The number of tons (of 2,240 pounds) of cargo, stores and bunker fuel that a vessel can transport. It is the difference between the number of tons of water a vessel displaces (light) and the number of tons it displaces when submerged to the 'load line.'
Decca navigator	A low frequency, short range, earth based navigation system.
DGPS	Differential Global Positioning System. Standard GPS provides navigators with position information that is accurate to within about 200 meters. In some situations a greater degree of accuracy is necessary. In such circumstances the GPS position is modified by signals from fixed land stations situated on known survey points. These land stations receive signals from GPS satellites, estimate the errors based on their own position, and transmit correcting signals to vessels within range of their signals. DGPS is not available outside areas covered by land stations.
ECS	Electronic Chart System
ECDIS	Electronic Chart Display
ENC	Electronic Navigation Chart
EPIRB	Emergency Position Indicating Radio Beacon. A device that automatically transmits distress information via satellite to the relevant authorities ashore.
Footprint	A 'footprint' in the context of this work refers to the area of the earth that is covered by any orbiting satellite. The higher the altitude of the satellite, the greater the footprint.
FMS	Flexible Manufacturing System
Full Containership	A ship equipped with permanent container cells, with little or no space for other types of cargo.
GMDSS	Global Maritime Distress and Safety System. GMDSS equipment became mandatory on most commercial ships world-wide on 1st February 1999
GNSS	Global Navigation Satellite Systems – the generic name for the various systems of satellite navigation that are evolving.
GPRS	General Packet Radio Service – A format developed for mobile 'phones that offers fast download speeds and the additional benefit of permanent connection to the Internet.

GPS	Global Positioning System – A navigation system that calculates the four navigation parameters (Latitude, Longitude, Altitude and Time) by measuring the time of arrival of signals from four different satellites.
Gross Tonnage (GT)	Applies to vessels, not to cargo, (0.2+0.02 log10V) where V is the volume in cubic meters of all enclosed spaces on the vessel.
HF Radio	High frequency Radio. Maritime HF operates on a frequency band of between about 1.6 MHz and 22 MHz.
ICT	Information and Communication Technology.
IMO	International Maritime Organisation.
INMARSAT	The International Maritime Satellite Organisation.
INMARSAT 'A'	A Satellite communication system that uses high altitude satellites in geostationary orbit. INMARSAT 'A' is an analogue system with voice, telex, data, and fax capabilities. Sometimes called 'Satellite A' or 'Std A' this was the first INMARSAT satellite communication system available to ships at sea.
INMARSAT 'B'	A digital version of the original 'A' system described above it is sometimes called 'Satellite B' or 'Std B'.
INMARSAT 'C'	A low cost, store and forward satellite communication system providing telex and low speed data facilities only - sometimes called 'Satellite C' or 'Std C'
INMARSAT 'E'	'E' means emergency - it is the satellite system that is used to transfer data received from EPIRBs to RCCs ashore.
INMARSAT 'M'	A low cost satellite telephone system. This system is not approved for distress and safety applications but may be used for commercial purposes. It does not meet the requirements for mandatory installation on commercial vessels. Mini 'M' systems can be housed in a small suitcase and are frequently used by journalists and others working in remote locations.
JIT	Just In Time. The idea of receiving supplies just as they are required thereby saving the costs involved in holding stock.
LAN	Local Area Network
Loran C	A low frequency long range navigation system
MAT	Marine Automation Technology

MIT	Marine Information Technology
MF Radio	Medium Frequency Radio. Maritime MF operates in a frequency band of about 410 kHz to 512 kHz
MSC	Maritime Safety Committee.
NBD	New Business Development
NPD	New Product Development
Offshore	In the context of shipping, offshore usually refers to vessels used in the offshore oil, gas, diamond drilling and other industries that work other than on land.
Partial Containership	A multipurpose containership where one or more but not all compartments are fitted with permanent container cells. The remaining compartments are used for other types of cargo.
Pre-GMDSS	The original maritime distress and safety system that relied on conventional radio equipment.
RADAR	A navigational aid which indicates the range and relative bearing of any object within range as a speck on a circular cathode ray tube.
RAP	Radio Application Protocol. A protocol that allows mobile telephones to access the Internet without using a computer.
RCC	Rescue Co-ordinating Centre - shore based establishments responsible for co-ordinating maritime distress and safety activities.
Reefer	In the shipping industry a reefer usually refers to a ship that carried refrigerated cargo. The term may however be used to refer to any form of refrigerated transport.
Rhumb Line	A line that makes the same angle with all meridians that it crosses. On a Mercator (flat) chart a Rhumb line appears as a straight line.
RNC	Rasterscan Navigation Chart. An electronic chart that is a scanned facsimile of an original official navigation chart.
Ro-Ro	Roll on - roll off vessel: A Ship specifically designed to carry wheeled containers or trailers using interior ramps.

S Band	A frequency band within the range of 3,000 MHz The term is normally used in reference to RADAR. S- Band radar is sometimes called 10 cm radar because it operates at a wavelength of 10 centimetres. (10cm = 3,000 MHz)
SCADA	Supervisory Control and Data Acquisition. A system for Controlling equipment or systems electronically.
SENC	System Electronic Navigational Chart
SES	Ship Earth Station. The equipment installed on board a ship to enable it to communicate with an orbiting satellite and a CES.
SOLAS	Safety Of Life At Sea. The SOLAS regulations embrace all aspects of safety at sea including radio and GMDSS regulations.
Tanker	A ship fitted with tanks to carry liquid cargo such as crude petroleum and petroleum products; chemicals, Liquefied gasses (LNG and LPG), wine, molasses, and similar products.
TEU	Abbreviation for Twenty foot Equivalent Unit.
Transceiver	Transmitter / Receiver.
Transit Sat-Nav	A system of satellite navigation that used one of a number of polar orbiting satellites to calculate a position using Doppler Effect. (Doppler Effect is the 'apparent' change in frequency as an object approaches and recedes).
TQM	Total Quality Management
VHF Radio	Very High Frequency Radio. Maritime VHF operates on a frequency band of about 150 MHz to 180 MHz.
VMS	Vessel Monitoring System
VTS	Vessel Tracking System
VTMS	Vessel Traffic Management System
WAN	Wide Area Network
X Band	A frequency band within the range of 10,000 MHz The term is normally used in reference to RADAR. X-Band radar is sometimes called 3 cm radar because it operates at a wavelength of 3 centimetres. (3cm = 10,000 MHz)

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Chapter One

Research Objectives and Thesis Overview

Introduction

'And all I ask is a tall ship and a star to steer her by'. The romantic images created by John Masefield's famous words[1] belong to an era in which Marconi[2] was still experimenting with electromagnetic waves and sailors needed to continually hone their celestial navigational skills in order to survive. But, as this study will show, surviving the economic ebbs and flows and the competitive challenges of the third millennium will require a radical overhaul of the technological, cultural, structural, and environmental resources in the United Kingdom (UK) shipping industry.

As the shipping community charts its strategic course for the twenty-first century, marine equipment manufacturers and service organisations are offering increasingly sophisticated communication and navigation packages to a somewhat sceptical market. Against a background of expanding awareness of the potential benefits of innovation and change that is evident in many industries ashore[3] the shipping industry displays relatively little interest in its concepts.

When, for instance, the North West Kent College, which hosts the National Sea Training Centre, adapted its nautical training material for delivery over the Internet it was unable to find a single UK ship-owner prepared to become involved in testing the concept (Johnston, 2002). Although several companies agreed that it was technically feasible their apparent reluctance to allow seafarers access to the Internet on the basis that it is too costly seems to be at odds with the characteristics required to support innovation.

The cultural differences between seafarers and their counterparts ashore that this type of scepticism implies suggests that the origin of these differences might lie in the isolation that the sea has imposed on generations of mariners, rather than in national characteristics. If such differences are spawned purely through the historical development of nations then the differences should manifest themselves in an appropriate comparison. Although a cross-national comparison of relevant factors would not in itself provide sufficient evidence to support one theory or the other it could act as a useful indicator of any cultural biases that could not be explained in a theory that presupposes that isolation alone is responsible. I therefore decided to include, at the empirical stage, data from a sample of Netherlands'[4] shipping organisations that could be compared with the data gathered from similar organisations in the UK.

In the innovation literature, organisational variables such as culture, structure, and the environment are assumed to be influential in promoting or restraining innovation. The majority of empirical evidence is however derived from intervention in shore based organisations where inter-organisation communication facilities are relatively well developed. There are few studies that focus on how these variables may impact on the shipping industry, where, I will show, inter-organisational communications[5] are markedly different. The innovation literature also suggests that new ideas frequently emerge through relationships and social networks, which are not easily accomplished in what for many seafarers might be termed a communication vacuum.

There are signs of improvement on the horizon as far as moribund communication facilities are concerned, but will that be enough to create the conditions necessary to build innovative UK shipping organisations that will not ultimately find themselves wallowing in the wake of more nimble international competitors? I will argue that as technological developments create the *potential* for innovation in the UK shipping industry, the *conditions* required to capitalise on this potential will demand new ways of thinking, new ways of working, and a new framework for understanding reality. I will argue that the industry is undergoing its first ever paradigm shift.

Focusing mainly, but not exclusively, on changes resulting from the recently introduced Global Maritime Distress and Safety System (GMDSS) that replaced Morse code as the primary communication system for ships in distress, the research explores how these changes might facilitate greater commercial integration between ships and their alliances. It seeks to discover whether prevailing cultures, structures, and environmental conditions are preventing UK shipping organisations from adopting or adapting new technologies as solutions to some of the problems that they face. In the light of the apparent disinterest in the concepts of innovation and change that the industry displays, the work also examines the extent to which historical factors related to culture, technology, and environmental conditions might have impacted on the industry's current perceptions of innovation and change.

The relevance of a number of theories to ongoing developments in the shipping industry are discussed in literature reviews and critiques that are the subject of separate chapters. In order to guide readers searching for more detailed discussions on specific points mentioned in the text I will make reference to the relevant chapter or section whenever this seems appropriate. There are occasions, however, when particular subjects are discussed in more than one context; when this occurs I will make clear why, and in what context, I am addressing the subject. The ultimate objective of the thesis, as the title makes clear, is to define a strategic direction through which the United Kingdom shipping industry might take on board the concepts of innovation and change. This will be achieved in three broad stages.

Firstly I will provide an overview of the industry, relating current conditions within it to some of the theoretical discussions in the innovation literature. The definitive research questions emerging from this overview will be influential in defining the context in which the research is being addressed. The second stage, an empirical investigation into the technological infrastructures, the organisational cultures, the organisational structures, and the environmental conditions that prevail in the UK shipping industry will provide evidence of how the current situation differs from the theoretical prerequisites for innovation as described in the literature. The final stage is concerned with relating some of the theories to the empirical evidence, providing coherent arguments to support the legitimacy of emerging theoretical models, and proposing improvements to the status quo. The following overview, which in essence describes the structure of the thesis, outlines the content of the remaining seven chapters.

1.1 Thesis Overview

In chapter two I review the UK shipping industry from two perspectives, both of which are important in the pursuit of defining a strategic direction for innovation. These are:

- The economic perspective and
- The technological perspective.

From an economic perspective, I draw attention, through the analysis of published data, to the importance of the UK shipping industry in the national economy, and to its relationship with other UK industries. The UK shipping industry emerges as one of the major players within the European community, with only Greece and Norway employing greater tonnage. Excluding the so-called 'flags of convenience' the UK, with almost ten million tons of fairly modern well maintained ships, also features in the premier league of international ship-owning nations. By analysing the different types of ships owned and operated from the UK and cross-referencing these with the list of ship-owners I identify those ship-owners who operate ships that are particularly relevant to this study so that the empirical work can be appropriately focused. In affirming the importance of the industry I also outline the significance of its potential to develop more innovative cultures and processes.

The technological perspective is concerned to a large extent with the research problem, which stems mainly from technological and cultural deficiencies within the industry. I highlight some of the historical difficulties related to communications and navigation systems that the industry has had to contend with and describe how these difficulties might have influenced the maritime culture. I show how developments in communications and navigational systems within the shipping industry have been hampered by an over reliance on moribund technology and by traditional cultures that shun change.

Using Actor Network Theory (Latour, 1987; 1991, Callon, 1986; Law, 1986; 1994 and Bijker, 1995) as a basis for my arguments, I show that, when viewed as holistic systems, many of the technological devices that are *perceived* as reliable by seafarers have serious flaws. Using a simple example, I demonstrate how the internal organisational culture can impact on the reliability of a system and how a rigid hierarchical command structure can aggravate the problem.

Legacy systems, I suggest, continue to impede progress, but confidence in new shipboard technology is unlikely to improve unless and until manufacturers and legislators take the legitimate concerns of navigators on board. How, for example, can ships' officers feel comfortable with a distress and safety system in which a passenger has to send a mobile phone text message to the other side of the world before rescuers are alerted to the plight of a stricken vessel? (BBC News, 15th Feb 2001)[6]

After pointing out some of the technological inadequacies inherent in ships' navigational and communication systems I draw on work by Negroponte (1995) and Peters (1999), which suggests that incremental attempts to improve such technology is only likely to reinforce innovation resistance in the industry. Newer technologies that promise to revolutionise communications and navigation systems are gradually making their way into the shipping industry despite the apparent resistance to change. I examine some of the fundamental reasons for concern about these technologies and ultimately suggest a model through which such concerns might be addressed.

A number of questions relating to the influence of technology, organisational culture, organisational structure, and the environment on the industry's potential to innovate emerge in this chapter. These questions form the basis of the research questions and hypotheses articulated in its conclusion.

Chapter three provides details the research methodology. Beginning with a framework that describes the context in which innovation in the shipping industry is being investigated it identifies two core innovation literature bases that will be used in the theoretical arguments and associated analyses. It continues with a review of the research process and with an evaluation of the methodological alternatives being considered. A justification for opting to adopt a cross sectional, questionnaire survey approach to examine the current situation in the shipping industry is provided, as well as an explanation of the strengths and weaknesses of this method.

Recognising some of the potential shortcoming of this inherently deductive approach, the chapter includes an examination of alternative research strategies, a description of the process of triangulation, and an explanation of the rationale for deciding to employ a hybrid approach in which both quantitative (questionnaire) and qualitative (interview) data would be gathered and analysed. After outlining the varying degrees of formal structure through which the qualitative data could be analysed, a justification for choosing to use an editing approach based on grounded theory (Strauss and Corbin, 1997) is provided.

Chapter four focuses on the theoretical framework for the research, drawing mainly on management and psychological literature relevant to innovation and change. From a management perspective it begins with a brief review of the 'scientific approach to management' advocated by Taylor and his followers (Taylor, 1911; Fayol, 1916;

Weber, 1947) and illustrates how, in a world of technological revolution, the efficacy of such ideas are eclipsed in more recent research.

Research, which suggested that as late as the 1960s most large corporations subscribed to the so-called 'Theory X'[7] (McGregor (1960) is used to substantiate an argument that such moribund ideas continue to dominate large sections of the shipping industry, and that this is detrimental to creating an environment that is conducive to the process of innovation. 'Theory Y', I argue, is much more likely to drive the innovation process and its adoption in the UK shipping industry will probably be instrumental in advancing a paradigm shift.

The chapter continues with a review of the meaning of paradigms in the analysis of social theory (Burrell and Morgan, 1979) and, in particular, paradigm shift as outlined by Kuhn (1970). The notions of paradigms and paradigm shift are related to the inherent perspectives of the organisation or industry within which they occur. In the context of this research therefore, I argue that paradigm shift should be viewed as an holistic phenomena that involves change in technology, organisational culture, organisational structure and environmental conditions.

Drawing on theories espoused by Adcroft and Wills, (2000), I relate the conceptions of an 'optimisation paradigm' and an 'innovation paradigm' to conditions in the UK shipping industry and argue that an holistic integration of these elements is fundamental to the industry's inauguration into the 'innovation paradigm'. The alternative - becoming a member of the 'optimisation paradigm' - would be tantamount to embracing the concepts of incrementalism, which, according to Negroponte (1995), is 'innovation's worst enemy'.

After a brief review of the systems approach I acknowledge the relevance of some of these concepts to conditions in the UK shipping industry, particularly the notion that a system interacts with its environment. Although I acknowledge that some of the social and systems theories to which Jackson (2000) refers may also have relevance, in this work I focus explicitly on the systems concepts of socio technical change (Bijker, 1995a) and Actor Network Theory (Latour, 1987; Law, 1992).

Technological innovation is discussed in the context of the linear model of the innovation process (Macdonald, 1998). Although such models do have some merit, however, the notion that information rather than sequences of events drives innovation and change (the aptly named information perspective) seems to be more appropriate to conditions the shipping industry. This, I argue, is because innovation and change are involved socio-technical processes demanding an analytic vehicle with the potential to tease out relevant issues related to the management of such a process.

The section on culture, from a management perspective, draws mainly, but not exclusively, on the work of Schein (1985) and Handy (1976). It is concerned with the role that culture plays in the innovation process, and on its relevance to organisational strategy. Although Peters and Waterman (1982) reinforced the premise that organisational culture is related to organisational strategy they do not seem to have considered the role that technology might play in shaping or modifying organisational culture.

The organisational structure that a firm adopts can also impact significantly on its ability to innovate and I argue that organisational structure therefore has a distinctive affiliation with organisational culture. It is relevant to any strategy aimed at motivating cultural course change and consequently needs to be considered as an inherent element in the equation. Adopting this standpoint, I continue with a discussion of the six types of organisational form suggested by Herber, *et-al* (2000), concluding that an appropriate organisational form for an innovative shipping industry might incorporate distinctive elements of each of the forms and be substantially moulded in the shape of a 'virtual organisation'. I point out however that the design of such a hybrid would have to take account of the different range of cultures that might emerge within the UK shipping industry as European integration unfolds.

Maintaining the 'holistic' theme I continue with a discussion about how technology influences, and is influenced by organisations, before developing some of the ideas residing in the domains of the Social Construction of Technology (SCOT) and Actor Network Theory (ANT) in the context of innovation in the UK shipping industry.

The term 'interpretative flexibility' used by Bijker (1995) in his classic case study of the bicycle emphasises the role that the perception of technology has on organisational culture and is developed throughout the section on SCOT. This leads to a discussion of a model attributed to van Hemert (2001) in which he contrasts the 'standard view' with the 'constructivist view' of technology and society.

In the concept of ANT an actor-network is not restricted purely to 'social actors' but provides conceptual links that include both people and artefacts. ANT makes the assumption that natural phenomenon, and even technology, is capable of independent action in forming new socio-technical relationships. After explaining, through a metaphorical example, some of the obscure meanings of the terms used in the actor-network theory, I define the conceptual basis in which the theory might be applied to an Ocean Wide Network (OWN) for the UK shipping industry. The narrative describes how an OWN might be developed using the theoretical principles of SCOT and ANT to create a network of ship and shore based 'actors' which could operate as a virtual organisation. Some ideas about how such a network might work, and how it could benefit shipping organisations and their alliances in a practical sense are then presented.

Turning to the psychological perspective I re-examine some of the cultural aspects within the shipping industry from a different angle. Two cognitive aspects related to culture are particularly important here - perceptions of definition and perceptions of the need for training - and these perceptions are inextricably related.

According to Damanpour, (1995: 125-130), there is a tendency for some writers to use the terms innovation and creativity interchangeably. This is a problem because it implies that creativity is necessary for innovation, and that training people to become 'creative' will enable an organisation to become 'innovative'. In this chapter I take issue with this notion, and, drawing on the work of a number of writers on the psychological aspects of innovation, shows that there is little, if any relationship between these terms in the general sense.

I contrast the notion of 'general creativity', which I argue has no relationship whatsoever with innovation, with the concept of 'domain specific creativity', which almost certainly does. I demonstrate, by citing a number of well-known 'innovators' how domain specific creativity, which emerges from the rigors of *domain relevant* training, is a significant driver in the innovation process, and how trying to cultivate the inspiration that many people call (general) creativity by training in divergent thinking is largely ineffective. The discussion on domain specific creativity leads to a brief review of the related subjects of 'domain hopping' and 'problem solving', after which I defining the type of learning that I consider would be most appropriate to the development of innovative cultures in the UK shipping industry.

The final section of this chapter is concerned with describing the characteristics of what Senge (1990) has called a 'learning organisation'. The development of a 'learning organisations' within the shipping industry is, I suggest, an essential ingredient in the specification of an appropriate model of strategic direction for innovation.

The empirical study looks at a number of factors in shipping organisations that are related to the research questions. The primary research design, which is described in chapter five, seeks to address the research questions and hypotheses through the generation of data that can be analysed both quantitatively and qualitatively.

In outlining the approach I describe how, by using information published in Lloyds Register of Ship Owners (2001-2002) and in Fairplay (2001-2002) I identified and targeted those shipping organisations that would be able to respond to the questionnaires and provide valid, reliable, and repeatable data. I explain how I was able to discount those shipping organisations that were less relevant to the research, before describing how each question in the questionnaires, (pilot questionnaire and final questionnaire) relates to the relevant research question(s) or hypotheses.

Data obtained through the use of questionnaires is, however, inevitably subjective - it represents for the most part the subjective opinion of those responding to the questionnaire. I therefore decided that the validity of the study would be improved if the quantitative analysis were reinforced through the qualitative analysis of supplementary data. Such data would be gathered from comments on returned questionnaires, through semi-structured interviews, and via literature reviews.

Various qualitative analytical techniques were considered and after discussing the alternatives I explain the rationale for deciding to employ an interpretive technique developed by Strauss and Corbin (1997). I emphasise the main characteristics of this 'grounded theory' and describe the principles through which the analysis of the qualitative data would be addressed.

In chapter six I explain how the empirical data, which was gathered mainly through questionnaires, was coded for quantitative analysis using a statistical software package (SPSS)[8]. I describe how an iterative process (analysing quantitative data using both exploratory and confirmatory techniques) was used to guide conception when a conclusion was inadequately substantiated, and I discuss the relevance of some of the published (secondary) data that was used. I also define the concepts of the different types of coding employed for qualitative data and provide a rationale for deciding against the use of computer based tools for its analysis.

The specific tests that were used in analysing the quantitative data, and the reasons for using them, are then described before the results are presented in the form of tables and graphs derived from the SPSS (quantitative data analysis) software.

To explain how the qualitative data were analysed, I reproduce three random paragraphs taken from actual letters, comments and interview notes and show how these notes were analysed in the context of the research questions. The results of the analyses are ultimately interpreted in narratives that relate the empirical evidence to the research questions and hypotheses.

Although the empirical evidence begins to clear the decks for emerging theories, in isolation it lacks tenacity; at best this evidence might be viewed as a minor tributary to the mainstream innovation literature. Establishing additional credibility to further my arguments demanded that empirical evidence be appropriately supported through the previous work of authoritative researchers. The purpose of chapter seven therefore is to synthesise the empirical evidence with the theoretical reviews presented in earlier chapters (chapters two and four).

Some of the unique characteristics of the UK shipping industry revealed in the empirical work are compared with the notions of the characteristics required for innovation from a theoretical perspective. The analysis seeks to establish whether characteristics within the industry need to change, whether they could change, and the processes that would be involved in implementing change.

Focusing on the implications of the empirical and theoretical findings, I begin to develop coherent arguments that have particular relevance to innovation in the shipping industry. I emphasise the necessity for cultural change in shipping organisations, but point out that this can only be achieved through the development of organisational forms (structures) designed to encourage cultural change. I also highlight the need for shipping organisations to recognise that diversity is an inevitable consequence of the industry's environment.

An appropriate model for change, I suggest, needs to take cognisance, not only of the human diversity within the industry, but also of the immaturity of technological systems. More than eight years ago, for example, Ryan (1994) was expressing concerns about technological instability, the difficulty of dealing with legacy systems, and the delays in aligning business processes to the environmental changes resulting from new technology. In the twenty-first century shipping industry, such concerns are equally valid, which implies that the flexibility to accommodate dynamic environmental factors needs to be integrated into the organisational structure.

But, as Neuhauser, Bender, and Stromberg (2000) have pointed out, maturing technologies expose organisations to new risks - information overload for example - where managers are swamped with irrelevant e-mail messages to the extent that they become less productive. In such circumstances a protocol that sets out explicit parameters for inter-ship and ship-shore communications may need to be included in a new structural model.

I continue the chapter with a discussion about the influence of technological advances on organisational hierarchy, social structure, and strategic direction before introducing the concept of a network of shipping organisations in the form of an ocean going global village.

What emerges from this discussion is that complex hybrid models such as those proposed by Burns and Stalker (1961), Davis and Lawrence (1977), Mintzberg (1983) and Applegate (1999) are ineffective without the technological infrastructure that supports them. Satellite communication, I argue, provides the catalyst through which 'Boundaryless organisations' (Monge and Fulk, 1999) could be created in the shipping industry.

Communications need not be the only beneficiary of technological advances in the shipping industry, but resistance to innovation seems to be just as prevalent in the area of navigation. A review of the ongoing development of electronic charts, for instance, reveals that two different types of electronic chart are being produced and that the equipment needed to access these are incompatible. As a consequence ship-owners are adopting a 'wait and see' attitude - refusing (quite understandably) to buy into either.

Circumstances in which:

1. The International Maritime Organisation (IMO) regulations pertaining to electronic charts remains unclear;

2. Manufacturers have still not agreed a standard protocol[9] for marine electronic equipment; and

3. Engineers remain free to re-design human-machine interfaces at will

are identified as additional factors contributing to innovation resistance.

After a discussion of the learning culture at sea and its relationship to cultural, structural, environmental, and technological change, I examine some of the recent legislative changes in relation to their impact on technological developments.

I conclude by highlighting the apparent stagnation in terms of innovation in which the industry finds itself and argue that, whilst the technology itself may be perfectly reliable, the context in which it is used is often inappropriate. The precursor to changing this situation, I suggest, lies in the creation of effective vehicles for communication between suppliers and end users and in capitalising on the knowledge available within the shipping community.

The final chapter, chapter eight, highlights the conclusions to be drawn from the research. After proposing a rationale for the reluctance of ship-owners to embrace some of the concept of innovation (such as electronic networks in which ships are treated as discrete business units), I examine the justification for their concerns about the reliability of modern communications and navigational systems. Three fundamental factors are identified as relevant:

1. The relatively high capital investment and the subsequent high cost of using systems based on satellite communications.

2. Regulations that effectively *allowed* organisations to install modern communication and navigation systems but did not allow them to *replace* the ageing technology.

3. Most shipping organisations saw the role of radio officer (RO) as redundant once a modern communication system was installed. The regulations, however, demanded that one or more ROs must be retained.

Although some relaxation in the regulations subsequently allowed shipping organisations to dispense with the services of an RO and to scrap moribund communication systems, no such dispensation has so far been granted for ageing navigational equipment.

Using these factors as a basis for my argument I explain how this has contributed to a situation in which the industrial culture is one of innovation resistance emanating from historical, technological, and environmental factors.

I then re-visit each of the research questions and hypotheses, and, by referring to the appropriate sections of the thesis, develop credible answers.

I conclude with an overview of the research findings and their usefulness in terms of developing appropriate strategies for innovation in the shipping industry. In outlining the limitations of these findings I highlight some of the areas where further research would be beneficial.

Notes - Chapter One

[1] John Masefield - British Poet (1878 – 1967) 'I must down to the seas again, to the lonely sea and the sky, and all I ask is a tall ship, and a star to steer her by' (sometimes misquoted as 'I must *go* down to the *sea* again…).

[2] Guglielmo Marconi (1874 – 1937) transmitted the first radio waves across the Atlantic Ocean on December 12th 1901.

[3] For example, the Information and Communication Technology (ICT), Pharmaceutical, and Petro-Chemical industries seem to be particularly ambitious in their demands for new and innovative products and ideas.

[4] The rationale for choosing to focus on the Netherlands for comparative purposes is explained in chapter five (section 5.2).

[5] By 'inter-organisational communications' I mean communications between different parts of the organisation. In the shipping industry this includes ships at sea where, at the time of writing, communication facilities such as mobile telephones, e-mail, Internet access, and wide area networks are either impossible, or far more expensive than comparable facilities ashore.

[6] A more detailed account of this incident appears in chapter two (section 2.2.2).

[7] McGregor outlined two theories that he called 'Theory X' and 'Theory Y'. Managers subscribing to theory X believe that most workers lack ambition, have no desire for responsibility and prefer the security of strict managerial control. 'Theory Y' on the other hand suggests that most individuals can be relied upon to put maximum effort into their activities and want more, rather than less responsibility.

[8] Statistical Package for Social Scientists.

[9] In this context 'protocol' refers to the 'language' through which one piece of marine electronic equipment 'talks' to another. The protocol recommended by the National Marine Electronics Association (NMEA) is called NMEA 0183. The format for NMEA 0183 is, however, interpreted by manufacturers in various ways, resulting in a situation in which different manufacturers' systems are often incompatible.

Chapter Two

The United Kingdom Shipping Industry
Economic and Technological Perspectives

Introduction

Two world wars during the first half of the twentieth century seriously weakened the United Kingdom's (UK's) role as the dominant industrial and maritime engine that was driving the international economy. From the ashes of a dismantled empire the second half of the century witnessed the country's reconstruction and reestablishment as a modern, prosperous, European nation. One of five permanent members of the United Nations (UN) Security Council, a founding member of the North Atlantic Treaty Organisation (NATO) and of the Commonwealth, the UK, according to government sources (DTI 2002), pursues a 'global approach' to foreign policy and is currently contemplating the scope of its integration with continental Europe.

Amid some uncertainty as to whether this 'contemplation' will result in economic strategies that focus on activities within the European Union (EU) to a greater or to a lesser extent, the importance of the UK shipping industry to the well being of the national economy remains indisputable. Its fundamental role as a vehicle for the development of international trade was explicitly recognised in the unveiling of Deputy Prime Minister, John Prescott's thirty-three point strategy designed to secure the long term future of British Shipping. This first ever shipping blueprint - entitled 'British Shipping - Charting a new Course' was intended to enhance the attractiveness of UK shipping enterprises, secure UK seafaring jobs, gain safety and environment benefits and further develop UK maritime skills (DTI 2002).

The latter point is paramount. Few people would seek to underrate the considerable 'traditional' skills that exist in the UK's marine environment, but the industry is being compelled by market, legislative, and technological forces to reconsider how its resources might better be employed in the current, more dynamic, environment. New skills, new ways of managing, working, thinking, and communicating are, as the report implies, likely to be essential ingredients in the cocktail of economic prosperity and progress for the industry. Exactly what these new skills should be, and how and why they should be developed, however, does not seem to have been adequately addressed in the ministerial rhetoric.

In the light of current uncertainty concerning the proficiencies that will be needed it is hardly surprising that the content and quality of 'training packages' being offered to the industry is so variable. Such variability prompted the director of training of at least one major ship-owner to vent his frustration in the international press[1], but the response from training providers could not have been more predictable. 'Tell us what you want', they said, 'and we'll provide it' (Lloyds List, Nov 5th 2001). The problem is that shipping organisations don't know what competencies will be required in the future because they don't know how technology might ultimately influence their strategic direction. Nevertheless, answering such questions is fundamental if the industry is to take on board the opportunities for innovation and growth that technology is offering.

But why is this research important? How relevant is the UK shipping industry to the health of the national economy? And why is it so important that the industry takes note of technological developments that seem poised to compel it to change tack?

The purpose of this chapter is twofold. Firstly I will justify the research in terms of its contribution to knowledge in an industry that, having once been at the helm of a global empire, now seems reluctant to change course. I will show that, as a major player in global transportation, the industry's importance to the overall UK economy is not limited to its direct financial impact but also to the global aspirations of a wide range of manufacturing, wholesale, and retail organisations that comprise its customers and its suppliers. I will emphasise this importance through the analysis of both primary and secondary data and examine ways in which the industry might capitalise on, and be strengthened by, its potential for innovation. I will show how the industry's opportunities for developing and adopting radically different services and processes are driven through change and provide examples of how changes in vessel types, and the technological infrastructure through which they are operated, offers unparalleled opportunities for innovation. Evidence has demonstrated significant correlations between overall business success and innovation performance in a number of industries (see for example Specht and Ohms, 2000). There seems to be no compelling reason why the shipping industry should be immune.

Secondly I will emphasise, through comparing and contrasting prevailing conditions in the UK shipping industry with some of the theoretical literature pertaining to technological, structural, cultural, and environmental issues, how moribund communication and navigational systems have inhibited both economic and cultural processes within the industry. The primary focus on communication and navigation technologies that are emerging as a consequence of the relatively recent introduction of the Global Maritime Distress and Safety System (GMDSS) is justified through an examination of the industry's structure, its idiosyncrasies and its changing character. Technology, I will argue, precipitates change by replacing and accelerating routine procedures to the extent that entire industries thrive or perish dependent upon their ability to adapt to different circumstances. GMDSS seems to be spearheading a technological revolution in the shipping industry, which suggests that the ultimate decision that ship-owners will have to make is not whether, but when to change.

2.1 The Economic Perspective.

In general terms, commercial ships are mere cogs in the mechanics of a complex transport infrastructure that embraces road freight, the rail network and numerous ancillary services. It follows that efficiency levels in commercial shipping will continue to have a profound influence on the equation of success for virtually the whole of the UK transport system, and ultimately the entire national economy.

As shown in figure 2.1, in terms of total vessel tonnage the UK operates the third largest commercial shipping fleet in Europe. Its growth of almost twenty-two percent in the last ten years is also one of the highest.

Figure 2.1
Comparison of the European Shipping Industry Fleet Tonnage

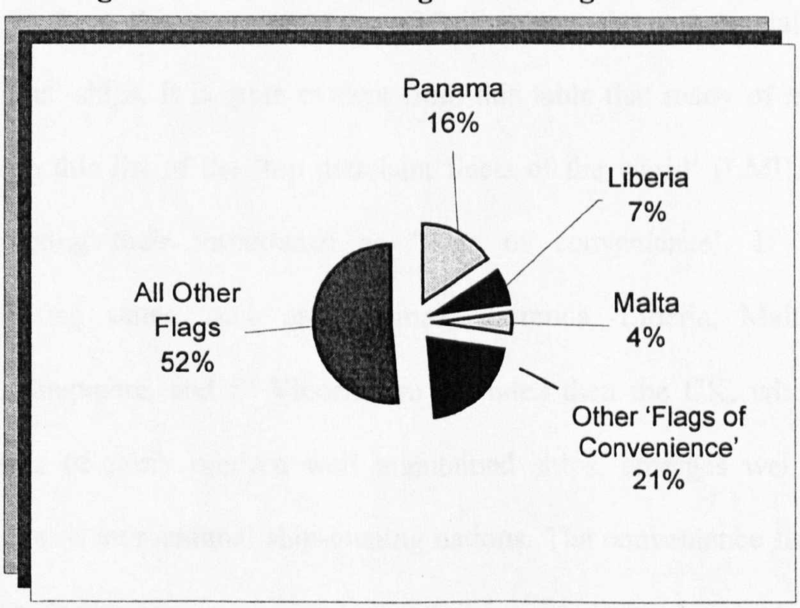
Flag	**Million Tonnes (dwt)**		
	1990	1995	2000
Greece	37.1	52.9	43.0
Norway	39.4	33.6	34.4
UK (including Isle of Man and Channel Islands)	7.6	7.2	9.7
Italy	11	8.8	9.4
Germany	6.8	6.3	7.9
France	5.7	6.3	7.4
Denmark	7	7	6.8
Netherlands	4.2	4.6	5.7
Spain	5.6	1.6	1.8
Sweden	2.9	2.3	1.8

(Data Source: Fairplay, 2000 - 2001)

On an international level, the UK is competing with many ship-owners who operate vessels under 'flags of convenience'. The term 'flag of convenience' refers to ships that are registered in countries which offer particularly attractive tax incentives, or where the various operational regulations are known to be less stringently applied than they are in, for example, North Western Europe or the United States. Whilst the total tonnage of ships operating under 'flags of convenience' far exceeds that of ships sailing under the UK flag, not all the vessels that sail under flags of convenience are as well maintained as those that sail under conventional flags.

Statistically the UK does not feature at all in the top twenty merchant fleets of the world. As illustrated in the graphical representation (figure 2.2), which is derived from statistics dated April 2001, (LMIU, January 2002) the world's top three 'convenience flag' states, Panama, Liberia, and Malta, account for some twenty-seven percent of the world merchant fleet.

Figure 2.2
Percentage of World Fleet Sailing Under Flags of Convenience



(Data Source: Fairplay, 2000 - 2001)

When other well-known flags of convenience countries are included it becomes clear that nearly half of the world fleet currently sails under one of these flags. Such statistics do not tell the whole story, however, because many UK ship owners openly admit to registering vessels under various flags of convenience. Their reasons for doing so are mainly financial, and in such circumstances it seems highly probable that other European and international ship owners will be doing the same.

In analysing the economic importance of the UK shipping industry from an international perspective therefore, it seems pertinent to exclude known flags of convenience states from such analysis. The main reason for this is that the numbers and type of ships that sail under convenience flags are as varied as the countries in which these ships are actually owned. To include convenience flag states in analysing the size and quality of the UK fleet would distort the true picture because flags of convenience are flown by ships belonging to many different countries, whilst this analysis seeks to compare the UK with other *true* ship-owning nations.

To further reinforce this argument figure 2.3 illustrates the commercial tonnage of various nations' ships. It is quite evident from this table that many of the countries that feature in this list of the 'top merchant fleets of the world' (LMIU, 2002) are merely reflecting their importance as 'flags of convenience'. If well-known convenience flag states, such as Bahamas, Bermuda, Liberia, Malta, Panama, Philippines, Singapore, and St Vincent are excluded then the UK, with nearly ten million tonnes of fairly modern well maintained ships, emerges well within the premier league of international ship-owning nations. The convenience flag states are marked *** in figure 2.3.

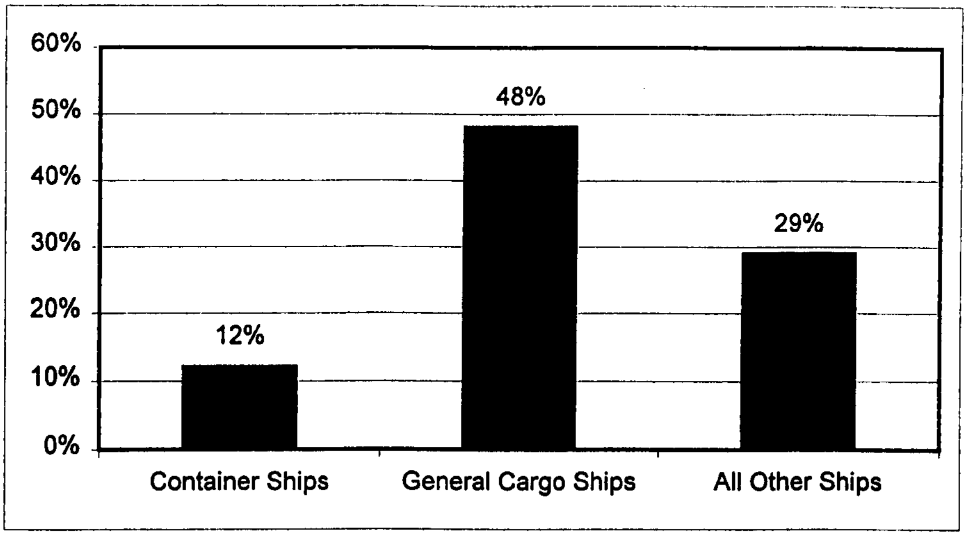
Figure 2.3
International Shipping Fleet Tonnage

Flag		Million Tonnes (dwt)		
		1990	**1995**	**2000**
Panama	***	59.7	100.9	155.6
Liberia	***	97.8	96.4	86.6
Malta	***	7.6	27.2	46.3
Bahamas	***	21.7	35.5	43.6
Cyprus	***	33.1	39.6	36.3
Norway		39.4	33.6	34.4
Singapore	***	12.5	19.7	33.9
USA		24.6	24.3	29
China		19.6	23.2	22.5
Japan		39.3	28.7	21.9
Hong Kong		10.7	14	12.1
Philippines	***	14.1	14.7	11.2
India		10.1	10.9	10.8
Bermuda	***	7.7	4.6	10.7
St Vincent	***	2.9	8.6	10.2
Turkey		6.2	9.3	10.1
USSR		24.9	0	0
UK (including Isle of Man and Channel Islands)		7.6	7.2	9.7

(Data Source: Fairplay, 2000-2001)

In order to confirm the changing characteristics of both the international and the United Kingdom shipping industry it was necessary to examine the age profile of the merchant fleet, the profile of the various vessel types, and the changing characteristics of the world order book. An analysis of the age profile of the World Merchant Fleet (figure 2.4) reveals that as of 1st March 2000, approximately twenty-nine percent (dwt)[2] of ships greater than ten thousand gross tons was built before 1980. The general[3] cargo fleet was the oldest with forty-eight percent of general cargo ships built before 1980. In contrast, only twelve percent of the containership fleet of the same size was built before 1980. Approximately two-thirds of the fleet dwt built from 1990 to 2000 was built after 1995 (LMIU, January 2002).

Figure 2.4
Age Profile of World Merchant Fleet
Percentage of Ships More Than 20 Years Old



(Data Source: LMIU, 2002)

Figure 2.5
World Fleet Vessel Type

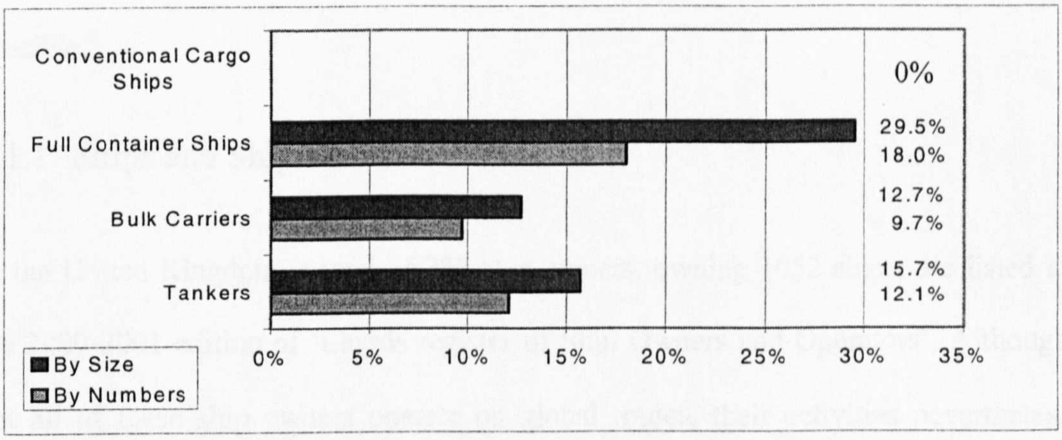
Vessel Type	Number	% of total	Total Tonnage	% of total
Bulker	8,637	36%	301,980,842	20%
Combination	197	2%	14,440,597	0.5%
Container	2,829	9%	75,117,091	6%
Dry Cargo	7,451	6%	48,198,361	17%
Miscellaneous	6,372	2%	16,218,542	15%
Offshore	3,061	3%	23,048,747	7%
Passenger / Ferry	2,956	1%	5,016,937	7%
Reefer	1,821	1%	8,998,546	4%
Ro-Ro	1,983	2%	18,165,448	5%
Tanker	8,470	39%	326,090,685	19%
Total	43,777		837,275,796	

(Data source: Fairplay, 2000-2001)

Currently, the world fleet is heavily biased in favour of bulk cargo carriers (bulkers) and tankers, whilst container vessels comprise a mere nine percent of the total number of ships and six percent of the total tonnage. The profile of the current world fleet vessel type is illustrated in figure 2.5.

The changing characteristic of the world merchant fleet may be confirmed by referring to the world order book. This data (illustrated in figure 2.6) shows that, as a percentage of the total world fleet, full container ships are increasing at a greater rate than any other type of ship - in terms of both the cargo carrying capacity (size), and in terms of the number of ships being built.

Figure 2.6
World Order Book
Ships on Order as a Percentage of World Fleet Totals



(Data Source: LLMI, 2002)

The reader may wonder why I used the term 'size' to compare the cargo carrying capacities of different types of vessels in figure 2.6, whereas in figures 2.1 and 2.3, I used the term dwt (deadweight tons). The reason is that the cargo carrying capacities of conventional ships are usually expressed in dwt, whilst the cargo carrying capacities of container ships are expressed in TEUs. A TEU (Twenty-foot Equivalent Unit) is a term used to describe the physical size and weight carrying capacity of a (hypothetical) twenty-foot long container. The data clearly shows that, world-wide, there has been a significant move away from conventional (general cargo) vessels and into large container vessels.

At the beginning of 2002 there were no orders for new general cargo ships in the world order book. This is hardly surprising given that container ships are considered to be more efficient, and therefore much more economical in terms of cost per ton (of cargo carried), than general cargo ships. Ship-owners, with whom I had discussions during the 'Europoort 2001' international maritime exhibition in Amsterdam, confirmed this. But from an innovation perspective, the drift from conventional to container ships offers even greater benefits. It could, for example, enable ship owners and operators to design new or enhanced services that might not otherwise have been possible.[4]

2.1.1 Ships and Ship Owners.

In the United Kingdom, a total of 287 ship owners, owning 1052 ships, are listed in the 2000-2001 edition of 'Lloyds register of Ship Owners and Operators'. Although not all of these ship owners operate on global routes, their activities nevertheless influence and support the ability of many of those who do to provide various levels of international freight service that might not otherwise be viable. For example, very large vessels, because of their physical size, are restricted to certain large ports. It is, however, often more convenient for the products that they carry to be distributed from one of the smaller ports. Small ships are used to transfer (mainly bulk) cargo between large and small ports.

These small vessels are significant contributors to the well being of the United Kingdom shipping industry and are therefore discussed in this analysis of the importance of the industry. The views of their owners, however, are somewhat less relevant to the study of technological, cultural, and environmental impacts on innovation in the industry. There are a number of reasons for this.

- Vessels that sail only within certain sea areas - for instance within a few miles of the land - are less dependent upon the types of innovations that are required on ships that operate globally. These 'local' vessels can normally communicate with the shore using equipment such as mobile phones and very high frequency (VHF) radio. They are in the main exempt from the stringent GMDSS regulations with which ocean going vessels have to comply.

- Vessels operating on short voyages are usually managed differently to so-called 'deep sea' vessels. The communications and navigational systems on 'deep sea' (ocean going) vessels rely to an increasing extent on the technological developments of satellite navigation and communication. Satellite communication costs are still relatively expensive and ocean going vessel owners are therefore much less likely to communicate with their vessels over trivial matters. Vessels operating close to the coast are usually in constant contact with their offices[5], which suggests that such vessels are less isolated from the organisation's shore-side business culture.

- This research examines how innovations related to communication technology could be used, for example, to monitor perishable cargo at sea and reduce its risk of deterioration. Smaller vessels, because of their relatively short voyages, would be much less likely to benefit from this type of innovation[6].

I am not suggesting that small vessels do not need innovation (they probably do) but one of the objectives of this research is to differentiate between the type of innovations that are relevant only to shore based organisations and those that could be used at sea. Vessels that operate within a few miles of the coast are, as far as this research is concerned, more akin to shore based organisations for the reasons just outlined. In analysing the type profile of UK ships from a perspective relevant to this research, therefore, I looked only at ships which are likely to engage in international voyages - vessels of at least 500 gross tons. As illustrated in figure 2.7, during the last decade the type of ships operated by UK ship-owners has changed dramatically. In 1988 the country boasted seventy-nine bulk carriers but by the end of the decade only twenty-nine remained. A similar trend is shown for other types of vessel. Liquid bulk and specialised carriers, for example, also experienced reductions in their numbers. In terms of container vessels, however, the numbers increased, from fifty-six in 1988 to seventy-three in 2000.

Figure 2.7
United Kingdom Owned Vessels

Year	Number of Liquid Bulk (e.g. oil or gas)	Number of Dry Bulk Carriers	Number of Specialised Carriers	Number of Full Container Vessels
1998	197	79	17	56
1989	178	65	16	60
1990	174	61	23	52
1991	168	61	23	52
1992	150	61	22	45
1993	145	51	22	44
1994	145	41	22	48
1995	139	41	22	52
1996	129	42	19	54
1997	123	35	11	60
1998	127	29	10	62
1999	124	29	10	57
2000	133	29	10	73

(Data Source: Lloyds Register of Shipping, 2000 - 2001)

This data reaffirms my assertion that UK ship-owners are gradually replacing conventional vessels with container ships. It is not unexpected to find that UK ship owners are following a world trend of course, but by doing so they are supporting my view that container vessels are more efficient, and therefore more profitable, than conventional cargo vessels. Furthermore, container vessels are prime candidates for the types of innovation that could tip the competitive balance in favour of owners whose ships have the capability to offer the enhanced services that technology has made possible. In chapter four, for example, I will discuss how ship owners could capitalise on technology to offer their clients an ability to monitor and control the environmental conditions of their own cargo. Such innovations, I suggest could act as formidable weapons in the battle against cut-rate 'rust-bucket' operators.

Ideas such as these are particularly appropriate for integration on container vessels and, since many of these vessels are relatively new, the investment in the technology to make it happen might also be justifiable. The UK, with a rapidly increasing container fleet is ideally placed to benefit from the development of innovative cultures that would more closely match its developing technological capabilities.

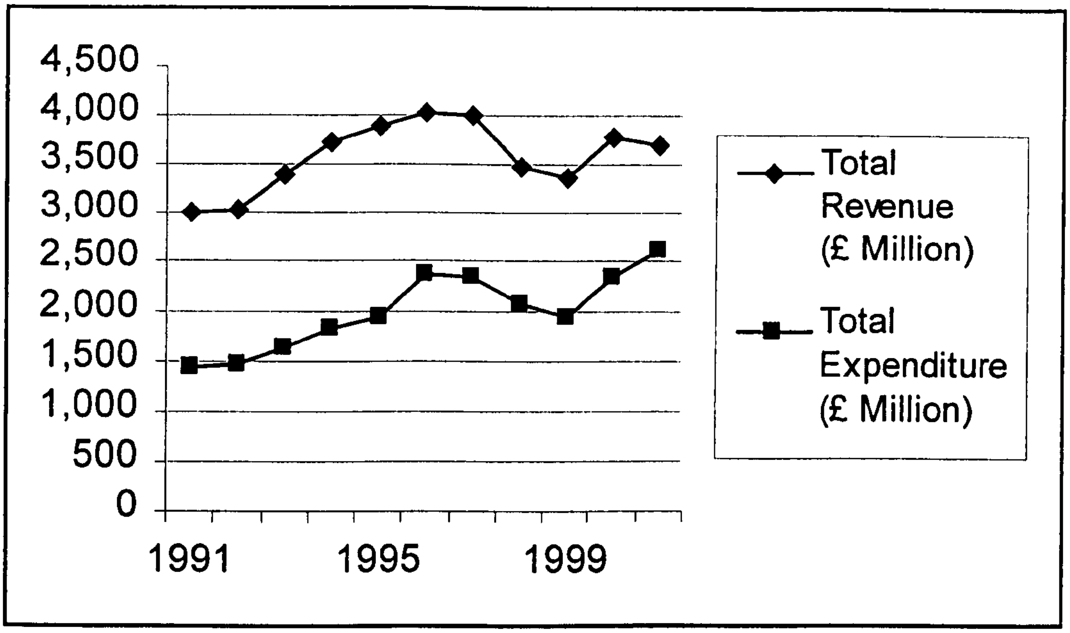
The world fleet comprises numerous different type of ship. Both Fairplay and Lloyds, the main publishers of shipping information, classify ships according to their designed purpose and have devised a coding system whereby different types of ship are represented by two letters that refer to the ship type. An accommodation vessel, for instance, has been assigned the letters 'AA', whereas a container vessel has been assigned the letters 'CN'. Since these codes were used to determine which of the various types of ship are operated in the United Kingdom the list is presented in appendix (a). In deciding which types of ship would be relevant to the research, however, the ship types were broken down into the ten broad categories shown in figure 2.5. Ship-owners in the UK operate all of the ship types detailed in this figure.

Appendix (b) provides details of the name of every ship-owner in the UK together with the head office location and a series of two letter codes representing the types of ship that the organisation owns. By cross referencing these codes with the vessel codes detailed in appendix (a) it is possible to establish exactly which types of ship each organisation owns or operates. Lloyds list (2001-2002) also provides specific information pertaining to the number of ships of each type that each of these organisations employ. By using this information I was able to establish whether or not each of the ship-owners listed owned or operated ships that were relevant to the objectives of this research and thereby identify which organisations should be asked to complete questionnaires[7] .

2.1.2 Direct and Indirect Financial Contributions.

Details of the United Kingdom shipping industry international revenue and expenditure statistics published by the United Kingdom Department for Transport (DfT) for the years 1991 to 2001 are provided in appendix (c). As illustrated in figure 2.8, which is derived from these statistics, UK cargo vessels averaged yearly incomes in the region of £3,500 million during the last decade. The increase in the industry's expenditure (from £1,445 million in 1991 to £2,620 million in 2001), however, may be cause for concern and seems to further re-enforce the need for innovations, and the cultural and organisational changes that are likely to precede them. Taken in isolation, however, these figures do not tell the whole story. According to the DfT, in the first year of this millennium British residents made more than fifteen million visits abroad by sea. Almost the same number of foreign residents travelled to the UK by sea in the same period. These figures include both business and holiday travel, as well as the considerable number of cars, coaches, and lorries carried by British ships on a daily basis.

Figure 2.8
UK Shipping: International Income and Expenditure (cargo) 1991 - 2000



(Data Source: Department of Transport Marine Statistics, 2002)

In outlining the importance of the shipping industry to the national economy, the DfT recently published an 'integrated shipping policy'. The stated aims of this policy are:

- To facilitate shipping as an efficient and environmentally friendly means of carrying our trade.
- To foster the growth of an efficient UK-owned merchant fleet.
- To promote the employment and training of UK seafarers in order to keep open a wide range of job opportunities for young people and to maintain the supply of skills and experience vital to the economy.
- To encourage UK ship registration, to increase ship owners' identification with the UK, to improve our regulatory control of shipping using UK ports and waters and to maintain the availability of assets and personnel that may be needed in time of war (DfT, 2002).

The DfT further reinforce their commitment to the UK shipping industry when they say:

> We are committed to working with the shipping industry to develop its potential to the full. We set up a Shipping Working Group last year to consider how to obtain the maximum national economic and environmental benefit from shipping. The Group reported in March with a range of proposals on seafarer training, employment, the fiscal environment and opportunities for UK shipping. Our response to these proposals and our strategy for reviving the shipping industry will be published shortly (DfT, 2002).

The transport and leisure statistics that the shipping industry generates are not the only statistics that should be considered in assessing its importance in terms of the national economy. For example, according to the DTI, shipbuilding and ship repairs generate about £2,000 million per annum and employs about four and a half thousand people (DTI, 2002).The Marine Equipment Industry has an estimated turnover of £825 million, with some sixty-seven percent of its products being exported (UK National Statistics, 2002). Marine Insurance generates revenues of £3,192 million, employs nine thousand people, and, (according to Lloyds of London) the UK enjoys more than a thirty percent share of the world's marine insurance market (DTI, 2002)

According to the UK department of transport:

> With 95% of the United Kingdom's trade by weight arriving or leaving by sea, and much of the world's trade passing near our coasts, a safe and thriving global shipping industry is vital to the country's economy. The Government recognises the special importance that shipping has for the UK, and its shipping policy is designed to reverse years of decline in the country's fleet and seafaring activities. It has introduced a tonnage tax, and reviewed the ship registration procedures. This is already attracting vessels to the UK flag. The Government supports the training of seafarers by meeting a substantial part of training costs through the Maritime Training (SMarT) scheme. London hosts the International Maritime Organisation, the only UN Agency based in the UK. "Maritime London" is a world centre for shipping business and expertise and makes a valuable contribution to the UK balance of payments (DfT, 2002).

This information, much of which was obtained from the DTI and UK national statistics websites, further amplifies the importance of the industry. When one also takes into account the considerable number of industries that rely on shipping for the import and export of raw materials and manufactured products to and from these islands it becomes clear that the usefulness of this research might extend far beyond the boundaries for which it was designed.

2.2 The Technological Perspective.

The distress signal from the East Goodwin lightship on March 17, 1899 heralded radio as the nucleus of the maritime distress and safety system. A dedicated 'Radio-Officer' (RO) emerged, whose primary task was to maintain radio communications between ships at sea and coastal radio stations ashore using a code developed some fifty-five years earlier by American portrait painter Samuel Morse. Despite being painfully slow, Morse code maintained its dominant position as the primary communication system for ships at sea for nearly a hundred years. At the beginning of 1999, when manufacturers were giving away mobile phones and the internet was promising an e-commerce revolution, a group of maritime techno-sceptics were seriously objecting to the intended scrapping of the use of Morse code at sea on 'traditional' and 'romantic' grounds (Lloyds list, letters, Jan 5th 1999).

The source of such watery arguments may of course have had something to do with their ancestral background - the founding members of the original *'Flat Earth Society'* were also sailors - but some of their concerns may have warranted more than a cursory brush off. The suggestion that Morse code provides a form of communication that, in terms of reliability, is unmatched is in some ways perfectly valid. Even in the worst atmospheric conditions, when it would be all but impossible to communicate using radiotelephony[8], it is still relatively easy for an experienced RO to interpret meaning in the purity and simplicity of Morse code. And the technical equipment needed to send and receive Morse is also relatively simple. The only equipment needed is a transmitter capable of generating a continuous wave (CW) and a basic radio receiver tuned to the appropriate frequency. Such equipment is so technically uncomplicated that even if it does fail, a competent RO can usually repair it at sea. At first glance then it might appear that the techno-sceptics' concerns have some validity; perhaps the inherent reliability of the original distress and safety system really is being compromised in favour of progress.[9]

But is the reliability of a technological artefact or even the reliability of technology itself the only factor to consider in evaluating the overall reliability of a *system*? Even if one concurs with the argument that Morse code and the equipment needed to use it is inherently reliable, that still does not mean that the *system* (in this case the maritime distress and safety system, or commercial communication system) is reliable. It is not sufficient to merely examine the technological aspects of a system in order to evaluate its merits; it is necessary to consider the idiosyncrasies of social, political and environmental factors as well.

What I am drawing attention to here is the prevalence of reductionism in some sections of the shipping industry, and the temptation to focus on what can be quantified or controlled rather than adopting a more holistic approach. Reductionism is a valid and sometimes useful way of diminishing ambiguity by weeding out irrelevant or subjective material from complex systems or events. Reductionism is ubiquitous, but it is often inappropriate to the circumstances as evidenced in what I will show are the superficial conceptions of maritime techno-sceptics. In the words of

Douglas and Wykowski (1999) 'reductionism can be seen as simplistic, immature, conceptually crude, and intellectually half baked'. It is, they claim, 'a constraint on authenticity, social progress, justice, equity, general well-being and meaningful existence in the surrounding culture' In the metaphorical language of Charles Handy reductionism is 'missing the message of the forest in a minute examination of its trees' (Handy, 1989).

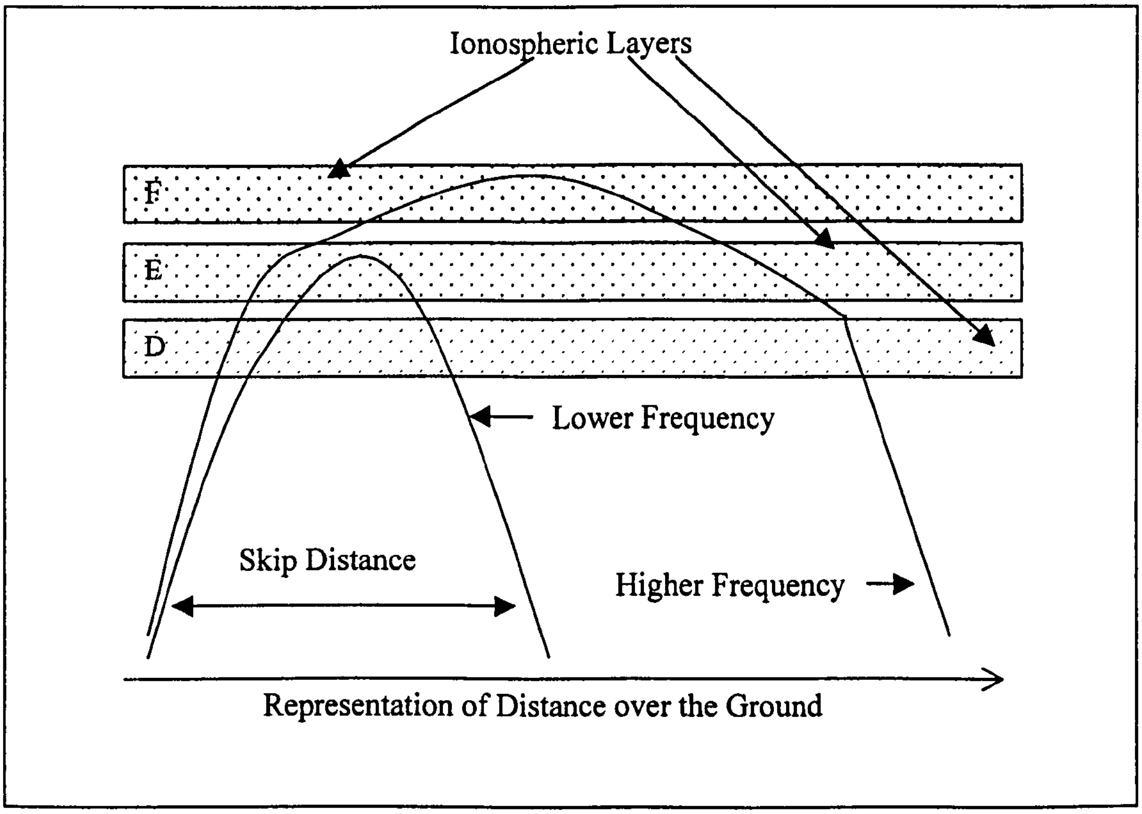
Not unexpectedly there are counter arguments to these somewhat over emphatic and metaphorical views. In any event the problem with using metaphors as descriptors is that they can easily be misinterpreted. Handy's views might, for example, be taken out of context and create an impression that reductionism means one 'cannot see the wood for the trees', and despite Douglas and Wykowski's comments, it is inappropriate to reject outright a concept that might be relevant in many situations. Nevertheless, as I have just highlighted, a holistic approach is called for in this instance. The notions that both human and non-human 'actors'[10] are influential in the dynamics of a network, and that both reliability and efficiency may be enhanced or constrained by these actors, seems to be a more pertinent perspective. These notions are at the heart of the Social Construction of Technology (SCOT) (Bijker, 1987) and 'Actor-network Theory' (ANT) (Latour, 1987) which are discussed more fully in chapter four. The following description of how ships communicate with the outside world using radio technology further endorses the rationale for the relevance of these theories to the study of technological innovation at sea.

2.2.1 Technology at Sea - Era One.

Communications with ships at sea throughout most of the twentieth century relied on radio waves in the medium frequency (MF) and high frequency (HF) spectrum. MF radio signals travel mainly over the surface of the earth and are attenuated as they do so. The level of attenuation depends upon the conductivity of the signal path, but in general MF radio has a maximum range of only a few hundred miles. It is therefore useful only when a ship is within a few hundred miles of a coastal radio station, or another ship with which it wishes to communicate.

HF radio, by utilising the region of the upper atmosphere known as the ionosphere, can be used for world-wide communications, but it is subject to the idiosyncrasies of that region of the atmosphere.

Figure 2.9
Basic Representation of HF Radio Transmission



Using the ionosphere for long-range HF radio communication demands that the user has at least a fundamental understanding of its dynamic nature. HF radio signals are subject to a degree of refraction as they enter various layers of the ionosphere.[11] As illustrated in figure 2.9 it is this refraction that causes HF signals to return to earth at some distance from their source.

The degree of ionospheric refraction is inversely proportional to the square of the frequency of the signals and hence the distance from the source that the signals will return to earth increases proportionally with frequency. Between the point of transmission and reception however (within the skip distance) no signals will be received. The degree of refraction also depends to a large extent on the density of ionisation within the different regions of the ionosphere, which is far from constant. The position and strength of the sun has a major influence on the density of ionosphere, which changes depending on the time of day, the season of the year, the latitude, various factors related to sunspot activity, and numerous other phenomena. In a nutshell, HF radio communication is difficult to manage and is to some extent unreliable. Despite the inherent reliability of the equipment needed and the simplicity of Morse code then, environmental factors have a negative influence on the system's overall reliability; and the negative environmental factors far outweigh the positive technological ones.

These negative environmental factors meant that for distress and safety purposes HF radio was precarious, and although some provision was available for using HF, the vast majority of distress and safety messages relied on MF radio. Since MF radio signals travel along the ground they are not significantly influenced by the ionosphere[12]. However, as I mentioned earlier, they are subject to some attenuation, which reduces their effective range. The comparatively short range of MF means that a ship in distress could easily be too far away for its signals to reach a land based radio station. Ships therefore had to rely, more or less exclusively, on other ships in the vicinity hearing and responding to their calls for help. To '*ensure*' that other ships in the vicinity would receive these distress and safety messages, legislation compelled ROs to listen on appropriate MF distress and safety frequencies for three minutes every half hour. No transmissions, other than distress and safety messages, were permitted during these 'silence periods'.

But what if the other ships were also out of the range? What if the receiving ship was also in difficulties, in severe weather situations for example? And what if a ship in distress simply didn't have the time to send a distress message during a silence period? What if a distress message had been sent outside of the silence period and had been missed because the RO of a potential rescue ship nearby had been busy with commercial traffic? What if there just happened to be no ships in the vicinity at all?

Clearly humans, not just technology are part of the complex equation of reliability. The *system* is only as good as the '*actors*' in the network and the actors in the network include both technological artefacts *and* humans. Whether the weakest link in the network is the technology itself, a technological artefact, or a human actor is irrelevant. The *system* flourishes, or fails, as a consequence of the integrity of the whole.

Political factors including the matter of who makes the decision concerning the capability of a ship receiving a distress message to actually render assistance add further to the system's fallibility. Culture plays a significant role as well. For instance, commercial ships operate in an international arena; they have unrestricted rights to sail anywhere in international waters. It might be that the officers and crew of a potential 'rescue' ship have entirely different cultural attitudes to those of the ship needing assistance. Their respective countries may even be at war. When such factors enter the equation it turns out that what has been regarded, technologically, as a superb system actually contains a huge measure of human subjectivity and potential biases. The *system* cannot be relied upon to behave in exactly the same way, even in identical circumstances - the system is unreliable.

2.2.2 Legacy Systems - an Impedimenta to Progress

Although the radio communication system just described was far from ideal, it was nevertheless the mainstay of both commercial and distress communications until relatively recently. In 1979 the International Maritime Satellite Organisation (INMARSAT) was set up and by 1982 it was offering a viable alternative in the form of satellite communications which are, in a practical sense, unaffected by the ionosphere. Despite its clear technological and practical advantages it took over fifteen years for the satellite communication system to effectively challenge radio's role as the primary system for maritime distress and safety traffic. From a commercial perspective the addiction that ship-owners had to radio and Morse code seems to be firmly anchored in their organisational culture, perhaps with considerable justification. Carrying at least one, and on some ships several, ROs was a mandatory requirement under the Safety of Life at Sea (SOLAS) regulations; it clearly made sense to make use of the RO for commercial communications as well. Commercial communications relied mainly on HF radio, and since world-wide communication using Morse code is (usually) possible in this frequency band, the RO would typically send messages via a coastal radio station located in the country of destination. This resulted in relatively low charges, which could not be matched by the emerging satellite technologies.

The carrot that ultimately led the industry to accept, though not necessarily to welcome, the new communications technology aboard was the legislators' announcement that ships exercising the option to install new communications technology in the year or so leading up to GMDSS would no longer be compelled to carry an RO. Such a move implied a considerable cost saving for those ship-owners who were prepared to change in favour of modern technology, but even this concession didn't convince everyone. Expensive heirlooms, electronic systems that had already been installed to meet SOLAS regulations would have to be scrapped. The perception that the system must be 'reliable' because it had served the industry well for so long prevailed. In any event, according to some ship-owners, these systems still had to 'earn their keep'[13] before they would be allowed to retire. How could ship-owners justify the costs involved in replacing electronic systems that were working, and had worked 'perfectly well'[14] for nearly a century? Despite the slow take up of the voluntary option to change, and the concentrated attempts to have the new systems' mandatory introduction further delayed, the ageing radio distress and safety system was finally laid to rest on 1st February, 1999. It was replaced by an entirely new system called the Global Maritime Distress and Safety System (GMDSS).

GMDSS no longer depends on other ships picking up distress signals. Instead, signals from ships in distress are relayed, via orbiting INMARSAT satellites, to a properly equipped coast earth station (CES). The CES takes responsibility for directing distress and safety traffic to appropriate authorities who co-ordinate search and rescue procedures. Although GMDSS is not perceived as entirely successful[15], it does offer a totally new and far more reliable method of communication, not only for ships in distress but for commercial purposes as well. The relatively recent changes in maritime communications appear to be signalling an opportunity for a paradigm shift[16], a shift that is probably long overdue in the industry.

Nevertheless, impediments to progress continue to surface on a regular basis. Confidence in GMDSS, for example, is hardly likely to be reinforced by headlines such as those appearing on 15th February 2001. When a vessel encountered problems in the Lombok straits (Indonesia) one of the passengers sent a text message from her mobile phone to her friend in England. The message, which read 'contact Falmouth coastguard, we need help SOS' (BBC News 15th Feb, 2001) triggered a successful international search and rescue operation involving authorities in the UK, Australia and Indonesia. Incidents such as this, in which GMDSS is effectively cast adrift in favour of solutions that smack more of common sense than subservience must surely set the alarm bells ringing, not only in the premises of the rescuers but in the minds of legislators as well.

As I highlighted earlier, ship owners have been compelled by legislation to carry one or more ROs. They have also been restricted in their choice of radio and navigation equipment, been forced to maintain detailed manual administrative records, and submit to regular inspections to ensure compliance with a myriad of rules and regulations designed to improve safety at sea. As a result many ships are now equipped with legacy systems that ship-owners are reluctant to scrap in order to transfer to newer technologies. Moreover, it is not only their reluctance to embrace the newer *communications* technologies that suggests that some shipping companies may be running out of the steam needed to drive the industry's innovation engine. Many of the navigational systems used at sea are also due for more than mere cosmetic surgery.

2.2.3 Marine Navigation Systems.

A Speck! If the ancient mariner[17] had used ancient radar he would have seen a speck, on the radar display. That speck might, or then again might not, have been another ship.

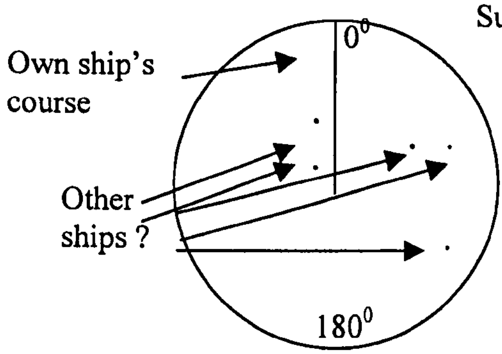
> *A speck, a mist, a shape I wist!*
> *And still it neared and neared,*
> *As if it dodged a watersprite,*
> *It plunged and tacked and veered*
>
> *The Ancient Mariner*
> *Samuel Taylor Coleridge*
> *1772 - 1834*

And, in the twenty-first century, a modern mariner looking at a 'modern' radar display sees exactly the same thing - a speck. The navigator can't be sure that the speck really *is* a ship; it might be. It could also be sea clutter[18], precipitation, an iceberg, a whale, birds, or just a (fairly common) false echo caused by technical anomalies. The radar is unable to determine the colour of the object that it 'sees', or its shape. In fact, the only genuine information that a radar system provides is that there *just might* be something out there.

Add a few bells and whistles and radar gets a new name. It becomes an Automatic Radar Plotting Aid (ARPA). Essentially, what an ARPA does is plot the movement of all the specks displayed on the radar display in order to estimate their course and speed. So, with an ARPA the navigator knows that whatever *might* be out there *might* be travelling at a certain speed in a certain direction, and, if it really is there, it *might* come within a certain distance within a certain time.

Manufacturers continue to advertise their latest radar and ARPA systems as 'state of the art', whatever that means. It seems to imply that a new technology or a significant improvement in the way in which the technology works has been developed. It hasn't. Radar is not in itself a technology; it is a derivative of a much older technology, radio technology. The word radar is actually an acronym (*RA*dio *D*irection *A*nd *R*anging) and its operation depends entirely on the transmission and reception of radio signals, which travel at a more or less constant speed. All radar really does is measure how long a radio signal takes to travel to its 'target' and back. Since the signal's velocity is constant, it then displays that information in terms of distance. By using a highly directional rotating antenna it can also indicate the target's bearing relative to the ship. That's it!

Figure 2.10 - RADAR



Suppose we take a closer look at what we really have in the latest 'state of the art' radar or ARPA system (figure 2.10). Suppose we ignore the bells and whistles and examine the system in realistic, practical terms. Is this really a new or better way of navigating a ship? Or is it a re-hashed '*exnovation*' (Anderson and King, 1995)[19], an attempt to present a world war two veteran, that would prefer a retirement home to yet another face-lift, as a valid innovation?

Fundamentally, radar hasn't changed a bit in the sixty odd years since the first system was installed on the German vessel Welle. It could even be argued that radar itself is an *incrementalism* rather than a true invention. An incrementalism in this context is a logical development of technology that has continued for so long that the final output of the development is already stale. Radar falls into this category because the technique upon which it is based was used to measure the height of the ionosphere long before anyone thought of using it at sea.

In asserting that 'incrementalism is innovation's worst enemy' Negroponte (1995) makes a valid point. Peters (1999) reinforces these views placing incrementalism firmly on the agenda of concern. Incrementalism is a highly contagious disease that is very difficult to cure, and in the marine environment nautical paralysis may be the predominant side effect. But nautical paralysis is not confined to radar, or even to navigation systems; it appears to have infected the entire shipping industry. By the end of the last century the industry had become one of over indulgent traditions riddled with moribund technologies and technological dinosaurs masquerading as navigation and communication instruments. The original innovations that were once the engine of these and many other developments in the marine industry had run their course and become relics of a bygone era. The industry had become the virtual slave of incrementalism and, with many ship-owners still complaining about the inadequacies of GMDSS, it is not out of the doldrums yet.

The subliminal processes that set the industry on this collision course with antiquity seem to be buried in its traditions, its organisational culture and its 'mechanistic systems of management' (Burns and Stalker, 1961). All of these notions are explored more fully in chapter four. A brief review of this latter point however suggests that mechanistic systems are intrinsic to the shipping industry and that whilst such systems are appropriate in the routine operations of ships, they are far less pertinent in the pursuit of innovation. A mechanistic system of management is, according to Burns and Stalker, characterised by a hierarchic structure of control, authority and communication, a vertical interaction between superior and subordinate and an insistence on obedience to superiors. Such a system may well be essential on board a ship, after all, if the captain is ultimately responsible for almost *anything* that happens to the ship or its crew it seems logical s/he should retain overall command.

But, in a mechanistic system such as this, how can the demands of the navigators of the future ever be even known, let alone addressed? In the presence of a system where the captain must accept full responsibility for all the activities on the ship, would s/he be willing to seek advice from junior officers concerning the technological systems that should be used on board the ship? How could the ideas and knowledge of a new breed of technologically literate navigators manifest themselves in social interactions when such a system acts as a deterrent to social interaction?

In reviewing the business culture in Silicon Valley California, Delbecq and Weiss (2000) have demonstrated that social interaction is a precursor to innovation and change. And, as Burns and Stalker have pointed out, 'a mechanistic system of management is appropriate to stable conditions', 'habitual behaviour', and 'routine decisions' but is inappropriate to the changing conditions inherent in innovative organisations. How then can the purely mechanistic management systems that prevail throughout the shipping environment align themselves with the concepts of innovation and change? Clearly an attempt to sketch the concepts, policies, and cultures that might launch an industrial quest for innovation also demands that the relevant aspects of the industry's organisational structure be addressed. An in depth discussion of these determinates is also presented in chapter four.

Communications technology, driven largely by mobile telephones and the Internet, is currently in the fast lane and provides the most obvious signal that the shipping industry needs to re-examine its own demands on technology. Radar, as I have just argued, appears to be trapped in a technological time warp, but the list of navigational *exnovations* still taking up space on board ships is far more extensive. Ships' speed logs are notoriously inaccurate because they measure speed through the water, which, in the presence of ocean currents, differs substantially from true (over the ground) speed. Mechanical speed logs are elements of the history of the sea but they are not themselves history. They seem somehow to have acquired a kind of reverence, like the wooden spoke wheel, the mystical sextant, and the engine telegraph; they appear to be immune from the influence of technological developments all around them.

Another 'basic essential' on a ship is the magnetic compass. These archaic devices suffer from all kinds of variable errors that cannot always be predicted. The errors can be so great that if a navigator pinned his or her hopes solely on a magnetic compass to steer a course from, say, Southampton to New York there would be just as much chance of the ship ending up in Florida, or Greenland. The direction finder (DF) too is living on borrowed time. Introducing errors related to the ionosphere, the structure of the ship and even the time of day, DF really does deserve a new lease of life - in a museum. With luck, a great deal of luck, it might provide a bearing within two or three degrees of the correct one. That means that if a DF was used to fix a ship's position the resulting error could easily be several hundred miles. Why this primitive device wasn't given a wide berth long ago is an enigma.

So here you have it - an unvarnished bullet-point overview of the technological infrastructure of the shipping industry as it prepared to enter the twenty-first century.

- Multinational businesses communicating in an ancient language that more than ninety-nine percent of employees within the industry cannot understand.[20]

- Radar systems that may or may not be capable of detecting the presence of other ships.

- Speed logs that have very little chance of indicating the ship's true speed.
- Magnetic compasses that hardly ever indicate the ship's real course.
- Direction Finders that are about as accurate as a bow and arrow in a hurricane.

The time to embrace current technologies, and to begin to fashion systems that are appropriate to a relevant era was long overdue even before the introduction of GMDSS. In terms of many of the navigational systems that the industry continues to use, it still is.

2.2.4 Era Two - A star to steer her by.

Poets such as John Masefield[21] brought an air of romance to the marine world and probably reinforced some of its time-honoured traditions; but there is no room for excessive sentimentality in the cut-throat world of competitive business. It's time to move on; the techno-sceptics might not like it but man-made stars in the shape of the Global Positioning System, (GPS) have already taken over all of the navigation functions of more familiar constellations.

GPS is a radio-satellite navigation system developed by the United States Department of Defense[22]. Using a total of twenty-four satellites in three different orbit planes the system is designed so that a GPS aerial anywhere on earth will normally have an unobstructed view of at least four of these satellites. By measuring and 'triangulating' the time of arrival of signals from these four orbiting satellites the system accurately calculates the four primary navigational parameters (latitude, longitude, altitude and time). The equipment needed to receive GPS signals is relatively inexpensive and there is no charge for using the system. The Russian Navy maintains a similar system called GLONASS (Global Navigation System). Used in combination with the recent developments in maritime communication technology, these systems represent a formidable enemy to maritime senility. Nevertheless, mechanical sextants used in conjunction with mechanical chronometers continue to be maintained as the *de facto* navigation standard on most ships. Why?

Based upon the response to the question 'do you think that modern navigation systems such as GPS will ultimately make traditional devices such as sextants and chronometers obsolete?' during the empirical phase of this work, there appears to be a lack of trust in the reliability of the system. Responses ranged from outright 'no' and 'unfortunately yes' to 'yes but what about when the GPS fails?' There seems to be an implied assumption that new technology is unreliable and therefore unwelcome at sea, and even when new technology is accepted, there usually remains a proviso that a 'tried and tested' alternative is maintained on board as well. The cultural and emotional attitudes of mariners to innovation seem to be the antithesis of their counterparts in many industries ashore. Is this antithesis linked in some way to the historical isolation of seafarers? Does the perception of technological unreliability correlate with the over emphasis on gimmickry that seems to prevail in many new products and systems?[23] Most marine GPS receivers for example also calculate the ship's speed over the ground, its time of arrival at various way-points, and a host of information pertaining to the ship's route plan. Most of these functions are quite useful but some are perceived as adding unnecessary complication and unreliability to the system. It is not that there have been problems with GPS, the system has actually been extremely reliable, but inadequate communications technologies that were responsible for the protracted isolation of mariners seem to have also reinforced their belt and braces instincts.

2.2.5 Beyond GPS.

Mariners frequently express concern over what might happen if the US authorities decide to 'turn off' the GPS system and the trusty sextants, chronometers and associated paraphernalia have already been consigned to the deep.[24] Would their giant tankers then be up the proverbial creek without a paddle? As these mariners correctly observe, even moribund systems of navigation are better than nothing at all; what guarantees do they have that GPS will always be around?

Historically, predictions about what the future holds have never been very reliable. As illustrated in figure 2.11 even the most seasoned experts' views invariable turn out to be wrong. There is no cast iron guarantee that GPS is an immovable anchor. Then again, there is no guarantee that GMT will always be around either, but that doesn't stop people relying on clocks and watches to tell the time. People don't usually hump sundials around just in case their wristwatch stops working. From the perspective of most mariners the over-riding consideration in the selection of navigational and communication equipment is, or at least should be, reliability[25].

Figure 2.11
The 'Experts' Views on the Future of Technology

'The Phonograph is not of any commercial value.'
(Thomas Edison, inventor of the phonograph, c 1880)

'Heavier than air flying machines are impossible.'
(Lord Kelvin, President, British Royal Society, c 1895)

'I think there is a world market for about five computers.'
(Thomas J Watson, Chairman of IBM, 1943)

'There is no reason for any individual to have a computer in their home.'
(Ken Olson, President of Digital Equipment Corporation, 1977)

Implicit in this thinking is the notion that new technological systems, once released, are mature and hence destined either to fail, or to set the standard by which all other systems are measured or compared. It is a cognitive approach that seems to assume that change should be initiated only when it is absolutely necessary, when for example a current system is no longer working - 'if it ain't broke, don't fix it'. This style of thinking, once prevalent in the industrial age, is inappropriate to an era where continuous innovation is essential to business survival. New technological systems are not made of stone; they are continuously evolving and changing. GPS will probably *not* be around forever, and yes, there might be occasional hiccups as the system evolves. But evolve and change the system inevitably will, like any other innovation, until the stage is reached when it will be replaced by something better. Compared with some of the technological dinosaurs still inhabiting the shipping industry, GPS is a totally new animal. Nevertheless, it has already received a major overhaul, new frequencies, new signals, new power levels, and the flexibility for reconfiguring satellite systems in flight. (Gibbons, 2000)

Moves are afoot to integrate the navigational functions of GPS with the communication services currently available through INMARSAT satellites. Once the European Space Agency sort out their leadership roles a new system called 'Galileo' (*ibid*) is likely to enter the race for supremacy in Global Navigation Satellite Systems (GNSS). Whether one system emerges as overall winner, whether some systems simply run out of steam (or money), or whether an international consortium pulls together to produce ever more attractive systems remains to be seen. What does seem certain, however, is that the era where mariners continue to rely on steam radios, clockwork course recorders[26], mystical sextants, and bits of wire trailing over the stern of the ship[27] needs to be rapidly brought to a close.

2.2.6 The Electronic Umbilical.

The underlying concept behind the relatively recent idea of creating an 'office at sea', a virtual extension of the shore based office network, is communications. Technology now offers communications capabilities at sea that are on par with the communication facilities ashore, although, unless the ship happens to be close to land, it is not possible to use standard mobile phones. This is because conventional mobile phone signals are directed through local land-based transceivers (cells) that have an effective range of only a few kilometres. For ocean-going vessels, satellite communications is the only viable alternative to the moribund high-frequency radio system.

INMARSAT currently operates several global satellite communication systems for ships at sea including an automatic distress system designed for ships that are, for whatever reason, unable to transmit messages themselves when they are in trouble. The analogue INMARSAT 'A' and the newer digital INMARSAT 'B' systems use *geostationary* satellites to provide world-wide telephone, fax, and data services. Geostationary satellites orbit the earth at an altitude of 35,786 kilometres. At this altitude, they maintain the same position relative to the earth. Each satellite's footprint covers up to one-third of the Earth's surface and the satellite is strategically positioned above one of four Ocean regions[28].

INMARSAT also operates a system known as INMARSAT 'C', which provides basic store and forward communication facilities such as telex, fax, and low speed data, at relatively low cost. INMARSAT 'E' is the automatic emergency system specifically developed for ships in distress. This system is triggered by an Emergency Position Indicating Radio Beacon (EPIRB) which in turn is activated by immersion in water. From a ship-owner's perspective this all sounds very useful; the downside however is that the equipment needed to access the INMARSAT communication systems is expensive[29] and the INMARSAT system does not currently cater for low cost, hand held, satellite phones that could be about to revolutionise maritime communications.

The pace of change that seems increasingly likely to affect the marine industry's technological capability is accelerating, but in some ways it is unpredictable. For example, the new types of satellite that could ultimately offer an alternative to the high altitude INMARSAT maritime communications satellites are in a stage of uncertain transition. An article in 'The Times' newspaper on 20th March, 2000 reported that the satellite Telephone Company 'Iridium' had spent £4.4 billion setting up a system that had attracted just fifty-five thousand customers and had filed for bankruptcy.[30] Iridium had sixty-six satellites[31] orbiting the earth at an altitude of four hundred and eighty-five kilometres providing world wide mobile telephone communications that was of vital interest to shipping. Carried to its logical conclusion the system would have revolutionised telephony by enabling anyone to send or receive voice or data signals from anywhere on earth without the restrictions of cables or the reliance on land based cells. It would probably have made the current generation of mobile phones obsolete. The problem was that by the time the iridium system was operational, land based mobile phones had already established a huge marketing advantage and were offering significantly lower call costs.

Another company, 'Globstar', which has the well known mobile telephone company 'Vodaphone' among its backers, operates a competitive system using forty-eight low orbiting satellites and hopes to pick up most of Iridium's original customers. And On May 17, 2000, yet another company 'NEW ICO' (Intermediate Circular Orbit) joined the race to change the nature of communications with ships at sea. NEW ICO, formerly ICO Global communications, emerged from bankruptcy protection following a $1.2 billion investment by Craig McCaw, one of the world's foremost cellular telephone pioneers. ICO satellites orbit the earth at about five thousand kilometres, which means that their footprints cover a much wider area of the earth's surface than the low orbiting systems. By using an intermediate orbit rather than a low orbit ICO's system needs far fewer satellites, which means lower operating costs for the company. New ICO expects to introduce its satellite services, the satellite equivalent of the third-generation (3G) wireless services, in 2003.

Who, or perhaps more importantly, which system will gain the upper hand? A low orbiting satellite system means that small hand-held devices that compete with current land-based mobile phones are likely to dominate. If geostationary satellites prevail, the total number of subscribers to the system is likely to be much smaller because of the relatively high equipment costs and that scenario implies an entirely different communications structure for ships at sea. For example, will communications to ships at sea continue to be routed through ships' masters as they are now, or will everyone on board have their own phone, and how would that affect the command structure at sea? The high operating costs of ambitious satellite based personal telephone systems demands a large customer base to remain viable. Will these systems be able to compete with low cost land-based cellular telephone systems? And, if they cannot compete, how will that affect future communications in the shipping industry? There are pending legal as well as technical implications to these questions. The European courts, for example, recently expanded legislation relating to privacy of correspondence (BBC News, 3rd October, 2000). Once again it seems that legislation might be poised to influence developments in maritime communications.

2.2.7 Technologically Driven Vessel Control

Developments in communications and navigational systems are at the forefront of technological changes that are destined, either through voluntary adoption, or via legislative compulsion, to open up new opportunities for innovation at sea. These developments could, provided that an environment appropriate to the development of innovation exists, significantly enhance the opportunities for technological improvement of ancillary systems and processes as well. Furthermore, these systems and processes need not be confined to ships; an effective merging of shore and shipboard operations through what might be called an Ocean Wide Network (OWN) seems to be a logical progression. The advent of a shipboard Local Area Network (LAN) could change the entire system of ship operation. Linking such a network (via an OWN) to operations ashore could reduce the need for the constant exchange of messages between the ship and the shore. It could also provide opportunities for authorised third parties, such as freight agents and other customers, to obtain information through the network[32].

On the ship, instead of hard wiring all systems throughout the ship to the bridge, for example, a supervisory control and data acquisition (SCADA) system could be used so that any device could be monitored and controlled from any workstation on the network. A set of course and engine changes could be pre-programmed and the ship left to operate on full airline style autopilot. Instead of sending a message to the captain to ask some routine question, such as the estimated time of arrival in port, the office ashore could simply interrogate the appropriate device on the network. Although the technology to offer such capabilities exists, ships are not subject to routing controls like aircraft and regulatory authorities do not yet appear to be convinced that a fully automatic ship is safe. In circumstances where much of the world fleet operates on shoestring budgets, their concerns may be justified, but the seeds are planted.

In many of the world's oceans, over-fishing has almost wiped out certain species. Sophisticated electronic tools contributed to the 'success' of the fishing industry to the extent that when fish spot these electronic fish catching machines, they throw in the sponge and surrender. Recognising the problem, the Australian Government declared its intention to install the largest satellite based vessel monitoring system (VMS) in the world. Some 700 vessels fishing off the coast of Queensland will be constantly monitored in a bid to protect the world-renowned prawn fishing industry (INMARSAT, April 1999: 12).

Such systems could find other applications in the marine world. For example, in some parts of the world the threat of piracy still exists, and valid concerns about the threats of international terrorism to commercial shipping are regularly discussed in the media. For example, the front page article of a leading international shipping newspaper recently focused on the threat of a 'dirty bomb' directed at European ferries. In the same issue the newspaper also reported that it had made the whole subject of maritime security one of its highest priorities (Lloyds list, 12th November 2002). Threats such as these might, to some extent, be countered through the use of appropriate technology.

Monitoring and tracking ships at sea, in much the same way as aircraft are controlled in flight, might also be beneficial in terms of safety and could conceivably be incorporated into a more effective maritime distress and safety system. Such a system would effectively place some of the responsibility for the safety of vessels in the hands of traffic controllers ashore. Although the technology for such systems is already available, there seems to be resistance to its implementation. This resistance stems mainly from concerns over safety and reliability, the same concerns that acted as an effective defence against the perceived dangers of dumping Morse code in favour of modern communication systems in the early 1980s. These concerns delayed the introduction of a modern distress and safety system for almost twenty years, and the antidote, I suggest, once again lies dormant[33] in the domains of organisational culture, structure, and environment.

For some time, a safety and environmental lobby within the marine industry has been gathering momentum in favour of mandatory long distance voyage tracking and control of ships carrying dangerous cargoes (Lloyds list, 3rd May 1999). The proposed Vessel Traffic System (VTS) would operate in a similar manner to air traffic control. However, according to the same source, the International Maritime Organisation's (IMO's) Maritime Safety Committee (MSC) adopted a regulation on VTS that effectively rules out air-traffic control style direction of ships on the high seas. The VTS regulations confirm that 'governments may establish a VTS wherever they believe that the volume of traffic or degree of risk justifies it' - but they state that VTS may only be made mandatory within a state's territorial waters. This notion of shore-based vessel traffic control is anathema to most seafarers, but it is already taking shape in some of the busier European ports, not in the regulatory sense but as a *de facto* result of the pressure. Somebody has to sort out the queues and act as a gatekeeper, and that, increasingly, is becoming the role of the VTS. Some ports have already experimented with incentive schemes. Provided they agreed to be guided by the VTS, certain ships were excused the requirement to use a pilot to berth the ship (Compuship, Feb 1999). Using a pilot and the associated infrastructures is expensive and most ships' captains are only too willing to agree to such ideas. Safety and concern for the environment might have altruistic appeal but it seems to have a lot more clout when it is motivated by the interests of commerce.

The United States coast guard has already made the decision that automatic vessel identification will be an integral part of any VTS enhancement that it may implement. Automatic identification will enable the US authorities to limit spending on what they call 'expensive active surveillance capabilities' [they mean RADAR] (Compuship, Feb 1999). If governments choose to implement VTS within their territorial waters, it is almost certain that ships sailing within those waters will be required to install aircraft style transponders that can be interrogated by the VTS.

The maritime safety committee originally supported the notion of a 'black box' voyage data recording system on ships; but they were undecided about whether it should be mandatory or voluntary. The fact that no one had developed a black box for ships seemed irrelevant. The potential for shift towards the development of a more innovative culture within the maritime environment appears to be in danger of becoming bogged down by assumptions and postulations. Some of the regulatory bodies, for instance, seem to think that 'inventions' (such as 'black boxes' for ships) should be created through legislation, picked up from a corner shop's 'inventory', and transplanted into the marine environment. Without considering how such impositions might impact on parallel developments that may already be in the pipeline the industry could easily end up, once again, with technology that fails to live up to its expectations[34].

The concepts of VTS, technology supported branch-offices, and fail-safe navigational devices at sea are still in the embryonic stage. Theoretically such ideas appear to be sound, but they are unlikely to work without a full understanding of the cycle of activities between the ship and the shore. For example, there are still vast differentials in reporting procedures, shipboard activities, the authority of masters, and methods of operation. A serious source of antipathy for mariners is that information technology in the office is usually handled by the corporate IT department who know all about the tools, but little about the applications for which they are needed. Fleet managers know what applications they want to use aboard the ships but they may have difficulty keeping up to date with the technology available to support them. The problem arises when the fleet managers, wanting to make the best use of the expertise available to them, are faced with the refusal by the IT people to support anything that they have not chosen themselves. The outcome is that fleet managers may be compelled to implement whatever technology is determined as best for the shore office, on board the ships. Inevitably, these systems fail to live up to their expectations and are ultimately rejected.

According to Zuboff (1988), IT has one fundamental function that differentiates it from all previous technologies. Whilst it can be used to 'automate' it can also be employed to convert material practices into information, which can then be displayed in alternative formats. This means that it is feasible to send and receive routine messages automatically, and to integrate communication and navigation systems through an OWN. A whole new method of working at sea may eventually become inevitable as the quest for greater efficiency gathers momentum. Routine information, gathered from the various navigation devices and sensors on board the ship would reside on a computer that could be interrogated from the shore. But ship owners face a paradox. There are unprecedented opportunities to improve operational efficiencies, but to do so they must invest heavily in new equipment and training. Legislation forced them to install new safety and communications equipment but they face an enigmatic choice in the future. Should they retain only the minimum equipment demanded by the regulations, or would it be wiser to adopt a long-term strategy and upgrade the entire communication infrastructure that could even include automatic ship tracking?[35]

The 1990s heralded the trend towards Local Area Networks (LANs) on ships, but there was inevitable haggling and dissension between those hoping to successfully install the systems and those hoping to use them. Installing a network on a ship is easier said than done. For one thing, using normal electrical cables, or radio devices, to connect computers together does not always work. Electrical noise and radio frequency interference are serious problems on board ship and fibre-optic interconnection is usually the only option. Most major companies have already tried installing computers and LANs on ships. The problem was that the people who were experienced in installing computer networks did not understand the mechanics and implications of the marine environment and those who did had no knowledge of networking. As a result ship-owners burned their fingers. Many previously enthusiastic network supporters within the ranks of fleet managers now reject the entire concept outright. Today, despite the wide spread use and acceptance of local area networks ashore, there is still an inherent resistance to change in many sectors of the shipping community[36]. The insistence on the use of specific IT equipment and software by shore based IT departments renders transparent their almost arrogant disregard for the opinions of fleet managers and others who understand the practical problems inherent in the marine environment. The apparent lack of co-operation between those who understand shipping and those who understand networks continues to be a handicap to progress.

The final cog in the machinery of efficient and cost-effective data communications and navigation systems is on-board management. Regardless of technological developments the most important parameter in enabling a paradigm shift is people (Tapscott and Caston, 1993). Any change must be accepted by the end users to become effective. New navigational, communication, and management tools are to a large extent being imposed by regulations and in some ways this nautical *force majeure* is counter productive. It is diluting the opportunity for the new generation of mariners to have a voice in the development of maritime innovation. The concept of innovation might be an enigma to the traditionalists, but the technological developments, coupled with the ease with which the new breed of navigation officers learn to use them is beginning to filter through. Even staunch traditionalists are impressed and some are beginning to welcome the new technology, recognising at last that change and learning are the inevitable consequence of living in a competitive world[37].

Conclusion

The United Kingdom shipping industry, as demonstrated in the evidence presented here, is a key component in the national economy. In emphasising this importance I underlined its value as a vehicle through which many other industries conduct international trade. It is portrayed as an industry in transition; from dirty tramp steamers to efficient container vessels, from well-worn Morse keys to satellite communications, and from mystical sextants to GPS. Throughout the industry however, there appears to be a subliminal assumption that maintaining a course in the direction of tradition is a viable alternative to vigilance, flexibility, and awareness of the value of change.

In describing some of the moribund systems, assumptions, and viewpoints that still dominate large sections of the industry, I highlighted some of the consequences of such deep-rooted opinions. At the heart of these opinions lies the belief that the over-riding factor in deciding on whether or not to embrace a particular technological artefact or system is *reliability.* Whilst reliability *is* a vital consideration, it transpires that the process of reasoning that determines whether or not a system is reliable is flawed. Although some of the time worn technologies of the past were *perceived* as reliable, an examination that included cultural, structural, and environmental factors in the equation of reliability exposed their vulnerability.

The relatively recent introduction of GMDSS had the effect of forcing new technology onto a sceptical community but, to a large extent, this nautical scepticism has been further reinforced by reported problems with the new system. The extent of the scepticism appears to be widespread in the higher echelons of the shipping industry and with many senior navigators taking up management positions in shipping organisations' ashore, there are prospects of even further deterioration. The new breed of computer literate navigators entering the industry is unlikely to improve the situation unless the technological, cultural, structural and environmental aspects of innovation can be addressed and changed as a system. The ships are changing, the technological capability is in place, but there seems to be an inherent mistrust in its ability to deliver the kind of reliability that the captains of the shipping industry demand.

Change, I argued, may be influenced or triggered, by legislative intervention as well as through technology but unless the change is designed to accommodate the intrinsic organisational culture, structure and environmental conditions there is likely to be resistance. Regardless of the origin of interventions, the nature of technological developments, or the cultural diversity however, there seems to be little doubt that the imperative for change in the shipping industry is likely to increase. It is the organisational response to the demand for change, I suggest, that will ultimately determine the extent to which organisations benefit from opportunities that continue to arise.

Commercial ships might already have an opportunity to assume more active roles in the business of global transportation, but are UK ship owners and operators initiating change quickly enough to benefit from this? And how does the UK compare with other European shipping nations in terms of the speed at which it is able (or prepared) to change? Questions such as these continued to emerge throughout the chapter and influenced the context in which the empirical research would be conducted. By comparing perceived conditions in the shipping industry with the theoretical reviews of the literature I was able to identify and enunciate the questions that were most relevant to the research. They are:

1 Could the UK shipping industry stimulate inter-organisational cultures that are more conducive to innovation by capitalising on the recently improved communications infrastructure now available to the industry?

2 Would the development and implementation of new organisational forms influence such cultural change?

3 How could developments in communications and information systems assist shipping organisations and their clients to create network alliances designed to improve business relationships and capabilities?

4 Are there any significant differences between shipping organisations in the UK and those in the Netherlands in terms of organisational culture, environment, technology, or structure?

5 Are changes to policies and structures (if any) since the introduction of GMDSS occurring at the same rate in the Netherlands as they are in the UK?

6 How can technology help to improve the profitability of vessels and the learning opportunities available to their crews?

7 Taking potential competitive and technological developments into consideration, what kind of training would provide the optimum benefit to employers and employees in the industry?

8 How could such training best be delivered and evaluated?

Decisions concerning the type, scope, and capabilities of electronic communication and navigational systems fitted on board most commercial vessels have, to a large extent, been motivated by the legislative demands of GMDSS. Although this legislation is primarily concerned with communications from a *distress and safety* angle, its technological implications are such that *all* aspects of communication with ships at sea are likely to change. The focus of concern from an economic perspective is with *commercial* activities and it is therefore pertinent to establish the extent to which GMDSS technology might improve commercial communications. It is also necessary to establish whether, in the opinion of leaders in the industry, various business imperatives[38] could be more comprehensively addressed through extending the technological capabilities of on-board communications and navigational systems. The review presented here, and reinforced in later chapters, seems to suggest that:

1. For more than a hundred years the moribund communication and navigational systems used at sea have effectively isolated ships from the rapidly developing technologies that are characteristic in many shore based industries. This isolation has significantly influenced the managerial structures and policies within the shipping industry.

2. The mandatory introduction of GMDSS on 1st February 1999 compelled ship owners and operators to install relatively modern communication systems. This creates an opportunity for the industry to integrate more closely with the transport industry of which it is a part. Such integration would be economically beneficial.

3. In order to capitalise on this opportunity, fundamental organisational changes that match changing organisational structures ashore will need to be embraced, both by marine managers, and by ships' officers, who will ultimately need to acquire additional skills within a managerial discipline.

The following chapter focuses on research methodology. Its purpose is to explain the conceptual framework, evaluate various methodological alternatives that might be used to answer the research questions, provide a justification for the research methods employed and expound the rationale behind emerging theories.

Notes - Chapter Two

[1] Captain Pradeep Chawla, Training Manager of Anglo Eastern Group, Hong Kong, claimed that most of the providers of 'training material' to ships at sea are not providing the material that industry needs (Lloyds List Nov 5th 2001).

[2] Deadweight Tonnage.

[3] 'General' cargo ships are ships that are designed to carry various types of cargo in their holds. Much of this cargo could also be carried by modern 'container ships'. Container ships carry their cargo in large containers, which improves the efficiency of operations such as loading and unloading, thus reducing considerably the time that ships need to spend in port. To illustrate the changing nature of the shipping industry I have separated 'general cargo ships' from 'container ships'.

[4] An example of how container ships might provide improved services to customers through information and communication technology networks appears in chapter four.

[5] The responses received from the pilot studies detailed in chapter six show that a large number of small vessels rely on short range VHF radio, e-mail and mobile phones as their only means of communication.

[6] In any event perishable cargo such as fruit or meat products discharged from large ocean going vessels is more likely to be 'containerised' and to be transported to its destination by road or rail.

[7] Further details of the process used for selecting which organisations to address in the surveys are provided in chapter five.

[8] Radiotelephony is the term used when using radio for voice communication.

[9] In responding to questionnaires several respondents complained about lower reliability and excessive false alarms inherent in the new system.

[10] The term 'actor' as used here is not meant to imply a human actor in the conventional sense but is used in the context of 'Actor-network theory', which is further discussed in chapter four.

[11] Three distinct regions or layers have been identified in the ionosphere. These are known as the 'D' 'E' and 'F' layer. Most of the refraction of HF radio signals occurs in the 'F' layer. In summer the 'F' layer sometimes splits into two regions known as 'F1' and 'F2'

[12] Although the ionosphere does refract MF radio waves, the signals return to earth a short distance from their original source. In practical terms therefore only the ground wave is useful.

[13] Comments from the management team of an international ship owner when discussing the installation of GMDSS.

[14] This was the view of many people that I spoke to in the industry during the interview stage of this research.

[15] When responding to questionnaires, several respondents complained about various aspects of GMDSS. Mainly the complaints related to false alarms.

[16] The notion of paradigm shift is discussed in chapter four.

[17] The 'rime' of the ancient mariner (originally rhyme was spelled rime).

[18] On marine radar, sea clutter is the name given to specks caused by waves. Rain clutter refers to similar specks caused by precipitation.

[19] Anderson and King use the word '*exnovation*' to describe an innovation that has run its course and has become stale.

[20] Morse code messages need at least two skilled human 'interpreters' - one sending and one receiving. Other than ships' ROs and coast station operators the 'language' was barely understood by anyone in the industry. Although navigating officers received a basic training in Morse code for the purposes of visual signalling, very few could be considered 'fluent' and were rarely able to send or read radio signals at commercial speeds.

[21] John Masefield, British poet (1878 – 1967) 'I must down to the seas again, to the lonely sea and the sky, And all I ask is a tall ship, and a star to steer her by' (sometimes misquoted as 'I must *go* down to the *sea* again...)

[22] US Spelling.

[23] Computers, mobile phones, video machines and many other consumer items seem to focus on providing numerous functions and facilities, many of which are never used.

[24] Concerns raised during discussions with international ship owners, masters, and operators, suggests that total trust in one system is anathema to most navigators and that an appropriate 'back up system' of navigation is paramount.

[25] This view has been expressed repeatedly during discussions with the navigators on vessels ranging from small fishing boats and coasters to 'super-tankers' (very large crude oil carriers - VLCCs)

[26] Clockwork course recorders linked to mechanical gyro compasses are still being installed as standard equipment, even on some new vessels.

[27] A mechanical speed log often consists of nothing more than a piece of wire with an impeller on the end. As the ship moves, the impeller turns providing an electrical output that is proportional to the ship's speed. This device measures the ship's speed through the water but does not take account of factors such as tide and current.

[28] The four ocean regions are: Atlantic East, Atlantic West, Pacific, and Indian. Together these four regions cover most of the earth. The Geostationary satellites cannot be used at latitudes higher than about 75 degrees (close to the poles).

[29] Typically $20,000 to $30,000 for INMARSAT 'A' or 'B' and $7,000 for INMARSAT C systems; INMARSAT 'E' (EPIRBs) normally cost less than $1,000 but cannot be used for commercial communications.

[30] Iridium PLC announced the end of commercial service after 11:59 p.m. (EST-USA) March 17, 2000.

[31] Iridium originally planned to launch 77 satellites. (The element iridium has the atomic number 77, hence the name of the company)

[32] I will discuss this subject more fully in chapter four.

[33] In using the word 'dormant' here I am suggesting that these factors - organisational culture, structure, and the environment - need to be addressed systemically. .

[34] GMDSS is just one example of technology that is failing to live up to expectations

[35] For further information see 'Shipping World & Ship Builder' March 1999: 21 and 'Motor Ship' March 1999: 28.

[36] Information received during discussions with a major international ship-owner in South Africa.

[37] ibid.

[38] Such as the integration of customers and suppliers, crew and officer training, or improved efficiency in operational or administrative matters.

Chapter Three

Research Methodology

Introduction

The shipping industry is renowned for its inherent 'traditions' and the 'traditions of the sea' appear to have infected many shipping organisations ashore. It's not surprising; many such organisations recruit their senior managers from the ranks of ex-captains or chief engineers who are 'promoted' to shore-based management positions when they decide to leave the sea. The ivory tower mentalities and pyramid shaped organisational structures that worked so well for generations of seafarers are ubiquitous in the shipping industry but, as I intend to demonstrate later, such structures are not appropriate to the promotion of innovation.

Flexibility - the desire, and the ability, to learn, to relearn, and to change in response to changing economic circumstances - appears to be a prerequisite to advancing the capability, the acceptability, and the reliability of many of the products, services, and processes that twenty-first century organisations seek to deliver.

The review presented chapter two suggests that the UK shipping industry is far from flexible, but is it realistic to suggest that the industry could deviate from its current 'risk aversive' course and steer its recently acquired technological resources in the direction of change without compromising safety?

A fundamental imperative of this research is to discover whether the prevailing structures and cultures are preventing shipping organisations from adopting, or adapting, new technologies as potential solutions to some of the problems that they face. Could the UK shipping industry, for instance, really take evasive action against a growing armada of international competitors by overhauling its cultural, technological and environmental infrastructures? Questions such as these continued to emerge during the literature reviews and served as a vehicle for supporting and refining the definitive research questions set out in the conclusion of the previous chapter.

3.1 Conceptual Framework.

Following a preliminary review of the some of the innovation literature it became apparent that an appropriate framework for research into innovation in the shipping industry could develop from a number of different disciplinary bases.

The innovation literature is both large and varied and it was necessary to consider the pertinence of various narratives, statistics, models, and seminars, to the overall perspective being taken. I therefore defined explicit criteria that would be used as a guide to assessing the relevance of previous work.

Much of the literature on innovation focuses on the manufacturing industry and upon the development of new products. Although some of the information available within these resources may be applicable to the shipping industry, the vast majority of material pertaining to product development appears to be peripheral to this study.

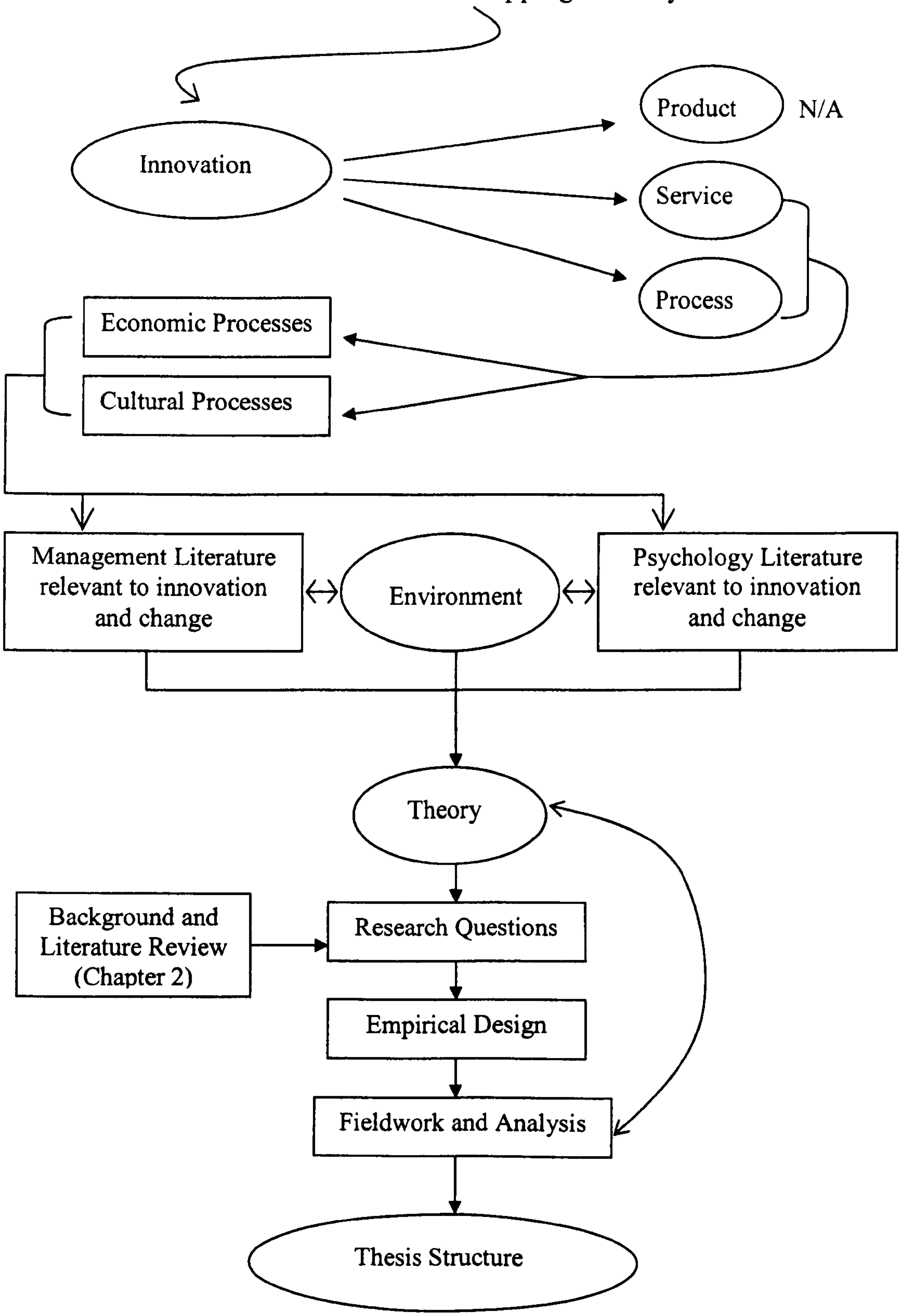
A further innovation literature base is concerned with the economics of innovation from a service industry or manufacturing perspective. The data contained in much of this literature has been gathered through specific case studies involving (mainly) large manufacturing or service organisations. Even when the business of the organisations being studied appeared to be related to the shipping industry[1] there seemed to be a fundamental tension between the cultural, technological and environmental factors existing in the shipping community and that existing in similar industries ashore. It was necessary to get to grips with how these cultures developed, and more importantly, how they could develop in the future.

I therefore decided that literature that was concerned with organisational culture relative to innovation and change in service organisations, and with the psychological aspects of the sub-discipline, would be particularly relevant. This is not meant to imply that *all* material falling outside of these boundaries has been ignored - but setting the boundaries was an essential prelude to defining and maintaining an appropriate focus.

Even with the benefit of such a focus however, the theories and ideas emerging from apparently relevant literature do not always seem to be appropriate to the environmental conditions within the shipping industry. Many shipping organisations currently rely on structures that focus on formal rules, common principles, assignment of responsibilities and the specialisation of functions - principles that emerged during the early part of the last century[2]. Clearly theories related to the emergence of these structures are relevant, as are many of the subsequent developments in management thinking. It was however, necessary to consider these theories and principles in the context of their relationship to the marine environment.

Figure 3.1 depicts the conceptual framework for the research, sets out the criteria discussed above, and illustrates how the framework relates to the development of the thesis through an appropriate synthesis of previous theories and empirical work.

Figure 3.1
Innovation in the Shipping Industry



As illustrated in the diagram, from an innovation perspective, the shipping industry is seen primarily as a service organisation, which implies that literature pertaining to innovation in service organisations is particularly relevant. This literature base, however, can be identified as falling into one of two broad areas; operational innovation and process innovation. This research focuses mainly on innovation process in service organisations and makes comparisons between innovations that are occurring in such organisations ashore, and the conditions prevailing in the UK shipping industry.

The relevant literature on process innovation is concerned with both economic processes, which reside mainly in the domain of management, and with cultural processes, that are more concerned with the psychological aspects of innovation and change.

By relating some of the theories in this literature base to environmental conditions in the shipping industry, I was able to begin to develop industry relevant theories and hypotheses that could be tested through empirical research. The diagram also shows how the research questions emerging from the preliminary literature review were refined through the ongoing development of these theories and hypotheses.

3.2 Evaluating Methodological Alternatives.

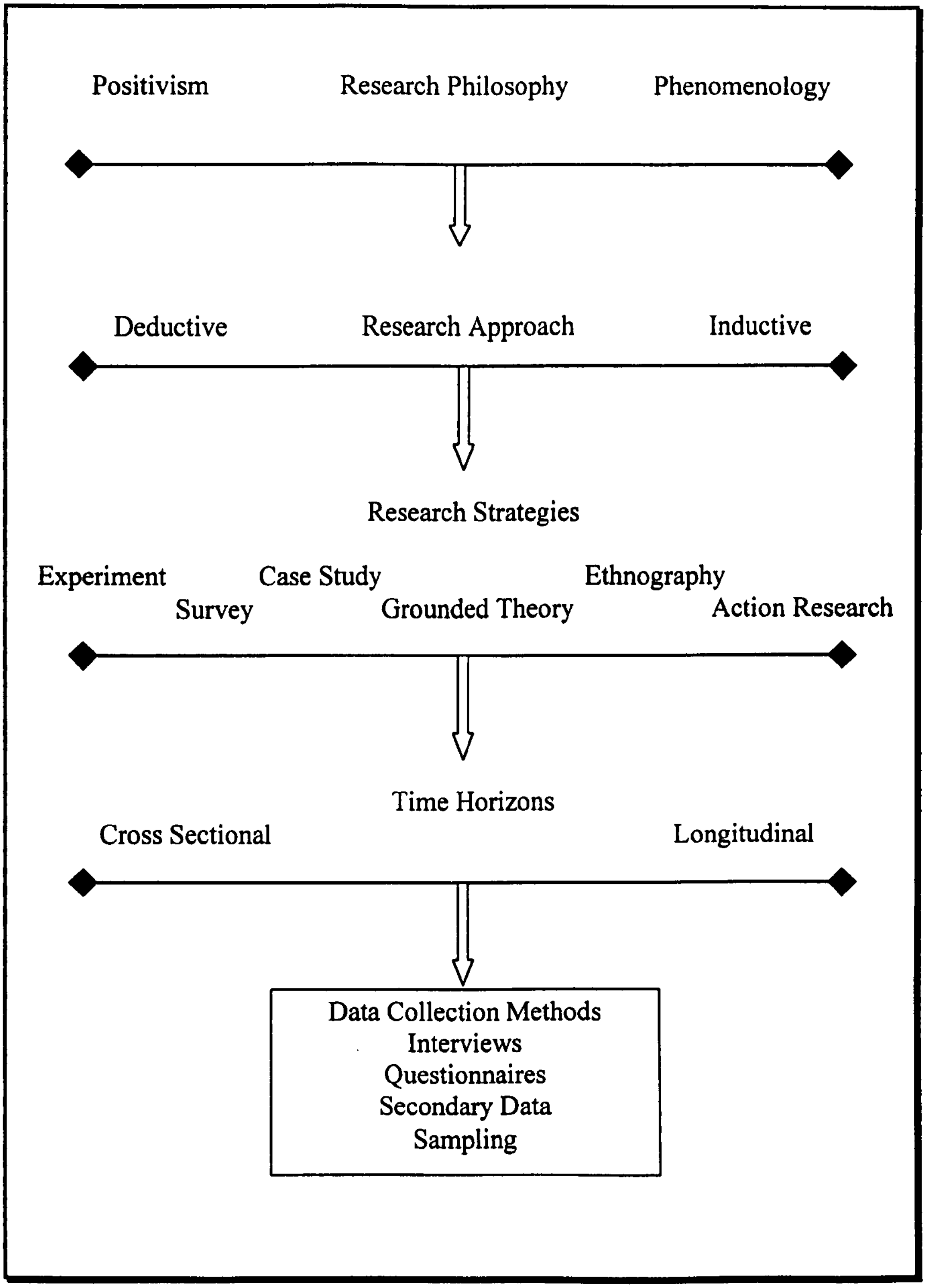
In deciding on an appropriate methodological design, the main considerations were whether or not the chosen design would be the most appropriate way of answering the research questions. An equally important consideration, however, lay in establishing whether, and how, these questions could be answered in a manner that was entirely objective. Whilst these imperatives dominated the methodological design I was also conscious of the need to ensure that the work could be completed within the normal time-frame for Ph.D. research.

The research literature distinguishes two main philosophical views pertaining to the research process - positivism and phenomenology[3]. Positivism reflects a view that the research outcome can be totally objective and unemotional. Adopting such a philosophical view would imply favouring a highly structured quantifiable methodology to favour replication (Gill and Johnson, 1997). A Phenomenological viewpoint, on the other hand, considers that the complex social world of business and management does not lend itself to such rigid structures. A basic diagram of the research process, which was used to evaluate various methodological alternatives, is shown in Figure 3.2.

From a purely technological perspective I might have maintained a positivistic bias; however, in dealing with organisational, cultural, and environmental issues in the shipping industry, I would have been extremely wary of assuming that 'the end product of such research can be law-like generalisations' as suggested by Remenyi, Williams, Money, and Swartz (1998: 32).

Although I was inclined to favour the collection of some form of quantifiable data, which implies a deductive research approach, I also recognised that a certain degree of subjectivity might be inevitable. This is because collecting industry relevant data implied asking questions, and, regardless of the format of these questions the responses would (mainly) be the opinions of respondents - not veritable facts.

Figure 3.2
The Research Process



(Adapted from Saunders, Lewis, and Thornhill, 2000: 85)

The research questions seek to discover the extent to which organisational cultures, organisational structures, and technological developments, have influenced the shipping industry's ability and motivation to innovate. A detailed examination of some of the socio-technical issues (the apparent resistance to technological innovation, for instance) that this would involve, demanded that the research philosophy and the research approach be tailored to suit an appropriate research strategy.

For example, according to Schein (1992), in order to understand organisational culture it is necessary to discover the underlying assumptions that influence how members of an organisation think and feel about issues. Adopting a phenomenological standpoint, I reasoned, might be appropriate in such circumstances. However, before committing to a particular research philosophy I needed to define a research approach that would be compatible with the information that I could realistically expect to gather about the industry, and its relevance to the research questions.

A deductive research approach (the dominant approach in the natural sciences) 'involves the development of a theory that is subjected to a rigorous test' (Saunders, Lewis and Thornhill (2000: 87). At the opposite end of a continuum, the inductive approach is more concerned with the context in which events are taking place (*ibid*: 89).

Although some of the socio-technical issues might have provided a motivation to adopt an inductive approach there were further issues, such as the research strategies, time horizons, and data collection matters that would inevitably impact on the final decision.

Saunders, Lewis and Thornhill, (2000: 93-98) talk about six alternative research strategies:

- Experiment
- Survey
- Case Study
- Grounded Theory
- Ethnography
- Action research

Although an experimental strategy may be applicable in the psychological arena, and hence may have been useful in uncovering cultural biases in the shipping industry, there would have been practical difficulties in gaining access to conduct such tests. In any event it would inevitably have meant a significant shift in the research focus. For example, instead of focusing on the socio-technical aspects of innovation, and the organisational change literature, I would have been more concerned with cognitive issues in organisations. This would have resulted in a weaker research outcome because it would have been neglecting a major source of potential innovation available to the shipping industry - the availability of entirely different technology to that which was common to the industry a few years ago.

The survey method, in which I planned to collect data through postal surveys by asking senior managers, many of whom are ex ships' captains, to respond to questionnaires, offered an opportunity to gather relevant information without asking the organisations to commit too much time to answering questions. It also allowed me to maintain a certain measure of control over the timing of the research process.

On the other hand, there was a certain element of risk. I would need to spend time carefully phrasing the questions so that they would reveal *underlying* information. It would, I decided, be unwise to ask 'direct' questions pertaining to organisational culture or management styles (autocratic, democratic and so on). This is because, having been associated with shipping organisations for many years, I was doubtful that such direct questions would be answered truthfully, if at all.

According to Saunders, Lewis and Thornhill, the survey method is usually associated with a deductive research approach and I was not entirely convinced that it would be possible to uncover cultural aspects, such as subliminal biases, or attitudes to change, using an entirely deductive approach. For example, I did not think that it would be possible to measure attitude through a statistical test without supporting the analysis with some form of inductive reasoning. It follows that although the data collection method would be based primarily on postal surveys, the research approach would be both deductive and inductive.

A case study (Robson 1993: 40) was also considered. However, from the perspective of this research there were two major disadvantages. Firstly, to obtain the data I needed would have probably meant carrying out numerous case studies; it would not have been possible to complete such work within the time frame of normal Ph.D. research. I would therefore have had to rely on only one (or two) organisations on which to base the research findings; I would have had to make assumptions about the industry as a whole that I would have no way of confirming. Even if, for example, I uncovered certain cultural traits in one or two companies, how would I know that these traits existed throughout the industry?

Secondly, there was the question of access. Although I was fairly confident that I would receive a reasonable response rate to postal questionnaires, I felt that, even if I did gain access to shipping organisations, I would be unlikely to gather direct information pertaining to innovation resistance (culture), attitudes to (pyramid) hierarchical structures at sea, or technological biases, without alienating some members of the organisation.

Grounded theory (Strauss and Corbin, 1997) is an inductive approach in which theoretical predictions are developed from data that is generated mainly through observation. It involves the making of comparisons between similar incidents in the data as a means of determining appropriate conceptual labels, and asking pertinent questions relative to the category to which phenomenon in the data might belong.

Although I considered the exclusive use of grounded theory as a research strategy I was concerned that, just as in relying on case studies, I would have had to become involved in asking pertinent questions that were directly related to cultures, structures and technological biases. Nevertheless, the strategy did seem to offer potential as a means of confirming what postal surveys might reveal and it could therefore be used to complement a survey method. Since I decided to use some of the principles of grounded theory for the analysis of supplementary qualitative data I will discuss the strategy more fully in section 3.4. The detail of how it was incorporated in the research design appears in chapter five.

Ethnography involves collecting primary data through what Gill and Johnson (1997: 113) call 'participant observation'. It implies a research strategy of 'immersion in the research setting, with the objective of sharing in peoples lives while attempting to learn from their symbolic world' (Delbridge and Kirkpatrick, (1994: 37). This strategy was rejected for the same reasons as those of case studies.

Action Research is a three-step spiral process of planning, which involves reconnaissance, taking actions, and fact-finding about the results of the action (Lewin, 1946). It differs from other forms of applied research because of its explicit focus on action, in particular promoting change within organisations (Marsick and Watkins, 1997). It is 'concerned with solving concrete problems in real situations, and trying to further the goals of science' (Robson, 1997: 60). None of these definitions were particularly helpful in defining how action research might be used as a vehicle for addressing this research agenda. I was in any event somewhat concerned about some of the criticisms in the literature. For example, in discussing Cohen and Manion's (1989) paper on research methods in education, Robson (1997) draws attention to the fallibility of at least fifty action research projects in which the research 'contributed almost nothing to knowledge of the factors that influence the learning process in the classroom' (Robson 1997: 439). In the light of the apparent risks to the outcome of this (relatively) short term research project therefore, I decided to focus on a more traditional methodology.

I also had to decide upon the time horizons - should I focus on a longitudinal, or a cross sectional study? In re-examining the research questions I decided that a longitudinal study would be ineffective, since I would be attempting to measure the situation in the industry at a specific point in time - now - and then looking at how it might develop in the future. If I had been aiming to measure how quickly (or slowly) the industry might be changing, a longitudinal study would probably have been a good choice. However, in this instance, a cross sectional survey - a snapshot of the current status within the industry - seemed more appropriate. I therefore decided that the required data could best be obtained through a questionnaire survey involving a representative sample of UK shipping organisations. The method for deciding which shipping organisations to target is detailed in chapter five.

When considering how the questionnaires might be designed it became evident that data generated through a postal survey may not be completely objective. This was mainly because most of the questions would be designed to examine whether the shipping industry would benefit from cultural, structural, and environmental changes and whether resistance to such change was hampering the industry's opportunities for innovation. As explained earlier, the questionnaires would have to be designed to provide relevant data without asking direct questions. Even then, the respondents' answers to the questions would subjective opinions, rather than objective facts. In view of the potential for misinterpretation of a single method, I therefore decided that it would be pertinent to use multiple methods to reduce the likelihood of drawing inappropriate conclusions. In emphasising the virtues of multi-methods, for example, Robson (1997) says, '...it is often possible to devote a small fraction of your effort to a complementary method... an unstructured interview session ...linked to a questionnaire survey' (Robson, 1997: 304).

I also recognised that the levels of measurable data that would be generated through the questionnaires would be essentially nominal (categorical) or ordinal (Tukey, 1977: Siegel and Castellan, 1988). Creating unnecessary complexity in the questions in an attempt to obtain higher levels of data (interval or ratio level) would, however, have been likely to confuse the intended respondents. In any event, the subjective nature of the responses would not change and the analytical precision would therefore not be improved. Positivistic approaches - deducing fact by testing generated hypotheses - did not seem to be wholly appropriate to this investigation into the synthesis of the psychological, social and technological phenomenon that appears to be preceding an imminent paradigm shift in the shipping industry.

The desirability to complement quantitative methods by harnessing a range of qualitative techniques is becoming increasingly fashionable in the social science arena (Cassell and Symon, 1994). It would clearly be of value in addressing the research questions.

3.3 Triangulation

As discussed in section 3.2, a research design that relied exclusively on the analysis of quantitative data would have been tantamount to attempting to deduce facts from subjective responses. No matter how rigorous the design criteria, the data that could be obtained through a questionnaire survey might not be sufficiently objective, or of an appropriate level to justify the use of a single analytical technique on which to base conclusions. I therefore decided to examine the concept of multiple methods with a view to adding substance to the methodological design.

According to Colin Robson, 'the main advantage of employing multiple methods is commonly cited as permitting *triangulation*' (Robson, 1997: 290). At sea, triangulation is a frequently used method of fixing a position by taking bearings on two or more different objects (measuring relative angles between the ship and these objects). Denzin (1988) suggested that by using two or more different data sources, methods, investigators, or theories, the triangulation method might also be useful in social research.

By employing a single method, Robson argues, 'some unknown part, or aspect of the results obtained is attributable to the method used' (Robson 1997: 290). It seemed to make sense therefore, to employ at least two different methods in order to address the potential deficiencies of a single method.

Not unexpectedly, however, there are critics of such approaches. Blaikie (1991) for example, argues that it is inappropriate to combine methods based on different theoretical positions. Blaikie's concerns might have alerted me to potential problems had I intended focussing on an entirely qualitative methodology in which competing theories might have blurred interpretation of the analysis. However, as Robson points out, 'in a primarily quantitative study, the interpretation of statistical analyses may be enhanced by a qualitative narrative account.' (Robson 1997: 291) Robson goes on to say 'you need not be a prisoner of a particular method or technique when carrying out an enquiry' (*ibid*). It is with this reassurance that I decided to make use of a qualitative method to complement the quantitative data analysis.

3.4 The Qualitative Imperative

In elaborating upon the basic groupings of qualitative analysis articulated by Crabtree and Miller (1992), Robson (2002) highlights the various degrees of formal structure inherent in alternative approaches to qualitative analysis (Robson, 2002: 458).

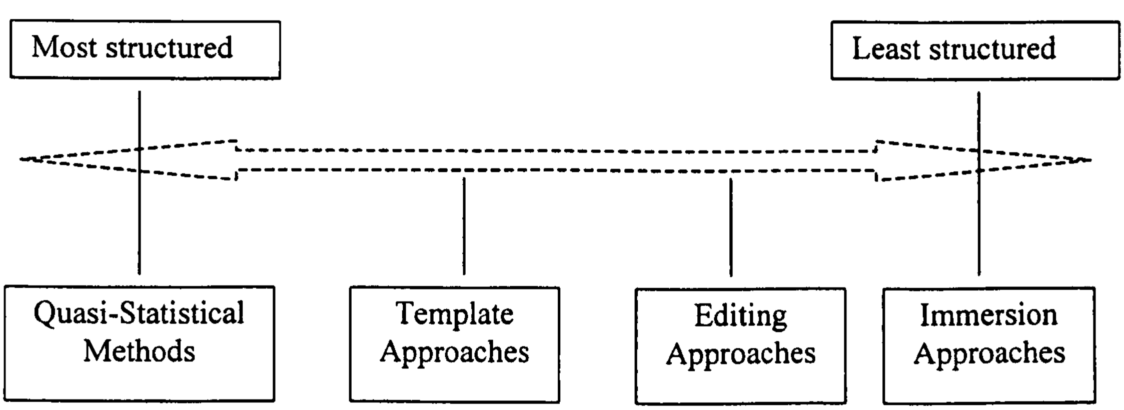
Robson argues that 'Quasi-Statistical approaches' rely largely on the conversion of qualitative data into a quantitative format. The analysis of word or phrase frequencies and inter-correlations are used to determine the relative importance of terms and concepts. Such an approach is typified by 'content analysis' and can, he suggests, be 'readily adapted for use in the analysis of qualitative interview and questionnaire data' (Robson, 2002: 351).

The reliability and the validity of findings analysed by quantitative methods could, I reasoned, be enhanced if supporting data, which could then be analysed using an alternative technique, were obtained. This would act as a check mechanism enabling any analytical errors to manifest themselves before conclusions were drawn.

The most appropriate way to obtain the supplementary data, I decided, would be to conduct semi-structured interviews with ships' captains, navigating officers and shore-based managers within the industry.

As alternatives to the quasi-statistical approach, Robson talks about the 'Template Approach', the 'Editing Approach', and the 'Immersion Approach, to qualitative data analysis. In his discussion Robson suggests that these approaches lie on a continuum ranging from more to less structured as illustrated in figure 3.3.

Figure 3.3
The Varying Degrees of Formal Structure in Alternative Methods of Qualitative Data Analysis.



(Adapted from the narrative of Robson 2002: 457)

Immersion approaches focus mainly upon the researcher's insight and intuition and are therefore the least structured of the four analytical techniques. The exclusive reliance on such a method for the analysis of qualitative data would, I believe, have resulted in even more subjective conclusions than previously discussed. According to Robson, for instance, such methods are 'close to literary/artistic interpretation and connoisseurship - calling for expert knowledge and targeted at a similarly skilled audience'. They are, he claims 'difficult to reconcile with the scientific approach' (Robson, 2002: 458).

Although my target audience is 'skilled' and perfectly capable of expressing opinions pertaining to shipping matters, that does not change the levels of subjectivity that would be inherent in employing this method. I am not claiming that subjectivity *per se* is 'bad'; indeed one could argue that it is an inescapable trait in humans, but I wanted to try to separate the personal biases of respondents from the opinions within the industry as a whole.

In the 'template' method, key codes are determined on an *a priory* basis, for example, from research questions, or from theory. The codes then act as templates for the data analysis; the templates can change as the analysis progresses. Typically, relevant text segments are identified and supplemented by matrices, network maps, flow charts, and diagrams.

I was concerned that this method, although somewhat more structured, and therefore potentially more 'scientific' than an editing approach, could have created more confusion than clarity when used in conjunction with a quantitative approach. I believed that using a qualitative method that was relatively close to the quantitative analysis that I planned to use would have been tantamount to using similar methods, and that, when analysed, the two methods might create different results. As Robson (1997: 290) points out, 'we should choose methods which are very different from each other to get a better estimate of *the* answer'. If I had used a template qualitative method with a quantitative study, it might have been difficult to determine which outcome of the analysis was likely to be the more feasible. Employing a more 'interpretative' approach to understanding the meanings and patterns in qualitative data, would, I reasoned, also enable me take account of the extent to which the respondents' subjectivity might be influencing the analysis.

The 'editing' approach is more interpretive, and more flexible, than the template method, in that codes are based on the researcher's interpretation of the meanings of patterns in the text. Since this method was chosen for subsequent 'supportive analysis' of the interviews, and the theoretical data emerging from the literature reviews, I will describe in greater detail how this 'grounded theory' (Strauss and Corbin, 1997) method was applied when describing the data analysis in chapter six.

Of course, there are numerous methods that could have been employed for the analysis of data derived from narrative and discussion. Tesch, for example, lists no less than forty-six alternative qualitative techniques - although these have been condensed into four basic groupings (Tesch, 1990: 58). These are:

- Characteristics of Language.
- Discovery of Regularities.
- Comprehension of the meaning of text.
- Reflection.

By making use of the 'editing' approach mentioned above, however, I would be able to focus on identifying central phenomena, exploring causal conditions, specifying strategies, identifying intervening conditions, and outlining the consequences of strategic choices. The ultimate outcome of this process, should, according to Strauss and Corbin (1998), result in a 'substantive-level theory relevant to the specific problem'.

Conclusion.

The unique cultural, organisational, and environmental characteristics in the shipping industry demanded a unique methodological approach to its analysis. The UK shipping industry comprises a diverse range of organisations, not all of which are relevant to this study.

Whilst the bulk of the empirical evidence will emerge from the statistical analysis of the research questions, I argued that a hybrid approach - using both quantitative and qualitative analytical techniques - would add substance to the research findings.

It is also imperative to ensure that the theories and critiques developed through the literature reviews (presented in chapters two and four) are appropriately linked to the industrial developments being discussed. The hybrid methodological design accommodates this imperative.

In presenting an overview of the proposed methodology I provided the rationale behind various choices. I recognise, however, that specific detail pertaining to the tests and procedures employed in gathering empirical evidence is an essential ingredient in establishing the validity, reliability and repeatability of the findings. Such detail is provided in chapter five where I provide the rationale for, and explain, the details of, the primary research design.

Notes Chapter Three

[1] The road transport and the air freight industries, for example, could be considered as having similar business objectives to the shipping industry since their main concern is also with moving goods between points a and b. Structural, cultural and environmental conditions in such organisations may however be entirely different.

[2] The multi-level hierarchical structure, which originally emerged from the work of Taylor and his followers in 1919, is discussed briefly in chapter four.

[3] Robson (1997: 59) lists a number of different labels for what he calls these 'very different paradigm[s]'. These are: 'post positivistic', 'ethnographic', 'phenomenological', 'subjective', 'hermeneutic', 'humanistic', and 'naturalistic'. 'This,' Robson says, 'is not to suggest that their aficionados would accept the interchangeability of these labels'.

Chapter Four

Theoretical Framework

Introduction

In the world of international shipping, legislative force, rather than altruistic motives, have been the main drivers of environmental change, but when recent safety at sea legislation virtually forced owners to think 'hi-tech', it inadvertently rocked the boat in more ways than one. The course of an entire industry changed and a new culture that would have been inconceivable a few years ago is beginning to emerge. But cultural change, no matter how desirable that might appear to be, does not happen in isolation; it impacts on, and is influenced by, changes in technology, organisational structure, and the environment. Change, I will argue, should be viewed as an holistic phenomenon; the interrelationship between emerging technologies, organisational structure, organisational culture, and the environment, determines the extent to which the motivation to change is driven or restrained.

From a technological perspective, modern communication and navigational systems should reduce the workload of ships' officers but intense commercial pressure is encouraging ship-owners and managers to exploit the financial opportunities. They frequently see new technology only as a way to reduce costs by cutting staff levels at sea. Technology presents new ways to communicate, navigate, and manage and organisations seize the opportunity to cut their operating budgets. The increased demands that are placed on remaining ships' staff make even more hi-tech gizmos virtually indispensable - *ad infinitum* - it's a perpetual spiral. Navigation officers are being compelled to learn about complex electronic systems, the technicalities of which are not in their domain, and the technological changes are occurring faster than at any time in maritime history.

With the recent developments in satellite technology the concept of an 'office at sea', a virtual extension of an integrated shore based network, is no longer a pipe dream but a *fait accompli.* Instigated by *avant-garde* legislators and supported by factory fresh technological capabilities and motivations, the new technology is on course to transform marine navigation and communication developments beyond recognition.

The advance in technology is encouraging an increasing number of companies ashore to devise radically different corporate structures as they contrive to outmanoeuvre their competitors by forming alliances with innovation. Such ideas and concepts have already revolutionised the industrial landscape ashore, mostly with positive results. Inviting them aboard the British merchant fleet may well be a positive strategy, but there are dangers.

The technological dinosaurs that I talked about in chapter two may be an endangered species, but their gradual demise is giving way to a new phenomenon that Edward Lawler (2000: 259) calls 'corporate anorexia'. It results from the perceived benefits of corporate downsizing. Leaner, more efficient organisations enjoy lower costs and, in the short term, higher profit. The danger is that some companies seem to have assumed that more of the same medicine will produce even better results. As Lawler points out, 'at some point... an organisation needs to begin to gain a competitive advantage because of the improvements it has made in quality and innovation' (*ibid*: 260). Clearly, organisations need to recognise the optimum point in their downsizing operations - the point at which further downsizing will have a negative impact on quality and innovation.

The technological dinosaurs, effectively camouflaged to take on an image of contemporary communication and navigation instruments, contrived to create conditions in which seafarers were effectively isolated from most of the developments that were occurring ashore. This isolation, I suggest, had a significant influence on the industrial culture and on its perceptions about innovation and change.

In the previous chapter I defined a framework through which the processes that influence innovation in the UK shipping industry were being investigated. Here I am concerned with exploring relevant literature, commenting on its theoretical implications to innovation, and showing how various theories relate to environmental conditions in the shipping industry. The two broad disciplinary areas on which I focus my theoretical framework (explicit in chapter three figure 3.1) are:

- Management literature relevant to innovation and change and
- Psychology literature relevant to innovation and change.

The research questions seek to discover the extent to which recent technological developments might align with alternative organisational structures, organisational cultures, and environmental conditions to positively influence the shipping industry's ability and motivation to innovate. Within the broad disciplinary areas highlighted above therefore, my main concern is with theories that relate to one or more of these factors.

The theoretical arguments emphasise how the assumptions and norms of the existing paradigm in the UK shipping industry are inappropriate to innovation. But, I will argue, kick starting a new paradigm in which the industry could benefit from its improving technological capabilities will demand knowledge of, and attention to, the dynamic relationships between technology, organisational structure, organisational culture and the marine environment.

4.1 Innovation from a Management Perspective.

The realisation that management thinking in organisations was due for a major overhaul occurred over ninety years ago with the publication of Taylor's revolutionary scientific approach to management (Taylor, 1911). It took much longer for organisations to realise that this model might need a regular tune up.

Taylor and his followers[1] developed and extended the scientific approach, setting the scene for the development of theories that focussed on formal rules, common principles, assignment of responsibilities and the specialisation of functions. Ideas drawn from the work of Henri Fayol (1916) and Max Weber (1947) helped to expand Taylor's ideas, leading ultimately to the multilevel hierarchy, a structure that still characterises many organisations in the shipping industry.

During an era when sending a message in a bottle was the only alternative to relying on a well oiled Morse key as the instrument of dialogue, there might have been sound reasons for maintaining such a structure. From navigational and safety aspects an authoritarian system may still be desirable at sea, but from a commercial perspective the fashion is increasingly to allow business to be driven by the real captains of industry - the customers. What I am highlighting here is that changing circumstances, resulting mainly from developments in maritime communications, have created the need for different organisational structures and functions at sea.

The challenge then is to design an appropriate model of organisational structure that will enable the shipping industry to embrace the concepts and ideas of innovation without compromising safety at sea. Formulating such a model, however, no matter how potent it might turn out to be, would not compensate for the inherent mistrust of anything that is not traditional. An even greater challenge lies in understanding how political and cultural factors within the shipping industry have germinated and matured, and how they might be modified to align with the concepts of innovation and change. That implies delving into the complexity of human behaviour and the interaction between the human and mechanical aspects of technology.

As far back as 1942, Mary Parker-Follett did just that. Her way of thinking was probably the fertiliser for the growth of both the human relations and the systems approaches to management (Mayo, 1945). By the mid 1950s human behaviour theorists such as McGregor (1960) and Maslow (1954) had made significant contributions to the theories of leadership, motivation and organisational design.

Outlining two alternatives that he called 'Theory X' and 'Theory Y', McGregor suggested that managers subscribing to the former believe that most workers lack ambition, are self-centred, and indifferent to the needs of the organisation. 'Theory Y' asserts that most individuals can be relied upon to put maximum effort into their activities and want more rather than less responsibility. The dominant organisational structure at sea where the captain, as head of an ocean going pyramid organisation, expects subordinates to follow orders without question suggests that 'Theory X' continues to dominate the management structures of this (major) sector of the shipping industry.

By the end of the decade the concepts of Total Quality Management (TQM) (Deming, 1988; Juran, 1988) were, to some extent, being adopted in some sections of the shipping industry. In particular, explicit 'mission statements' in which customer service was promoted to the highest rank suggested, at least implicitly, that change was on the horizon. Concepts and processes such as TQM may (or may not) be regarded as innovative, but it would be illogical to imagine that simply *using* an innovative product or process would result in an innovative output. The point I am making is that creating a climate that is *conducive to innovation* is not the same as creating a climate that might be *regarded as innovative*. The former may be more difficult, but also much more effective, and it almost certainly begins with management thinking in terms of 'Theory Y' or one of its derivatives. It will probably culminate in a paradigm shift.

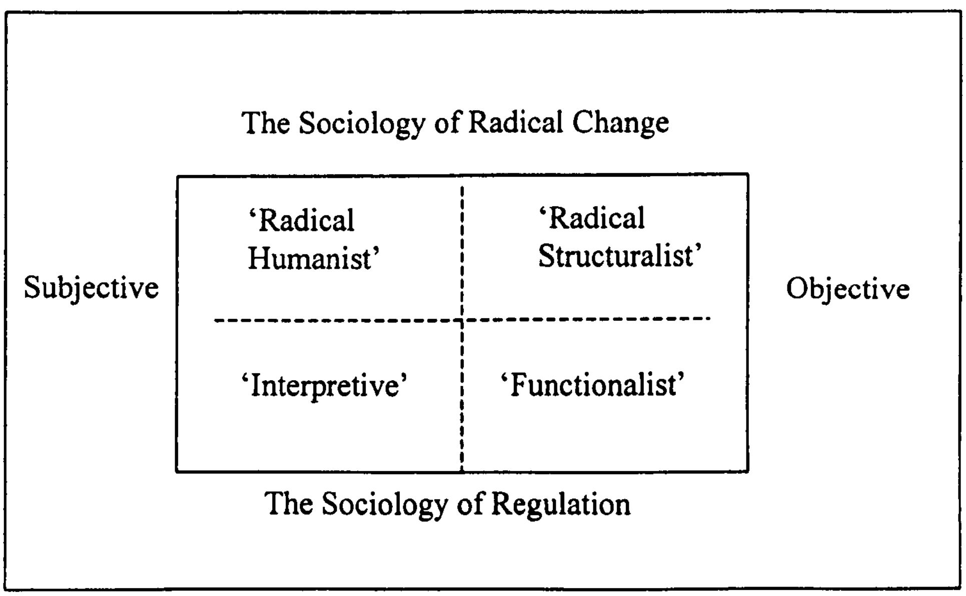
4.1.1 Paradigm Shift.

Most dictionaries define a paradigm as a basic theory, or a conceptual framework within which scientific theories are constructed but this definition is evolving. The term is now widely used to define a broad model, a framework, a schema for understanding reality, or a way of thinking. Psychologists talk about reinforcement paradigms, politicians quibble about political paradigms, doctors debate paradigm shifts in medicine, and so on (Ferguson, 1976).

Burrell and Morgan (1979) present the notion of four alternative paradigms of organisational analysis that are differentiated by assumptions made about social science and society. They oppose the concept that only one approach is scientific and argue in favour of both 'subjectivist' and 'objectivist' philosophies of science. They claim that 'consensus' and 'conflict' theories of society are equally valid and by combining philosophies of science with theories of society suggested four distinctive paradigms.

Assumptions about the nature of science can, according to Burrell and Morgan, be analysed in terms of the 'subjective - objective' dimension, and assumptions about the nature of society in terms of the 'radical change - regulation' dimension. These two dimensions can be expressed in terms of the four sociological paradigms, which relate to each other as illustrated in figure 4.1.

Figure 4.1
Four Paradigms for the Analysis of Social Theory



(Source: Burrell and Morgan 1979: 22)

The four paradigms provide a frame of reference - alternative views of social reality - each view based on opposing assumptions. Acceptance of the assumptions of one paradigm implies rejection of all the others so that choosing a particular paradigm is tantamount to setting the boundaries of the subject under analysis.

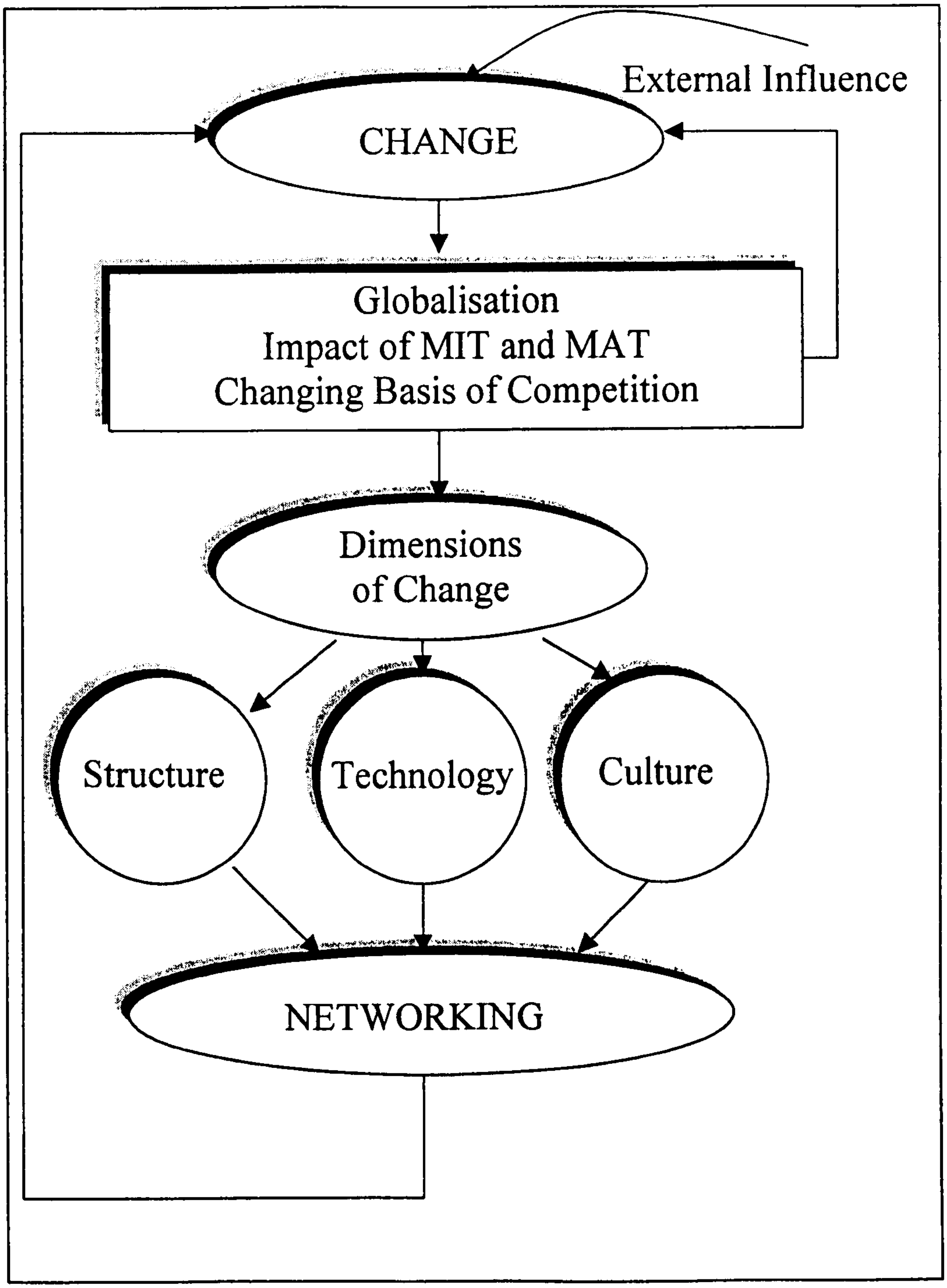
The notion of paradigm shift was originally conceived by philosopher Thomas Kuhn (Kuhn, 1970) and this concept has been gathering momentum ever since. Whilst many of Kuhn's concepts and ideas render intelligible the notion that a paradigm shift within the shipping industry is imminent there appears to be some diversity of opinion concerning the meaning of the phrase. Kuhn, for example, suggests that 'one of the things that a scientific community acquires with a paradigm is a criterion for choosing problems that, while the paradigm is taken for granted, can be assumed to have solutions' (Kuhn, 1970: 37). He goes on to illustrate that, 'though quantum mechanics (or Newtonian dynamics, or electromagnetic theory) is a paradigm for many scientific groups, it is not the same paradigm for them all' (Kuhn, 1970: 50).

In essence then the terms paradigm and paradigm shift are related to perspective; 'a revolution in one tradition will not necessarily extend to the others as well' (ibid.). The discussions concerning the changes that are occurring in the navigational and communications sectors of the shipping industry focus primarily on navigation and communication perspectives. The changes in these areas are so dramatic, so revolutionary, that whilst in (say) the Information and Communications Technology (ICT) industry they might not be considered radical, for the shipping industry they could represent a paradigm shift. The word 'could' is used deliberately here because this focus completes only part of the picture. Technological change alone is unlikely to be enough to trigger a paradigm shift. Fundamental changes in organisational culture and organisational structure also enter the equation.

What I am suggesting is that, in the shipping industry, change should be viewed as an holistic phenomenon that embraces technology, culture and organisational structure. Change, I suggest, is probably the most vital ingredient in the innovation cocktail but the concept that I want to argue here is that change is also a dynamic entity that feeds on itself, and that either external or internal events can initiate the change process. Customers or suppliers, for instance, might initiate an external demand for change by insisting on a different method of supply, delivery, or accounting. Competitive influences such as an increased threat from globalisation might spearhead a decision to change. Internal events, the introduction of new technology, for example, could require a change in procedures for contacting, or controlling a ship. External or internal influences could permeate the various dimensions of change impacting on organisation culture, organisation structure or form, and on technology. A change in any one of these dimensions would necessitate a corresponding and complementary change in the others. And, if this argument holds water, change is also an iterative process. Changing the technology, for instance, implies changing the culture, which implies changing the structure, which implies modifying the technology to align with the new culture, which ... This 'holistic' concept is illustrated in figure 4.2.

Taking this argument further by suggesting, as I do, that innovation has its roots in change, that *holistic* change is an effective fertilizer, and that the organisational culture is determined by paradigm requires an expansion of Kuhn's theories. Fundamental and often dramatic changes in global economic affairs prompted authors such as Nadel (1987), Drucker (1989), Tapscott and Caston (1993), Cox (1990)[2] and many others to do just that, bringing fresh ideas and perspectives into the business world. A recent theory suggests that management activity in this millennium is founded in one of two broad paradigms; the 'optimisation paradigm' and the 'innovation paradigm' (Adcroft and Wills, 2000: 178).

Figure 4.2
The Concept of Holistic Change:
From Optimisation to Innovation through Iteration



The optimisation paradigm ascribes importance to slow, gradual change and improvement whereas the innovation paradigm emphasises revolutionary change.

The integration of the various elements depicted in figure 4.2 precedes, I would argue, an organisation's ability to enter the 'innovation paradigm'.

Many writers refer to the 'optimisation' and 'innovation' paradigms in terms of what they call 'incremental innovation' and 'radical innovation'. Incremental innovation implies that the small and incremental changes to products and processes *are* innovative, only not *as* innovative as 'radical innovation'. The fallibility of this terminology however manifests itself when one considers that the optimisation paradigm is concerned with delivering the *same* product or service, with a small or incremental change providing a temporary competitive advantage. The innovation paradigm takes the opposite tack, aiming to gain competitive advantage through difference, rather than through similarity. Nichols Negroponte makes this point succinctly, asserting that 'incrementalism is innovation's worst enemy' (Negroponte, 1995).

The debate concerning paradigms and their influence on innovation in the global economy is likely to continue for some time. A search for authoritative literature that focuses on paradigms within the marine industry proved elusive and it was necessary to conduct an in depth appraisal of *prima facie* evidence emanating mainly from the industry itself. This information, which appears in chapter six, is used to substantiate my argument that the marine industry is about to enter its first ever paradigm shift and is attempting to distance itself from the stereotypical view of an industry steeped in tradition.

4.1.2 The Systems Approach.

Systems theory, first proposed by Ludwig von Bertalanffy over sixty years ago, focuses on the relationships between elements that make up the whole, rather than on the discrete elements. Bertalanffy emphasised that real systems are open to, and interact with, their environments. He suggested that, through what he called 'emergence', they could acquire qualitatively new properties resulting in continual evolution (Bertalanffy, 1968). This notion - that a system interacts with its environment - is central to the theme in which I illustrated that, within the shipping environment, change must be viewed as an holistic phenomenon.

The holistic model is not intended to imply that it is possible, or desirable, to view the shipping industry in terms of a 'whole system' without boundaries, or that change must take account of every potential property that might emerge by adopting such a perspective. It is merely intended to reinforce the argument that, within the UK shipping industry, reductionism and change should be seen as being at opposite ends of a continuum. Reductionism, as Midgley points out, 'has long been seen as the traditional enemy of systems thinking' (Midgley, 2000: 39).

The concept of depicting a bird's eye view of various aspects of change phenomenon, and embracing a 'systems' approach to innovation does not mean that the boundary in such a perspective is irrelevant, that it disappears, or that it need not be defined. Indeed, following Midgley's view that 'there is no such thing as a complete whole' system (Midgley, 2000: 41), I limit the boundaries of my enquiry within the confines of the conceptual framework that I outlined in chapter three. Although I acknowledge that some of the social and systems theories to which Jackson (2000) refers in his latest work[3] might have relevance to this study, I would argue that it is also necessary to limit the boundaries of the theoretical framework.

Much of the current research in the systems arena is in any event about methodology[4] and such work is not discussed here. On the other hand, I have also argued that in the UK shipping industry the concept of holistic change denotes conceptual relationships between organisational structure, organisational culture and technology. This suggests that the relationships influence an organisation's transition from optimisation to innovation, a notion that accentuates the relevance of two particular perspectives within systems theory to the industry's imminent developments. More specifically it raises the salience of theories residing in the domains of the social construction of technology (Bijker, 1995a) and actor-network theory (Latour, 1987; Law, 1992). I will discuss these theories in sections 4.1.7 and 4.1.8. First though I want to look at how the distinct elements of technology, culture, and structure interact in the holistic model that I discussed earlier (figure 4.2).

4.1.3 Technological Innovation - The Information Perspective.

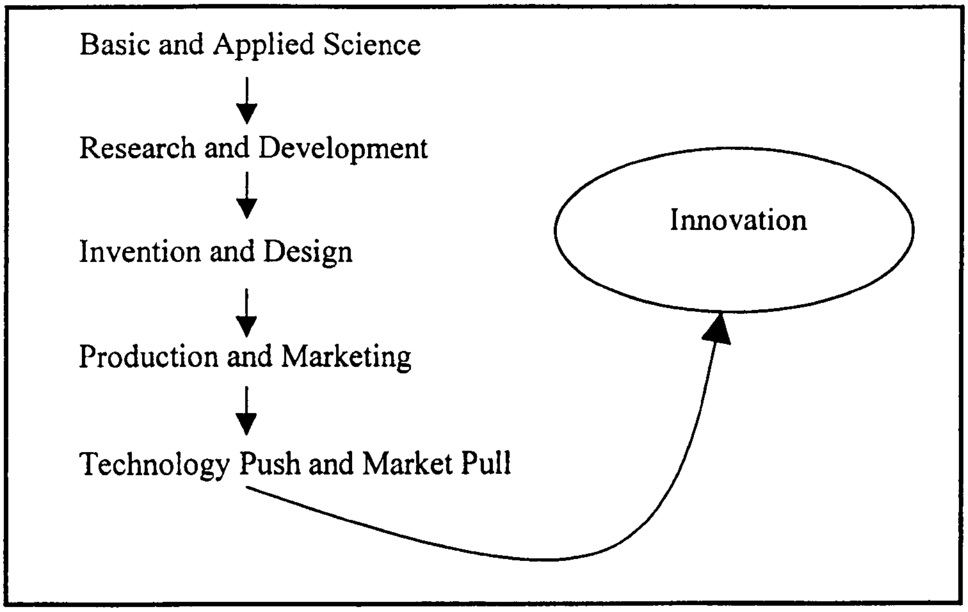
Engineers and scientists, perhaps understandably, tend to assume that their contribution to technological innovation and its supposed benefits in terms of improved competitiveness outranks the contribution of other factors, whether within or outside of the organisation. The notion that forces outside of the organisation might influence the technological innovations being developed within it is anathema to many engineers who seem to endorse the view that research and development (R&D) is a prerequisite for innovation. 'Technological advances are only possible because of major investments in research and development' (Girifalco, 1983).

The apparent bid to claim victory for science over the uncertainty of change and serendipity probably led to the development of the linear model of technological innovation (Macdonald, 1998). Unfortunately, such models fail to address the influences that organisational culture, politics, marketing mix, environment, and a dozen other factors have to the final outcome in the equation of innovation. On the other hand rhetorical accounts of the influence of change seem to overemphasise its value. It is often taken for granted that all change is good. Indeed the terms 'change' and 'innovation' are often used synonymously, sometimes in the context of technology but increasingly in an organisational context. Although change may be required for progress, I put forward the argument that progress is not an inevitable consequence of change.

> There is a tendency among the proponents and leaders of change to disregard the unpredictable - the random elements in change, serendipity in innovation - and to focus on what seems to be predictable. Past experience of change should warn us that the transition is neither smooth nor predictable...(Macdonald, 1998: 39)

The linear model of innovation (figure 4.3) depicts new technology as the product of a process in which science must precede technology and invention must precede innovation. In effect this type of model seems to suggest that 'because a process is at work it can be controlled and therefore contained within the boundaries of the organisation' (Macdonald, 1998: 42). Such a notion is rejected on the grounds that it ignores the important influences already mentioned. I am not suggesting, however, that a linear model of the innovation is completely useless. Although it represents a complex process - technological change - in a simplistic manner, there is often a need for simplification as an aid to understanding.

Figure 4.3
Linear Model of the Innovation Process



Modified version of original (Macdonald, 1998)

Technological change, as I have already argued, is not a unidirectional discrete process, and the more complex the phenomenon, the more there is a need for simplification.

As an aid to understanding then, the linear model does have value within an organisational context. Nevertheless, as several influential authors have shown (Leonard-Barton *et-al,* 1981; Rothwell, 1986; Von Hippel, 1988 for example), the rationale for embracing change within an organisation invariably emerges from outside of the confines of that organisation, in other words from outside the closed system of a linear model.

These authors have also shown that the flow of information that is fundamental to innovation is multi-directional. Innovation it seems is not the culmination of a linear process and 'it may be that existing ways of looking at innovation and change are unsatisfactory' (Macdonald, 1998: 52). As I have already argued the linear model fails to address the complexity of the innovation process and in any event there is no particular reason to suppose that innovation is the exclusive domain of research and development, or that the process occurs in a predetermined sequence.

The notion that information, rather than sequences of events, drives innovation and change (the aptly named information perspective) seems to be more feasible in that it recognises that sources outside of the organisation often provide the new bits of information that the process of innovation and change frequently need. As Herbert Simon correctly observes, whilst 'a focus on research suggests the importance of creating new information for change, emphasis on information suggests that very little information is actually created and that very much is gathered even in research' (Simon 1991: 125).

The implication then is that innovation is just as likely to result from the rearrangement or utilisation of existing information as it is from the acquisition of new information. In effect it is endorsing the notion that incremental innovation, building on what is already available, is exactly the same as radical innovation. In that respect it takes an opposing view to the concept of two alternative paradigms, the 'optimisation paradigm' and the 'innovation paradigm' that Adcroft and Wills proposed (Adcroft & Wills, 2000: 178).

An information perspective, possibly reinforced by the simplicity of a linear model, might well be a useful tool for developing an understanding of how change occurs but in terms of prescribing how to bring about that change it fails dismally. This does not mean that the development of an appropriate conceptual framework cannot include relevant factors of an information perspective. Innovation and change are involved socio-technical processes demanding an analytic vehicle with the potential to tease out relevant issues related to the management of such a process.

4.1.4 Organisational Culture.

Commonly credited with establishing the first comprehensive definition and analysis of corporate culture, Edgar Schein (1985) coined the term 'psychological contracts'. Psychological contracts, he claimed, are informal unwritten understandings that exist between employees and employers. The current fashion is for organisations to draw up a 'mission statement'; a concise statement defining the organisation's purpose in life and how it hopes to relate to the outside world. Typical mission statements may focus on markets, the desired quality levels, customers, attitudes to staff and so on. Schein argued that the more concrete the mission statement, the easier it is to determine objectives and that management and workers must concur in areas of mutual interest, such as the company's mission, its culture and its procedures. The problem is that many of these so-called 'mission statements' are nothing more than political tactics designed to suggest a change of tack that never really happens. But on the basis that consistent innovation seems to develop and mature in organisations where specific expertise exists its seems pertinent to take on board ideas and concepts that could stimulate it. I discuss some of the concepts associated with domain specific expertise and their relationship to innovation later in this chapter.

The premise that corporate culture is relevant organisational strategy was reinforced by Peters and Waterman (1982), although the notion that corporate culture could have something to do with technology does not appear to have been considered at the time.[5] To most managers organisational culture is about customs, attitudes, behaviour, perceptions, opinions and feelings that employees and employers exhibit in their work. Schein calls this the 'soft stuff', and claims that this is more akin to 'organisational climate' than culture (Schein, 2000). Most managers, he says, are 'blind to the fact that their strategies and structures are dominated by cultural assumptions and that histories of success and failure hardwire these cultural assumptions into their thinking'. I consider it particularly relevant to raise the salience of this point, since any attempt to devise an appropriate strategy that might enable the shipping industry to embrace aspects of innovation more positively needs to consider and address the weather beaten cultural biases that appear to infect the industry. It was necessary, both in the design of the primary research aspects of this work, and in considering its ultimate usefulness as a tool in the development of appropriate strategies for innovation, to devise various means of attempting to measure organisational culture and climate. [6]

An organisation, according to Charles Handy (1976), might be dominated by a single culture. Alternatively, contrasting cultures may be exhibited in different parts of the firm. Handy identified four culture types based on person, power, role, and task. A person culture might be evident in a partnership or professional organisation, and a power culture in a small business where one person makes all the decisions. Such organisations are highly flexible, able to make snappy decisions and make rapid tactical course changes if circumstances dictate. In contrast, a role culture relying on rules, established procedures, and a vertical bureaucracy is more predictable, although sometimes slow in making decisions. A task culture is directed toward a specific project, all team members focussing on completing a specific task.

Handy does not endorse a particular culture, arguing instead that culture arises from historical circumstances, the environment, technology and human needs. Organisational success however is often attributed to the ability of senior management to ensure that the organisation's activities are matched to the demands of the environment. The shipping industry, as I discussed earlier, seems to be dominated by what Handy calls a 'role culture' - a culture that relies extensively on formal rules and established procedures. But, as a number of authors have shown, (Kanter, 1984; 1988; Anderson and King, 1995; Fonseca, 2002, for instance), such cultures are not the most conducive to innovation.

4.1.5 Organisational Structure.

Important as cognitive, historical, cultural, political and environmental factors are to the cultivation of organisational innovation, many of these conditions are either sluggish or inherently difficult to change. The problem is that all these aspects depend in one way or another on the perspectives that people have of their own environment. In the absence of an appropriate support mechanism that effectively brings into focus the consequence of change, and the alternative consequence of quiescence, there is unlikely to be sufficient motivation to change. It is however the prerogative of management to devise a working structure, or form, that is appropriate to the organisation, and as several authors have shown (Herber, Jitendra, and Useem, 2000, for example) the organisational structure that a firm adopts can impact significantly on its ability to innovate. In effect organisational structure has a distinctive affiliation with organisational culture and is therefore relevant to any strategy aimed at motivating a cultural course change.

For much of the last century management theory and research has focussed on the hierarchically structured organisation model and its dominant variations (Herber *et-al,* 2000). Although structures such as the 'Vertically Integrated Company', the 'Multidivisional Firm' and the 'Conglomerate Corporation' still enjoy some support, in the turbulent environment of emerging technologies and escalating globalisation their weaknesses are becoming increasingly salient. For example, placing too great a focus on current competitive advantage may render an organisation vulnerable to abrupt changes in its market. On the other hand mobilising excessive resources to presumptive future capabilities implies short-term risk. The key is balance. It may be that a single organisational structure will no longer call the shots but that a flexible hybrid, tailored to specific organisational departments, will emerge.

Arguing that traditional organisation forms have tended to inhibit innovation by threatening existing knowledge bases and production systems, Herber, *et-al* proposed six new organisational forms. These are:

1. The Virtual Organisation. This type of organisation is geographically dispersed but united by technology. There are no physical boundaries, the company can buy and sell goods or services to and from anywhere. The 'headquarters' of such an organisation could be in the proprietor's garage. The well-known computer seller 'Dell Computers' is an example of a highly successful Virtual Organisation.

2. The Networked Organisation: This implies an organised relationship between autonomous units, delivering a complete product or service to customers. Such an organisation can accept and deliver orders that far exceed the capacity of any single member of the network. Kwik Fit is a typical example.

3. The Spinout Organisation: Companies establish fresh entities and possibly new business concepts and then let the new organisation run with the ball. The parent of a spin out organisation may, or may not, retain control of the spinout.

4. The Ambidextrous Organisation: In this form both established and emerging businesses flourish side-by-side and are able to overcome the so-called 'innovation dilemma.[7] The ambidextrous organisation structure can be useful for fostering emerging technologies without abandoning the old.

5. The Front - Back Organisation (Galbrath *et-al,* 1993): This structure is organised around customer in front with all company functions placed at the back to serve them. For example, all line executives, systems, and support staff, in effect work for the front line person, allowing him/her to concentrate on the company's capabilities in satisfying the customer.

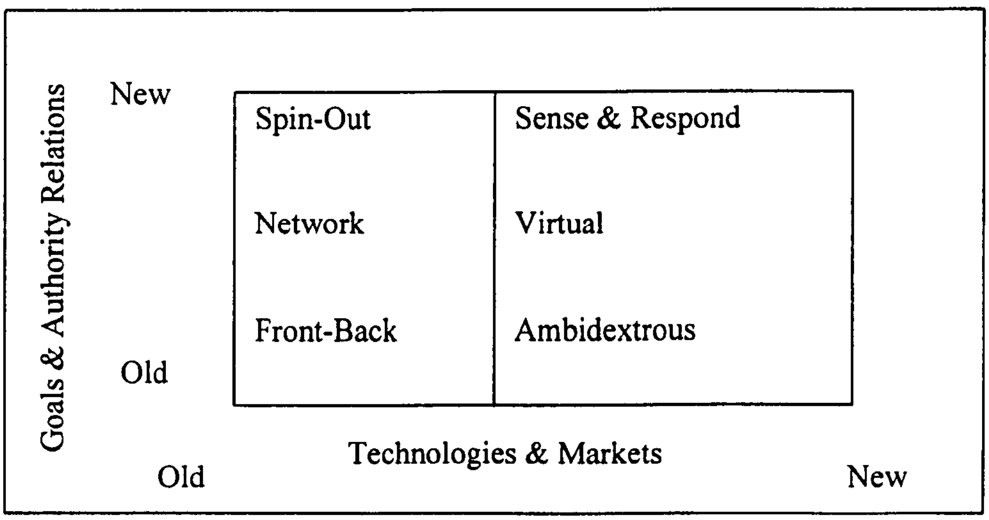
6. The Sense and Respond Organisation: This form is focussed even more intensely on identifying emerging customer needs. Adaptability is the focus of sense and response firms. They tend to plan from the bottom up, with few predetermined long-range plans, reacting almost daily to market movement.

Competitive advantage may be achieved through being the first to design an organisational form that 'best capitalises on technology in a way that is responsive to customer needs' (Herber, *et-al* 2000).

The choice of which of the six forms is most appropriate depends on the unique configuration of a company's goals and authority relationships on the one hand, and the nature of its changing markets and technologies on the other, as illustrated in figure 4.4. Where an organisation's goals and authority relationships are new but its markets and technologies are old, for example, a spinout form of organisation would be appropriate.

Although I subscribe to the argument that organisational structure is relevant to innovation, I repudiate the implicit suggestion permeating these models - that organisational structure carries the same weight in the innovation equation as organisational culture.

Figure 4.4
Organisational Form & Changing Environments



(Source Herber, *et-al* 2000)

I would argue that culture - the culture of the organisation *and* the culture of the environment in which the organisation operates - is fundamental to innovation. Organisational culture, I argue, plays a pivotal role determining an appropriate structure, but these elements need to be addressed as a system. Changing an organisation's structure in isolation is unlikely to be an effective strategy for innovation unless it is specifically designed to match, and is woven into the fabric of the organisational and environmental cultures. Perhaps an example will help clarify this point. A clockwork radio that needed no batteries proved to be a highly successful innovation in a culture where the nearest mains electrical supply was five hundred miles away and batteries were seen as an expensive luxury. A person in a business suit hawking all-singing all-dancing microprocessors in the same culture would probably generate as much interest as a shipyard in Alice Springs. The culture of the organisation and its products must match the culture of the market. The notion that the primary parameter to consider in determining an appropriate organisational structure is the firm's internal capacities and its competitive environment is therefore flawed.

That is not to say that there is no value to the paradigms and organisational forms discussed here. There is. Elements of the distinctive features within the model could be moulded into an appropriate hybrid of organisational structure that would form an alliance with the cultural, environmental, and competitive aspects of innovation.

Designing such a hybrid would however also have to take account of different cultures 'within' the shipping industry. For example, the 'culture' on a British ship may be very different to that on a Dutch, French, Scandinavian, Italian, Greek or German ship. As European integration unfolds and ship-owners juggle with dilemmas of cost versus professional competence there seems to be an increasing likelihood that ships' crews will ultimately face the challenge of working in a multi-cultured environment. How they, and the strategic management team, address that situation is likely to have a significant impact on the potential for innovation.

It could be argued of course that, in a broad sense, shipping has always been part of the global community and that therefore its cultural environment is not changing at all. The point I am making however, is that the impacts of European integration, and indeed globalisation *per se*, is likely to influence the need for additional organisational changes at sea that might not have otherwise been necessary. For example, in examining the impact of globalisation on organisation development, Kenichi Ohmae (1985) claimed that major companies need to establish a physical presence in all three areas of the triad of economically advanced nations.[8] Failure to do so, he argued, renders a company vulnerable to attack by rival businesses. Such an argument may have been valid in the past, but rapid developments in ICT are transforming the *modus operandi* of more and more businesses. Service organisations, such as banking and insurance companies, already conduct much of their business electronically - over the Internet, the telephone, or via electronic 'cash machines'. It is already quite common to use 'direct line' telephone services to obtain insurance throughout the UK. As far as many of their customers are concerned as long as they don't have to pay for the telephone call these companies could conduct their business from the moon. Innovation, price, service quality and reliability are the business drivers for these organisations, not their physical location. Why, as technology emerges, should companies not conduct their business from the remote location of a ship? Such a development would clearly require organisational changes and could reverse the current trend toward leaner staffing levels at sea.

Highlighting the significance of cultural differences in the evolution of paradigmatic assumptions, Gregory (1990) presages Midgley's view that 'learning through the appreciation of others' viewpoints can ... transform one's own paradigm' (Midgley, 2000: 251). If this reasoning is sound, then it is, I suggest, also reasonable to argue that paradigm shift is conceived and fertilised by an appropriate cocktail of cultural, structural, and technological factors, the blend of which can significantly influence the likelihood of innovation. Creating a culture that is conducive to innovation seems to demand changes to structure and culture, and may be supported by technology. In emphasising the argument that to be effective change should be managed as an holistic phenomenon, I suggest that incremental tweaking, or fiddling, with either the organisational structure, the organisational culture, or the supporting technology in isolation may do more harm than good. It doesn't work to leap a twenty-foot chasm in two ten-foot jumps. (American proverb)

If Herber's suggestion that organisational form significantly influences the development and commercialisation of innovation is legitimate, then it follows that the significant drivers of innovation are not individuals but networks. And, as the resources needed to drive innovation continue to increase, the management of knowledge networks becomes a strategic issue in the innovation game. In a nutshell - innovation demands teamwork. And teamwork is one tradition that seafarers have relied on for generations. The industry's strengths in that territory might be its trump card as it faces the challenge of inevitable change. Having said that, it may be unrealistic to suppose that the future course of the UK shipping industry will be determined entirely through its own structures and cultures. It is I suggest much more likely that emerging technologies will play a significant role, not only in determining how the industry develops but also in guiding its cultural and structural shape.

4.1.6 The Influence of Technology on Organisations.

In attempting to enhance their understanding of the needs of customers and potential customers, manufacturers of technology rely to a large extent on market research methods for gathering information about how and why customers chose a particular supplier, product or service. They then try to design products and services to meet these perceived demands. The assumption that customers will buy those technologies that meet pre-defined organisational, fiscal, technical or bureaucratic needs is based on a perception that assumes that it is possible to identify user needs and then develop appropriate technologies to meet them. But are such simplistic notions valid? Do organisations really think about their technological needs in advance? Is it not more likely the case that busy executives simply wait until the advertisement for the latest technological gizmo, together with explicit details of why they must have it, appears on their desk?

There are numerous instances where technological developments seem to have taken relatively little account of the real needs of end users despite manufacturers' claims that their products and services are specifically designed to meet user demands. There appears to an abyss in separating *actual* user needs from the user needs that are *perceived* as real by technology developers and manufacturers. For example:

- Many end users seriously question the value of so-called 'built in functionality' of computer software programs that often make the program more difficult to use than is necessary.

- Users frequently redesign the technologies they buy, or disable certain functions so that they, and not only the designers, can understand how to use them.

- There are many instances where products *are* meeting user needs but are 'upgraded' to the extent that they no longer do so.

The relationship between technological design and user need appears to be a somewhat fragile one. There appears to be an unnecessarily wide potential for misunderstanding, dissension, challenge, and tension both at the individual and at the organisational level. This tension, in many instances, seems to be accepted by both users and suppliers as one of the inevitable consequences of innovation. The acquisition of technology and its subsequent deployment by users are, I suggest, complex processes that are not being adequately addressed or anticipated by designers or manufacturers of processes or products. Understanding the relationship between organisations, particularly the relationships between culture, structural form, and the technology that is inherent in driving innovation in organisations, calls for a knowledge of the relevant theoretical foundations, both of organisations and of technology.

A number of authors are critical of the notion that technology is neutral in its relationship to organisational politics and culture or that it has inevitable determining impacts on organisations. For example, as McLoughlin points out 'whilst factors such as product markets, technological environment, and the like on are important, they do not themselves shape the organisational outcomes of technological change' (McLoughlin, 1999: 69).

The identification of technology as a key variable in shaping organisations emerged from research published in the USA in the 1950s. In their study of the attitudes of car workers in Detroit, Walker and Guest (1952) observed that assembly-line technology tended to inhibit the formation of work groups. Technology, it appeared was influential in determining social relationships within organisations. The research suggested that technology was, in varying degrees, an important and relevant factor in determining human behaviour in the work place and managers were encouraged to 'take note of the ways in which technology was influencing organisational structure' in their quest to improve organisational efficiency (Rose, 1988: 175-176).

Towards the end of the last century Neil Pollock presented a paper in which he described the relationship between user needs and the perceptions that computer programmers and analysts who were working on the proposal for a new system had of these needs. He described how 'time' entered the equation as the relationship between perceived needs and actual needs were ultimately blended through a process of negotiation and re-negotiation (Pollock, 1996).

Time it seems is an essential ingredient; time provides the seasoning, the maturity needed to ensure that an idea gains value in its transmigration from concept to innovation. In describing how manufacturing companies trying to introduce new computer technology into their organisations found it necessary to revamp their organisational settings in order to make the new systems workable, Robert Thomas (1994) had come to similar conclusions. The perceived and real value of technology then appears to be influenced both by time and by changes in the organisational structure or form. The inherent value of innovation, particularly technological innovation, lies partly in its potential for redefining organisational strategy and managerial methods. This potential is likely to impact on shipping to at least the same extent as it has in other industries. The work of both Pollock and Thomas seems to suggest that both technologies and organisations exhibit cultural and political phenomena that should be examined and addressed from a social perspective.

In his critique of the notion that technology could be employed to replace human intervention that requires mainly cognitive processes, Beeson (1997) draws attention to a further element concerning the neutrality (or otherwise) of technology. He argues that:

> Zuboff's claim that in the informating process bodily skills are satisfactorily supplanted by mental skills is ... dubious. ... it looks highly improbable that [the] disembodiment of the worker and the separation of physical process from mental model can produce better understanding of and engagement in the production process. It is easy to see many of the quotes Zuboff includes in a different light... (Beeson, 1997: 215 - 220)

Communications and technological advances at sea are almost certainly poised to enable the forming of network linkages that will impact both on the quest for cultural symmetry, and on the strategic direction of shipping organisations. I would however argue against the notion espoused by Zuboff (1988), who implies that focusing on pre-defined goals prescribed by the ruler of a bureaucratic hierarchy is conducive to innovation. 'Subsuming' decision making to technology by installing ivory tower rules in a machine that, allegedly, 'empowers' an organisation's employees looks a lot like bureaucracy in disguise to me. How does that flatten existing hierarchies?

As I highlighted in chapter two, new, and to some extent radical, communication systems have begun to emerge from the ashes of the moribund Morse code system that dominated marine communications for nearly a century. The measure of the success of these new technologies is however unlikely to manifest itself merely in the improved communications that the technologies offer. Improved communication is an inevitable consequence of such technological change, but the implications for the industry are likely to be much more radical.

The new technology offers opportunities for changes in working practices, methods, processes, and ways of doing business. The contribution in terms of improvements to overall efficiency within the industry that the new technology offers is substantial but the new systems must first be socially embedded in the fabric of organisational culture and policy. How does that happen? How can we understand the processes by which a technology becomes socially acceptable? Is it possible to manipulate the environment or to develop technology so that it is socially desirable or are we at the mercy of unexplainable social forces that make the successful implementation of a communication network a matter of luck regardless of how technically competent we are? In addressing some of these questions it became apparent that an explanation of why and how technological artefacts combine with social networks and become culturally and politically embedded into organisational structures would be needed. Relevant theoretical discussions appear in the literature in the areas of the 'Social Construction of Technology' (SCOT) and 'Actor-Network Theory' (ANT). Both the SCOT and ANT perspectives are relevant in this study because the attitudes, values, and ideas of diverse social groups within the marine industry are likely to influence both the direction and the extent of any change.

4.1.7 The Social Construction of Technology.

Understanding how technology influences specific organisational assumptions and decision-making processes is vital to interpreting the subliminal cultural, political and technological relationships that appear to be at the heart of organisational change. People have different perceptions of the emerging technologies, their capabilities, their possible uses, and the value that might accrue to particular individuals or organisations by their adoption. The term 'interpretative flexibility' used by Bijker in his classic case study of the bicycle emphasises this point (Bijker, 1995).

Attempting to ride the 1870s 'penny-farthing' bicycle demanded a lot of skill, a certain amount of risk, a quest for excitement, a reckless disposition, or all of these things, depending on one's perception of the new invention. As the design improved, and more people learned to ride them, their role in society changed. Instead of being perceived as a machine for thrills and excitement they became inexpensive and reliable forms of transport. Learning to use one became, well, as easy as learning to ride a bike.

Work undertaken by Badham (1995) and Orlikowski (1992) examined the process of 'socio-technical change' within organisations. In order to manage the change process associated with the introduction of new socio-technical systems, Badham argued, such systems must be adapted and customised through a process of 'socio-technical configuration' to 'fit the context within which they are to operate'. This 'socio-technical configuration', Badham suggests, 'includes a set of meanings or interpretations of the technology and its requirements that, to a degree, constitute the technology in a specific operating environment and undermine any simple view of the non-human character of such configurations'. Orlikowski similarly argues in favour of a perception of technology that is an outcome of co-ordinated human action that is inherently social. Once again this highlights the need to understand that technology is socially constructed and that the acquisition and implementation of a new system is not an isolated event driven mainly by perceived economic advantage, but is an inherently socio-technical process in which time is also relevant.

Over generalised accounts of the impact of new technological systems on organisational form and culture may however be flawed. For example, in suggesting that the 'informating' qualities of information technology formed a basis for a flat, decentralised, responsive, organisational form, Zuboff (1988) may be ignoring the opinions of other researchers who maintain that technological development has a life and momentum of its own. Webster (1995), for example, identifies an over emphasis on transformation, a tendency to over-simplification, and the implicit or explicit treatment of technological development as an independent variable driving organisational change. Highlighting oversimplification as a clue to the inadequacy of such generalised accounts he writes:

> ...it follows such a neat linear logic - technological innovation results in social change - that it is almost a pity to announce that it is simply the wrong point of departure for those embarking on a journey to see where informational trends, technological and other, are leading (Webster, 1995: 215).

Components of the organisational culture that influence the perceived and real technological value include the organisation's rules and practices, the various ways in which such cultural elements are interpreted, and the authority relationships within and between different groups in the organisation. How and why such technologies are integrated into an organisation is a fundamental factor in the determination of its ultimate value. For example, suppose a ship-owner decided to install a microwave oven in the cabin of every person on board in order to dispense with the services of the catering staff. Would this 'new technology' have the same perceived value as it would if the same ship-owner installed instead just one microwave oven in the ship's bar so that the users could enjoy a hot snack with their drink?

The concept of organisational culture (the notion that 'organisations *have* cultures') has been widely recognised and accepted both in academia and in management. There does however appear to be dissension in both camps in defining the exact nature of organisational culture. Should we regard organisational culture as a finite management resource that can be defined and manipulated in the higher echelons of the organisation as suggested by Brunsson (1995: 178)? Or should we follow the more recent, and probably more realistic, views of Martin (1992) who argues that 'cultures can also be differentiated and fragmented across organisations'?

My observation, that the UK shipping industry is increasingly likely to witness cultural diversity as the reality of a 'United Europe' emerges suggests that fragmentation is already imminent and that the latter view would therefore be more appropriate. Recognition of the existence of inter and intra organisational cultural groups with diverse norms, beliefs, and ideas is surely a pre-cursor to a holistic understanding of how such groups might influence technological change.

McLaughlin, Rosen, Skinner and Webster concur, that rather than thinking in terms of an organisation '*having* its own particular culture' it is preferable to think of organisations '*as* cultures' (McLaughlin *et-al*, 1999: 28). 'Awareness of the existence of multiple groupings and varied cultural understandings in organisations' has, they say, 'important implications for the analysis of techno-organisational change' (*ibid.*).

The quest for techno-organisational change seems to be driven by subliminal assumptions that innovation and changes are inevitable in order to:

- Keep up with technological progress
- Maintain organisational efficiency or

- Remain competitive.

Such assumptions present organisations as passive respondents of external pressure to change, represent change as inevitable, and suggest that change affects all organisations in the same way.

In overemphasising the value of innovation for its own sake these assumptions imply that a refusal to innovate is evidence of poor management. McLoughlin and Harris summarise the failings of such assumptions when they say:

> ...the idea of an unyielding technological and commercial imperative has increasingly been viewed as problematic, in particular, since it tends to evaluate the role of such things as management and worker attitudes, existing organisational structures and cultures, industrial relations and so on, in relation to their propensity to either facilitate or impede innovation. (McLoughlin and Harris 1997: 6).

Part of the rationale for acquiring a new system is, presumably, to deploy it to improve efficiency. The notion of 'piloting' and then 'rolling out' a new IT system, for example, is founded on the assumption that the 'pilot' irons out the wrinkles of technology and identifies relevant user needs. But identifying user needs and incorporating these needs into a new technological gizmo at a given point may fail to take account of the organisational response to technological change. A manager's strategic choice in shaping the organisation's response to some technological change or development, for instance, may be influenced not only by socio-technical factors inside the organisation but also by such considerations as customers' perception to the change, fiscal backers' opinions, or trade union responses. And the sometimes-opposing views of these various groups might be weighted differently across divergent organisations. Nevertheless, these inter and intra organisational responses may predominate in the formula for management decision making and therefore constitute an effective source of power that could mould the organisation in a way that may not have been originally planned.

The idea that 'power' might be relevant in the equation of organisational response to technological change seems to have been largely ignored in the contingency theories that dominated organisational analysis in the 1970s. The 'strategic choice approach', originally developed by John Child, was clearly an attempt to bring this concept of power into focus (Child, 1972). According to Child, strategic choices are a critical variable in the theories of organisations. Such choices, he says, are made by 'dominant coalitions' both within and external to the organisations. More recently, Child observed that the strategic choice approach might be attractive as an alternative to concepts that would 'deconstruct organisational life down to untrammelled actions of sense making individuals' (Child, 1997: 72). The explanation of the effects of technological change appears to be moving away from simply considering the effects, or anticipated effects, of the technology itself. The strategic choice perspective is an attempt to understand 'the full content, context, and process of change and the manner in which these are shaped by intra-organisational political processes' (McLoughlin, 1999).

The social constructivist approach originated as an attempt to take the study of social science beyond the empirical stage and concentrated instead on scientific knowledge itself. As Pinch and Bijker put it 'explanations for the genesis, acceptance, and rejection of knowledge claims are sought in the domain of the social world rather than the natural world' (Pinch and Bijker, 1987: 18).

The 1980s saw research in the domain of the Sociology of Scientific Knowledge (SSK) focusing on the social construction of the technological knowledge embodied in individual artefacts and systems (Edge, 1995: 14-32). . Bijker, Hughes and Pinch (1987: 3) defined the characteristics of SSK as 'regarding the social and technical as a seamless web'. They suggested that no clear distinction between the technical, social, economical, and political elements of technological development should be made. The social constructivist approach examines the relationship between the technological and social environment as a network, rather than as separate systems (Grint and Woolgar, 1997: 10). A comparison of the 'standard' and 'constructivist' view of technology and society is presented in figure 4.5

Figure 4.5
The 'Constructivist' versus the 'Standard' Perspectives of Technology and Society

Standard view of technology.	Constructivist view of technology.
Clear distinction between the political and the technical domain.	Both domains are intertwined.
Difference between 'real science' and 'trans-science'.	All science is value-laden.
Technology develops linearly.	Technology development cannot be a process with separate stages.
Clear distinction between technology development and control.	Technology does not have the context-independent status necessary for a separation in its development and control; its social construction and the political/democratic control are part of the same process.
Technology determines society, not the other way around.	Social shaping of technology and technology building of society are two sides of the same coin.

(Source van Hemert, 2001)

Understanding the relationships between technological development, cultural and political elements, and innovation in the shipping industry clearly needs to take cognisance of these theories.

According to Bijker (1987; 1995a), the development of a technological artefact or system is not a linear process. Rather it is a more complex process that involves negotiation and consensus between key individuals or groups with a stake in the project who consider various options before agreeing on an appropriate design. The views of these different social groups about what a particular technology is, and what it can and cannot do, will differ in terms of definitions, identifications, and expectations. This is the fundamental concept of *interpretative flexibility,* which supports the notion that there is no 'one best way' to design an artefact (Pinch and Bijker, 1987: 40).

In evaluating the opinions of the relevant social groups about which technology is most appropriate, the SCOT approach considers all claims as equally valid. In this respect the final form of a particular artefact or system does not reflect its technological superiority but establishes consensus about what the relevant social groups believe to be superior. Members of the various social groups might emerge from diverse backgrounds and could, for example, include designers, engineers, managers, customers, protestors, lawyers, accountants and so on. Each will perceive of different problems, ideas and solutions in the light of their specific competencies. The shared knowledge, assumptions and expectations of an appropriate social group could be an effective engine for driving thought, idea generation, and subsequent action.

However, as boundaries such as what constitutes a design problem and what is an acceptable solution to it are set, inhibitions are likely to become more pronounced. At the beginning of a technological development the 'thought and action of relevant social groups is more enabled than constrained, [but] as more dominant members of the social group gradually establish the legitimacy of their ideas the thinking and action becomes progressively more constrained' (Pinch and Bijker, 1987: 192-193).

Eliminating competing designs because a relevant social group sees one as a more appropriate solution to a perceived problem is one method of reaching final consensus. The alternative is that of redefining the problem itself; for example, a design that is rejected as a solution to one problem may be accepted as an ideal solution to another.

The SCOT approach, it is claimed, seeks to open the 'black box' of technology by highlighting how technology can be seen as being socially constructed, in terms of both design and perception (McLoughlin, 1999: 93)

4.1.8 Actor - Network Theory (ANT).

Innovation, from a perspective of Actor-Network Theory (Latour, 1987) represents a process of changing networks of social and technical relations. Technology is viewed as a form of social relation that just happens to take a material form (Woolgar, 1997). The concept of ANT began with the work of Bruno Latour and Michel Callon and, like SCOT, is concerned with the socio-technical networks that scientists and engineers create in managing their projects.

Both the SCOT and the ANT perspectives draw on a variety of metaphors such as the 'black box' the 'seamless web' and 'networks' as a means of thinking about the ways in which technology is socially constructed. A 'black box', for example, is a term derived from cybernetics. The term is used to signify some, perhaps complex, process or machine whose internal workings are largely unknown and directly unknowable. A 'network' is defined as 'a group of unspecified relationships among entities of which the nature itself is undetermined' (Callon, 1993: 263).

In the concept of ANT then, an actor-network is not restricted purely to 'social actors' but provides conceptual links that include both people and artefacts. The ANT approach makes the assumption that natural phenomenon, and even technology itself, is capable of independent action in forming new socio-technical relationships.

According to Latour an 'actor' is what he calls 'a semiotic definition' (Latour, 1997). Actors are 'entities that do things... it implies no special motivation of human individual actors, nor of humans in general. An actor can literally be anything provided it is granted to be the source of an action' (Latour, 1997: 241).

The unfortunate choice of words that Latour uses to describe the concepts that form the basis of ANT leads to confusion and has most probably had a negative influence on its popularity. Commonly understood words (at least in terms of the English language) have been used in a different context, and sometimes the same words have been used to project entirely different meanings. For example, the word 'actor' is normally associated with human (male) activity. In the theory of ANT the word is used in a different context. Recognising this, and in an attempt to dislodge this impediment to conventional thinking, some writers use the more neutral neologism 'actant' instead. This only adds to the confusion. In the terminology of ANT, whether an actor is a social or a technological entity is unimportant. The emphasis is rather on the concept of action; 'whatever acts, or shifts action... An actor is an actant endowed with a character' (Alrich and Latour, 1992: 259). An *actant* on the other hand is an entity in itself, an *actor* comprises both an entity and the competencies attached to the entity (Latour, 1992: 259). For me, Latour's explanation does little to alleviate the confusion and an example might be a more appropriate way of simplifying what he is trying to say.

A credit card, as a piece of plastic, is an *actant*; it is an entity in itself. It exists as a piece of plastic even when it has been cancelled, or when it has not yet been activated to enable it to be used within the banking system. Once activated, the same piece of plastic operates within the context of an economic device - the banking system. It can be used to buy products or to get cash. It is not a human actor, but nevertheless it '*acts*' in terms of the transactions that it enables within the network of the banking system. It becomes an *actor* within that network.

ANT was developed on the back of the, probably correct, assumption that communication networks and the applications they support often fail to deliver the expected benefits. Even though a technological artefact may be well designed, economically viable, and supported by a strong technical infrastructure it may fail to gain user acceptance. According to Latour, people need to 'negotiate' with machines in the same way as they would with other people. They need to recruit machines as 'allies'.

This idea may sound a bit far-fetched, after all granting the same status as human actors to artefacts seems to suggest that human actors are mere objects and that social science is the same as natural science. However, as John Law points out, the idea represents 'an analytical stance, not an ethical position' (Law, 1992: 383).

Thomas Kuhn provided a vivid illustration of the consequences of different perspectives during his discussion of the priority of paradigms (Kuhn, 1970: 50). The importance of the perspective is not so much that it radicalises the theoretical interaction between humans and machines but rather its potential for increasing detail and precision in the analysis of that interaction. It is a way of focusing on influential factors in a socio-technological network and ignoring unnecessary *a priori* between social and technical elements. For example, using a motor car as a metaphor, the driver's ability (non-technical), the car's engine and road holding capability (technical), and the road surface (environmental), all influence the way a car actually handles on the road. Is there really a need for a hypothesis about why that should be? Both the SCOT and ANT approaches consider the social rather than just the technological aspects of change and innovation but there are fundamental differences.

Approaches which assume that social actors plan the consequences of introducing technology focus on the social construction of artefacts or on the political and economic aspects of the technology (MacKenzie and Wajcman, 1985). Approaches that lean towards technology assume that technology develops according to the law of internal necessity; 'necessity is the mother of invention'. Both of these approaches seem to lie on opposite sides of a continuum; 'social determinism' at one extreme and 'technological determinism' at the other. The question is which is leading which? Is society made up of technology, or is technology constructed by society? ANT is an attempt to consider both the technological development and social aspects at the same time.

But it's not all cut and dried for ANT. For example, the responses to serious questions pertaining to the boundaries of analysis appear to be somewhat vague. Michel Callon for instance suggests that 'a network's boundary can be related to its degree of convergence' (Callon, 1992: 8). Bijker and Law suggest that 'in effect it rests on a bet that for certain purposes some phenomena are more important than others; It simplifies down to what it takes to be essential.'(Bijker and Law, 1992: 7). The implication that the boundary of analysis can only be addressed at the empirical level seems to be a major weakness in adopting the ANT approach in isolation.

On the other hand, Parson (who was influential in the founding studies of the SCOT approach) also described how society is comprised of systems (Parson, 1951), thereby addressing the concepts of system boundary and environment in social science. Although transferring concepts from one discipline to another is inherently risky, the concepts of systems theory seem to offer an opportunity to expand ANT in order to define the limits of an actor-network in the shipping industry. From a practical perspective understanding the fundamentals presented in this summary of the Actor Network Theory might provide a valuable insight into how a practical form of actor-network could be designed for the UK shipping industry. From a theoretical angle, I will now present what I see as a conceptual form of an intra or inter organisational network for the industry - an ocean wide network - and offer some views on how such a network might be used, both in the practical sense, and as a tool for further industry relevant innovations.

4.1.9 The Concept of an Ocean Wide Network (OWN).

In its capacity as the mainstay of the wider transport industry, the UK shipping industry, through the improved communications and navigation facilities afforded by third generation satellites, now has the opportunity to become fully integrated with its logical partners. These partners include customers, agents, and allies of the industry (the rail and road freight industry, for example). The shipping industry depends on such groups to take its services forward - from the port where the consignment is off loaded from the ship to the customer. There is unnecessary complexity when these customers, or their agents, have to make separate arrangements with each organisation in the transport chain just to get goods delivered.

The current situation is illustrated in figure 4.6, a scenario that assumes that there will be no hiccups and that everything will happen just as it should. Unfortunately, in an industry where the fickle moods of Mother Nature take precedence over even the most authoritarian captain, absence of wind is something of a rarity - hiccups come with the territory. And, if ships are delayed through adverse weather conditions the scenario presented in figure 4.6 gets repeated, over and over, for every consignment on every ship affected. This time wasting, and consequently expensive scenario, in which suppliers and customers have to constantly engage in dialogue with the ship owner or agent in order to gather basic information could and should be avoided.

Satellite communications provide the infrastructure that could allow ships to be integrated into whatever corporate structures are appropriate to the organisation, and to become an essential part of a corporate network. But creating an Ocean Wide Network (OWN) to cater for the unique demands of the shipping industry need not be the end of the story.

Figure 4.6
Current Ship - Shore Intervention Scenario

- Customer contacts supplier and orders products.
- Supplier contacts freight agent to arrange shipment.
- Freight agent contacts ship-owner to book space on ship.
- Freight agent contacts supplier to confirm.
- Freight agent contacts road/rail transport company to arrange collection.
- Freight agent contacts supplier to confirm.
- Freight agent contacts local customs to arrange clearance.
- Freight agent contacts supplier for valuation for customs and insurance.
- Freight agent contacts local insurers and arranges cover.
- Freight agent contacts supplier to confirm.
- Supplier contacts customer to advise the shipment date and insurance details.
- Customer contacts local freight agent to arrange delivery.
- Local freight agent contacts ship owner for estimated time of arrival of vessel.
- Ship-owner contacts ship for information.
- Ship-owner contacts local freight agent to advise estimated time of arrival.
- Local freight agent contacts local transport company to arrange delivery.
- Local freight agent contacts local customs to arrange clearance.
- Local freight agent contacts customer to advise the delivery date.

The new organisational forms presented earlier are designed to encourage flexibility, innovation, entrepreneurship and responsiveness. In doing so they offer opportunities to significantly improve customer service. Synthesising an appropriate organisational form with the technology of satellite communications would enable customers to address relevant requests for information directly to the ship. Engaging the tools of innovation and change would be tantamount to sending a signal to customers that the industry was changing course, and the logical developments of such change could manifest themselves in even more ambitious service improvements.

If, for instance, an on-board computer was permanently connected to the Global Positioning System (GPS), information such as the ship's position, speed, course, and ETA could be stored in a file that would be automatically updated every few seconds. Customers could be permitted to access this information through their own computers so that they could obtain up to the minute information directly from the ship whenever they wished. The strategic advantage to ship-owners that implement such ideas lies, not so much in the immediate positive impact that it would inevitably have on customer relations, as in the undercurrent of innovations that might be spawning beneath the surface. Once such a system was operational it would be relatively easy to expand its capabilities to allow certain customers to *control* the environment for their products.

Suppose, for example, a container ship is carrying fresh fruit from Australia to the UK. The temperature and humidity within the containers must be maintained within certain parameters or the quality of the fruit will deteriorate excessively during the voyage. On-board sensors and controllers maintain this temperature and humidity within pre-determined limits. The problem is that these pre-determined limits are not necessarily appropriate for an entire voyage, which might take several weeks. It may be that changing the temperature or the humidity of specific containers during a long voyage would result in a better quality product. Perhaps different varieties of fruit would survive better if the humidity or temperature were constantly varied just as it did when the fruit was growing. Who knows? It's hardly likely that the ships' crew would, and the people who might know have no direct control. The people who are most knowledgeable about *maintaining* the quality of their products do not even have a way of *monitoring* its gradual deterioration. At the start of the voyage, they might specify what they think are the optimum temperature and humidity and leave the rest to the ships' personnel, trusting that these parameters will be maintained. At the end of the voyage they inspect their products, see how they survived and either fix or change the environmental specifications for the next consignment.

How much more peace of mind would it give these customers if they could simply log on to the ship's computer, check the condition of their products, and make any adjustments that they felt were appropriate? How much more liberating would it be if they could do this through their WAP[9] phone during a round of golf? How would such a facility impact on a ship-owner's customer relations and why would any fruit importer consign products to a competitor who failed to embrace the concepts of innovation? The technology is available; capitalising on it demands new ways of management thinking and a rejection of moribund traditions. It demands a change in organisational culture, organisational structure, organisational environment and the technological infrastructure that supports these elements - radical change. It demands, as I emphasised earlier, paradigm shift.

4.2 Innovation from a Psychological Perspective.

Implicit in an objective of this research, which is to define a strategic direction for innovation and change in the UK shipping industry, is the need to articulate how this might be achieved from both the organisational design and the learning perspectives. From the learning perspective it is imperative that I examine some of the training methods that purport to drive innovation, and dispel related misconceptions.

A reasonable starting point for understanding how some of the psychological perspectives emerged might lie in what Schumpeter (1939) claimed were his 'rigorous definitions' of innovation. Expanding on Schumpeter's work, researchers such as Mensch (1979), Clark and Soete (1981), Freeman (1950; 1979; 1983; 1994) and Kuznets (1954) suggested quite different definitions based on their own area of expertise and in doing so introduced phrases such as 'creative effort' to describe the innovation process. It may be no coincidence that, as Damanpour, (1995: 125-130) pointed out, there is now a tendency for some writers to use the terms innovation and creativity interchangeably. The main problem with the inadvertent suggestion that innovation and creativity are essentially the same lies in the underlying implication that working to improve individual or organisational creativity will create an appropriate climate for innovation. This notion, that training people to be creative will make an organisation innovative, is, I suggest, fundamentally flawed.

Writing from a psychological perspective for example, King (1995) highlights at least one serious problem that might be caused by failing to distinguish between the terms innovation and creativity. Arguing that 'some of the traits found to be associated with creativity could be problematic for organisation innovative performance' he suggests that, in personality terms at least, people who are perceived as creative are a different species to those who are regarded as innovative. The DTI's view, that 'innovation is a key driver of sustainable organisation growth' (DTI, 1996), seems to be a perfectly reasonable argument, but the notion that innovation success lies in developing organisational creativity could be problematic in the shipping industry.

Finding a universal definition for creativity could also be problematic. Taylor (1988), for example, identified over fifty. Let's just say then that creativity is usually perceived as being about bringing something that previously did not exist into the world, or about forming links between diverse entities. Innovation on the other hand is usually perceived as being about managing new products, processes or ideas to the extent that they become commercially viable; these are entirely different animals.

A number of researchers have, of course, suggested quite viable differentials between the two terms. King, for example, suggests that 'creativity requires that the product be novel to the creator whereas innovation requires that the product be novel to its organisational setting' (King, 1995: 83 - 87). Damanpour, (1995: 125 - 130) seems to agree, at least in principle, arguing that 'creativity and innovation should be understood by organisations as distinct, though related, potential goals'. On the other hand he also appears to agree with the definition of innovation suggested by Aiken and Hage (1971) and Daft (1982), who suggest that innovation is 'the adoption of an idea or behaviour that is new to the adopting organisation'. Whether the word 'adoption' is to be taken as meaning that it is also commercially viable is not clear. An organisation might, for example, have other motives for adopting ideas that are not commercially viable.[10] And, by adopting a new 'behaviour', organisations might be addressing their creative, but not necessarily their innovative needs.

King argues that innovation is an essentially public process - it has an effect on people other than the initiator of the innovation. Creativity, he says, does not have to be. He cites empirical studies by Nystrom (1979) who found that the division of a chemical company whose climate was [theoretically] the most favourable toward creativity was not the most successful division in terms of innovation.

At first glance, Csikszentmihalyi (1998) appears to disagree with King's stance, particularly with the idea that creativity can be a solitary activity. He asserts that 'what we call creative is never the result of individual action alone'. He goes on to argue - at length - that creativity can only result from interaction between three systems: social, cultural, and individual. Csikszentmihalyi's assertion, whilst sounding remarkably similar to my discussions on *innovation,* talks about an entirely different subject - *creativity.* His argument appears to stem from his rejection of the views of 'rationalists', such as Simon and Weisberg, who argue that creativity relies on exactly the same problem solving skills as those used in every day life (Simon, 1977; Weisberg, 1986). The potential for misunderstanding lies not so much in what Csikszentmihalyi means, but in the way that he says it. 'Without a culturally defined domain of action in which *innovation* is possible,' he says, 'the person cannot even get started; without a group of peers to evaluate and confirm the adaptiveness of the *innovation,* it is impossible to differentiate what is *creative* from what is simply statistically improbable or bizarre.' To me, the wording creates an impression that innovation and creativity are essentially the same thing. In my view, they are not.

Creating a culture of innovation in the shipping industry implies addressing the realities of change in terms of culture, structure, and technology. Creating a culture of creativity would probably imply addressing entirely different organisational phenomena. And the phenomena that impact on the domain of creativity are not necessarily the same as those that influence innovation. The shipping industry, the UK shipping industry at least, is operated and managed by experienced professionals who understand the practicalities of working in a hostile environment. Many of these professionals still endorse traditional ideas and management styles. Much of the technology is from a bygone era, and many of the organisational cultures could do with a spring-clean. But planning a route to innovation does not mean that we should try to replace professionalism with fads, or that we should encourage mariners to indulge in unproven techniques that claim to make people creative, as some authors would suggest (Gelb, 1995, for example).

Carr and Johanson (1995) define creativity as the generation of ideas and alternatives, and innovation as the transformation of those ideas and alternatives into useful applications that lead to change and improvement. Nystrom (1995: 66) argues in a similar vein, suggesting that innovation is the result and implementation of creativity. Neither of these definitions are particularly helpful in that they imply that creativity is inevitably linked to innovation.

In suggesting that innovation, rather than creativity, is the tool of entrepreneurship, Peter Drucker obviously takes note of the differences, and of the implications the differences have to management in organisations (Drucker, 1985a). On the other hand, he appears to view creativity as a special form of thinking that differs fundamentally from the style of thinking used in every day problem solving. It is difficult to quantify this notion, but even if it is true that still does not mean that innovation has any special relationship with creativity. Drucker appears to support this argument when he says:

> The popular notion of innovators - half pop-psychology, half Hollywood - makes them look like a cross between Superman and the Knights of the Round Table. Alas, most of them in real life are unromantic figures, and much more likely to spend hours on a cash-flow projection than to dash off looking for risks (Drucker, 1985b: 139).

Other authors have exposed the same potential for confusion in expressing how the perceived definition of creativity is influenced by perspective. For instance:

> Common-sense psychology tends to mystify creativity as a gift, psychoanalysts make it out to be a variety of neurosis and cognitive psychologists treat it simply as problem solving (Bereiter and Scardamilia, 1993: 122).

UK ship owners rely extensively on professionals trained in specific industry relevant domains to operate, maintain, and manage their fleets. The notion that creativity could have any bearing on the operation or management of a ship would be anathema to most mariners. On the other hand, there appears to be recognition within the industry that innovation and change are desirable.[11] It follows that it is imperative that members of the shipping community recognise the fundamental difference between the terms innovation and creativity. Alienating sea-going professionals by asking them to indulge in 'creativity training' (techniques that they might not endorse) could be counter-productive. Plotting a course in the direction of an integrated cultural, technological, and structural, innovation strategy implies examining the conflicting factors that, theoretically, drive innovation and focusing on those that are most appropriate to the industry.

4.2.1 The Concept of Domain Specific Creativity.

Henry Ford did not invent cars. Nor did he invent the machines that he used to make them. But the methods he used to build and sell his cars must surely rank as innovative. It is my contention that it was not creativity *per se* that was at work during this period of Ford's history, but rather a process of systematic, progressive re-formulation of problems that enabled him to re-define industry norms and values to his advantage. Ford continually worked on developing his expertise in a specific domain - building cars - and it was through development of domain specific expertise that he was able to develop and implement many new ideas in his field - to innovate.

Ford was *perceived* as creative and, in his own domain, and he probably was. But I put forward the argument that developing creativity within his specific domain had nothing whatsoever to do with buying creativity enhancement products, indulging in divergent thinking exercises, or metaphorical hat swapping. Domain specific creativity is the result of an iterative process in which problems and ideas are constantly re-evaluated and re-formed - in other words it results from the rigors of training.

The pages of history provide ample evidence to substantiate this argument. Edison, the Wright Brothers, Beethoven and Brahms are all well known for continually revising their ideas, trying over and over, and ultimately developing great expertise within their own domains. Famous writers such as Salinger[12] are known to have reworked virtually every sentence over and over. This progressive development of expertise within a domain is what I mean when I talk about domain specific creativity. The choice for mariners with an interest in the development of industry relevant innovation then, is whether to spend a few afternoons attempting to sow the seeds of general creativity in what might be a rhetorical workshop, or to nurture and refine their existing domain specific competencies. Which choice has the best chance of getting innovation underway in the UK shipping industry?

In the second edition of his book on problem solving, Kahney (1993: 90) pointed out that 'research in a number of different domains, such as chess and computer programming, indicates that highly skilled performance is based on highly organised domain specific knowledge' Kahney also highlighted differences in the way that novices and experts in specific domains solved problems. Experts, he found, tended to classify problems in terms of underlying principles and spend time reformulating problems. They tended to work towards their goal whereas novices tend to work backwards from the goal. Experts, he said, 'have a store of patterns representing commonly occurring configurations of information in the knowledge domain, and a store of solutions, or operations, to apply to them'. This suggests that experts acquire problem-solving schemas (representations based on experience and knowledge) relevant to their particular domain during the learning process.

In referring to what they called 'problem reduction', Bereiter and Scardamalia suggest that acquiring expertise within a specific domain involves a process called 'progressive problem solving'. Contrasting with the common sense view that problems should be eliminated, progressive problem solving involves the 'reformulation of problems at higher levels as lower levels are achieved'. This they identified as the major cognitive aspect in the process of the development of expertise (Bereiter and Scardamalia, 1993).

Empirical work carried out by Hayes seems to suggest that the commercial success achieved from acquiring expertise within a domain gradually increases for a period of about ten years before levelling off, the actual time varying between domains (Hayes 1985: 391-405)[13]. Simonton (1991), whose methods bore a striking resemblance to Hayes's, reached similar conclusions.

Problem-solving schemas seem to be perfectly adequate in most straightforward situations but the process of gaining expertise involves using, and perhaps modifying, these schemas to progress complex problems - working to the edge of competence[14]. Cultivating, gaining, sustaining, nurturing, strengthening, and whenever necessary overhauling this domain specific expertise seems to be a precursor to acquiring the domain specific creativity that invariably leads to innovation.

The notion that 'general creativity', if such a thing exists, can be artificially enhanced leading to a kind of subconscious ability to innovate is, in my view, an over simplification. More specifically, it can be observed that innovations invariably emerge through intimate knowledge of a particular discipline. Innovations that depend on knowledge of more than one discipline are fairly common, but these are typically the outcome of project focused inter-disciplinary or inter-organisational co-operation.

Whilst it is true that relying on a fertile imagination or creative genius might result in an odd innovation now and then, a more reliable strategy might be for ships' navigators to refine and redefine their existing competencies. For example, many sailors would find navigating business and innovation strategies an even greater challenge than gybing in a storm[15]. But as global competitive influences continue to impact on the need for innovation and change, the twenty-first century mariner is increasingly likely to be involved in both the celestial and the commercial brands of navigation. And managing that scenario will demand something a bit more consistent than the waves of inspiration that seem to be the goal of many 'creativity training' programs. It is, I suggest, domain *specific* creativity, not *general* creativity, that is one of the key drivers of innovation; and domain specific creativity is acquired through expertise, which in turn is acquired through training. I therefore make the assertion that the blueprint for consistent innovation does not reside in the realms of pop psychology and gimmickry but in professional, domain specific training. In short - consistent innovation is a strategic choice that can, and should, be planned.

4.2.2. Domain Hopping.

So far I have argued against the notion that general creativity has a substantial effect on the development of successful innovations and have presented an argument in favour of domain specific creativity. But there are numerous instances where organisations have diversified in order to survive. And there are also numerous instances of ideas that have been 'borrowed' from other domains in order to produce a new product. In 1967 for example, Hoyle Schweitzer, a surfer, colluded with skiers and sailors to develop the first wind-surfer. The 'clip on' pedals now fitted to most racing bicycles originated on the ski slopes and the CD ROM, now common on personal computers was conceived in the music recording industry. So does this disprove my idea that domain specific creativity rather than general creativity will be more likely to result in commercial innovations? I think not. Even though the cross-pollination of ideas borrowed from different domains has resulted in a substantial number of new ideas, new products and new inventions, that does not mean that the illusive general creativity rather than domain specific creativity was the culprit. Firstly, when these ideas have been borrowed from other (usually adjacent) domains they have already been well developed in that domain. In other words experts in that domain or discipline have already developed the original idea to a significant level of maturity. Secondly, the borrowed idea, even if it did happen to materialise from a wave of inspiration, still requires incorporation into the adopting domain; it still has to be exploited and marketed successfully to match its new setting. And that demands domain specific expertise - creative or otherwise.

In their 'Turn-of-the-Century Reflection on the Business Culture of Silicon Valley' Delbecq and Weiss (2000) talk about the valley as a 'unique confluence of factors and forces mixed together over time'. They illustrate how variables such as meritocracy, diversity, and excitement about new ideas and change, contribute to innovation. In this exposé domain specific expertise manifests itself as a vital ingredient in what must surely be regarded as one of the most innovative cultures on the planet. Innovation projects in this 'incubator of the future' are, according to Delbecq and Weiss, driven by diverse groups of highly skilled professionals 'at the peak of their technical competencies and close to the knowledge base of recent major university training'. California's Silicon Valley is, according to Posner (2000), 'a networked scheme of intellectual property and financial resources'. Certainly this review suggests that such diversity of knowledge and resources plays an important role in driving the innovation process. But it also adds weight to my assertion, that the notion that the combined expertise of members of a project team can be substituted by a few hours training in 'divergent thinking' (Wallas, 1926), 'brainstorming' (Osborn, 1953), 'synetics' (Gordon, 1961) 'lateral thinking' (De Bono, 1971) or 'the six thinking hats' (De Bono, 1985), is absurd.

4.2.3 Innovation is no Problem.

I now want to address another misconception; the notion that '*creative* problem solving' is a route to innovation. Although I argue that it is not, in doing so I emphasise, once again, the importance of definition and perspective. The term 'creative problem solving' from the perspective of many mariners would probably be seen as contradictory because it implies that 'problems' and 'creativity' lie at the same point of a continuum and that problems can be 'solved' through the flash of inspiration that some people call creativity. Whilst some problems might, occasionally, be solved in such a way the vast majority demand relevant skill, knowledge, or expertise.

One of the concerns I have with linking problems to creativity is that a problem (unlike a creation) must first manifest itself before it can be solved. The second concern I have with viewing problem solving in terms of creativity is that solving a problem implies attempting to make something that has already appeared go away. Creativity, on the other hand, is not about making something go away; it is about bringing something that previously did not exist into perspective. It is about finding links where none are apparent. And this type of creativity, I would argue, would be inappropriate to solving the types of problem that are common at sea because seafarers would be unlikely to endorse it.

Historically, operational problems at sea have been well-defined and unlikely to attract the label 'mess', which Ackoff (1981) uses to describe complex problems. But if ships' officers begin to adopt more proactive roles in the international business arena this situation is likely to change. Ackoff's suggestion that complex problems should be broken down to *minimise* interconnections between them in order to aid analysis, however, seems to be at odds with the notion of creative problem solving. In outlining an alternative to reductionism, Keys (1987: 17) talks about the need to 'consider the whole mess'. In doing so, however, he points out that:

> ...such a system does not solve a problem, but merely changes it, hopefully for the better. Further changes then need to be identified and implemented in a continuous manner.

To me, this seems more akin to *progressive*, than *creative* problem solving. Eden (1987) also argues against the notion of '*problem solving*' in an organisational context and favours the term 'problem finishing'. An interventionist, he suggests, should be just as concerned with the management of meaning as with analysing the situation. And this is my point, my concern is not so much with whether a problem is 'solved', 'reformulated', 'finished', 'alleviated', 'closed', or 'disposed of'; it is with whether ships' officers will understand the context in which such terms are used. Progressive problem solving seems to me to be a term that seafarers could take on board without creating confusion, creative problem solving does not.

4.2.4 The Learning Organisation.

Having argued that it is possible to influence an organisation's culture in the direction of innovation through changes in both its management (structure and technology) and psychological (environment and training) domains, I would like to take the argument further. I want to make one further proposal that I believe will benefit the UK shipping industry; the adoption of the concept, ideas and practices of a learning organisation.

Debates about what it means to be a 'learning organisation' have continued ever since Senge (1990) published his highly acclaimed book 'The fifth discipline'. Engaging in a protracted argument about different types of learning organisations is beyond the scope of this thesis and I therefore emphasise the main aspects of such an organisation. These are derived mainly from the works of Schein (1985; 1992; 2000).

In a 'learning organisation':

- Leaders balance the interests of all stakeholders, for example, customers, employees, and suppliers. ... 'no one group dominates the thinking of management... ' (Schein 1992).
- People share the belief that they have the capacity to change their environment, and ultimately decide their own fate.
- The organisation makes time for learning.
- People in the organisation believe that economic, political and socio-cultural events are inter-connected, both inside the organisation and in its environment.
- There is a commitment to learning within the organisation.
- Managers and employees are open to extensive communication and there is a common vocabulary throughout the organisation.
- People share the belief that trust, teamwork, coordination and cooperation are critical for success.
- Leaders acknowledge their own vulnerability and uncertainty. The leader acts as a teacher and steward of change rather than a charismatic decision maker.

Despite the enthusiasm with which ship's officers approach their own quest for professional competence, the UK shipping industry may still have a long way to go before it begins to develop a 'learning culture' in Schein's terms. Nevertheless, by synthesising some of the ideas presented in this chapter with the empirical evidence presented in the following chapters, I will progress these ideas and arguments, ultimately suggesting a change of tack that might be point it in the right strategic direction.

Conclusions

The mechanics of paradigm shift have the potential to change the methods of communication, navigation, automation, control and organisation within the U.K shipping industry. The influence that such change would have on the industry's relationship with the wider transport industry is inherently positive, but longstanding paradigms seem to exhibit symptoms of immortality. The shipping industry has for too long relied upon its traditional merchant of change - the legislator - to pre-empt, authorise, and enforce, rules and regulations that were primarily designed to guard against the perceived risks and perils of the sea.

Traditional maritime organisations and their supporting industries continue to be characterised by multiple layers of management, accountability, and bureaucracy; their main business criterion appears to be to avoid mistakes. A failure to move out of this moribund paradigm is eventually likely to manifest itself in diminishing returns and counter-productivity, not only to the shipping industry but also to those economies that depend on it.

The assumptions and norms of the old paradigm are inappropriate to an era where customer service, flexibility and innovation are paramount, but kick starting a new one demands holistic change. The basis for a fundamental transformation in the organisational structure and organisational culture is seen to lie with a logical extension of the ship into the inter-office communication network. Technology is seen as the support mechanism for both structural and cultural change.

In setting out the psychological characteristics required to drive the organisational culture in the direction of innovation I argued for a coherent interdependence between domain specific creativity and innovation but refuted implicit suggestions in the literature that innovation was affiliated to general creativity. Highlighting the non-problem concept of creativity in the innovation process I suggested that adopting the principles of 'learning organisation' designed to enhance the prospects of innovation through the development of domain specific expertise appears to be most appropriate for the UK shipping industry.

Notes Chapter Four

[1] For example, H.L. Gantt (1861 - 1919), Frank and Lillian Gilbreth (1868 - 1924 and 1878 - 1972).

[2] This article discusses the revolution in industrial software. The new marine environment is following a similar pattern.

[3] For example, Jackson's interpretation of sociological paradigms, organisation metaphors and Socio-technical systems theory.

[4] For example the work of Checkland (1981), Flood and Jackson (1991), Flood and Romm (1996) Midgley (2000), and many others.

[5] I discuss this matter further when examining implications of the Social Construction of Technology (SCOT) and Actor Network Theory (ANT) to the shipping industry.

[6] Chapter five deals with the issues of measurement and provides the rationale for choosing a perspective lying at the quantitative end of the methodological spectrum.

[7] Some companies attempt to innovate by listening to their customers. They listen so well that they fail to anticipate radical new technologies that the customer does not yet know about but will eventually demand.

[8] The world's major trading regions: Western Europe, North America and the Pacific Rim are known collectively as the 'Triad of economically advanced areas'.

[9] Wireless Application Protocol (WAP) is the standard protocol used to enable mobile phones to access the internet. During the writing of this chapter, even more ambitious protocols were being developed.

[10] For example, adopting a 'green' idea because legislation demands it, or to avoid potentially costly disposal costs in the future.

[11] The empirical evidence is presented in chapter six.

[12] Salinger, J(erome) D(avid), 1919 - US writer. He wrote the classic novel of mid-20th-century adolescence *The Catcher in the Rye* in 1951. He developed his lyrical Zen themes in *Franny and Zooey* (1961) and *Raise High the Roof Beam, Carpenters and Seymour: An Introduction* (1963), short stories about a Jewish family named Glass, after which he stopped publishing.

[13] Hayes counted the number of classical music recordings in Schwann's record guide for each of the major composers and plotted the number as a function of the passage of the number of years the composer had been writing. Success increased steadily for ten years before levelling off.

[14] Bereiter and Scardamalia call these endlessly complex problems 'constitutive problems of a domain'.

[15] Gybing is a nautical term, which refers to shifting a fore-and-aft sail from one side of a vessel to the other while sailing before the wind. Changing tack by gybing in a storm is a dangerous manoeuvre that, if not executed correctly, can easily result in capsize.

Chapter Five

Primary Research Design

Introduction

Predominant in the design of the empirical phase of this research were three overriding objectives:

1. To ensure that the method used to obtain and analyse data would offer the best chance of answering the research questions (set out in the conclusions of chapter two) as objectively as possible.

2. To ensure that survey and interview questions would be easily understood by the recipients, that they would be able and willing to answer questions, and, that I would be able to guarantee anonymity to those respondents who did not wish to be identified.

3. To ensure that the data would be sufficiently substantive (that the survey represented a sufficiently large sample of UK ship-owners), and that it would be possible to analyse it in such a way that the conclusions would be based on valid, reliable, and repeatable data.

With these three primary objectives in mind I decided that it would be pertinent to conduct an initial pilot survey, which would provide an opportunity to test the effectiveness of the questions, and the likely response rate, prior to sending out the final questionnaires.

The design of the pilot and final questionnaires were based on slightly different criteria. In designing the pilot questionnaire, which was essentially intended as a trial run, I relied to a large extent on my own knowledge of the international shipping industry to define the questions. In doing so, however, I remained conscious of the need to maintain a focus on the research questions, and on the need to gather general information pertaining to the current technological infrastructure, cultural conditions, structural shapes, and operating environments within the UK shipping industry.

The final questionnaires were designed with the benefit of hindsight, in that by the time I needed to mail the final questionnaires I had already reviewed a substantial volume of relevant literature, and received feedback in the responses to the pilot questionnaires. That is why there are some differences between the two sets of questionnaires.

In chapter three I provided the rationale for deciding to base the empirical research on both inductive and deductive approaches and in that respect defined a mainly quantitative research strategy based on a postal survey, supplemented by a qualitative strategy which would be analysed using grounded theory. This chapter will provide details of how both of these broad strategies were designed in the context of this research.

5.1 Defining the Target Organisations

Comprehensive details of all registered vessels and their owners are provided in Lloyds Register of Ship Owners (2001-2002) and in Fairplay (2001-2002). In seeking to establish which ship operators and owners in the UK would be able to provide information that was relevant to the research questions it was necessary to analyse the information provided in these publications and to compile a condensed data table of relevant parameters.

This condensed data table (shown in appendix b) was derived from the analysis of data in these two publications and shows that at the end of 2001 there were a total of two hundred and eighty-seven ship owners in the UK. As I explained in chapter three, it is possible (by cross referencing the 'vessel owner' with 'vessel type' code) to identify the various types of vessel in the fleets of each ship owner.

By referring to these tables (appendices a and b) it can be seen that some ship owners employ a range of different vessels whilst others employ only one or two specific vessel types. The type, and the variety, of vessels that a ship owner owns or employs provides a fairly solid indicator of which sector or sectors of the shipping industry that particular owner addresses. The tables suggest that some owners are interested only in specialised segments of the shipping industry - the offshore oil or gas industry for instance - whilst others are active in several segments.

The criteria for selecting those organisations that would more likely be able to provide relevant information would, I decided, be based on an analysis of the market sectors in which the organisation seemed to be interested, and upon their physical areas of operation. For instance, ships that trade worldwide are more likely to benefit from the innovations related to long range navigation and communication systems than ships that trade locally. Such ships would also have the basic essentials of reliable long-range communication - GMDSS equipment - already installed.

Prior to GMDSS, the type of electronic navigation and communication equipment that commercial ships were compelled to install depended primarily upon the vessels' physical size. Most commercial ships of greater than three thousand gross tons were compelled to carry both a qualified radio officer and appropriate radiotelegraph equipment. Such vessels were capable of communicating on a global basis, even if they did not need to do so. Smaller vessels were normally subject to less stringent regulations, regardless of where in the world they operated.

The type of equipment that must be installed under GMDSS regulations depends, more logically, upon the vessel's intended area of operation rather than on its physical size. Since this research is concerned with innovation on ships that operate in distant waters, the most logical criteria for asking specific organisations to complete a survey questionnaire would have been to select those organisations that owned vessels on which GMDSS equipment was installed. By focussing the empirical work on such organisations' vessels, there would be a strong probability that it would also be focussed on vessels that routinely sailed in distant waters.

Unfortunately currently available maritime statistical data does not provide direct information about which United Kingdom ships have, and which do not have GMDSS installed. It was therefore necessary to develop an appropriate method of determining the probability of a particular organisation owning ships that were likely to be employed on a global basis before requesting them to participate in a questionnaire type of survey.

The criteria for deciding which vessels were more likely to be employed on a global basis could not be based upon whether or not the vessel had GMDSS equipment installed without first contacting the organisation concerned and asking the question directly.

This would have meant contacting the same organisations at least twice, once to ask the relevant manager if any of their vessels had GMDSS equipment installed, and again to ask if s/he would complete a questionnaire. This method was rejected because it was felt that asking for the same type of information twice would be likely to irritate busy managers who might then not respond to the second questionnaire.

Another alternative would have been to send a questionnaire to all two hundred and eighty-seven shipping organisations. This was rejected on the basis that organisations whose vessels did not operate globally were unlikely to know what GMDSS was and would therefore find the questions confusing. The condensed data table discussed above provided a method by which I could identify ship owners whose vessels were likely to be most relevant to the research questions.

It is logical to expect that large ships are more likely to have been designed for global trading than small ships. The first criterion then was to define the minimum vessel size that a shipping organisation's must have within its fleet before being a possible candidate for global trading. The most logical cut off size to choose was three thousand gross tons[1]. Such vessels, it was reasoned, would at least have the capability to be involved in global trading. However, it was also recognised that not every large vessel is built for this purpose.

The second criterion was based on the type of vessel. The vessel type coding system previously mentioned (see appendix a) provides a fairly reliable indicator about whether or not a particular vessel is likely to be regularly sailing on a global basis and therefore out of touch with normal land based communication systems. Accommodation vessels (AA), Dredgers (GN), and Offshore Drilling Barges (ZD), for instance, are unlikely to be employed doing anything other than the work for which they were designed. Such vessels are therefore likely to be employed in some fixed location, often relatively close to land, and almost certainly within radio or mobile telephone range of their controlling shore based office.

The vessel types that were excluded from the survey because they were unlikely to be regularly sailing on global routes have been marked with an asterisk (*) on the ship operator vessel type codes shown in appendix (a).

Excluding shipping organisations that do not have at least one ship of greater than three thousand gross tons, and that were therefore more likely to be focussing on activities of a local rather than a global basis, reduced the number of *relevant* shipping organisations in the United Kingdom to one hundred and seventy. Between them these shipping organisations own a total of one thousand and fifty-two ships.

By excluding shipping organisations that *only* own vessel types that are likely to be permanently employed within coastal regions, the number of United Kingdom shipping organisations that would be able to provide information relevant to this study was further reduced to one hundred and thirty-six. Between them these organisations own nine hundred and fourteen ships. These ships, all larger than three thousand gross tons, are likely to be involved in global trading.

Questionnaires were sent to the owners of all of these vessels. I decided that the first forty questionnaires would form the basis of the pilot study mentioned earlier, and that the remainder of the questionnaires would only be dispatched after the pilot study was completed. This provided an opportunity to refine the questions, change the order of the questions if necessary, and to conduct further literature reviews based on the results of the pilot study.

The pilot questionnaire - appendix (d) - was sent to forty shipping organisations - appendix (e) - randomly selected from the one hundred and thirty-six organisations previously defined as relevant. The final questionnaire - appendix (f) - was sent to the remaining ninety-six shipping organisations - appendix (g). Based upon previous experience in the industry I expected a response rate of around forty percent from each of the surveys.

5.2 The Questionnaire Designs

The questionnaires were designed with a number of specific objectives in mind. Firstly the response to the questions would form a basis for both inductive and deductive analysis in the context of the research questions. Another consideration was to obtain feedback from professionals within the industry that would provide an insight into whether, how, and why industrial cultures, structures, policies and training opportunities should change and indeed whether they could change. Managers' views on technology would influence the prospects for change, and any evidence that might suggest significant differences between organisations could indicate industrial diversity. In the latter event it would be necessary to examine whether this diversity was related to the type of ships that the organisation operated or to historical, structural, or cultural differences in wider organisational communities.

To measure the extent of any historical, structural, or cultural influences, I would need to be guided by some form of benchmark. In attempting to derive such a benchmark I decided to address the same questionnaire to a sample of forty similar organisations in the Netherlands, a country where the history of organisational development differs considerably from that in the UK, and to see if there were significant differences in responses.

Of course it would have been possible to assess the possible influence of historical and cultural differences by addressing organisations in almost any European country. In opting for the Netherlands, various factors relating to the shipping industry were considered. The total number of registered ship owners is approximately the same in both countries - two hundred and eighty-seven in the UK and two hundred and twelve in the Netherlands[2]. The average age of both countries' international commercial fleet is also approximately the same[3]. Several of the major ship-owners in the Netherlands operate joint ventures with similar organisations in the UK (P & O - Nedlloyd for example) and the competitive 'seascape' is approximately similar. Royal Dutch Shell's arch competitor, for instance, is British Petroleum (BP).

The port of Rotterdam is the largest commercial port in the world, whilst, according to Associated British Ports (ABP), several major British ports, including the largest, are currently experiencing unprecedented growth[4].

Language was another important factor. English is well understood throughout the Netherlands, I have some knowledge of the Dutch language, and its structure is such that the risk that the questionnaires might be misunderstood or inappropriately translated was low.

Finally, towards the end of 2001, the Netherlands hosted one of the world's most important maritime exhibitions and conferences (Europoort 2001). This conference would create an opportunity to talk to managers and sea going officers in the industry and thereby provide an opportunity to gather further information relevant to the research questions.

As I mentioned earlier, it would have been unrealistic to expect that managers would be prepared to answer questions related to the research questions directly, and even if they did their responses could have been arbitrary. It was therefore necessary to develop research instruments - questionnaires, interview criteria, and rationale for appropriate literature reviews and analysis - that balanced the potential for arbitrary responses with the need to address the research questions.

In phrasing the specific questions, consideration was given to the possibility of generating interval or ratio level data directly from each question. Such data could then have easily been analysed with the *exclusive* use of quantitative data analysis software (for example, SPSS). However, introducing this criterion into the development of the questionnaire would, as I also discussed earlier, have increased the complexity of the questions and would almost certainly have resulted in a lower response rate. It was therefore accepted that only nominal and ordinal level data would be generated directly and that this would be analysed using both quantitative and qualitative techniques.

Direct analysis of the responses would provide a basis for specific assumptions relating to the responding organisation's attitude to technology and change, and to its organisational culture and structure. In short, the questionnaires were designed to address the research questions by generating data that could be analysed both inductively and deductively without introducing unnecessary complexity, and without asking questions that might not be answered truthfully.

It was evident that even if a response was received from every questionnaire, and even if all the questions were answered, the data would still need to be synthesised and combined with existing knowledge before probable answers to the research questions would begin to emerge. Information in the literature review and theoretical framework (chapters two and four) focuses on organisational culture, organisational change, and technology and provided additional substance, reason, and credibility to justify the conclusions. However, I also decided to visit the 'Europoort 2001' conference. This conference, which is held bi-annually in Amsterdam, provided a platform for discussion with captains, navigating officers, and managers in the shipping industry. Information and comments obtained from these sources would, I decided, enable me to judge to some extent the validity and reliability of the answers to the questionnaires.

5.3 Rationale for the Specific Questions - Pilot Questionnaire

The pilot questionnaire was intended to address five specific objectives. Firstly it was intended to be used as a vehicle for examining the opinions and attitudes of managers to changes that had, and that were likely to continue to occur in the shipping industry as a consequence of the GMDSS regulations. It was equally important to test the relevance of the questions, and the data that would accrue in the responses, to the research agenda. A third purpose was to verify that the managers to whom the questionnaire was addressed would clearly understand the questions and would be willing and able to answer them. Fourthly, the comments and responses would call attention to any deficiencies in the conceptual framework and act as a beacon for confirming the relevance of further literature reviews that would ensue. Finally it would provide an indication of the likely response rate to the proposed final questionnaire.

5.3.1 Pilot Questionnaire - Question 1

Before installing any GMDSS equipment, which of the following communications systems were installed on *most* of your ships?

Radio (voice) ☐ Radio (Morse) ☐ Radio (telex) ☐

Satellite (C) ☐ Satellite (A) ☐ Satellite (B) ☐

Satellite (M) ☐ Sat-Nav (transit) ☐ Decca Navigator ☐ Loran ☐

GPS ☐ Radar (X band) ☐ Radar (S Band) ☐ ARPA ☐

Inter switched Radar/ARPA ☐ Direction Finder ☐ Echo Sounder ☐

Electronic Log ☐

This question was designed to provide an insight into the organisation's attitude to the benefits of technology and to technological change. An organisation that was still using some of the moribund technology on the above list, before the GMDSS regulations all but demanded[5] that they change, could be considered less supportive of technology than one that had already installed more modern systems. Some of the systems on the list that could be regarded as fairly modern would include satellite communications, GPS, and inter switched Radar/ARPA. Equipment such as Radio (Morse) could be regarded as being on a course to obsolescence even before GMDSS, although many shipping organisations were still relying on this kind of technology for most of their communications.

The nominal data that would be generated from this question could, I decided, be analysed using the non-parametric frequency tests described in the following chapter. However, I also recognised that if valid ordinal level data could be generated then it would also be possible to employ non-parametric tests based on the ranked order of the data.

Tests such as the Mann-Whitney U test (Siegel and Castellan, 1988: 128-137), also described in the following chapter, would reinforce the nominal data tests and provide additional support for the various comparative analyses that I intended to use.

One way to generate ordinal level data would be to rank each piece of equipment in terms of factors such as its technological capability, its perceived value, its age, or its cost. Clearly, in order to rank equipment in this way I would need to develop a method of assigning order to various items of technological equipment through the use of 'judgement samples' in which the potential for subjectivity was weak. According to theoretical statistician Deming:

> A judgement sample is one in which an expert in the subject matter makes a selection of 'representative' or 'typical' countries or other areas or business establishments. For an evaluation of reliability of such a survey we must rely on the expert's judgement: we cannot use the theory of probability (Deming, 1960: 31).

The items of equipment listed in question number one consist of two broad types - communications equipment and navigational equipment. Clearly it would be illogical to assign rankings to these two completely different types of equipment; that would be tantamount to arguing that an apple is better, worse than, or equivalent to a screwdriver. It would however be reasonable to assign rank order to equipment, which could be used for the same purpose, provided that the purpose and the criteria are explicit.

For example, I would probably rank an electric saw 'better' than a hacksaw blade for sawing a large quantity of wood. Assigning such a ranking would be 'subjective' but it would also a reasonable 'judgement' based on a specific criterion and purpose (speed, ease, and sawing wood).

On the basis that I would expect most people in the industry to agree with my judgement then, I assigned (separate) rankings to the communications and navigational systems listed in question one of the two questionnaires. The criteria on which I base these ranking is outlined in appendix (h).

This appendix provides details of the technological capabilities, the relevant costs, and the specific advantages and disadvantages of the various items of equipment. The alternatives that a ship-owner might chose in deciding whether or not to invest in specific systems is also explicit. Figure 5.1 represents a coherent 'judgement sample' ranking of all the items listed in the pilot and final questionnaires.

Figure 5.1
Judgement Sample - Ranking of Technological Systems.

Communication Equipment Type	Rank	Navigation Equipment Type	Rank
Satellite Standard B	1	Inter-switched ARPA / Radar	1
Satellite Standard A	2	ARPA	2
Satellite Standard C	3	S Band Radar	3
Radio Telex (TOR)	4	X Band Radar	4
Satellite Standard M	5	Electronic Log	5
Radio (Voice)	6	GPS	6
Radio (Morse Code)	7	Sat-Nav	7
		Loran C	8
		Decca Navigator	9
		Echo Sounder	10
		Direction Finder	11

Relating these equipment rankings to the responding organisation provided a basis by which the organisations could also be ranked in terms of their attitude to the benefits of technology and technological change. Organisations that install equipment with higher rankings are considered to be more supportive of technology than those that do not. Organisation ranking is therefore based on the overall technological capability of the various items of equipment installed on the majority of the organisation's ships.

In order to produce an organisational ranking, I considered assigning a value to each item of equipment that was based upon the rank order defined in figure 5.1. Assigning a specific value to the equipment however might have been considered subjective. I therefore employed a coding system in which I assigned separate variables to each item of equipment in question one of the questionnaire. Using the 'compute' facility within the (SPSS) software I then reproduced the list of navigation and communication equipment in ranked order for each organisation in two additional variables (one variable for communication equipment and one for navigational equipment). It would not have made much sense to try to combine the two rankings for the reasons discussed earlier. However, by examining relationships between the two independent ranking variables it was possible to gain an insight into whether organisations that installed the 'best' communication systems also installed the 'best' navigational systems. Details of the coding and computing facilities used to achieve the two sets of organisational ranking are provided in chapter six. The data derived from the responses to this question are analysed using various non-parametric statistical tests. The details of these tests are also explained in chapter six. The question is designed to partially addresses the first of the three hypotheses set out in the conclusion of chapter two.

5.3.2 Pilot Questionnaire - Question 2

At that time, [Prior to GMDSS] which of the following was used for *most* of your *commercial* communications? (Please tick only one box)

Radio coast station ☐ Satellite (C) ☐ Satellite (A) ☐ Satellite (B) ☐

Satellite (M) ☐ Other means (please specify)

This question was intended to query whether ship owners who had installed satellite communications systems were aware of all of the potential benefits to be gained from using it. Prior to GMDSS, using satellite communications was considered very expensive and the question sought to find out whether or not ship owners thought that the benefits of improved communications outweighed the increased costs. The different forms of maritime satellite communications ('C', 'A', 'B', 'M' etc.) offer various levels of service and have different capital and operational cost structures. These alternative forms of satellite communications were discussed in chapter two. The question provides direct information relative to research questions four and five. It is also intended to provide an impression of whether or not the organisation recognised the capabilities, possibilities, applications, and limitations of the various forms of satellite communications. In that respect it begins to provide an insight into research question number three and into the second hypothesis. In a later question (question seven) the organisation is asked to provide a rationale for their choice of GMDSS equipment. The answer to this question supplements this impression.

5.3.3 Pilot Questionnaire - Question 3

Which system do you *currently* use most for *commercial* communications to most of your ships? (Please tick only one box)

Radio coast station ☐ Satellite (C) ☐ Satellite (A) ☐ Satellite (B) ☐

Satellite (M) ☐ Other means (please specify)

This question was designed to examine whether or not there had been any significant changes to the methods of communication with ships since the mandatory introduction of GMDSS. If there had been a significant change it could indicate that the organisation was beginning to recognise the potential benefits of change, at least in terms of communication. It could also suggest that the organisation might have plans for further change. In the event that the organisation was using satellite communications, the form ('C', 'A', 'B', or 'M') that the organisation was using would provide some indication about what type of communications (for example mass data, voice, or text messages) the system was being used for. The question provides further information pertaining to the second hypothesis, and, by comparing the responses from UK organisations with those from the Netherlands, provides further evidence relative to research questions four and five.

5.3.4 Pilot Questionnaire - Question 4

Do you think that the GMDSS system is better or worse than the original system for *distress and safety communications?* Better ☐ Worse ☐

This question serves two purposes. Firstly it looks at the organisations' views on technology as a means of providing improved distress and safety systems. A prior review of some of the press reports on the value of GMDSS suggested that many ships' officers were unimpressed with the new system, mainly because of the large number of 'false' distress messages they had experienced. In view of these reports I expected that several respondents would take the opportunity to elaborate on their answer to this question and explain why they thought one way or the other. I did not specifically ask them to elaborate because that would have reduced the potential to gain a further insight into the respondent's attitude to technology in general. If a respondent simply said that the system was 'worse' without any explanation, it could suggest that s/he would prefer not to change at all. Conversely, those who simply said it was 'better' might not have experienced any problem with 'false' distress messages and their response might not therefore reveal their true feelings about technology in general. Respondents who took time to elaborate would provide a valuable insight into their feelings and interest in technology. By expressing a desire to see improvements in the new systems, rather than simply accepting or rejecting the technology as it stood they would effectively be providing an indication of their interest in, and desire for, change. The question is intended to provide indicative information relative to the first two hypotheses and to research questions one, three, four and five.

5.3.5 Pilot Questionnaire – Question 5

> Do you think that the equipment that was installed as part of the GMDSS package is adequate for most *commercial* communications? Yes ☐ No ☐

The objective here is to obtain reinforcing information in respect of the organisation's views on technology, this time from a commercial, rather than a safety perspective. By combining the answers to questions four and five it would be possible to judge whether or not the organisation had thought about the consequences of GMDSS in terms of their commercial activities.

The implications of using (or not using) particular methods of communication are likely to play an increasingly important role in the ability of shipping organisations to respond to competitive challenges. For example, if a shipping company offered its clients direct 'on line' access to all of its ships it might gain a significant competitive advantage over shipping organisations that did not. This question seeks to find out whether such possibilities have been considered.

5.3.6 Pilot Questionnaire – Question 6

> Did you install additional equipment, over and above the GMDSS requirements, for commercial communications? Yes ☐ No ☐

Again, this reinforcing question was aimed at gathering additional data. It was intended to serve as an indicator of whether or not there had been unexplained discrepancies in the responses to questions aimed at determining the respondents' attitudes toward technological change (questions four and five). Additionally, the question sought to discover whether the organisations that had responded negatively to question five had actually attempted to improve their communication's capabilities.

5.3.7 Pilot Questionnaire - Question 7

What was your main consideration in deciding when, and which, GMDSS equipment to install (please tick one only box)

Equipment price ☐ Running costs ☐ Delivery time ☐

Ease of use of equipment ☐

Possibilities to integrate with existing equipment ☐

Technical capabilities of equipment ☐ Future plans for integration ☐

There are six possible answers to this question and the respondent was asked to tick only one box. Ticking any of the first three boxes would indicate that the respondent organisation was primarily interested in complying with the new GMDSS regulations and had probably given little thought to the possibilities of benefiting from the technological capabilities that the new equipment might offer.

There would be a greater probability that organisations whose primary interest was in the technological capabilities covered by the last three options would already be considering how the changes might influence their structural, cultural, and environmental models in the future. The responses could be further subdivided to provide an indication of how responsive the organisation was to change.

For example, the GMDSS regulations provided organisations with a four-year 'window' in which to have the GMDSS equipment installed before the system finally became mandatory on February 1st 1999. Organisations that ticked 'delivery time' as the prime motivator in deciding which equipment to install had probably left the decision until the last possible moment and in doing so had, to some extent, exposed their culture of resistance to change (or their resistance to spending money).

Similarly, ticking equipment price, or running costs, would suggest that short-term financial implications commanded a higher priority than future plans for innovation.

5.3.8 Pilot Questionnaire - Question 8

Subsequent to the installation of GMDSS equipment did you decide that:

The Radio Officer was redundant □

The Radio Officer would be retained with the same duties as before. □

The Radio Officer would be retained, but his/her duties would be mainly administrative □ The Radio Officer would be retained but his/her duties would be mainly technical support. □

(Please tick one box only)

Organisations that decided that the radio officer (RO) was redundant may have made this decision from either of two general perspectives.

1) They simply wanted to save money, and, since the GMDSS regulations did not require an RO to be carried, they decided to implement immediate cost savings, or

2) There were plans to change either the corporate, or the on board structures to accommodate the new technologies and the RO was not included in their plans for innovation.

Deciding which of these imperatives was more likely would be established through the phrasing of the additional questions in this pilot questionnaire. The remaining three options in the question sought to establish why the organisation had decided to retain the RO. For example, organisations that ticked 'technical support' or 'the same duties as before' might be showing a concern for the reliability of the new system. Organisations that ticked 'mainly administrative' had probably thought about changing the hierarchical structure on board ship in some way and may have considered the influence that technology might play in such re-organisation. Whilst it is not possible to identify the *prima facie* reasoning with a single question, subsequent questions, and planned semi-structured interviews were designed to encourage discussion on this subject.

5.3.9 Pilot Questionnaire - Question 9

> Do you believe that the new communication capabilities will make it easier, faster and / or cheaper to communicate with ships at sea?
>
> Now - Yes ☐ No ☐
>
> In the Future - Yes ☐ No ☐

Different organisations will have formed their own opinion about whether the new technologies would provide substantial improvements or not. Some organisations were expected to answer no to both questions and this would, to some extent, confirm their lack of trust, or lack of interest, in innovation and change.

This 'pilot' question was designed to examine the extent of this lack of trust or interest. Once this had been established it would serve as a basis to guide the design of further questions that would be included in the final questionnaire. If the results of the pilot questionnaire indicated an extensive lack of trust or interest in innovation and change, then questions in the final questionnaires could be designed to establish the probable reasons for this. If, on the other hand the results indicated a positive consensus, then the final questionnaire could address aspects relating to how the new technology might influence, and be influenced, by organisational form and culture.

5.3.10 Pilot Questionnaire - Question 10

> If you answered NO to both parts of question number nine, could you please explain why you do not expect to see such improvements?

This question is self explanatory; it is intended to provide information about why a particular organisation might have responded as it did to the previous question. By including this type of question I was attempting to encourage respondents to engage in a form of dialogue that might provide information relating to organisational culture, structure, or environment. For example, had respondents thought about the strengths and weaknesses of new communications technology? Did they see technology as a potential driver of innovation, or as an additional burden on their budgets? And had they linked change in technological infrastructures in the shipping industry to a possible need to change their organisational structures, cultures or environments?[6]

5.3.11 Pilot Questionnaire - Question 11

> Do you think that new navigation systems (such as GPS) will ultimately make traditional navigational instruments (such as sextants) obsolete?
>
> Yes ☐ No ☐

In the light of the apparent soft spot that some members of the shipping community have for technological dinosaurs and moribund technologies (discussed in chapter three) I expected such respondents to view new technology as a threat to 'traditional' communication and navigation instruments, as well as to their views. Respondents who believe that traditional systems might survive a tidal wave of new technological instruments that are more accurate, faster, easier to use, and considerably cheaper than the originals are unlikely to be interested in, or support, any maritime innovation that might pose a challenge to their own traditional competencies.

This question is designed to examine the extent of such opinions and in doing so it partly addresses the first two hypotheses set out in chapter one. It also serves as a precursor to some of the questions in the final questionnaire.

5.3.12 Pilot Questionnaire - Question 12

> Do you think that your ship's officers may require additional training in subjects over and above their core competence (for example, do you think that training a navigation officer in management techniques or some other skill would benefit either the company or the individual?)
>
> Please tick all appropriate boxes
>
> Yes ☐ Benefits to the company ☐ Benefits to the individual ☐
>
> No ☐ Would not benefit either ☐

This question is self-explanatory. It seeks to establish whether or not shipping organisations have considered the possibility that additional training might enable ships officers to perform duties that are currently being handled in some other way. For example, could ships' officers perform administrative duties related to delivery of consignments that are currently managed ashore? It forms, to some extent, a basis for defining more specific questions for the final questionnaire and is intended to generate information that is relevant to hypotheses one and two, as well as to research questions six, seven, and eight.

5.3.13 Pilot Questionnaire - Question 13

> If you have ticked yes to the above question, what type of training do you think will be required in the future?
>
> Technical ☐ Commercial ☐ other (please specify)

Question thirteen is also self-explanatory but the objective here is to gain an insight into whether organisations have considered using ships' officers for commercial activities, or whether they regard these officers' functions as purely technical. 'Commercial' activities could be regarded as new and different tasks that are not currently performed on board ship. 'Technical' activities, such as navigation and engineering are tasks that ships' officers already perform. I am seeking here to establish the extent to which organisations might be thinking in terms of change. This cannot be established in a single question and so, once again, the response were intended to guide the questioning in the final questionnaire and in planned semi-structured interviews. The question is directly relevant to research question number seven.

5.3.14 Pilot Questionnaire - Question 14

> Do you think that new communication technologies (such as the internet) could be used to deliver such training to ships at sea economically?
>
> Yes ☐ No ☐ Now ☐ In the future ☐

Some shipping organisations will already have experimented with using their new technology for different purposes, whilst some will not. The purpose of this question was to try to establish the extent of any planned changes that might have been considered in the light of developing technology. It was also fundamental to the research to discover whether or not shipping organisations had the confidence to rely upon new technology, at least in principle. This question is particularly relevant to research question number eight.

5.3.15 Pilot Questionnaire - Question 15

> Do you think that the organisational structure on board ship will change, or already has changed, as a result of the developments in information and communication technologies?
>
> Will change ☐ Will not change ☐ Has already changed ☐

Hypothesis number three is directly addressed in this question, which sought to establish the extent to which shipping organisations had undertaken, or had planned for, change as a result of new technology. The question is also relevant to hypothesis number two, and to research questions numbers two, four, five, six and seven.

5.3.16 Pilot Questionnaire - Question 16

> Do you think that the organisational structure ashore will change, or already has changed as a result of the developments in information and communication technologies and / or as a result of any changes in the organisational structure at sea Will change ☐ Will not change ☐ Has already changed ☐

Essentially this is a repeat of question fifteen, but this time addressing the subject from a shore based perspective. It is likely that organisational structures within the shipping industry's offices ashore will ultimately need to be designed to match any organisational changes at sea. This question looks at the extent to which organisations are aware of this. It also seeks to establish the extent to which shipping organisations appear to be resisting innovation and change and in that respect it is relevant to the three hypotheses and to research questions numbers one, two, four and five.

5.3.17 Pilot Questionnaire - Question 17

> Do you think that new technology, particularly information and communications technology, will improve the profitability or learning opportunities for the shipping industry as a whole?
>
> Yes ☐ No ☐

Of direct relevance to the three hypotheses and to research questions numbers one, two, three, four, and five, this question looks primarily at the industry's opinions and attitudes to change, particularly change that is influenced by technology.

5.3.18 Pilot Questionnaire - Question 18

> Are your ships trading world wide, or on specific routes?
>
> World Wide ☐ Specific routes only ☐

In the cover letter that accompanied each questionnaire (appendix i), I guaranteed the confidentiality of the respondent's views and, in effect, assured them that they could not be identified through their response. However, it was also apparent that the various 'types' of shipping organisation would have different agendas and that they might therefore respond accordingly. For example, a shipping organisation that operated ships that traded globally might be very interested in the improved navigational and communication capabilities of GMDSS whereas organisations that operated primarily on short sea routes might not. Even though both sets of respondents might have the same views regarding innovation and change, they might respond differently because of their own environmental influences. The ethical dilemma (ensuring that I would have the ability to disclose the 'type' of ship-owner without necessarily revealing the identity of the respondent) was resolved through the inclusion of this question, which sought to separate these two different 'types' of shipping organisation without directly identifying them.

5.4 Rationale for the Specific Questions - Final Questionnaire

During the analysis of the returned pilot questionnaires, a number of supplementary questions emerged. Subsequent to a further literature review that focused on some of the issues emerging from the pilot study it also became apparent that some of the questions would need to be modified. On the other hand, several of the questions that were asked in the pilot questionnaire were clearly providing useful data, prompting a desire to obtain a larger sample for the final analysis. These questions were therefore repeated. Question one remains unchanged from the pilot study.

5.4.1 Final Questionnaire - question 2

Do you think that the methods used for communicating with ships at sea since the introduction of GMDSS is better or worse than the original system?

(a) For distress and safety communications Better ☐ Worse ☐

(b) For commercial communications Better ☐ Worse ☐

In the pilot study I focused this question on distress and safety communications only and described the underlying rationale for doing so (pilot question 4 - section 5.3.4). Subsequent to the analysis of the data it became clear that ship owners had varying degrees of respect for the new distress and safety system but recognised to a large extent the value of improved communications from a commercial perspective. The pilot question was therefore modified so that both the commercial and the distress and safety aspects were addressed.

The rationale for this question is essentially the same as discussed in section 5.3.4 but the revised question gains value over the original pilot question by providing more comprehensive information pertaining to the first hypothesis.

5.4.2 Final Questionnaire – Question 3

Do you think that manufacturers of communications and navigational systems should be compelled to adopt a 'standard' method of controlling their equipment so that, regardless of manufacturer, all marine electronic equipment would have a standard set of controls in more or less the same place?

Yes ☐ No ☐

Several respondents, in providing detailed comments in response to the pilot questionnaire, had expressed concern about the different ways in which new technological systems were being designed from an operational perspective. It became apparent that there was considerable concern about the ways in which the various manufacturers of marine electronic systems were adopting widely different methods of operation for their equipment.

The problem was not so much that it was difficult to learn how to use a new system, but the fact that ships' officers frequently had to 're-learn' how to use equipment that they considered essential to safe navigation when changing ships. Sometimes, due to the short time that modern ships spend in port, these officers had to learn how to use unfamiliar navigational equipment whilst actually engaged in navigating the ship.

Legislators seem to be reluctant to intervene on the grounds that the different systems of operation allow manufacturers to compete on the basis of what they call innovation.[7]

This question looks at the respondents' attitudes towards technological change and provides an indication about whether such widely varying technological 'developments' may adversely affect these attitudes.

It may well be that manufacturers can claim an 'innovation' by changing the operational controls on its products. It may also be true that a different method of operation from the traditional is desirable. But are ships' officers willing to endorse such change, do they see such change as a threat to their safety, and is that potential subliminal in their apparent overall resistance to innovation and change?

5.4.3 Final Questionnaire - Question 4

> Do you think that technological developments, such as satellite communications, GPS, and ECDIS could create commercial opportunities that you might not have considered prior to these developments? Yes ☐ No ☐

Exploring the views and attitudes of the respondents to the commercial opportunities that they might not have previously considered is the main objective of this question.

During the analytical phase of the research it was possible (by combining the responses to this question with the responses to both sets of questionnaires, questions number five and six) to develop an insight into the industry's overall attitude to technological change.

5.4.4 Final Questionnaire - Question 5

> Since the mandatory introduction of GMDSS equipment, have you considered or implemented any supplementary systems designed to enhance the communications or navigation facilities for your vessels?
>
> Considered ☐ Not considered ☐ Implemented ☐ (Please specify)

This question designed as a reinforcing mechanism. It begins to examine the issues raised in the research questions from a practical viewpoint and seeks to discover the extent to which organisations that believe that technology could create greater commercial opportunities are willing to commit to the necessary investment. In the analytical phase, it was possible to examine the correlation between those who answered yes to question four in the final questionnaire and those who had shown the necessary commitment. When combined with the responses received from organisations in the Netherlands it also reinforces the data needed to address the comparative questions (research questions four and five).

5.4.5 Final Questionnaire - Question 6

Do you consider such supplementary systems essential to your longer-term plans in terms of communications or navigation? Yes □ No □

This is another reinforcing question with the same basic motivation as the previous two questions. However, it also attempts to establish whether or not organisations are considering the implications of technological development to potential innovation and change in the longer term. Have they, for instance, considered how technological developments might influence competitors to develop alternative business strategies and processes that could impact on their own business? The overall response to this question was also intended to provide further foundation for formulating appropriate questions to be asked during the interview stage of the research.

5.4.6 Final Questionnaire - Question 7

Do you think that further developments in communication and navigational technologies could provide any commercial advantages to shipping organisations?

Yes □ No □

Respondents who answered yes to question four in this questionnaire should, theoretically, also answer yes to this question and the main intention is therefore to test for consistency. The question, once again, examines the respondent's attitude to technological change and seeks to establish the extent of the industry's likely demand for it.

5.4.7 Final Questionnaire - Question 8

Do you think that new technology could be used to support closer collaboration between you and your clients? Yes ☐ No ☐

Using the term 'network alliances' might not have been understood by many of the respondents, which is why the question is phrased as it is. It sought to discover whether respondents understood how technology might begin to influence their potential to integrate their activities with those of their customers.

5.4.8 Final Questionnaire - Question 9

Do you think there would be any commercial advantages in such collaboration? Yes ☐ No ☐ N/A ☐

This question is intended to providing supplementary information relevant to the previous question.

5.4.9 Final Questionnaire - Question 10

Do you think that your ship's officers may require additional training in subjects over and above their core competence (for example, do you think that training a navigation officer in management techniques or some other skill would benefit either the company or the individual? (please tick all appropriate boxes)

Yes ☐ It would benefit the company ☐ It would benefit the individual ☐

No ☐ It would not benefit either the company or the individual ☐

This question is a repeat of question number twelve in the pilot questionnaire and the comments in section 5.3.12 are equally applicable here. The primary reason for repeating this question was to clarify the extent to which organisations have considered how changing technology might influence the demands placed on ships' officers, and how organisational structures and cultures might change in the future. The theoretical review presented in chapter four highlights how these technological and environmental factors are inextricably linked.

Question eleven is a repeat of question thirteen in the pilot questionnaire.

5.4.10 Final Questionnaire - Question 12

> What level of training and/or certification do you think would be the most appropriate?
>
> No certification ☐ Certificate (ONC/ HNC) ☐ Diploma (HND) ☐
>
> Degree (BA/BSc.) ☐ Post Graduate Degree (MA/M.Sc./ MBA) ☐
>
> Professional / other qualification (please specify)

This question probes a little deeper into the probable reason for the response to the previous question. Some organisations may be primarily concerned with their immediate requirements, others may be concerned about their future requirements, and some may believe that their employees should benefit by gaining an appropriate qualification from their training.

5.4.11 Final Questionnaire - Question 13

Do you think that new communication technologies - such as the internet - could be used to deliver such training to ships at sea economically?

Yes ☐ No ☐

This is a repeat of question fourteen in the pilot questionnaire. The comments in section 5.3.14 are equally applicable here.

5.4.12 Final Questionnaire - Question 14

Do you think that your organisation would consider providing financial support (training costs) to officers undertaking such training? Yes ☐ No ☐

This question is self-explanatory. It was included to test the commitment of organisations who answered yes to question numbers ten, eleven, twelve or thirteen to providing financial backing for the training that they deemed to be necessary.

In the final questionnaire, questions fifteen and sixteen are unchanged. Question seventeen is also unchanged, however, in the pilot questionnaire it was designated as question eighteen. The comments in sections 5.3.15, 5.3.16, and 5.3.18 are therefore equally applicable here.

Figure 5.2 provides a summary of the relationship between the research questions, the hypotheses, and the two sets of questionnaires that I have just discussed. These relationships are, as I explained, indirect, in that it would have been inappropriate to ask direct questions related organisational culture, or to make the questionnaires unnecessarily complex.

Figure 5.2
Relationship between Questionnaires, Research Questions and Hypotheses

Pilot Questionnaire Question Number	Research Questions (Q) or Hypothesis (H) Addressed	Final Questionnaire Question Number	Research Questions (Q) or Hypothesis (H) Addressed
1	H1, Q4, Q5.	1	H1, Q4, Q5
2	H2, Q3, Q4, Q5.	2	H1. H2. Q1. Q3. Q4, Q5.
3	H2, Q4, Q5.	3	Q3, Q4, Q6.
4	H1, H2, Q1, Q3, Q4, Q5.	4	H1, H2, Q3, Q4, Q5, Q6.
5	H1, H2, Q1, Q3, Q4, Q5.	5	Q1, Q3, Q4, Q5, Q6.
6	H1, H2, Q1, Q3, Q4, Q5.	6	H1, H2, H3, Q1, Q2, Q3, Q4, Q5.
7	H1, H2, Q4, Q5.	7	H2, Q1, Q3, Q4, Q5, Q6.
8	H3, Q1, Q2, Q3, Q4, Q5.	8	H1, H2, Q2, Q3
9	H2, Q1, Q4, Q5.	9	H1, H2, Q2, Q3
10	H2, H3, Q1, Q2, Q3, Q4, Q6.	10	H1, H2, Q6, Q7, Q8.
11	H1, H2.	11	Q7.
12	H1, H2, Q6, Q7, Q8.	12	Q4, Q6, Q7.
13	Q7.	13	Q8.
14	Q8.	14	Q4, Q5, Q6.
15	H2, H3, Q2, Q4, Q5, Q6, Q7.	15	H2, H3, Q2, Q4, Q5, Q6, Q7.
16	H1, H2, H3, Q1, Q2, Q4, Q5.	16	H1, H2, H3, Q1, Q2, Q4, Q5.
17	H1, H2, H3, Q1, Q2, Q3, Q4, Q5.		

5.5 Qualitative Research Design.

In chapter three I justified the intended research method of gathering, and subsequently analysing both quantitative and qualitative data, and described the various methods through which these data might be analysed. The primary data that would emanate from the questionnaire design described in this chapter was intended to be analysed using standard quantitative statistical techniques. Additionally however I decided to generate supplementary data through semi-structured interviews, which would involve discussions with ships' officers and with senior managers within the UK and the Netherlands shipping communities. Supplementary data was also expected to emerge in the form of comments and letters in response to some of the questions in the questionnaires. Such data does not lend itself to quantitative analysis and, as I explained in chapter three, this data will be the subject of qualitative analysis.

In designing the structure of the proposed semi-structured interviews I was able to consider how such data would ultimately be analysed. In the case of some of the informal comments that might emerge in the responses to the questionnaires this was less predictable, but nevertheless needed to be considered. The semi-structured interviews were intended to provide supporting evidence concerning the veracity of the answers to the questionnaires and were planned with the objective of obtaining responses that could, relatively easily, be coded and subsequently analysed.

Explicit in the aims of this study is the need to examine how technological, cultural, structural, and environmental factors impact on the perceptions of innovation within the shipping industry. It could be argued therefore that what is being measured is the *degree* of industrial subjectivity, making subjectivity an indispensable ingredient in the equation. On the other hand theoretical implications are, I propose, equally indispensable to understanding how these opinions evolved, whether they might need to change, and the processes that are involved in engineering any cultural, technological, or environmental change that might be desirable to the objective of enhancing innovation.

Understanding theoretical implications, and establishing conceptual meaning in data obtained through comments, interview notes, and observation, demanded that an appropriate tool be employed to simplify analysis of such data. The 'editing' approach to qualitative analysis, described in chapter three (section 3.5), is based upon the procedures and techniques of 'grounded theory' (Strauss and Corbin, 1997) and provides an appropriate conceptual tool. The rationale for its use as an instrument of authentication is explained in the same section. In designing an appropriate procedure for recognising and conceptualising the relevance of the phenomena present in the raw (qualitative) data, two fundamental criteria were applied.

- Making comparisons between similar incidents in the data as a means of determining appropriate conceptual labels.
- Asking pertinent questions relative to the category to which phenomenon in the data might belong.

The assigning of appropriate conceptual labels and categories to the personal observations, written reports, feedback comments, and interview notes provided an invaluable aid to establishing the meanings behind various verbal and written statements. But to ensure that the number of categories to which data could be assigned did not become unwieldy it was necessary to continually revise these categories in terms of their properties and dimensional range. Since these terms (properties and dimensional range) are also used to describe a subsequent (axial) coding procedure the example provided by Strauss and Corbin, which illustrates the precise meaning of the terms, is reproduced in figure 5.3.

Figure 5.3
Meaning of Terms

Category	Properties	Dimensional Range (applied to each incident)
Watching	Frequency	Often ....Never
	Extent	More ....Less
	Intensity	High ....Low
	Duration	Long ....Short

(Source: Strauss and Corbin, 1997: 72)

The following categories and conceptual labels were defined:

	Category		Conceptual labels				
A	Reliability	1	Very reliable	10	Unreliable		
B	Improvement	1	Improved	10	Not improved		
C	Change	1	Positive	2	Negative	3	None
D	Value	1	High value	10	Low value		
E	Cost	1	Satisfactory	10	Too expensive		

During, or immediately after, each interview I intended to assign one or more of these labels to the interview notes, letters, and comments received from respondents. Where the conceptual labels allow for a number between 1 and 10 to be assigned I assigned a number corresponding to the emphasis that the respondent gave in his/her comment. For example, if the respondent said equipment was 'a little expensive' I would categorise it E3/4, whereas if s/he said it was 'grossly overpriced' I might categorise it E10. Having assigned conceptual labels and categories to various statements and comments derived from the sources mentioned above, a second coding procedure, designed to extend the data in terms of the context or framework through which it is supported, becomes implicit. I use the word 'implicit' deliberately here; I will explain why shortly.

The qualitative analysis technique of 'axial coding' (Straus and Corbin, 1997: 96-142) is a procedure in which connections between various categories and their 'sub-categories' are established. The term 'sub-category' in this context refers to the specific properties of the category (see figure 5.3 above).

The raw data were in effect dissected in order to identify categories, properties and dimensional ranges. As these elements were identified the underlying relationships between categories and sub-categories manifested themselves and were intrinsically linked through 'the paradigm model' (Strauss and Corbin, 1997: 99). Briefly the paradigm model is designed to aid in the recognition of these relationships through the identification of causal conditions, phenomenon, context, intervening conditions, interaction strategies, and consequences. It is in essence an explicit statement describing a cognitive function - a predetermined process for systematic thinking.

A detailed description of the 'paradigm model' would occupy several pages, but would none the less retain a status that is peripheral to the main focus in this study. Since a detailed review of this model is available in the original source (cited above), it was not considered appropriate to provide an in-depth account of it here. In any event, many of the procedures employed in the axial coding of qualitative data occurred as almost involuntary responses to the identification of categories, properties and dimensional locations. Much of the deeper analysis - establishing the presence of possible relationships through the paradigm model, for instance - can therefore be regarded as a cognitive, rather than a mechanical function, which is why I used the word 'implicit' earlier.

This does not mean however that a fundamental understanding of how the coding process occurs is unimportant and that it was therefore unnecessary to describe it. By intentionally focussing on the procedures outlined above, whether the eventual outcome is the result of a cerebral, visceral, or an exegetical process, the discovery of similarities and differences in qualitative data is likely to increase.

Subsequent to the analytical procedures described above the remainder of the analysis of qualitative data will focus on considering the observed similarities and differences in the light of previous work, and with a view to developing theories that will enable the research questions set out in the conclusions of chapter two to be addressed more fully. This 'selective coding involves systematically selecting core categories, relating them to other categories, and validating these relationships. It culminates in a narrative that focuses on the subject being studied' (Strauss and Corbin, 1997: 116).

Conclusion

The main objectives in the primary research design were: to expound a means of answering the research questions, to ensure coherence in the questioning of potential respondents, and to provide mechanisms to assure validity, reliability and repeatability. These objectives manifest themselves in the design described, which provides for an initial pilot study based upon a postal survey, followed by a similar final survey, which is further reinforced by semi structured interviews. Both quantitative and qualitative data will be collected and analysed.

Potential respondents to the questionnaires were carefully targeted through an in-depth analysis of the type of vessels that these ship-owners employ, and on their vessels' most likely area of operation. The outcome of this analysis is that all *relevant* shipping organisations in the UK have been identified, and are therefore addressed.

The questionnaire design forms a basis for both inductive and deductive analysis of the anticipated data and is intended to reveal underlying information relevant to the research questions and act as a support mechanism for any subsequent recommendations. The design provides for an additional survey sample involving shipping organisations in the Netherlands. This is intended to act as a benchmark and establish whether or not similar technological, cultural, structural and environmental conditions exist in comparable shipping organisations in the European Union.

Both the detail, and the summaries of the relationships between the primary research design and research questions are included, as well as an explanation of the methods to be used in the analysis of both the quantitative and the qualitative data. The following chapter provides details of the actual analysis.

Notes - Chapter Five

[1] This vessel size was used as a cut of because previous legislation had already decided that vessels larger than 3000 dwt must install technology that would enable them to communicate globally.

[2] Figures obtained by counting the number of ship owners listed in Lloyds Register of Ship Owners (2001-2002).

[3] Lloyds list provides information concerning the year of build of every vessel listed. This information was used to compare the average age of vessels in the two countries.

[4] For example, in an Associate British Ports (ABP) press release dated 22nd February, 2001, Dennis Dunn, ABP's port director, talks about the phenomenal growth of the company's number one port. He says 'To have exceeded the 50 million-tonne milestone [in Grimsby and Immingham] is a tremendous achievement .... throughput has consistently increased for fifteen successive years...'

[5] Although the GMDSS regulations do not actually 'demand' specific types of navigational or communication systems (satellite communication for example) the practicalities of complying with the regulations usually make it more attractive financially to install such systems than to opt for alternatives (such as terrestrial systems)

[6] Environment in this context refers to the organisation's working practices, location, and management styles. For example, it might be that developing technology will enable shipping organisations to conduct business directly from ships at sea, which would imply a need for changes in organisation structure and management style in that environment. The question does not try to generate specific ideas or innovations but aims to establish whether a motivation for change exists.

[7] This issue is one that governments are beginning to grapple with. For example, the European Union is currently providing funding for research into systems integration and the barriers to this.

Chapter Six

Primary Research Analysis

Introduction

Relevant data were collected from several sources, which, as I explained in the previous chapter, motivated my decision to employ both quantitative and qualitative techniques during the data analysis.

Responses to the two questionnaires (detailed in appendix j) provided much of the primary empirical data. As expected, these two surveys produced nominal (categorical) and ordinal level data that could be analysed using conventional quantitative analytical tools to perform non-parametric tests.

The response to the questionnaires was better than expected. I received replies from twenty-one of the forty UK companies targeted in the first (pilot) survey and forty-nine of the ninety-six targeted in the second (final) survey. This represents an overall response rate of 51%. The vast majority of the major ship-owning organisations[1] that I targeted responded to the questionnaire, suggesting that the data is representative of 51% of the relevant shipping companies operating from the UK and considerably more than 51% of the country's ships. Several of the major shipping organisations provided valuable comments and some wrote informative letters pertaining to the specific questions and to related issues.

The focus of the research is primarily upon United Kingdom (UK) shipping organisations and in order to obtain the most reliable sample possible, all relevant shipping organisations in the UK were addressed. However, as I explained in chapter five (section 5.2), the study also seeks to examine whether managers' attitudes to technological and environmental developments are influenced mainly by organisational differences or by disparity in national cultures or history. Consequently, identical (final) questionnaires were addressed to a sample of forty shipping organisations in the Netherlands. Seventeen (43% of those targeted) responded, providing a viable platform from which to examine whether managers' opinions were moulded mainly by historical, cultural, or organisational differences[2].

The returned questionnaires, together with supplementary information in the form of comments and letters from shipping organisations, personal observations, and interviews with mangers in the industry, make up the bulk of the empirical data.

Relevant secondary data are published annually - usually in either (or both) Lloyds Register (2001-02) or Fairplay (2001-02). Data derived from both of these publications has already been discussed in chapter two and, where appropriate, will be cited in the concluding narrative.

The guiding principle for analysing the questionnaires, and establishing what the data were revealing could probably best be described as an iterative process in that a combination of analytical methods were deemed necessary to corroborate the findings. Tukey (1997) discusses two broad analytical methods - confirmatory and exploratory, both of which were employed during the quantitative analytical stage. Confirmatory data analysis (CDA), the mainstream approach to statistical analysis, (Robson 2002: 399) is a preferred option for testing hypotheses through a purely deductive research approach. The alternative, exploratory data analysis (EDA), advocated by Tukey (1977) was a useful channel for guiding conceptualisation when a CDA test could not be relied upon to provide a substantive conclusion (for example, when a hypothesis could not be adequately confirmed through a statistical test).

For the quantitative data, the use of a computer software package for statistical analysis (SPSS)[3] reduced the potential for errors in calculations that might otherwise have occurred.

The coded primary data, emanating mainly from the two questionnaires, were keyed into the data analysis software manually. An account of the coding detail appears in sections 6.1 to 6.3 and the specific statistical tests that were carried out on the responses to each of the questions in the questionnaires are detailed in section 6.4 to 6.4.17.

The data derived through semi-structured interviews with managers in shipping organisations, discussions with sea going captains and officers, personal observations, and from the literature, are of a more qualitative nature. They provided an additional mechanism for examining those research questions and hypotheses that could not be fully addressed through the exclusive use of quantitative techniques.

In designing the questionnaires, for example, I deliberately refrained from including questions that were directly related to culture since I believed that managers would either be unlikely, or unable, to respond. Furthermore, relying exclusively on quantitative analysis would have lengthened the project considerably because sufficient quantitative data would only have been obtained through longitudinal studies. The qualitative techniques employed offered an appropriate alternative for managing this aspect of the work.

Although several computer software packages are available for use in qualitative analysis[4] I decided against using such tools for three fundamental reasons.

1. The majority of the data collected emanated from responses to the questionnaires, which I had already ascertained could be analysed using the quantitative analytical tools available in SPSS.

2. Since the primary qualitative data collected were relatively small I reasoned that manual analysis of this data would result in a higher productivity than having to first evaluate, and subsequently learn to use, one of the specialist qualitative data analysis software packages.

3. Qualitative analytical software is more applicable to data derived from structured formal interviews where the precise wording of the question and response has been recorded. This study relies in the formal sense on responses to questionnaires whilst only semi-structured interviews were planned. The rationale for maintaining a measure of informality in the interviews was that I believed that ships officers might react negatively to having their conversations recorded and would be less open to discussing their opinions than they would be during a more 'informal chat'.

The analytical procedures of grounded theory articulated by Strauss and Cobin (1998) are designed to build relevant theories through the systematic interpretation of words or phrases in text. These procedures represent a framework for the manual analysis of empirical data that could not have been analysed effectively using quantitative tools.

The essential principles of grounded theory as they relate to this work were discussed in the previous chapter. The method of analysis of the qualitative data is described in section 6.7.of this chapter.

6.1 Coding Procedures: Pilot Questionnaire.

The coding system does not differ substantially between the pilot questionnaire and the final questionnaire. To avoid repetition, I will only discuss the coding procedure of questions that have changed between the two sets of questionnaires.

Reproducing the specific questionnaires here might also be perceived as unnecessary repetition and I therefore refer the reader to the relevant appendices (d and f). Both the pilot and the final questionnaires were designed for analysis using quantitative methods even though it was recognised that neither interval level nor ratio level data would be generated from the responses.

6.1.1 Pilot Questionnaire - Question 1.

In chapter five (section 5.3.1) I explained that the nominal data generated from the responses to this question would be analysed using non-parametric frequency tests. I also devised a method through which ordinal data could be generated by ranking the various items of equipment listed in this question. The explicit criteria detailed in appendix (h) were used as a basis for assigning rank. The equipment ranking, I explained, would then serve as a basis for ranking the responding organisations in terms of their attitudes to the benefits of technology and technological change.

I decided to code the data from this question so that the non-parametric frequency tests performed on the nominal data could be reinforced by separate tests based on the ranked order of the data. For the nominal data I assigned eighteen separate variables to represent the eighteen different pieces of equipment listed in the question and gave each variable an appropriate name and value label.

The names are simply an abbreviation of the equipment type, for example, voice (radiotelephony), Morse (radiotelegraphy), tlx (telex over radio), stdc (INMARSAT standard C satellite communications), whilst the value labels use the same wording as used on the questionnaires. The values assigned to each of these variables are:

0 Equipment not installed

1 Equipment installed

The organisation ranking, as I explained in the previous chapter, is based on the overall technological capability of the various items of equipment installed on the majority of the organisation's ships. However, as I also explained, assigning ranks to technological equipment, which is designed for different purposes, would be illogical. Assigning specific 'weights' or 'numbers' to equipment in order to rank the organisations might also be considered tantamount to imposing my own subjectivity on the data.

I therefore created two separate variables, 'allnav' and 'allcom' in which all the navigational (allnav) and communications (allcom) equipment would appear in ranked order. These variables simply indicate, in the order of the equipment ranking, whether or not the equipment is installed on the majority of each organisation's vessels. The rationale and criteria for assigning the various navigational and communication equipment rankings are explained in the previous chapter and are based on 'judgement sampling' (Deming, 1960: 31).

The variables allnav and allcom are a reproduction of the value labels of the eighteen separate variables, eleven digits representing navigational equipment and seven representing communications equipment. In these two variables the value labels appear with the most significant digit (highest rank) on the left and the least significant (lowest ranking) on the right. The total value of ones and zeros in each of the two variables, which were calculated using the compute facility in SPSS, therefore represents a rank for each of the organisations in terms of either navigational equipment or communications equipment.

6.1.2 Pilot Questionnaire - Question 2.

The rationale for this question is explained in chapter five (section 5.3.2). The variable associated with this question was assigned the name 'q2p' and labelled 'Q2 Pilot Questionnaire' in the SPSS software. Values were assigned as follows:

1. Radio Coast Station.
2. Satellite INMARSAT Standard 'C'.
3. Satellite INMARSAT Standard 'A'.
4. Satellite INMARSAT Standard 'B'.
5. Satellite INMARSAT Standard 'M'.
6. Non-standard method of marine communication.

6.1.3 Pilot Questionnaire – Question 3.

Although this question asks the same questions as the previous one, it does so from a 'post GMDSS' perspective. The coding is exactly the same as for the previous question but of course this question was assigned a different variable name (q3p) and label (Q3 Pilot Questionnaire) in the analysis software.

6.1.4 Pilot Questionnaire - Question 4.

In chapter five (section 5.3.4) I explained the rationale for this question. The respondent is given only two choices, which, in the data analysis software have been assigned the values 0 (GMDSS worse) and 1 (GMDSS better). In view of the considerable negative reports in the maritime press on this subject however I expected several respondents to elaborate (which many did). These elaborations and reports form the basis of further (qualitative) analysis of this question, which I address later in this chapter. In the quantitative data analysis software the variable was named 'q4p' and labelled 'Q4 Pilot Questionnaire'.

6.1.5 Pilot Questionnaire - Question 5.

This is a simple yes/no question, the rationale of which is explained in chapter five (section 5.3.5). Continuing with the same coding convention, the variable was named 'q5p' and labelled 'Q5 Pilot Questionnaire'. A response of 'yes' - meaning that the respondent thought that the equipment installed as part of the GMDSS package was adequate for commercial communications - was assigned a nominal value of 1 in the SPSS software analysis program. A response of 'no' was assigned a nominal zero (0).

6.1.6 Pilot Questionnaire - Question 6.

The variable name 'q6p' and label 'Q6 Pilot Questionnaire' was assigned the same nominal values for a 'yes' or 'no' response as the above question. In this case 'yes' means that, for commercial purposes, the responding organisation installed equipment over and above the legislative requirements of GMDSS whilst 'no' means that it did not.

6.1.7 Pilot Questionnaire – Question 7.

This question provided seven different boxes and asked the respondent to tick only one. Some organisations however provided detailed information pertaining to their reasons for choosing specific equipment but did not tick any of the boxes. For this reason, when assigning nominal values to the responses I included an additional nominal value (8), which I labelled 'other'. Where this value appears in the analysis it indicates that it was not immediately clear from the response which of the boxes the respondent would have ticked if s/he had not responded in detail. In view of the very small number of respondents who provided this level of detail however, attempting to carry out further (quantitative) analysis of this response to the question would have been futile, and in any event would not have improved the reliability, or the validity, of the findings.

The variable name 'q7p' and label 'Q7 Pilot Questionnaire' was assigned the following nominal values:

1. Equipment Price.

2. Running Costs.

3. Deliver Time.

4. Ease of Use of Equipment.

5. Possibilities to Integrate with Existing equipment.

6. Technical Capabilities of Equipment.

7. Future Plans for Integration.

8. Other.

6.1.8 Pilot Questionnaire - Question 8.

The rationale for this question is detailed in chapter five (section 5.3.8). In the data analysis software it was assigned the name 'q8p', labelled 'Q8 Pilot Questionnaire', and given the following values:

1. RO [Radio Officer] redundant.

2. RO retained - same duties as before.

3. RO retained - administrative duties.

4. RO retained - technical support.

6.1.9 Pilot Questionnaire - Question 9.

This question asks whether, in the opinion of respondents, the new communications systems that were installed, as a consequence of GMDSS, will make it easier, faster, or cheaper to communicate with ships at sea. In essence there are four possible answers, which have been assigned the following value labels:

1. Respondent thinks that there will be no improvement, either now or in the future.

2. Respondent thinks there will be no immediate improvement but that there will be improvement in the future.

3. Respondent thinks that there will be an immediate improvement but that there will be no further improvement in the future.

(To cater for possible unexpected answers to this question this response was coded and assigned a value label (3). I did not however expect this response to appear on any of the returned questionnaires.)

4. Respondent thinks that there will be an immediate improvement, and that further improvements could be expected in the future.

The rationale for the question appears in chapter five (section 5.3.9). Continuing with the previously adopted convention it was assigned the name 'q9p' and the descriptive label 'Q9 Pilot Questionnaire' in the software analysis program.

6.1.10 Pilot Questionnaire - Question 10

The response to this question is entirely descriptive. It was included to try to gain an insight into the reasons why the respondent (who would have answered 'no' to both parts of the previous question) might think that there will be no improvements from the technological developments in the industry. The response to this question is not analysed using quantitative techniques but relevant comments are included in the coding of the data used in qualitative analysis.

6.1.11 Pilot Questionnaire – Question 11

The response to this question, the rationale for which appears in chapter five (section 5.3.11), should have been a simple yes or no. Some respondents however included comments, which were taken on board during the qualitative analysis. The nominal data emanating from the question was assigned the name 'q11p' and labelled 'Q11 Pilot Questionnaire' in the SPSS software file. It was assigned the value labels:

0 Traditional navigation instruments will not be made obsolete [by the development of improved systems such as GPS].

1 Traditional navigation instruments will become obsolete.

6.1.12 Pilot Questionnaire - Question 12.

This, and the following two questions examine the respondents' attitudes towards training. Five boxes are provided in question twelve and the respondent is asked to tick all the appropriate boxes. Although this would appear to create a situation where the number of possible responses could overwhelm the analysis, there are only five answers that could be considered coherent - all other combinations would be classed as invalid responses.

The five acceptable responses have been assigned the following value labels in the analysis software:

1 Training would benefit both the individual and the company.

2 Training would only benefit the individual.

3 Training would only benefit the company.

4 Training would not benefit either the individual or the company.

5 Additional training is not necessary.

Continuing with the usual convention the name assigned is 'q12p' and the label 'Q12 Pilot Questionnaire'.

6.1.13 Pilot Questionnaire - Question 13.

Three boxes are provided for this question and again the respondent is asked to tick all appropriate boxes. In the event that the respondent ticked the third box (other) s/he was asked to specify the type of training needed. This implies that the explanation would become the subject of qualitative analysis. However, I considered that this would be inappropriate because a qualitative analysis of information pertaining to training would not address either the research questions or the hypotheses. Instead, the response would be analysed in the light of the boxes that were ticked. If no other boxes were ticked, then the explanation provided by the respondent would be used to make a subjective decision about which of the two main categories (technical or commercial) would be the most appropriate.

The assigned name 'q13p' - 'Q13 Pilot Questionnaire' therefore has the following value labels in the analysis software file:

1. Technical training will be required in the future.

2. Commercial training will be required in the future.

3. Both technical and commercial training will be required in the future.

6.1.14 Pilot Questionnaire - Question 14.

This question is in two parts. The respondent is asked to tick yes or no and then to decide whether to tick either or both of the remaining two boxes ('now' or 'in the future'). If the respondent ticked 'no' then whatever else s/he ticks is irrelevant since s/he is declaring that s/he thinks that new communication technology could not be used, either now or in the future, to deliver training to ships at sea.

The possible coherent responses to 'q14p' - 'Q14 Pilot Questionnaire' have therefore been coded as value labels in the SPSS analysis software as follows:

0. New technology could not be used to deliver training at sea.

1. New technology could be used to deliver training at sea now.

2. Technology could be used in the future to deliver training at sea.

6.1.15 Pilot and Final Questionnaire - Question 15.

The question, which has been named 'q15pf' and labelled 'Q15 Pilot and Final Questionnaire', is self-explanatory. The value labels assigned in the analysis software are:

0. On board structure will not change.

1. On board structure will change.

2. On board structure has already changed.

6.1.16 Pilot and Final Questionnaire - Question 16.

This question looks at the how the organisational structure ashore, rather than on board the ship, might change. In other respects it is essentially the same as the previous question. It has been named 'q16pf' and labelled 'Q16 Pilot and Final Questionnaire'. The value labels assigned are:

0. Organisational structure ashore will not change.

1. Organisational structure ashore will change.

2. Organisational structure ashore has already changed.

During the interview stage, questions were asked about the *nature* of any structural changes that might occur (or had already occurred) on board ship (question fifteen) or ashore (question sixteen). The analyses of these data are explained in section 6.7

6.1.17 Pilot Questionnaire - Question 17.

'Q17 Pilot Questionnaire' - 'q17p' asks for a simple yes or no response. Some respondents did not answer the question directly but responded with detailed comments. Where comments were provided, and the comments did not make a clear distinction about whether the respondent would have replied yes or no, I used a third value label in the software analysis program to indicate that the response required further (qualitative) analysis. The value labels are:

0. Technology will not improve learning or profitability [for the shipping industry as a whole].

1. Technology will improve learning or profitability.

2. Respondent gave detailed comments [which may require further analysis].

6.1.18 Pilot Questionnaire - Question 18.

The rationale for 'q18p' - 'Q 18 Pilot Questionnaire' is detailed in chapter five (section 5.3.18). The question allows for only two possible answers, which were coded as follows:

1. Organisation's ships trade world-wide.

2. Organisation's ships trade on specific routes only.

6.2 Coding Procedure Final Questionnaire.

Subsequent to the analysis of the responses to the pilot questionnaires and the re-visiting of appropriate innovation literature, I decided on a more focussed approach to establishing how technological developments might influence structural, cultural and environmental change in the industry. This necessitated some rephrasing, changes in the order of questions, and in some cases replacing questions with different ones. The coding procedure for preparing the data for keying into the statistical analysis program (SPSS) has, however, not been changed.

6.2.1 Final Questionnaire - Question 1.

Question one remains unchanged from the same question in the pilot questionnaire. The procedure for coding is therefore the same as outlined in section 6.1.1.

6.2.2 Final Questionnaire - Question 2.

This question is in two parts. The respondent is asked to decide whether s/he thinks that the method of communicating with ships since the introduction of GMDSS is better, or worse than the previous system from two alternative perspectives –

(a) Distress and safety and

(b) Commercial.

In the software analysis file, four nominal value labels are assigned:

1. [The respondent thinks that] GMDSS is worse [than the previous system] for both distress and safety communications and for commercial communications.

2. GMDSS is better for distress and safety communications only.

3. GMDSS is better for commercial communications only.

4. GMDSS is better for both distress and commercial communications.

The variable is named 'q2f' and labelled 'Q2 Final Questionnaire'.

6.2.3 Final Questionnaire - Question 3.

The respondent is asked to decide on two alternatives, which have been assigned value labels:

1. Manufacturers should be compelled to standardise on basic operating controls.

2. Manufacturers should be free to decide on appropriate controls for themselves.

The variable 'q3f' is labelled 'Q3 Final Questionnaire'.

6.2.4 Final Questionnaire - Question 4.

The rationale for this question is detailed in chapter five (section 5.4.3). The response is a simple yes or no, which are assigned value labels:

0. No - Technology will not create commercial opportunities.

1. Yes - technology will create commercial opportunities.

The variable name assigned is 'q4f' and the label 'Q4 Final Questionnaire'.

6.2.5 Final Questionnaire - Question 5.

This question provides for three options. The first two options can be analysed using standard statistical techniques. The third option asks for specific details about what supplementary systems the respondent has implemented. The coding was therefore designed to highlight a possible need for further (qualitative) analysis of the response.

The responses were assigned the following value labels:

0. [Organisation has] not considered supplementary systems.

1. [Organisation has] considered supplementary systems.

2. [Organisation has] implemented supplementary systems as specified on [the appropriate response] form.

6.2.6 Final Questionnaire - Question 6.

The response to this question, named 'q6f' and labelled 'Q6 Final Questionnaire', is a simple yes or no. It has been assigned the value labels:

0. Do not consider supplementary systems essential [to longer-term plans for communications or navigation].

1. Consider supplementary systems essential.

6.2.7 Final Questionnaire - Question 7.

In attempting to establish the industry's likely demand for technological change, this question asks respondents to choose only one of two options. Some respondents however provided detailed comments without ticking either box. I therefore coded the value labels to cater for three alternatives. These are:

0. [Further development in communication and navigation] technology will not provide commercial benefits [to shipping organisations].

1. Technology will provide commercial benefits.

2. See detailed comments on [appropriate response] form [with a view to performing further (qualitative) analysis].

The variable was named 'q7f' and labelled 'Q7 Final Questionnaire' in the SPSS data analysis software.

6.2.8 Final Questionnaire - Question 8.

Most respondents simply ticked the yes or no box in answering this question - named 'q8f' and labelled 'Q8 Final Questionnaire' in the analysis software. Some respondents provided additional comments however and the value labels were therefore coded in the same manner as the previous question:

0. Technology could not be used to support closer collaboration [with clients].

1. Technology could be used to support closer collaboration.

2. See comments on appropriate response form.

6.2.9 Final Questionnaire - Question 9.

All respondents answered question nine by simply ticking the appropriate yes / no or N/A box. The variable is named 'q9f' and labelled 'Q9 Final Questionnaire'. The value labels assigned are:

0. No commercial advantages in closer collaboration with clients.

1. Commercial advantages in closer collaboration with clients.

6.2.10 Final Questionnaire - Question 10.

This question is a repeat of pilot questionnaire question twelve and has been coded in exactly the same way. However, it is (re) named 'q10f 'and labelled 'Q10 Final Questionnaire'. Although the questions are identical it is clear that, for analysis purposes, I decided to assign a different name to the same question in the pilot questionnaire (q12p). There are two reasons for this. Firstly I placed the questions in the final study in a different order to those in the pilot study because I wanted to see if this influenced the response. By assigning a different name it would be relatively easy to identify any differences in the responses. Secondly, if there were differences, it could suggest that there had been change between the first (pilot) and second (final) study in the attitudes or opinions of respondents to additional training. It would then be necessary to re contact some of the respondents from the pilot study in an attempt to discover the reason for these differences. Possible reasons would include genuine changes in attitudes or opinions, differences between the two groups of respondents, or factors related to the order of the questions. Using a different name enabled me keep track of how different population groups had responded to the question.

6.2.11 Final Questionnaire - Question 11.

Only those respondents who answered 'yes' to question ten are asked to answer this question - 'q11f' - 'Q11 Final Questionnaire'. There are three possible answers, which are assigned the following value labels:

1. Technical training.

2. Commercial training.

3. Both technical and commercial training.

If the respondent ticked 'other' s/he is asked to specify what type of training s/he thinks would provide the most benefit. Unless this specification could be directly assigned to either a technical or commercial category further qualitative type analysis would be necessary in order to form an inductive judgement.

6.2.12 Final Questionnaire - Question 12.

The question itself is self-explanatory and the rationale is described in chapter five (section 5.4.10). It is assigned the name 'q12f' and the label 'Q12 Final Questionnaire'. The value labels assigned are:

0. No certification.

1. Certificate (ONC/HNC).

2. Diploma (HND).

3. Degree (BA/BSc).

4. Postgraduate degree (MA/MSc/MBA).

5. Professional qualification - see relevant form.

Rather than assign dozens of value labels that may or may not have covered all the possible relevant professional qualifications, I simply assigned the value label 5 above. By using a non-specific value label here it was possible to gain an insight into the respondents views of the perceived quality, or interest in, various alternative qualifications. Once this was established I was able to plan an appropriate strategy to obtain more detailed information from subsequent interviews.

6.2.13 Final Questionnaire - Question 13.

Although this question asked for a simple yes or no response, several respondents provided additional comments. The value labels assigned are therefore:

0. Technology could not be used to deliver training economically.

1. Technology could be used to deliver training economically.

2. See comments on appropriate form.

In the pilot study (pilot questionnaire - question fourteen), I asked this question in a slightly different form by providing two additional boxes labelled 'now' and 'in the future'. This allowed respondents to decide whether they thought that technology could be used to deliver training immediately, or at some unspecified future date. In this final questionnaire I decided not to include these boxes because almost all the respondents ticked 'in the future', and I had no idea how long they thought it might be before technology would be sufficiently mature to provide this benefit. By deliberately not including the choice of 'now' or 'in the future' the respondents would either have to decide that it was possible to use new technology to deliver training at sea, or it was not. If they decided that it was not, I reasoned, they would probably comment - and many did. These comments form a useful source of data for qualitative analysis. Following my usual convention the name 'q13f' is labelled 'Q13 Final Questionnaire'.

6.2.14 Final Questionnaire - Question 14.

This question, named 'q14f' and labelled 'Q14 Final Questionnaire', can only be answered with a simple 'yes' or 'no'. It is coded as follows:

0. Organisation would not consider financial support for training.

1. Organisation would consider financial support for training.

6.2.15 Final Questionnaire - Question 15.

Question fifteen remains unchanged from the same question in the pilot questionnaire. The procedure for coding was therefore the same as outlined in section 6.1.15.

6.2.16 Final Questionnaire - Question 16.

Question sixteen also remains unchanged from the same question in the pilot questionnaire. The procedure for coding was the same as outlined in section 6.1.16.

6.2.17 Final Questionnaire - Question 17.

This question is identical to question 18 in the pilot questionnaire. It is named 'q17f', labelled 'Q17 Final Questionnaire', and assigned the same value labels as in the pilot questionnaire.

6.3 Grouping Variable

Since I intended to conduct tests that compared organisations in the Netherlands with those in the United Kingdom, I assigned different values in a separate grouping variable. To allow for comparative analysis between the different questionnaires I assigned separate values to the two United Kingdom questionnaires. The values assigned in the grouping variable are:

1. United Kingdom (final questionnaire)

2. The Netherlands

3. United Kingdom (pilot questionnaire)

6.4 Statistical Tests.

The choice of appropriate statistical tests that would serve as a basis for the analysis of the research questions and testing of the hypotheses (outlined in the conclusions of chapter two) was limited by the nature of the data. Parametric tests require interval or ratio level data, which clearly would not be generated through the design of either the pilot or the final questionnaires. As I explained in chapter three, (section 3.3) the generation of nominal and ordinal level data was predetermined in the methodological design.

Calculating measures such as the mean, or the standard deviation using data gathered through the responses to these questionnaires would have been meaningless in the statistical sense because the numbers do not reflect an underlying scale. Non-parametric tests, which do not make assumptions about the scale of measurement, or about the underlying distributions, were the only appropriate means of statistical analysis.

Although the respondents who answered questions from either the pilot or final questionnaires were providing information that was *relevant* to the research questions and hypotheses, they were not *directly* addressing any of them. As I explained in chapter three it would have been unrealistic to expect respondents to answer such direct questions truthfully.

It was therefore necessary to perform appropriate statistical tests on the data, observe the results, and draw inferences from a combination of empirical results and theoretical assumptions. I will discuss the empirical findings here; however, since I intend to refer to the theoretical arguments of both previous and following chapters to substantiate my conclusions, I will reserve the discussion of the implications of these findings for the concluding chapter.

Much of the data from the pilot study is of a similar nature to that obtained through the final questionnaires and some of the questions are identical in both the pilot and the final questionnaires.[5] Where the questions are identical both sets of data (data from the pilot and final questionnaires) are analysed together.

The differences in the analytical results between the pilot and the final questionnaires are relatively minor and in order to avoid unnecessary duplication I present only the latter. However, where differences do exist these are discussed in the context of the overall conclusions in chapter eight.

6.4.1 Pilot and Final Questionnaire - Question 1.

An examination of the frequency statistics revealed the results detailed in figures 6.1 and 6.2 for communication and navigational equipment respectively. Since the questions were the same on both the pilot and the final questionnaires, the United Kingdom (U.K.) figures and percentages represent the total of both the questionnaires.

Figure 6.1
Table of Communication Equipment UK and Netherlands

Equipment Type	U.K. (Nr.)	U.K. %	NL. (Nr.)	NL %
Radio (Voice)	68	97.1	15	88.2
Radio (Morse Code)	52	74.3	16	94.1
Radio (Telex)	40	57.1	11	64.7
Satellite Standard C	32	45.7	9	52.9
Satellite Standard A	36	54.1	5	29.4
Satellite Standard B	19	27.1	2	11.8
Satellite Standard M	10	14.3	4	23.5

Figure 6.2
Table of Navigational Equipment UK and Netherlands

Equipment Type	U.K. (Nr.)	U.K. %	NL. (Nr.)	NL %
Satellite Navigation (Transit)	31	44.3	3	17.5
Decca Navigator	42	60.0	6	35.3
Loran C	17	24.3	4	23.5
GPS	66	94.3	16	94.1
Radar (X Band)	67	95.7	17	100.0
Radar (S Band)	63	90.0	16	94.1
ARPA	61	87.1	17	100.0
Inter-switched Radar/ARPA	40	67.1	9	52.9
Direction Finder (DF)	62	88.6	16	94.1
Echo Sounder	67	95.7	16	94.1
Electronic Log	36	51.4	7	41.2

Respondents answering question one, which is identical in both the pilot and final questionnaires, were ranked in order of the perceived value of the navigational and communications equipment installed on most of their vessels using the method described in chapter five (section 5.3.1). Organisations that installed the 'best' equipment are considered to be more receptive to the benefits of technology than those that did not. The rankings, which compare organisations' attitudes to the benefits of technology, comprise supplementary ordinal level data.

Using this data it was possible to employ the Wilcoxon-Mann-Whitney statistical test (Siegel and Castellan, 1988: 128-137) to examine the technological aspects of research question four (conclusions of chapter two). For the purposes of this test the research question needed to be re-formulated into a testable hypothesis. The hypothesis (H_1) states that:

- There are significant differences between shipping organisations in the UK and those in the Netherlands in terms of technology.

The Mann-Whitney test is a non-parametric, ordinal level procedure designed to determine the probability that two independent groups have been drawn from the same population.

The hypothesis in question (H_1) is a two-tailed prediction[6] and a normal significance level of 0.05 would have been accepted as an indication that the two groups were significantly different in terms of the level of technology installed on their ships. A significantly higher average ranking for the Netherlands group would have confirmed the validity of the part of the hypothesis H_1 related to technology. The null hypothesis (H_0) in this case states that there is no significant difference between the UK and the Netherlands in terms of technology.

Six tests were carried out that compared the two groups using data from the pilot questionnaire on its own, data from the pilot and final questionnaires together, and data from the final questionnaire only. Each test was repeated twice, once using the rankings based on the communication systems installed on most of the respondents' vessels, and again using the navigational equipment as the basis for ranking. There were no significant differences in the results obtained when using different sets of questionnaires and I have therefore illustrated only the tests performed on the data from the final questionnaire in figure 6.3.

Although the data sample obtained from the Netherlands organisations does not include *all* the shipping organisations in that country it does cover most of its *major* ship-owners - owners who, on the whole, operate similar commercial ships to those employed in the United Kingdom. The Netherlands data is therefore sufficiently extensive for its use as a comparative instrument.

The tests show that there is little overall difference in the technological systems installed on commercial ships in the United Kingdom and the Netherlands. The apparent differences that show up in the data can be explained through an examination of the type of ships responsible for creating such an illusion.

An examination of figure 6.3 reveals that in terms of navigational equipment the difference between the United Kingdom and the Netherlands is negligible. Whilst at first it might appear that United Kingdom ships carry more advanced communications systems than Netherlands ships, an examination of the types of ships involved revealed that the UK distribution was positively influenced by large cruise ship operators.

Cruise ships invariably carry much more sophisticated communications equipment than traditional vessels. The rationale for doing so was explained to me during a conversation with a senior manager in a well-known shipping company.

Figure 6.3

Mann-Whitney Test - Question One - Final Questionnaire

Ranks

	Country Group	N	Mean Rank	Sum of Ranks
ALLCOM	United Kingdom	49	36.09	1768.50
	The Netherlands	17	26.03	442.50
	Total	66		

Test Statistics[a]

	ALLCOM
Mann-Whitney U	289.500
Wilcoxon W	442.500
Z	-1.865
Asymp. Sig. (2-tailed)	.062

a. Grouping Variable: Country Group

Ranks

	Country Group	N	Mean Rank	Sum of Ranks
ALLNAV	United Kingdom	49	34.19	1675.50
	The Netherlands	17	31.50	535.50
	Total	66		

Test Statistics[a]

	ALLNAV
Mann-Whitney U	382.500
Wilcoxon W	535.500
Z	-.516
Asymp. Sig. (2-tailed)	.606

a. Grouping Variable: Country Group

On most ships the costs of communications are charged as an operating cost that can only be recovered through increased freight charges. On passenger vessels the communications facilities available on board have the potential to attract affluent passengers who often need to remain in contact with their business associates ashore, even when they are on holiday. The equipment also generates income for cruise ship operators because passengers are charged premium rates for using it. On this basis cruise ship operators tend to install the most modern communications systems available on their vessels.

I did not (as far as I can tell, since several respondents chose to remain anonymous) receive any response from cruise ship operators in the Netherlands. If this assumption (that no cruise ship operators were present in the Netherlands distribution) is correct, then UK cruise ship operators should also be excluded from the comparative analyses.

The Netherlands data does not appear to have been influenced by the presence of cruise or other passenger ship operators. If known cruise ship operators are excluded, then the United Kingdom distribution is substantially normal and the corresponding Mann-Whitney test becomes much clearer in its rejection of H_1. H_0 therefore has a greater probability of being true and the statistical tests are consistent with the view that there is no significant difference between respondents in the UK and respondents in the Netherlands in terms of their attitude to the benefits of technological change.

The results of the analysis of this question seems to suggest that differences in frequency distribution between the two countries have more to do with the type of ship that different organisations operate than with any differences in national culture.

It does not however rule out differences that might exist in internal cultures between organisations. It suggests that the demand for instant communications by cruise ship passengers has, in the UK at least, been assigned a higher priority than the commercial needs of customers served by cargo carrying vessels.

6.4.2 Final Questionnaire - Question 2

This question sought to discover whether, in the opinion of the respondents, the Global Maritime Distress and Safety System (GMDSS) was an acceptable system in terms of both its distress and safety aspects and its commercial implications.

As illustrated in figure 6.4, of the forty-nine respondents from the UK survey only nineteen (about 39%) thought that GMDSS was a better all round system. In the Netherlands respondents were even less impressed, only three of the seventeen respondents (less than 18%) believing that GMDSS was better overall. Many respondents commented on the reasons for their unhappiness. The majority of these comments related to problems with false distress signals caused by technical problems and with the inability of the system to differentiate between distress signals on which they might be capable of offering assistance and distress signals from the - other side of the world. The significance of such comments to the perceptions of the benefits of change in the industry is discussed in chapter eight.

Figure 6.4

Q2 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	GMDSS Worse	3	6.1
		GMDSS better for distress & Safety only	3	6.1
		GMDSS better for commercial only	24	49.0
		GMDSS better for both distress and commercial	19	38.8
		Total	49	100.0
The Netherlands	Valid	GMDSS Worse	2	11.8
		GMDSS better for distress & Safety only	1	5.9
		GMDSS better for commercial only	11	64.7
		GMDSS better for both distress and commercial	3	17.6
		Total	17	100.0

6.4.3 Final Questionnaire - Question 3

The question asked 'Do you think that manufacturers of communications and navigational systems should be compelled to adopt a 'standard' method of controlling their equipment?' As illustrated in figure 6.5 some 75% of United Kingdom respondents though that they should, although in the Netherlands the consensus was not quite as clear.

Figure 6.5

Q3 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Manufacturers should be compelled to standardise on controls	37	75.5
		manufacturers should be free to decide on controls	12	24.5
		Total	49	100.0
The Netherlands	Valid	Manufacturers should be compelled to standardise on controls	10	58.8
		manufacturers should be free to decide on controls	7	41.2
		Total	17	100.0

6.4.4 Final Questionnaire - Question 4

Figure 6.6 depicts the number, and the percentage of respondents who answered question four in the final questionnaire. It shows that about 41% of UK respondents believe that changing technology will create additional commercial opportunities. The percentage is considerably (nearly 25%) higher in the Netherlands, although it is still lower than one might expect from an industry that has only recently begun to emerge from an era in which its communications capabilities were, to put it mildly, less than adequate.

Figure 6.6

Q4 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	No - Technology will not create commercial opportunities	29	59.2
		Yes - Technology will create commercial opportunities	20	40.8
		Total	49	100.0
The Netherlands	Valid	No - Technology will not create commercial opportunities	6	35.3
		Yes - Technology will create commercial opportunities	11	64.7
		Total	17	100.0

6.4.5 Final Questionnaire - Question 5

The apparent lack of awareness of the potential benefits of technological change is again reflected in the response to question five. Only about 39% of United Kingdom shipping organisations and 12% of shipping organisations in the Netherlands say they have actually implemented supplementary systems to improve their communications or navigation capabilities since the introduction of GMDSS. The frequency data in figure 7.7 seems to suggest that almost 60% of shipping organisations are either still thinking about changing their commercial capabilities or have decided not to do so.

Figure 6.7

Q5 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Not considered supplementary systems	13	26.5
		Considered supplementary systems	17	34.7
		Implemented supplementary systems as specified on form	19	38.8
		Total	49	100.0
The Netherlands	Valid	Not considered supplementary systems	8	47.1
		Considered supplementary systems	7	41.2
		Implemented supplementary systems as specified on form	2	11.8
		Total	17	100.0

6.4.6 Final Questionnaire - Question 6

Figure 6.8 shows that, although they have not actually committed themselves to the investment, some 71% of United Kingdom shipping organisations say that they believe supplementary systems are essential to their longer-term plans. In the Netherlands about 53% had similar views.

Figure 6.8

Q6 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Do not consider supplementary systems essential	14	28.6
		Consider supplementary systems essential	35	71.4
		Total	49	100.0
The Netherlands	Valid	Do not consider supplementary systems essential	8	47.1
		Consider supplementary systems essential	9	52.9
		Total	17	100.0

6.4.7 Final Questionnaire - Question 7

A similar picture emerges from the frequency analysis of question seven (figure 6.9) where 71% of United Kingdom and 59% of Netherlands shipping organisations thought that further development in technology would provide potential commercial benefits.

Figure 6.9

Q7 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Technology will not provide commercial benefits	14	28.6
		Technology will provide commercial benefits	35	71.4
		Total	49	100.0
The Netherlands	Valid	Technology will not provide commercial benefits	7	41.2
		Technology will provide commercial benefits	10	58.8
		Total	17	100.0

6.4.8 Final Questionnaire - Question 8

When asked if they thought that new technology could support closer collaboration with their clients, organisations in both countries were fairly close in their agreement that it could, 77% in the United Kingdom and 71% in the Netherlands (figure 6.10).

Figure 6.10

Q8 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Technology cannot support closer collaboration with clients	10	20.4
		Technology can support closer collaboration with clients	38	77.6
		Total	48	98.0
	Missing	System	1	2.0
	Total		49	100.0
The Netherlands	Valid	Technology cannot support closer collaboration with clients	5	29.4
		Technology can support closer collaboration with clients	12	70.6
		Total	17	100.0

Figure 6.11

Q9 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	No commercial advantages in close collaboration with clients	27	55.1
		Commercial advantages in closer collaborating with clients	19	38.8
		Total	46	93.9
	Missing		3	6.1
	Total		49	100.0
The Netherlands	Valid	No commercial advantages in close collaboration with clients	7	41.2
		Commercial advantages in closer collaborating with clients	8	47.1
		Total	15	88.2
	Missing		2	11.8
	Total		17	100.0

6.4.9 Final Questionnaire - Question 9

The two countries responded somewhat differently when asked if they thought that closer collaboration with their clients would be beneficial. In the United Kingdom only 39% percent saw any possible advantages, whereas 47% of organisations in the Netherlands predicted advantages (figure 6.11).

6.4.10 Final Questionnaire - Question 10

When asked whether they thought that additional training over and above ships officers' core competencies would be necessary, and whether it would be beneficial to the organisation, to the individual taking the training, or to both, there was a strong consensus in favour of additional training. Figure 6.12 depicts the actual frequency table.

6.4.11 Final Questionnaire - Question 11

About 23% of respondents from each country thought that additional training should be mainly technical. 41% of shipping organisations in the United Kingdom thought that both technical and commercial training was necessary. In the Netherlands however, 35% of shipping organisations considered commercial training more important than technical training (figure 6.13).

Figure 6.12

Q10 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Traing would benefit both the individual and the company	35	71.4
		Training would only benefit the individual	4	8.2
		Training would only benefit the company	8	16.3
		Training would not benefit either individual or company	1	2.0
		Total	48	98.0
	Missing		1	2.0
	Total		49	100.0
The Netherlands	Valid	Traing would benefit both the individual and the company	10	58.8
		Training would only benefit the individual	3	17.6
		Training would only benefit the company	3	17.6
		Additional training not necessary	1	5.9
		Total	17	100.0

Figure 6.13

Q11 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Technical training	11	22.4
		Commercial training	14	28.6
		Both technical and commercial training	20	40.8
		Total	45	91.8
	Missing		4	8.2
	Total		49	100.0
The Netherlands	Valid	Technical training	4	23.5
		Commercial training	6	35.3
		Both technical and commercial training	5	29.4
		Total	15	88.2
	Missing		2	11.8
	Total		17	100.0

6.4.12 Final Questionnaire - Question 12

In asking this question I expected that most organisations would have been looking at their long-term commercial needs and would have thought about training their officers accordingly. Shipping organisations traditionally draw their senior shore-based commercial and management staff from the higher ranks of former sea-going officers and as technology matures the likelihood that ships will become essential elements in corporate networks increases.[7]

Considering that even a second officer on a British or Dutch vessel will usually hold a formal qualification that typically takes at least five years to achieve, I reasoned that a high percentage of shipping organisations would consider postgraduate training the most appropriate. Surprisingly, as illustrated in figure 6.14, shipping organisations do not appear to place much emphasis on the necessity for high level formal qualifications.

6.4.13 Final Questionnaire - Question 13

Well over 60% of shipping organisations do not believe that technologies such as the Internet are viable platforms that could be used to deliver training to ships at sea economically. Although the technology is available, many ship-owners commented that they think that the added cost of using satellite communications to access the Internet makes it too expensive.

Although INMARSAT[8] recently introduced a dedicated network service that allows permanent Internet connection at much lower cost than with the earlier systems[9] ship-owners are reluctant to invest in the necessary hardware.

Figure 6.14

Q12 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	No certification	28	57.1
		Certificate (ONC/HNC)	12	24.5
		Diploma (HND)	1	2.0
		Degree (BA/Bsc)	1	2.0
		Postgraduate degree (MA/Msc/MBA)	4	8.2
		Total	46	93.9
	Missing		3	6.1
	Total		49	100.0
The Netherlands	Valid	No certification	7	41.2
		Certificate (ONC/HNC)	2	11.8
		Diploma (HND)	3	17.6
		Degree (BA/Bsc)	1	5.9
		Postgraduate degree (MA/Msc/MBA)	3	17.6
		Total	16	94.1
	Missing		1	5.9
	Total		17	100.0

Figure 6.15

Q13 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Technology could not be used to deliver training economicall	30	61.2
		Technology could be used to deliver training economically	18	36.7
		Total	48	98.0
	Missing		1	2.0
	Total		49	100.0
The Netherlands	Valid	Technology could not be used to deliver training economicall	11	64.7
		Technology could be used to deliver training economically	6	35.3
		Total	17	100.0

The results reflected in figure 6.15 are consistent with this view, which is further supported by the recent attempts by the North West Kent College to introduce its on-line training system to United Kingdom ship-owners[10].

6.4.14 Final Questionnaire - Question 14

Nearly all the respondents said that they would be willing to provide financial support for training. However, it seems that the extent of any financial support might be limited to the costs of the actual training material. Ship-owners are not prepared to invest in the kind of technology that could enable their sea-going staff to benefit from the same opportunities for higher education that people ashore take for granted (figure 6.16).

Figure 6.16

Q14 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Organisation would not consider financial support	2	4.1
		Organisation would consider financial support for training	39	79.6
		Total	41	83.7
	Missing		8	16.3
	Total		49	100.0
The Netherlands	Valid	Organisation would consider financial support for training	15	88.2
	Missing		2	11.8
	Total		17	100.0

6.4.15 Final Questionnaire - Question 15

In attempting to gain an insight into whether shipping organisations had thought about how their on-board and shore-based management structures might need to change to accommodate the influences of changing technology I posed two separate questions. Figure 6.17 reflects the opinions of respondents from the two countries on the question pertaining to the structure on board the vessel.

Figure 6.17

Q15 Pilot and Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	On board structure will not change	21	42.9
		On board structure will change	17	34.7
		On board structure has already changed	11	22.4
		Total	49	100.0
The Netherlands	Valid	On board structure will not change	3	17.6
		On board structure will change	9	52.9
		On board structure has already changed	5	29.4
		Total	17	100.0

Figure 6.18

Q16 Pilot and Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Organisational strucure ashore will not change	12	24.5
		Organisational structure ashore will change	22	44.9
		Organisational structure ashore has already changed	15	30.6
		Total	49	100.0
The Netherlands	Valid	Organisational strucure ashore will not change	3	17.6
		Organisational structure ashore will change	8	47.1
		Organisational structure ashore has already changed	6	35.3
		Total	17	100.0

6.4.16 Final Questionnaire - Question 16

Figure 6.18 reflects the opinions of respondents from the two countries on the question pertaining to the shore based structure.

6.4.17 Final Questionnaire - Question 17

The final question merely asks whether the respondents' ships trade internationally or mainly on fixed routes. In the procedure for selecting potential respondents it was intended that ship owners whose vessels traded mainly on fixed routes would be eliminated from the survey.[11] This procedure identified the gross tonnage of the majority of each ship-owners' vessels and (based on the premise that larger vessels were more likely to trade internationally than smaller ones) sought to focus only on the most relevant organisations - those organisations whose vessels traded internationally.

Although this procedure was expected to eliminate *most* 'non-conventional' ship-owners, there was no guarantee, or even expectation, that it would eliminate *all* of them. Question eighteen in the pilot questionnaire and question seventeen in the final questionnaire were included to identify shipping organisations whose ships traded only on fixed routes that had not been identified earlier. The result is shown in figure 6.19.

In subsequent discussions with shipping managers however I discovered that although some ship-owners ticked 'fixed routes' their vessels might still have been relevant to the survey. For example, an organisation with a fleet of tankers carrying crude oil from the Persian Gulf to Rotterdam said that their vessels only operate on fixed routes whilst another organisation with a similar fleet might say that they traded internationally. I therefore decided to rely on the procedure outlined in chapter five (section 5.1) as a basis for decided which vessels were relevant and to include all the respondents to the survey in the analysis.

Figure 6.19

Q17 Final Questionnaire

Country Group			Frequency	Percent
United Kingdom	Valid	Organisation's ships trade world wide	45	91.8
		Organisation's ships trade only on specific routes	4	8.2
		Total	49	100.0
The Netherlands	Valid	Organisation's ships trade world wide	8	47.1
		Organisation's ships trade only on specific routes	9	52.9
		Total	17	100.0

6.5 Analysis of Pilot Questionnaires

Since several of the figures which were taken from the SPSS analysis of the final questionnaires are shown above, and are similar to those of the pilot questionnaire I have not included the pilot questionnaire figures here. The actual analysis figures are however presented in the relevant appendix (j).

The analysis details for pilot questionnaire, questions two and three show that prior to installing GMDSS equipment over 14% of ship-owners used coastal radio stations for most of their commercial communications and about 43% said they used INMARSAT standard 'A'. About 29% used satellite standard C.

Immediately after GMDSS a third of all United Kingdom ship-owners selected

INMARSAT standard 'C' as their primary method of commercial communications. Most of the increase came from ship-owners who had previously used coastal radio stations but some of those who had been using standard 'A' also switched to standard 'C'. 14% upgraded to the new digital standard 'B' and there was a 10% increase in the use of standard 'M'. Significantly, the use of coastal radio equipment (Morse code) for commercial communications virtually ceased overnight.

In responding to the pilot questionnaire, questions five, almost 48% of respondents said that they thought that the equipment provided as part of the GMDSS system was adequate for their commercial communications. Nearly 43% of respondents to pilot questionnaire, question seven said that price was their main consideration in deciding which equipment to install.

Despite this in their answer to pilot questionnaire, question six over 85% of respondents said that they had subsequently installed additional equipment, purely for their commercial needs.

Although some 39% of organisations surveyed decided to retain the services of the RO, most of these were more interested in having appropriate technical expertise available on-board than on using the RO for communications. Less than 10% said that the RO's duties would be the same as before.

Over 71% of respondents to pilot questionnaire, question nine said they could see an immediate improvement in the communication capabilities of the new systems although, in their response to pilot questionnaire question eleven, 38% refused to believe that traditional instruments would become obsolete. Over 76% of those responding to pilot questionnaire, question seventeen believed that new technology would ultimately improve the potential for profitability or learning opportunities in the shipping industry as a whole.

6.6 Independent Samples Tests

In seeking to look at the relationships between variables I decided to use an appropriate independent samples statistical test for nominal data. The well-known chi-square (χ^2) test is sometimes used to examine whether a pattern of frequencies significantly differs from an expected pattern. As far as this analysis was concerned however I was more interested in its value as a test of the independence of two samples (Siegel and Castellan 1988:111).

I wanted to further examine relationships between variables to establish whether or not there were significant differences between organisations in the Netherlands and the UK as well as whether any significant relationships existed between variables related to culture, organisational form or technology.

For example, a variable that asked whether an organisation thought that technology had the potential to create commercial opportunities should, theoretically, show a significant relationship with a variable that asked whether the same organisation had implemented the latest technology on its ships. The results of these analyses, which are based on the subjective opinions of respondents, provide a basis for theoretical discussions pertaining to culture, environment and technological infrastructure in the UK shipping industry. These discussions draw on both relevant literature discussed in chapters two and four and on the data analysis. The discussions and conclusions form the basis of chapters seven and eight.

6.7 Analysis of Qualitative Data.

In chapter five I described how the qualitative research design was based on the procedures and techniques of 'grounded theory' (Strauss and Corbin, 1997). I discussed how conceptual labels and categories would be assigned to personal observations, written reports, feedback comments, and interview notes and identified the categories and conceptual labels, which would be used as an aid to establishing meaning to these reports and comments.

Reproducing all the feedback comments, letters from ship-owners, written reports and interview notes here, and then describing in detail how each statement or comment was analysed, would require considerable space and would result in a disproportionate balance between the quantitative and qualitative elements of the research. Since these reports and comments were intended only as a supplement to reinforce or confirm results in the questionnaire data I will describe how these data were analysed by referring to three sample paragraphs selected at random from the large volume of informative reports received.

> '[company A] began an extensive training program in 1989 to re-integrate all our fleet Radio Officers and Electrical engineers into the one consolidated rank of Electro Technical Officer. With the pioneering technology we have onboard our vessels, there is a real need to have an experienced Electro Technical officer on hand at all times and the way forward was seen as creating this new role...
>
> ... Our vessels trade worldwide and often in places where shore side support is not available a great deal of the time.... Our GMDSS systems are an up rated version of the standard unit... We use 600 and 800 watt main transmitters, incorporating two inmarsat C systems instead of NBDP radio telex... This gives us a practical useable voice backup in the event of inmarsat problems.'

This comment represents a relatively small part of a long report received from a major ship-owner and contains a lot of information that might be considered peripheral. At the conceptual level however, it is relatively simple to analyse. The main message to be drawn from this comment is that the company decided to carry on board an 'Electro Technical Officer' because they are concerned about the reliability of the equipment. This comment was therefore assigned a category 'A' - (reliability) and a conceptual label '7' - (concerns about the unreliability of technology).

> '[Company B] ... We believe the e-mail situation is still in its infancy at the present moment and high speed data systems are far too expensive. E-procurement is an advancement at which we might look in the future but only if Inmarsat rates continue their downward trend.

Again this is a small part of a fairly lengthy report, but the conceptual message here is that company B is concerned about the high operating cost of using INMARSAT technology. I therefore assigned the category 'E' - (cost) and the conceptual label - '8' (considers running costs far too expensive).

This technique, which involved extracting the main message in each paragraph of the qualitative data, provided a means through which the properties and dimensional range (extent, duration, frequency or intensity with which each statement was made) could be identified. It also provided an aid to identifying underlying relationships between various comments and statements and the current theories discussed in the literature review and theoretical framework.

Conclusion

In this chapter I provided explicit details of how the (mainly quantitative) data were analysed using a computer based statistical package (SPSS) and presented the results of the statistical analysis. I also demonstrated how the mainly cognitive procedures employed in the analysis of qualitative data elements were aided by using some of the principles of grounded theory described by Strauss and Corbin (1997).

This research does not rely entirely on the analysis of quantitative or qualitative data to support its arguments however. The predominantly quantitative analytical results presented here are to a large extent supported by the reinforcing mechanism of qualitative data but these results do not in themselves answer the research questions, or define a strategic direction for innovation in the shipping industry.

In chapter two I examined a range of secondary data related to the shipping industry, using much of this data to assert the importance of the UK shipping industry in economic terms. In the same chapter I emphasised the role of technology in the equation of innovation and in chapter four I expanded on some of the theories of innovation in the context of the UK shipping industry.

In the following chapter, chapter seven, I will draw on the theoretical critiques of these earlier chapters in order to synthesise the theoretical discussions with the empirical evidence presented in this chapter. I will then reflect on how this analytical hybridization impacts on the search for answers to the research questions, how it informs the research in its quest to define a new strategic direction, and on contingent implications for the UK shipping industry.

Notes - Chapter Six

[1] I define a *major* shipping organisation as an organisation that operates at least ten ships under its own brand name and whose ships regularly sail on international voyages.

[2] Are, for example, managers' opinions moulded mainly by differences in national cultures or by differences in areas such as the management structure, the internal culture or the business focus?

[3] Statistical Package for Social Scientists

[4] For example, NUD.IST (Non-numerical Unstructured Data - Indexing, Searching and Theorising) or MAX.qda (Sage Publications' Micro-Soft Office compatible alternative).

[5] The two questionnaires - pilot and final - and the rationale for the different questions are discussed in chapter five.

In a one-tailed prediction the hypothesis is stating in which direction the unknown distribution will be shifted relative to the known distribution. The hypothesis that was tested states that 'there are significant *differences* between the UK and the Netherlands in terms of…' it is not predicting direction and is therefore a two-tailed prediction. If the hypothesis had been reformulated, for example, to state that: 'change…. is happening *more quickly* in the Netherlands than it is in the UK' it would have been a one-tailed prediction.

[7] This subject was discussed in chapter four

[8] INMARSAT is the service provider of satellite communications for the marine industry

[9] INMARSAT Standard 'E' a high speed data network service, which allows permanent Internet connection with users paying only for the data transferred was launched at 'Europoort 2001' in November 2001

[10] See chapter one for further details.

[11] See chapter five for an explanation of the procedures employed in selecting potential respondent organisations.

Chapter Seven

Shaping a Course for Maritime Innovation

Introduction

If becoming an innovative organisation demands an holistic approach to change; if shipping organisations need to address their technological, structural, cultural, and environmental foundations systemically, then the pertinence of these elements in the equation of innovation cannot be underestimated. In mapping out an industrial infrastructure aimed at stimulating innovation through holistic change I have discussed all these issues.

In chapter three I argued that social interaction is a precursor to innovation and change and that a 'mechanistic' system of management (Burns and Stalker, 1961) is inappropriate to the changing conditions currently being experienced by UK shipping organisations. The apparent resistance to innovation and change that I highlighted in chapters one and four was also evident in the analysis of the data (chapter six). The purpose of this chapter is to define a strategic direction that will enable the industry to take on board the concepts of innovation and change in order to compete effectively in its increasingly dynamic environment. Three fundamental factors are particularly relevant to developing the industry's potential to embrace innovation: organisational culture, organisational structure, and technology. As I pointed out in chapter four, these three factors are inter-related - changing either one will impact on the others. Prior to mapping out a potential route to innovation in the industry, therefore, it is necessary to relate the influence of each of these factors to innovation in the context of its applications within the UK shipping industry, and to the findings of the empirical analysis.

Traditional views of innovation tend to focus on manufacturing and emphasise the creation and distribution of physical artefacts (Robertson, Scarborough and Swan, 2000). But in a developing service sector, where knowledge based products or processes predominate, innovation, it is claimed, 'is better conceptualised as a particular combination of flows of knowledge and information' (Macdonald and Williams, 1992). The knowledge-based view of innovation, according to Robertson, Scarborough and Swan, 'moves us beyond the linear assumptions of the artefact-based model and highlights the complex and recursive interactions which filter and shape the innovation from inception through to end-use'.

The unique character of the UK shipping industry does not readily lend itself to being described either as a manufacturing or as a knowledge industry. In the light of rapidly developing technologies that could ultimately enhance the industry's functional relationships with its customers it might better be described as an industry in transition. Therefore, whilst a conceptual organisational model built on a platform of knowledge and information might take the strain for the time being, such a model would also be transitional.

The industry's ability to make headway with a revised organisational strategy that would embrace the concepts of innovation will be contingent on further developments in communications, particularly non-terrestrial communications.

As I indicated in chapter two such developments are almost inevitable but whether one non-terrestrial system will dominate or whether several systems will emerge from the current 'space war'[1] is uncertain. As the technology develops, however, it does seem certain that organisations within the UK shipping industry will be compelled, through competitive influences, to either adopt or adapt new organisational forms or structures. As I will show later, engineering an appropriate organisational form to address the changing business environment in the industry will also be influential in changing its cultural biases.

In their basic form none of the six organisational forms discussed in chapter four (section 4.1.5) are ideally suited to an industry in which neither the extent of the change, nor the degree of flexibility that will ultimately be required, is certain. However, as technological infrastructures and cultural moulds within the industry continue to converge, elements of these models are increasingly likely to manifest themselves in new, industry-distinctive, organisational forms.

7.1 The Contribution of Organisational Form to Innovation.

The competitive threats to the UK shipping industry are unlikely to diminish as globalisation increasingly attracts low cost operators into the market. In such an environment a strategic focus on new markets, new products, and flexibility seems to be appropriate. According to Fernández and Giménez (2000), a good way of achieving such a focus is through the inter-organisational co-operation afforded to the 'virtual organisation' (introduced in chapter four, section 4.1.5).

Although some of the concepts associated with Fernández and Giménez's interpretation of a virtual organisation are applicable to the shipping industry a potential for misunderstanding is apparent in their definition, which asserts that a virtual organisation is specifically and exclusively designed for inter-organisational co-operation.

It may well be that a virtual organisation elects to co-operate with other organisations on the basis that it seeks to benefit from their competencies whilst maintaining its own independence but it is not only virtual organisations that behave in this way. It is quite common for different types of businesses to form strategic alliances and to co-operate for their mutual benefit. A house builder, for example, would almost certainly sub-contract a large percentage of the electrical, plumbing, tiling, painting, garden design work, and so on, to specialist organisations but such a cluster of co-operating organisations could hardly be classified as 'virtual'.

Fernández and Giménez suggest that information technology (IT) differentiates the co-operation that exists between virtual and non-virtual organisations, but once again this introduces a potential for misunderstanding. An example of a strategic alliance between companies that are both non-virtual, and that rely on IT for their co-operation is the link between major banks and airlines who offer 'air miles' for bank credit card users (De Sanctis and Fulk 1999: 23). Fernández and Giménez seem to be suggesting that because two or more (non-virtual) companies co-operate using IT they become one virtual organisation.

In engineering an organisational form designed to increase flexibility within the UK shipping industry, it is imperative that the potential for such confusion is reduced. Although it would be unrealistic to try to model an organisational form that would be suitable for every company or organisation in the UK shipping industry, the essential characteristics of such a model need to be unambiguously defined.

Fernández and Giménez define a 'virtual organisation' as:

> ... a transient and reconfigurable network that allows (horizontal and/or vertical) co-operation among legally independent and geographically dispersed organisations (with possible participation of institutions and/or people). It intends to provide a service or product on the basis of joint understanding of the business. The organisations involved, spontaneously co-operate, combining and co-ordinating their distinctive capabilities in a coherent way with the objective of bringing differentiation and value to the market, thus obtaining competitive advantage.

There are numerous different definitions of a virtual organisation and a number of authors have been credited with coining the term[2]. From the perspective of the UK shipping industry, the elements of a virtual organisation that impact on the industry's culture, and ultimately on its potential to influence innovation are the most important requirements.

Floating a new or a differently structured company, however, always includes elements of risk and the successful implementation of a new form of ocean going organisation is no exception. The continued developments of technologies described in chapter four, Marine Information Technology (MIT) and Marine Automation Technology (MAT), for instance, are pre-requisites to success; as Wayne Cascio pointed out, 'it is technology that makes virtual workplaces possible' (Cascio 1998).

Changing to an organisational form that relies heavily on technology for its success also increases the potential costs of technological failure. For example, as Cash, McFarlan, McKenney, and Applegate (1992) pointed out, 'in an investment firm that relies on instantaneous communication and integration of market information from nodes around the globe, failure of a computer system could result in the end of a business within hours'.

Cascio (1999) highlighted another prominent feature in virtual organisations that is particularly relevant to ships that routinely cross numerous time zones during the course of a single voyage. 'Not only is work becoming seamless... it is also becoming endless as it rolls through a twenty-four hour day'.

According to Neuhauser, Bender, and Stromberg (2000), most people in business agree on two key points.

- Companies must figure out how to be part of the e-business revolution or they will not survive.
- Eventually there will be no distinction between traditional business and e-business. (Neuhauser, Bender, and Stromberg, 2000: 101).

Unless the views of these authors is completely erroneous, and it is unlikely that they are, then it is time to scuttle the notion that the shipping industry's hundred-year immunity from technological innovation could somehow be preserved. And if the industry is not exempt from twenty-first century ideas it also needs to develop more appropriate organisational forms that will support cultural diversity.

Although I intend to borrow some of the concepts of the 'virtual organisation' and adapt them to develop a conceptual model for innovation in the UK shipping industry, however, I explicitly refrain from suggesting that the industry should be managed *entirely* as a virtual organisation. An organisation specific model will, as I pointed out earlier, need to be tailored to suit its unique setting and take account of cultural alignments or imbalances between internal and external stimuli.

For example, vessels trading internationally are likely to encounter several business cultures. In such circumstances there is a possibility, even when the internal organisational cultures are aligned[3], of cultural conflicts between the organisation and its clients. A conceptual innovation model for the industry must therefore not only allow for flexibility in terms of operations, but must also include a degree of flexibility in its design - its ability to be uniquely tailored for individual organisations.

Prior to setting out the characteristics of a virtual organisation that apply to the shipping industry, however, it is necessary to clarify the industry's operational characteristics in terms of an organisational definition that would apply to the majority of organisations within the industry. This definition - the prelude to arguing for the necessity for fundamental change in the structure of organisations in the UK shipping industry - would be:

> An organisation, whose employees do not all work in group settings or in corporate offices, but where a significant proportion of staff work from the remote location of an ocean going vessel. Such an organisation provides transportation, storage, and logistics services to global customers working in various time zones and with varying business cultures. The organisation itself will also be subject to time zone and cultural differences or changes. The generic synthesis of satellite, telecommunications and computer technologies that enable inter, and intra, organisational communication makes this type of organisation possible.

It could, of course, be argued that in the shipping industry a significant number of employees have always worked remotely and that therefore it is not appropriate to simply redefine a ship at sea as a satellite of a new type of organisation.

Whilst it is true that seafarers have always worked in isolation however, the underlying rationale for redefining the new organisational form as conceptually different lies in the significant changes that have occurred, and that are still occurring, in maritime communications. The isolation age had an affinity with a traditional paradigm based on conservatism and risk aversion, but the paradigm shift referred to in chapter four (section 4.1.1) is ushering in a new age of industrial integration that has the potential to revolutionise maritime business processes and practices.

The majority of organisational forms at sea are, as I pointed out in chapter four (section 4.1), based on conventional hierarchical pyramids; the captain gives instructions to subordinates who are expected to obey without question. This structure may still be the most appropriate to the safe navigation of ships at sea but the imperative to satisfy the changing needs of customers ashore demands a radical course change. This may not be possible without introducing flexibility into the organisational structure. For example, if a customer decided that s/he wanted to offload the cargo at a different port s/he would probably have to give several days notice before such a change would be possible (if at all). It would involve a scenario similar to the one presented in chapter four (figure 4.6). Improved technology could improve the situation, but it would also require a change in organisational structure that would enable decisions concerning the customer, and his or her cargo, to be made on board the ship without the necessity to involve either senior navigating officers or shore-based agents.

The characteristics of a new organisational model for the shipping industry should therefore be based on a dual organisational structure:

- The basic organisational structure embraces the ship officers' safety and navigational functions and relies on the existing hierarchical order in which the captain retains overall authority for all matters related to these functions.

- The second structure is based on the characteristics of a virtual organisation described in chapter four (section 4.1.5). This model is reserved for all operational matters concerning customers agents, suppliers, and communications of a general nature that do not concern safety or navigation (For example, training, crew changes, or routine personnel matters).

Changes to the organisational structure at sea would probably lead to increased efficiency in terms of the way in which shipping organisations work with their customers and suppliers; however, modifying the traditional cultures will probably demand further strategic initiatives. For instance, in linking organisational culture to strategic direction Ansoff and Mc Donnell (1990) talk about two styles of behaviour which they term 'incremental' and 'entrepreneurial'.

Incremental behaviour, they argue, is resistant to change whereas entrepreneurial behaviour welcomes it. In the environment of cultural diversity that is inherent to the UK shipping industry it seems reasonable to assume that both of these alternative styles of behaviour are present. It is also reasonable to suggest that these different cognitive aspects should be taken into account by organisations' strategic managers.

Ansoff and Mc Donnell summarise strategic management as being concerned with:

- Bringing about strategic changes in organisations.
- Building organisational architectures that are conducive to change and
- Selecting and developing individuals who are motivated and capable of creating strategic change.

They also point out that the 'social architectures' required by different behaviours are distinct and different.

According to Fred Fiedler there is no 'best' way to manage. Different circumstances create different requirements and leadership style is contingent on the circumstances (Fiedler, 1967). The theory supports the notion that some situations demand a strict authoritarian approach whilst others benefit from more democratic behaviour. The problem for shipping companies is that it seems to imply that managers should change their modes of behaviour as *circumstances* change. That's the last thing one would expect from the captain of a ship. Shipping is an industry that demands a cool, consistent, approach in any circumstances and subordinates would almost certainly misread any behavioural changes related to circumstances. Imagine the reaction from subordinates if the ship's captain adopted a different leadership style relative to the *circumstances,* say for example the weather conditions, the traffic density, or the state of the tide (the moon). Should s/he 'suggest' a course change in fine weather or light traffic conditions but 'command' it when the going gets tough?

Addressing the competitive wind shifts and changing horizons at sea probably demands an entirely different organisational structure. For example, the Captain could own two hats. His/her 'authoritarian hat' could be reserved for matters related to the control of the ship; when the captain says 'hard a starboard' s/he means NOW and no subordinate has authority to question this 'order'. The 'democratic hat' could be worn in matters related to business where the views of other organisations enter the equation - customers and competitors for instance.

The metaphorical change of tack attributable to such an idea might sound just the same - a change in behaviour related to circumstances. However, there is, I suggest, a subtle but vitally important difference. 'Management style' would be clearly related to 'role' rather than to 'circumstances' and would therefore be less likely to send conflicting messages. Subordinates would respect the authoritarian role and professional competence of the captain but still recognise his/her identity as a democratic manager.

One of the problems with trying to develop a new organisational structure that might be appropriate to a unique environment such as the shipping industry is the possibility of making it too complex. A structure that incorporates both a traditional 'command' hierarchy that is all but demanded in legislation, running in parallel with a flatter 'business' structure that is not, may be a recipe for complexity. How could such complexity be managed? The solution it seems lies in the domains of technology, and perhaps more specifically in the complexity of human behaviour and the interaction between the human and mechanical aspects of technology, which I addressed when discussing the concepts of SCOT and ANT in chapter four.

As I emphasised earlier, the successful implementation of an appropriate organisational structure for the UK shipping industry is dependent upon technology, but, as I pointed out in chapter two, the development of marine technology is still in an embryonic phase. Until the technology and the associated organisation culture is sufficiently mature to deal with the consequences it seems that a transitional organisational model will be indispensable. How long a transitional model will be required is difficult to predict.

Concern about the immaturity and instability of technology, the costs and difficulties of dealing with legacy systems, and the delays in re-aligning business processes to the environmental changes resulting from the implementation of IT, were being expressed back in 1994 (Ryan 1994). Eight years on these concerns are still relevant, which suggests a need to expedite the search for technological stability whilst maintaining flexibility in the transitional stage. I will talk about the issues of technology, and its influence on developing or restraining innovation, in sections 7.5 and 7.6 of this chapter.

7.2 The Cultural Divide

Historically, seafarers were isolated from the real world of business to the extent that they developed a unique organisational culture that was founded on isolation. This nautical culture was, in the words of Rosabeth Moss Kanter, 'built on a reservoir of experience' (Kanter 1989); it was, as I pointed out earlier, also reinforced by an aversion to risk. Now that a modern communications infrastructure is beginning to take shape however, the prospects for disparity between the 'shore side' and 'shipboard' cultures may be beginning to recede.

Innovation, according to Kanter, 'makes progress by mistakes, false starts, dead ends, blind alleys and failed experiments that build their own reservoir' (Kanter 1989: 203). If this is true, and if, as I have suggested, the development of innovative processes and products should be included within the domain of the sea-going community then there is a need to accelerate the cultural realignment.

The blending of previously disparate organisational cultures offers potential benefits to organisations, but the nature and extent of the cultural merge will have an inevitable influence on the industry's prospects for innovation.

If , for example, I follow the logic of Shoshana Zuboff, then I must conclude that changes and improvements in maritime communications will enable shipping organisations to 'flatten existing hierarchies as managers' co-ordination and control functions are subsumed to technology' (Zuboff 1988). This phenomenon, the reduction of human intervention in parts of an organisational hierarchy, has been described as 'the substitution of technical rationalisation for social rationalisation' (Heyderbrand 1989) but, as I emphasised in chapter four (section 4.1.6) such substitution may fail to adequately address the need for meaningful co-operation between individuals and organisations.

In defining the so-called 'intelligent enterprise' Quinn (1992) argues that successful corporate strategy should be focused around two major components.

1. An organisation must identify its 'core competencies' - the things it

does best, and

2. It should outsource all other activities required to produce its products or deliver its service.

Arguments such as this seem to suggest that organisations should reject opportunities for diversification and, in the words of Peters and Waterman (1982), 'stick to the knitting'. But as I argued in chapter four (Section 4.1.4) interaction with partners, even if such a strategy does result in diversification, is far healthier than counting on a strategic anchor to provide a safe passage to innovation. The dynamic nature of the innovation process demands flexibility, which is not enhanced by such rigid focus.

Strangely enough, in his latest work Peters appears to deviate from his earlier arguments and now seems to argue, perhaps too emphatically, in favour of this viewpoint. 'You can't shrink your way to greatness', he says, as he goes on to suggest that 'ready, fire, aim', is an appropriate strategy for innovation (Peters 1997). The reality I suggest probably lies somewhere between these two perspectives.

Addressing the cultural disparities of the shipping industry through the opportunities available in maturing technologies is precursory to reshaping the overall culture in favour of innovation. The first step in the process then is to define and shape a more appropriate organisational form.

The search for appropriate hybrid models of organisation design is not new. For instance, the adhocracy and matrix forms (Burns and Stalker, 1961; Davis and Lawrence, 1977; Mintzberg, 1983) were born of a desire for flexible, adaptable, information-sensitive, team-based, collaborative, 'empowered' organisations

(Applegate, 1999).

These desires are just as relevant to the twenty-first century organisational needs of the shipping industry and it might therefore appear to make sense to simply adopt one of these, or an appropriate variant[4]. But why were so many of the traditional hybrids abandoned in favour of less complex, but less appropriate models the first time around?

Applegate argues that the hierarchy managed complexity by minimising it, whereas the hybrid designs were created to deal directly with the complex, ambiguous, and often conflicting information flows that characterise contemporary organisations. She goes on to suggest that, technologically, 1950s and 1960s organisations were incapable of managing the volume of information produced by complex organisational models (Applegate, 1999).

Applegate's analysis is perfectly valid, but it does not directly address questions of relevance to the shipping industry. Why, for example, are such large volumes of information essential to the management of contemporary organisations? Why is ambiguity and contradiction tolerated? And why should the degree of complexity increase as organisations seek to address the inevitable consequences of a shift in competitive sedulity fuelled by globalisation?

As the concepts and realities of a metaphorical 'global village' impact on both the markets and the labour sources available to organisations, and as the competitive horizons of diverse organisations and countries merge, flexibility and adaptability in organisations becomes indispensable. In such circumstances, hierarchical organisational forms become a 'liability' (Powell, 1990). In some ways many of the new organisational forms create opportunities for the establishment of what Monge and Fulk, (1999) call 'boundaryless organisations' - organisations that share resources and collaborate to their mutual advantage - similar in concept to the 'virtual organisation' described by Fernández and Giménez. In circumstances where it may be difficult to determine where one organisation ends and the other begins, complexity and ambiguity are bound to be aggravated, leading to a stretching of both the communications infrastructure and the demands for information. Such an organisational form is almost impossible to create without resorting to the use of sophisticated ICT (Child 1987).

7.3 Re-defining the learning culture

The 'Taylor' hierarchical organisation structure that I mentioned briefly in chapter four, and which, I argued, still prevails in many organisations in the shipping industry, does not require subordinates to have interest in, or a knowledge of, products or processes that are outside their defined job description. This model worked successfully in an era of mass production; it played a leading role in increasing productivity, reducing prices, and increasing sales at a time when companies were faced with little or no international competition. But, as I also argued, competitive challenges are demanding that organisations harness the diverse and often untapped skills of their workforce.

As Paul Taffinder (1998) demonstrates in speculating about 'the winning corporation of 2015', the dangers of procrastination - waiting until the organisation shows signs of crisis before thinking about change - are real. And as Peter Ellwood, Group Chief Executive of Lloyds TSB Group, observes in his introduction to Taffinder's book, 'things are never permanent, never as good as they might look, ... the company is always vulnerable'. I also suggested earlier that there is no reason to believe that the shipping industry is immune; the need for change is inevitable.

It is my contention that change in the shipping industry can best be brought about through the development of a learning culture and that the organisational structure at sea will need to be adapted to accommodate such a change. One way in which the cultural divide discussed in section 7.2 might be overcome is through the networking opportunities that would be available to a 'virtual' organisation operating through the conceptual mechanism of an ocean wide network, which I described in chapter four. Embracing the features of a 'learning organisation' within such a technological infrastructure would enable sea-going personnel to begin to recognise the relevance, and the advantages, of developing their current competencies.

Based upon what I discussed in earlier chapters it would not be unreasonable to assume that a culture of learning already exists at sea. Properly trained ships' officers, it could be argued, do not have much difficulty in learning to use several different varieties of navigation or communication instruments even when the method of control changes between manufacturers. And of course they don't - ships' officers generally adapt very well and take variations in the controls of navigation and communication systems very much in their stride. But what I am talking about here goes beyond the concept of ship's officers *improving* their competencies; I am talking about *redirecting* them, *modifying* them to cater for the inevitably different demands of a changing industry.

Zuboff's arguments (section 7.2) suggest that many of the functions relating to navigation could, in her words, be 'subsumed to technology'. Freeing ships' officers from such routines would enable them to handle other aspects of ship management. In such circumstances it would probably be beneficial for ship's officers to adopt a proactive role in learning to manage the business imperatives of their industry. I have already discussed what it means to be a 'learning organisation' in the context proposed by Senge (1990), and expanded by Schein (1985; 1992; 2000), in chapter four (section 4.2.4). In this discussion I argued that the shipping industry still has a long way to go before it can begin to develop a 'learning culture' in Schein's terms.

The prevailing shipboard hierarchical organisational structure, in which the views of other stakeholders are barely considered, for example, could hardly be considered as supportive of a learning organisation. So how would it be possible to change? The answer, I suggest, lies in restructuring the organisational form, and that, as I argued earlier, will demand further improvements to the technological infrastructure.

7.4 Launching the Infrastructure for an Ocean Wide Network.

Satellite communication supplies the catalyst that will enable maturing MAT and MIT systems to provide an appropriate architecture for business networks in the shipping industry. Despite initial concerns over the reliability of GMDSS, the clouds of suspicion surrounding nautical evolution seem to be gradually dispersing. AP Møller, Denmark's largest ship owner, for example, is currently offering voluntary 'dual officer training' to members of the industry's engineering officers union. The idea is that the responsibility for buying supplies, running budgets, and so on, should eventually be delegated to ships' officers rather than to shore based managers. The move is expected to improve both the efficiency and the profitability of participating vessels. The union believes that such changes could ultimately lead to the abolition of ships' masters and chief engineers in favour of a single 'ship manager' capable of overseeing both functions (Draper, 2001). Draper also reported that 'a recent seminar organised by the Danish Ship-Owners Association was unanimous in its assertion that the subject of ship organisation must now be debated' (*ibid.*).

Technological alliances, such as the integration of satellite communications, MAT, and MIT are also at the forefront of a current drive to bring e-commerce to the shipping industry. Although 'dot.com' bunkering and chartering agencies have so far failed to make a serious impact on the traditional shipbrokers' market there are signs that some major ship-owners are beginning to take an interest. They like the idea 'not only because it allows them to potentially cut out brokers but because it gives them command and control of the information flow' (Smith and Warner 2001).

Ironically the surge of interest comes at a time when several of these dating agencies for ships and cargoes have already floundered in the paucity of transactions. But, according to Smith and Warner, not all the illnesses are terminal. 'Buyers and sellers, principals and owners, shippers and carriers no longer go pale and sweaty at the mention of the 'I' word', they say. And at least one dot.com agency is planning a comeback with an investment of some three million pounds in a bid to capture a share of what they believe is a potentially lucrative market (*ibid.*).

Technological course changes such as these, however, will not necessarily take the industry in the direction that it needs to go. Citing examples of recent developments in navigational and communication technologies (in sections 7.6 and 7.7) I will show that although technology *can* function as an efficient engine for driving innovation and cultural change, in some circumstances its implementation may be more reminiscent of an intransigent anchor.

7.5 Examples of Technological Barriers to Innovation.

The demand for electronic chart display systems (ECDIS) have so far been minuscule in the shipping industry despite the versatility that they offer compared to paper charts (Marsh 2001). The implementation delays, however, have as much to do with the lack of appropriate software[5], the demands of legislation, and the battle for system supremacy, as they do to ship-owner procrastination.

Achieving the performance targets to obtain 'type approval' by global authority IMO requires hardware capable of displaying 'raster' or 'vector' electronic navigation charts, and a chart updating and cataloguing system. A 'raster' electronic chart is a scanned reproduction of an original paper chart. A 'vector' electronic chart is produced in various 'layers' in much the same way as a modern computer aided drafting or drawing package. The 'vector' electronic chart allows the navigator to view specific chart information without cluttering up the display with irrelevant information. It therefore provides much greater flexibility than a 'raster' chart.

Producing a 'vector' chart for every part of the world will obviously take many years since chart producers and hydro-graphic offices have to manually' re-draw' every chart from scratch. Recognising this, the IMO agreed that 'official raster scan navigation charts' (RNCs) may be used in the meantime.

Using 'vector' and 'raster' charts in parallel however requires hardware that is capable of processing either of the two formats. Although manufacturers are offering 'dual' systems, ship-owners are, perhaps understandably, reluctant to invest in hardware which would mainly be used to display 'raster' charts, the originals of which are on board the ship anyway (Marsh, 2001). Impediments to progress, it seems, are present in the very fabric of the mechanisms by which the industry plots its course.

Another source of innovation resistance lies in the way in which manufacturers continue to impose their own ideas about how their equipment should be operated, where the controls should be situated, and even which controls should and should not be included. Some bridge electronic systems, for example, use a computer style trackball to control the various functions, whilst others feature dozens of buttons that do essentially the same thing. Unfortunately there are no statutory regulations pertaining to the human-machine interface in marine electronic systems and manufacturers are free to design and re-design the operating controls as this wish. Not only does this introduce unnecessary obstacles to the development of officer proficiency but it also creates confusion in the market. For instance, in arguing for the supposed superiority of their preferred method of operation (a computer style track ball with three buttons) one marine equipment manufacturer[6] claims that their system improves reliability because there is less to 'go wrong' (Marine Engineering Review, October 2001: 35). Competitors would argue that such systems are actually less reliable because if the track ball fails the whole system becomes inoperative.

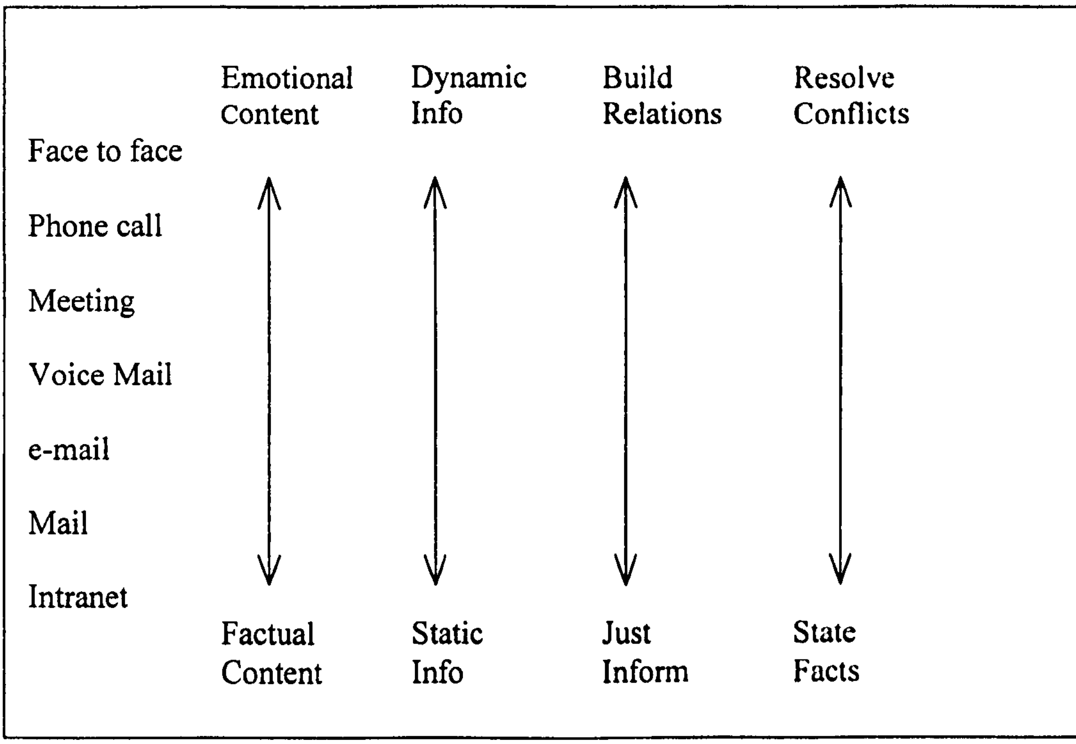
The diversity of different operating controls on these instruments means that ships' officers must re-learn, usually during an actual sea voyage, how to 'drive' the instruments on which, in an emergency, their survival may depend. Current regulations are tantamount to giving motor car manufacturers the licence to 'improve' their models by creating different methods of driving each time a new model is designed. A steering wheel and three pedals in one model, a joystick and two buttons in another, and, on the top of the range model, a touch screen display with a 'help' menu that teaches you how to drive it as you go along. It's not hard to imagine the confusion that a ship's officer might feel when, with little more than a cursory hand over, s/he takes over all the navigation responsibilities of a new vessel. And it's not hard to imagine why, in such circumstances s/he would have more confidence in a sharp pencil, a paper chart, and a decent pair of binoculars than in electronic wizardry.

In the communications arena too, even mature technology is unlikely to guarantee a smooth passage. One risk associated with developments in MIT is the risk of information overload. As it becomes easier, and cheaper, for ship operators and their customers to communicate directly with ships at sea there is a risk that much of the communication will be irrelevant. This has, to a large extent, already occurred in many organisations ashore, where the ease with which e-mail messages can be sent, copied, and forwarded has resulted in managers being swamped with irrelevant messages[7].

In these circumstances it may be necessary to develop an Intranet wide protocol designed to reduce unnecessary or irrelevant messages. One major company, for example, found it necessary to develop specific guidelines to encourage employees to think about whether, and how, they should communicate (Neuhauser, Bender and Stromberg 2000: 188). Employees were advised to analyse their proposed messages and classify them according to the communication guidelines shown in figure 7.1.

They could then decide on the most appropriate method of communication. A similar system might eventually be required in the UK shipping industry.

Figure 7.1
Communication Choices



(Source Neuhauser, Bender and Stromberg, 2000: 188).

7.6 Examples of Technological Drivers of Innovation.

For the second time in a decade, it seems, the availability of the technology has encouraged legislators to take the initiative and effectively move the goalposts in the name of safety. Such legislation inevitably sets the scene for further innovation by manufacturers eager to benefit from the sales that result when ship-owners have no choice but to install the new technology.

The latest legislation made its debut in December 2000 in the form of a complete revision chapter V of the *Safety of Life at Sea* convention (SOLAS 1978). Most vessels will now be required to install both automatic identification systems (AIS) and voyage data recorders (VDR). AIS systems transmit a unique identifier signal that can be interrogated by various navigational devices on other ships or aircraft. Such devices are relatively new to the marine industry but have been used extensively to identify specific aircraft on air traffic control radar systems for many years. Similarly, VDR systems record the various manoeuvres, changes of course and so on that a vessel makes during its voyage. Although VDRs do not go as far as recording all conversations on the bridge, they are conceptually similar in to the 'black box' recorders used on aircraft.

Taken a step further, these automatic recording devices could be linked to on board computers so that navigating officers would no longer need to manually record every course change or incident in a log book. Such a move would enable shore-based authorities, or clients, to interrogate the relevant computer file using satellite communication and obtain up to date information about the voyage without involving ships' personnel at all. The following is an example of how such a device might have saved a ship-owner many thousands of dollars in a compensation claim.

The Master of the 'Hill Harmony' drew a straight line on his chart - a direct course that would be used to navigate his vessel between Vancouver and Japan. What seemed to be the most obvious route actually added about nine days to the length of the voyage, prompting the charterers to claim substantial damages. They argued that the captain should have chosen a great circle route, rather than a Rhumb line, for the particular voyage. The high court agreed, paving the way for legislative action from disgruntled clients around the world (Lloyd's list Sept 04, 2001). The device described above could automatically have kept the charterers informed about the course that the ship was following and would have alerted them to the potential problem far earlier.

In responding to the questionnaires, and during the interview phase of this research, several ship-owners complained about the relatively high cost of using satellite communications. At the 30th international maritime exhibition in Amsterdam on 13th November 2001, however, INMARSAT unveiled its 'fleet F77' service, which goes some way towards addressing this problem. Fleet F77 provides a high quality ISDN service to ships at sea, enabling them to send and receive data at 64-kilo bits per second. The system, a Mobile Packet Data Service, where users are charged for the information sent and received, rather than for the time that they are connected, allows ships to maintain a permanent presence on a network. In effect they have the capability, for the first time ever, to fully integrate with the wider business community's networks, and to access all the applications that are available to network users ashore (INMARSAT 13 Nov 2001).

Although UK ship-owners have so far been less than enthusiastic about installing the new 'fleet' system[8], mainly because of the perceived high cost of the hardware, such resistance would probably be overcome if similar incentives to those offered by shore based mobile telephone organisations were available to the shipping community.[9]

Conclusion

The international shipping industry is indispensable to the economic well being of much of the world economy but in terms of innovation it seems to be close to stagnation. Experienced ships' officers frequently reject technological developments on the grounds of 'unreliability'. Whilst the technology itself may be perfectly reliable, the context in which it is used is often inappropriate to its purpose (as evidenced by the current GMDSS fiasco). In this situation even mature technology will not be enough to provide the confidence necessary to create an appropriate culture for innovation and change within the shipping industry.

The precursor to changing the position seems to demand change in three fundamental areas - Technology, organisational culture, and organisational structure. Such change must be appropriately adjusted to match environmental conditions. An appropriate organisational structure designed to address the changing business environment in the industry is likely to influence the industry's organisational culture, however, the structure must be flexible enough to cater for the uncertainty concerning the direction in which technologies will change.

The most appropriate characteristics within the organisational form that the industry should adopt are based on three fundamental requirements:

- The need to retain an existing hierarchical structure for functions related to the operation of the ship - the operational imperative.
- The need to address business matters concerning customers, agents, and suppliers - the business imperative.
- The need to cater for changes in terms of technology, culture, environment and business practices - the learning imperative.

The features of a structure based on a virtual organisation, as proposed by Fernández and Giménez (2000) seem to be the most appropriate. However, in managing aspects of ocean-going business units, shipping organisations should also focus on developing a learning culture based on the organisational characteristics that I summarised when discussing the work of Senge (1990) and Schein (1985; 1992; 2000) in chapter four.

Notes - Chapter Seven

[1] I do not mean this in the literal sense. As discussed in chapter three (section 3.7) there is strong competition between various organisations offering different systems of satellite communications. It may be that only one system will ultimately survive this competition.

[2] Harper-Collins, for example, have so far credited Charles Handy, William H. Davidow and Michael S. Malone as the originators.

[3] The 'internal cultures' of a shipping organisation could be considered as aligned when both the 'shore-side' and the 'shipboard' cultures are similar. 'Cultural imbalance', the opposite of cultural alignment, may vary between different countries, different organisations, and even between different ships within the same organisation.

[4] Numerous additional organisational forms that rely on mature technology have been proposed in the literature. For example, 'Knowledge-linked' (Badaracco 1991), 'Platform' (Ciborra 1996), 'T-Form' (Lucas 1996), and Postbureaucratic (Heckscher 1994).

[5] Electronic charts are easy to reproduce by scanning original paper charts. Such charts are freely available. However, to achieve full flexibility a digitally layered

vector chart and appropriate hardware, known as S57/DX90 is required. Producing these vector charts for all areas of the world is expected to take several years.

[6] Kelvin Hughes

[7] 'Junk' e-mail is often called 'SPAM'.

[8] See chapter one, where I outlined the experience of 'North West Kent College' in attempting to introduce internet training modules to ships at sea using INMARSAT FLEET.

[9] For example, shore-based mobile telephone organisations 'subsidise' the cost of mobile telephones to subscribers who take out monthly contracts. Such schemes seem to have had a substantial driving effect on the mobile phone industry.

Chapter Eight

Conclusions

Introduction

In the autumn of 1945 an RAF electronics officer, Arthur C. Clarke, wrote a short article in the popular magazine 'Wireless World' describing how man-made satellites in twenty-four-hour orbits high above the world's land masses might be used to distribute television programs. The article received little attention.

Twelve years on a shocked western world was virtually forced into taking action that ultimately turned Clarke's ideas into reality. On October 4, 1957, the Soviet Union successfully launched Sputnik I, the world's first artificial satellite, triggering the USA - USSR space race.

For the shipping industry the ultimate effect of this communist inspired precipitation was the development of a new method of communications that would allow it to bury the moribund Morse telegraphy system of communication. The maritime-focused intergovernmental organisation INMARSAT, which provides ships at sea with virtually the same telephone, telex, fax and data capabilities that are available ashore was formed in the early 1980s but the take-up of its services by the shipping community, has been less than enthusiastic.

I conducted the two surveys described in chapters five and six almost twenty years after the first satellite communication systems became available to ships at sea. Twenty years, during which just 54% of United Kingdom and 29% of Netherlands ship owners have been persuaded to install even the most basic (INMARSAT 'A') satellite communication system. The newer digital system (INMARSAT 'B') received an equally indifferent reception with take-ups of 27% and 12% respectively. And, as I explained in chapter three, the two countries in question operate some of the most modern ships in the world. If I had conducted a survey of ship owners operating fleets of so-called 'rust buckets' I would probably have found that few, if any, such ships had been equipped with satellite communication systems in the period leading up to the regulatory overhaul. Prior to the mandatory changes imposed as part of the Global Maritime Distress and Safety System (GMDSS) it seemed as if ship-owners had become addicted to Morse code, despite the clear superiority of satellite systems.

The rationale for this preference is easily justified. Firstly, the cost of installing and using satellite communications was considerably higher than the cost of maintaining the existing systems. Secondly, the regulations dictated that all ships with a gross tonnage of more than three thousand tons must carry at least one (and in some cases more than one) dedicated radio officer together with appropriate radiotelegraphy equipment for sending and receiving Morse code. Thirdly, there were no incentives in the regulations; no dispensation for ship-owners choosing to invest in more modern communication systems. Whether ships had satellite communication systems installed or not they still had to install equipment capable of sending and receiving Morse code and they were still compelled to employ one or more dedicated radio officers. In effect it meant that even newly built ships were being forced to continue to use a moribund communications system.

In the twenty-first century navigation arena such a situation still exists. Most commercial ships are still compelled to carry the same type of navigational equipment that Christopher Columbus used despite the widespread availability of superior technology.

In chapter two, I drew attention to the inadequacies of some of the primitive devices that, allegedly, are essential to the safe navigation of ships at sea. I cited examples, such as how relying on the information provided by a magnetic compass to steer a ship between two specific points on a chart is as fallible as steering a ship without a rudder. I explained how a so-called 'speed log' uses technology that is so antiquated that it might routinely tell you that you are travelling at five or six knots when you're anchored.

Many of the so-called 'traditional navigational instruments' described in chapter two are mandatory equipment on the majority of commercial ships. 'New-fangled devices' such as Global Positioning Systems that use satellite and computer technology to calculate a ship's 'true' course and speed, its estimated time of arrival at various waypoints, the speed and direction of prevailing currents, and other potentially useful information - the ship's position for instance - are not.

Over a hundred years of virtual stagnation, particularly in terms of communication systems, has been reinforced by the apparent inability of shipping to maintain parity with shore-based organisations in the development of technological systems. This, I argued, has contributed to a situation in which ships' officers have become accustomed to relying entirely on their traditional skills and to relegating technology to an incidental status.

It has created a situation in which even when superior products and systems do become available the interest in implementing them is at best lukewarm. The situation in the shipping industry then might be described as one of innovation resistance emanating from historical, cultural, technological, and environmental factors. Such resistance to, or at least lack of belief in, the benefits of innovation is evident not only in the responses to the formal questionnaires but also in the various comments and letters received from ship owners and ships' officers.

One such comment I believe sums up current feelings among ships' officers concerning the benefits of technology. I was discussing the merits of the Global Positioning System (GPS) with a senior navigating officer of a Dutch super-tanker.

'Yes', he said, 'I think GPS is a real nice way to navigate, I use it all the time to check the accuracy of my manual calculations. That way, when it fails (he was adamant that the correct word was 'when' not 'if') I can blow the dust off my sextant, wave bye-bye to those artificial satellites, and log on to something more reliable'.

In the light of observations such as this the research set out to answer the research questions and hypotheses detailed in the conclusions of chapter two. In addressing these questions and hypotheses and presenting a framework for progress I draw on the findings of the empirical work and on the theoretical arguments presented in earlier chapters. I also refer to some of the comments and letters that I received during the formal (questionnaire) and the informal (discussion) phase of the research.

8.1 Research Question 1

> Could the UK shipping industry stimulate inter-organisational cultures that are more conducive to innovation by capitalising on the recently improved communications infrastructure now available to the industry?

Both the data and the theoretical reviews are consistent with the view that it could. The design of the questionnaires, the details of which appear in chapter five, is intended to provide both direct, quantifiable, data and relevant information that can be used as a basis for assessing the probability of a hypothesis being true (deductive analysis) or answering a research question (inductive analysis). In the pilot questionnaire (questions two and three) I asked organisations to indicate which type of communications they mainly used for commercial communications. The questions related to the situation immediately prior to, and immediately after, the mandatory introduction of GMDSS.

I sought to examine the extent of the change, if any, that had occurred in the methods of communication that ship-owners used since the installation of newer technology. This provided an indication of whether organisations were beginning to recognise the potential benefits of new technology to their operations and whether this might ultimately influence cultural attitudes.

As I illustrated in chapter six (section 6.5), there was an immediate and dramatic change in the methods that ship-owners were using for commercial communications with their ships after they had been compelled to install GMDSS equipment. The use of Morse code for commercial communications, which over 14% of ships had previously relied on, virtually ceased overnight. Almost a third of ship-owners opted to use INMARSAT standard 'C', not only for ships' distress and safety traffic, but also for most of the organisation's commercial communications.

This analysis (chapter six, section 6.5) suggests that, although the legislative demands were concerned with the distress and safety aspects of communication, there was a positive benefit to ship-owners in terms of commercial communications. This benefit would have been seen both by ship-owners who previously used coast stations, and those who had been using the older INMARSAT standard 'A' for commercial communications.

The reason for this is that INMARSAT standard 'C' offers a much cheaper method of communications for basic text messages and those ship-owners who had been using standard 'A' prior to GMDSS would have seen an immediate reduction in the cost of their commercial communications. Those that switched from standard 'A' to standard 'B' would have also seen a dramatic reduction in the cost of their commercial communications because standard 'B' being a digital system has the capability to handle far greater volumes of traffic than standard 'A' and therefore offers significantly cheaper rates.

Ship-owners who migrated to standard 'M' were clearly using voice rather than telex or fax for commercial communications. They would also have seen a reduction in the cost of their calls since they had probably been using coastal radio stations for commercial telephone communications previously.

Standard 'M' is specifically designed as a low cost telephone only system and compared to the cost of calls through coastal radio stations is relatively inexpensive. All those who 'upgraded' their commercial communications would have also experienced dramatic improvements in the efficiency of the system.

Such a positive impact in terms of both the cost, and the efficiency of communications, on nearly forty-three percent of the shipping organisations surveyed must have had a corresponding positive influence on their attitude towards technology.

On the basis of the analysis of pilot questionnaire, questions five and six (chapter six. section 6.5) it seems that technology might already be having an influence in changing organisational attitudes, particularly if the impetus that was mainly spawned in legislation can be maintained. However, there remains the apparent, and perhaps understandable, concern with the reliability of technological systems. These concerns will probably have to be addressed through further developments in the technological capabilities of the systems. For instance, it is already possible to monitor, control, and to some extent repair, electronic equipment in remote locations using enhanced communications technologies that access equipment through a standard protocol. If some of these capabilities were included in marine navigational systems it would go some way toward resolving the problems that ships' officers face 'when' their equipment fails.

8.2 Research Question 2

> Would the development and implementation of new organisational forms influence such cultural change?

The data and the theoretical reviews suggest that it would, but that it is unlikely that cultural change can occur in isolation.

In chapter four I argued that three factors - culture, organisational form, and technology - needed to be addressed and developed within the marine environment in order to accommodate appropriate innovation processes. But creating an environment in which innovation and change might flourish demands, as I pointed out in the introduction to the chapter, that impediments such as inefficient and unreliable communications systems be removed from the equation once and for all.

The technological capabilities that could drive the innovation engine at sea are themselves being driven by mass-market demand ashore. Navigational and communication systems that were originally designed for specific applications have evolved to the extent that they are creating their own markets. Systems that were originally designed for use at sea, for example, have found attractive markets outside of that environment; similarly, products that have their foundations in mass-markets are making headway in the nautical arena. Satellite communication system, 'INMARSAT standard 'C', for instance, is now widely used to enhance security in the long-distance road haulage industry. Some airlines offer satellite communication facilities to their passengers and devices such as GPS and satellite telephones have assumed an 'essential equipment' status in some domains.

The massive increase in the market potential for these products suggests that prices will continue to plummet. In such circumstances it seems conceivable that the necessity for ships' officers to maintain traditional skills in radio communications or celestial navigation will diminish. And if such traditional skills are no longer required it would make sense to adjust the on-board organisational structures or forms to accommodate the new competencies that, it seems, are destined to replace the old.

Speculating exactly what these new competencies might be would call for specific research that focuses on that angle, but it seems reasonable to assume that the duties of ships' officers are set to drift in the direction of administration and management and that many of the navigational functions will ultimately be handled by technology.

Citing evidence of the risks facing organisations that fail to adjust their organisational form to match changing circumstances (in the introduction to chapter four) I emphasised the significance of organisational form to innovation and change. And in my discussion of paradigm shift in section 4.1.1, I pointed out that technology is unlikely to trigger change unless fundamental changes in organisational culture driven by changes in organisational form also enter the equation.

Illustrating the concept in graphical form (figure 4.2), I argued that change is a dynamic entity that feeds on itself and that either external or internal events can initiate the change process.

Using appropriate evidence to substantiate my assertions I argued that organisational structure has a distinctive affiliation with organisational culture and is therefore relevant to any strategy designed to motivate cultural change.

In the same chapter (section 4.1.5) I examined the rationale behind the six new organisational forms originally proposed by Herber, Jitendra, and Useem (2000). In my critique of these models, I pointed out that although organisational form might influence organisational culture the reverse is also true (the organisational culture demands, and indeed reinforces, an appropriate organisational form).

Using an example to clarify the meaning, I explained how, in terms of innovation, the culture of the environment is inexorably linked to the organisational culture. Organisational culture, I suggested, plays a pivotal role in determining an appropriate organisational form but these elements cannot be changed in isolation.

The empirical evidence that supported the first research question suggested that technology might already be having an influence in changing organisational culture and organisational form. As I pointed out earlier however, it is unrealistic to suppose that the future course of the UK shipping industry will be determined entirely through its own structures and cultures. It is much more likely that emerging technologies will play a significant role in determining how the industry develops, and in guiding its cultural and structural shape.

8.3 Research Question 3

> How could developments in communication and information systems assist shipping organisations and their clients to create network alliances designed to improve business relationships and capabilities?

The analysis shows that technological infrastructure already exists but political, cultural, and environmental changes will be necessary before the industry will be able to capitalise on its capabilities.

The idea that both human and non-human 'actors' are influential in the dynamics of a network and that both reliability and efficiency may be enhanced or constrained by these actors is fundamental to the 'Actor-Network Theory' (ANT) discussed in chapter four (section 4.1.8). In this discussion I emphasised the point that communication networks often fail to deliver the expected benefits regardless of the potency of the technology.

Network alliances, as I pointed out in my discussion on the concepts of domain hopping (chapter four, section 4.2.2), are influential in the equation of innovation and it seems ludicrous to imagine that ship-owners have not yet recognised the potential benefits of nurturing them. The evidence that they have not however is overwhelming.

The empirical analysis, which I referred to in discussing research question one (section 8.1), seems to suggest that the industry lacks the political and cultural drive to invest in the level of technology that would be necessary to create effective network alliances, let alone benefit from them. The response to several of the questions in the final questionnaire does little to alter that conclusion.

For example, in responding to final questionnaire question four, 59% of UK and 35% of Netherlands organisations did not think that technology would create commercial opportunities that they had not previously considered (chapter six, figure 6.6).

This implies either that these organisations thought that they understood the technology so well that they had already considered everything that was possible, or, the more likely scenario, that they had not thought about the further business opportunities that might be spawned by technology at all.

Although a relatively large number of ships were equipped with new communications equipment during the change over to GMDSS (section 8.1) relatively few have implemented new systems since then (chapter six, section 6.4.5). Despite this, almost three-quarters of UK and well over half of Netherlands shipping organisations believe that supplementary communications systems are essential to their long-term plans (chapter six, section 6.4.6).

When asked whether they thought that technology might provide commercial benefits (as opposed to potential opportunities) 71% and 51% of UK and Netherlands organisations respectively thought that it could. This suggests that although these organisations have considered the commercial advantages of being able to communicate efficiently with their own vessels they have not considered whether, or how they might use technology to form network alliances with their clients.

Probing a little deeper through subtle changes in the wording of the questions, the responses to final questionnaire questions eight and nine merely reinforces this opinion. Whilst over 70% of organisations in both countries believed that technology provided the infrastructure to support closer collaboration with their clients only about a third saw potential benefits from developing the concept (chapter six, figures 6.10 and 6.11).

8.4 Research Question 4

> Are there any significant differences between shipping organisations in the UK and those in the Netherlands in terms of organisational culture, environment, technology, or structure?

Contrary to expectations, the analysis did not support my original expectation - that I would find a significant difference between the two countries.

The theoretical discussions in chapter four, that I referred to in section 8.2 of this chapter, emphasises the relationships between organisational structure, organisational culture, and technology. These discussions suggest that if there are significant differences between organisations or countries in terms of culture, for instance, then there are likely to be corresponding differences in both technology and structure.

Nevertheless, in the design of the questionnaires and during the discussions I had taken cognisance of possible cultural undercurrents in an attempt to bring these to the surface. In the pilot questionnaire for example, question one is designed to reveal any significant differences in the type of technology that the different countries might use. The following seven questions, although also related to technology, were also designed to identify potential cultural biases.

Personal experience working both at sea and ashore in shipping related organisations based in the UK and the Netherlands led me to believe that I would find that Netherlands shipping organisations were significantly more likely to install more 'commercially useful' technology than UK organisations. However, the empirical evidence did not support this supposition.

In chapter six, (section 6.4.1) I describe how organisations were ranked, firstly according to the type of communication systems installed on the majority of the organisations vessels, and again according to the type of navigational systems being used. The tests performed on the resulting ordinal data suggested that the more 'commercially useful' systems (better quality communication equipment) were actually installed on UK vessels. This was contrary to expectations and after re-examining the data I discovered that data from known cruise ship operators had significantly influenced an otherwise normal data distribution in the UK sample.

Cruise ship operators have an entirely different motivation for installing 'commercially useful' systems, which I explained in chapter six (section 6.4.1). As far as I could tell there were no such influences in the Netherlands data and after performing the same tests without the abnormal influence of the cruise ship operators the data was more evenly distributed. In the final analysis, there were no significant differences between the UK and the Netherlands in either communication or navigational systems.

The pilot and final questionnaires, questions fifteen and sixteen asked specific questions relating to organisational structure on board vessels and ashore. Nearly 43% of UK shipping organisations, compared to only 18% in the Netherlands, expected the on board organisational structure to be maintained.

There was little difference between the two countries in terms of those that said that the organisational structure on board had already changed (chapter six, figure 6.17). There was also much closer consensus in the response to the question pertaining to the organisational structure ashore (chapter six, figure 6.18).

During the discussions, representatives of two different organisations in the Netherlands both said they 'expected' the organisational structure at sea and ashore to change as a direct result of technological change. However, when I attempted to ascertain exactly what type of organisational structures they envisaged the answers were vague. Both saw the administrative duties of the captain increasing and visualised a situation in which various members of the ships' crew might assume different functions. Neither described a true change in the existing hierarchical structure, either at sea or ashore.

It seems likely that those organisations who said that their organisational structure 'had already changed' may have been referring simply to changes in the duties of a number of their personnel, rather than to a genuine change in organisational structure.

8.5 Research Question 5

> Are changes to policies and structures (if any) since the introduction of GMDSS occurring at the same rate in the Netherlands as they are in the UK?

The data analysis suggests that there is no significant difference between the two countries.

This is, to some extent, a reinforcement of the previous question. As I explained in section 8.4, although I expected to see a difference between the two countries the reality is that the differences in the percentage of organisations that have actually changed is relatively small. As illustrated in chapter six (figure 6.17) 22% of UK and 29% of Netherlands organisations say that the organisational structure on board ship has changed. Figure 6.18 reflects a similar pattern in terms of changes to the organisational structure ashore, 31% and 35% respectively.

8.6 Research Question 6

> How can technology help to improve the profitability of vessels and the learning opportunities available to their crews?

The technology offers numerous opportunities but a cultural course change will be required before UK shipping organisations are likely to see the benefits.

Subsequent to the mandatory introduction of GMDSS some 38% of organisations responding to the pilot questionnaire said that their radio officers (RO) had been made redundant. Less than 10% said that the RO's duties would be the same as before. This in itself represents a substantial saving for most ship-owners, but the potential opportunities for capitalising on the improved technology in terms of innovation are considerable.

In chapter two (section 2.2.7) I discussed the concept of using satellite communication technology as a vehicle for interlinking the organisations' wide area networks ashore with local networks that embraced the engineering, navigational, and information functions on board each of the company's ships. I illustrated how, by simply interrogating the vessel's computer, the owner would have immediate access to virtually any information required.

I explained how freight agents and other customers might benefit from being able to access information that is not normally available ashore. I talked about the potential benefits of using supervisory control and data acquisition (SCADA) systems through which clients ashore could monitor and control the local environment for perishable cargo at sea. And I pointed to the contribution that such devices might offer in terms of their marketing, fiscal, and insurance values. These are just some of the avenues through which technology could lead to improvements in profitability.

The opportunities from a learning perspective are equally valid. 71% of organisations responding to the surveys thought that the new technological capabilities made it easier, cheaper and faster to communicate with their ships at sea. Roughly the same proportion believed that both the organisation and the individuals concerned would benefit from receiving education beyond their core competencies, although only 28% agreed that it could economically be delivered to ships using current technology.

The operative word for most ship-owners it seems is 'economically'. As I highlighted in the introduction to this thesis (chapter one) U.K. shipping organisations appear to be overly concerned about limiting their communication costs, which has an adverse effect on advancing their prospects for innovation.

Certainly the historical cost of installing and using a satellite communication system has, theoretically, been much higher than relying on Morse code but this argument does not hold much water when one considers what would have happened if Morse code had been rejected for the same reasons. Imagine how competitive a shipping organisation would be today if it had refused to install Morse code on the grounds that it would be far cheaper to send a message in a bottle.

As I outlined in chapter seven (section 7.6), the introduction of the INMARSAT 'fleet 77' service on 13th November, 2001 should have done a lot to eliminate ship-owners concerns about charges. Using 'fleet', ship-owners are charged only for the data they send or receive, rather than for the connection time. Staying connected all the time and only getting a bill if you transfer data sounds like a pretty reasonable deal to me, but most ship-owners are still deliberating over the idea. It might be too early to gauge the real influence that this system will have on the UK shipping community, but if the experience of the North West Kent College is anything to go by (introduction to chapter one) modifying the cultural biases might take a considerable time.

Throughout this thesis, I have made frequent references to the union between organisational culture, organisational structure, and technology. In chapter two, (section 2.2.3), for example, I discussed the relationship between mechanistic management systems and innovation culture. In chapter four, (section 4.1.1) I underlined the inadequacy of investing in technological change without a corresponding change in both culture and structure.

Taking the theoretical arguments further I examined the concept of risk management with a particular emphasis on the UK shipping industry, and described how risk at sea is managed through a set of rules that are part and parcel of the bureaucracy. This bureaucratic approach to risk management has, I suggested, failed to address the concept of managing risk on a personal level or in a commercial sense. The consequences of such bureaucracy are manifest in cultures that are inappropriate in a twenty-first century industry because they resist rather than encourage innovation.

Drawing on the work of Schein (2000), Peters and Waterman (1982), Handy (1976) and other authoritative researchers (in chapter four, section 4.1.4), I further illustrated the relationship between technology, culture and the environment. Synthesizing the theoretical arguments with the empirical evidence then suggests that the U.K. shipping industry is in urgent need of a cultural course change that matches current technological and environmental circumstances.

8.7 Research Question 7

> Taking potential competitive and technological developments into consideration, what kind of training would provide the optimum benefit to employers and employees in the industry?

The data suggests a combination of technical and commercial training without certification would be preferable. Theoretically, however, high level commercial training seems to be more appropriate.

The answer to this research question depends very much on perspective. If I accept the opinion of respondents then I must conclude that there is an overall demand for training. I must also accept that no particular certification is needed, that UK organisations see both technical and commercial imperatives, and that the main interest for Netherlands organisations is on commercial training (chapter six, figure 6.13).

On the other hand I might also assume that in responding to this question most organisations would have considered their needs relative to the industrial conditions as they currently stand, rather than after any change. They might not be considering change at all, and they may see on-board training merely as a substitute for something they were already planning. Despite the high proportion of ship-owners who believed that additional training would be beneficial to both the organisation and the individual (discussed in section 8.6), relatively few saw any need for certification. This tends to reinforce my opinion that most respondents were concerned with present circumstances and had not considered how potential changes might re-shape their needs.

From a theoretical perspective I have argued that cultural, environmental and technological course changes are virtually inevitable if the industry is to survive the economic quagmires of the third millennium. It seems logical therefore to consider the likely competencies and address these through appropriate training.

As I pointed out in chapter seven (section 7.3) changing conditions within the shipping industry are beginning to suggest that a change in the function of ships' officers is imminent. In examining what these changes might entail in the way of training, I endorsed the theory espoused by authors such as Zuboff (1988), who imply that many of the routine navigational functions of such officers could be handled by technology. Whilst retaining some of their traditional competencies, these officers could also use technology to become more involved in activities of a commercial nature.

In such a situation, the whole training scenario would need to change. Instead of focussing on improving existing capabilities the focus would shift to one in which new competencies were created. From a theoretical perspective then, the emphasis seems to point more to a need for commercial training at postgraduate level than the preferred 'technical/commercial no certification' route that is suggested in the data.

8.8 Research Question 8

How could such training best be delivered and evaluated?

Theoretical arguments suggest that the most appropriate method is through the effective use of what I referred to as an ocean wide network (OWN).

Once again however, there are differences between the empirical and theoretical perspectives and once again the word 'economically' is at the heart of the discrepancy. Theoretically technology is quite capable of transporting, and delivering, interactive training material. As I explained in chapter seven, (section 7.6) the recently introduced 'INMARSAT fleet' system is ideally placed to operate as the interface between the ship and the shore. Once this link is in place there will be almost no difference between the capabilities on board ship and those available ashore. Interactive training, whether via the Internet, via corporate Intranets or through 'live' discussions with teachers and lecturers is already fairly well established. The problem from the ship-owners point of view is not the cost of the training - as I illustrated in chapter six, (figure 6.16) more than 80% of shipping organisations said they would consider financial support for training - it lies in their perceptions of unnecessarily high communication costs.

'INMARSAT Fleet' might go some way towards resolving this problem but the cultural biases discussed in section 8.6 are unlikely to undergo change until ship-owners and operators begin to see the benefits.

One way in which this might be achieved would be for the training organisation to provide the majority of the training material in some form of firmware (such as on a computer or videodisk). Queries and e-mails emanating from students on board could be stored in a 'training file' that resided on the ship's local area network (chapter two, section 2.2.7).

Whenever any device on the ship's network is interrogated through the organisation's shore based network the data residing in the ship's training file could be automatically transferred to a corresponding file ashore. Training providers could have access to the training files and would collect and reply to e-mails in the same way as they would if their students were working ashore.

The method of assessment would have to be negotiated with the training provider. Depending upon the particular training module, it might, for example, be possible to assess some projects through the electronic communication facility just described. In the event that more formal examinations were deemed necessary, students could be examined during one of their 'off duty' periods ashore as they are at present.

Although the operating costs of the system just described would be negligible and the data transfer would be invisible to the user, the ship-owner would still have to commit to the investment necessary to have appropriate high-speed data equipment installed. It seems that the potential for training on-board ship is still being hampered by technological, cultural and environmental factors.

8.9 The Research Hypotheses

The first hypothesis, set out in the conclusion of chapter two, asserts that for more than a hundred years the moribund communication and navigational systems used at sea have effectively isolated ships from the rapidly developing technologies that are characteristic in many shore based industries. Both the theoretical discussions (chapters two, four and seven), and the evidence gathered from respondents in the industry (chapter six) support this assertion. The hypothesis also states that this isolation has significantly influenced the managerial structures and policies within the shipping industry. Once again the evidence shows that the basic organisational structures and policies on board ship have remained virtually unchanged for over a hundred years. The responses to the questionnaires, and the various comments received from senior managers within the industry also suggests that the management policies and structures ashore mirror those used at sea.

The second hypothesis claims that the mandatory introduction of the Global Maritime Distress and Safety System (GMDSS) in February 1999 compelled ship owners and operators to install relatively modern communication systems and that this creates an opportunity for the industry to integrate more closely with the transport industry of which it is a part. The GMDSS regulations (discussed in chapter two) confirm that ships subject to chapter IV of the *Safety of Life at Sea* (SOLAS) convention are compelled to install GMDSS equipment and that such equipment provides ships at sea with improved communication capabilities. The evidence gathered from the industry (chapter six) shows that a majority of ship-owners chose to install satellite communications as part of the GMDSS and that they now use this system for the majority of their commercial communications. As I demonstrated in chapter two (section 2.2.2), the facilities now available through INMARSAT provide ships at sea with virtually the same communication capabilities as organisations ashore. The statement in the hypothesis that such integration would be economically beneficial is also supported in the theoretical reviews, which suggest that innovation is, to a large extent, driven by the ability to network.

The third hypothesis pre-supposes that in order to capitalise on the opportunities presented by GMDSS, fundamental organisational changes, which match changing organisational structures in alliance organisations ashore, will need to be embraced throughout the shipping industry. The veracity of this hypothesis is partially verified in the discussions relating to the first two research questions (sections 8.1 and 8.2). It is further supported in the literature review in chapter four, which demonstrates the necessity for holistic change that addresses relationships between technology, culture, and organisational structure. The hypothesis also states that ships' officers will ultimately require additional training within a managerial discipline. This statement is supported both in the evidence gathered from the industry and through various discussions of its changing needs. In chapter seven (section 7.4), for instance, I highlighted how moves are already in progress in a bid to integrate the functions of 'master' and 'chief engineer' into a single 'ship manager'. Issues concerning the type of training that might be necessary in the light of such changes and how it might be delivered have already been addressed in section 8.7 and 8.8 of this chapter.

8.10 Recommendations

By identifying and focusing on the significance of historical influences on organisation culture, technological developments, and environmental conditions in the UK shipping industry this work raises the salience of associated problems.

In the main these problems relate to an inefficient communication system that retained its dominant status for far too long. Innovative as it was - in its day - radiotelegraphy turned out to become one of the shipping industry's most effective obstructions to innovation and progress.

However, radiotelegraphy can hardly be accused of outstaying its welcome - many would welcome its return, and the subliminal reason for that kind of thinking is a widespread lack of confidence in what is often referred to as 'new' technology. I base this assertion on the results of, the two surveys and on my discussions with ships' officers. During discussions, several ships' officers claimed that GMDSS is a complete failure and that, in terms of distress and safety at least, the original system was better.

One way out this impasse would be to make technology more reliable, but that I believe is an unrealistic expectation in the short term. Computer networks and other 'hi-tech' devices that 'go down' from time to time are, it seems to me, something that most people ashore have learned to live with. The way forward, I suggest, is to recognise the legitimate concerns of mariners and begin to address them through appropriate managerial and technological solutions.

One way in which the *perception* of reliability can change is through the development of knowledge that ship-owners currently seem to regard as peripheral. In responding to the questions pertaining to training for instance, most organisations seemed to be thinking in terms of maintaining current competencies rather than developing new ones.

Recognising the potential values in developing technology demands a greater understanding of its capabilities than most ships' officers currently realise. If ship officers' do not perceive of a *need* for technology then they are unlikely to endorse it. Training, and involving ships' officers in the commercial imperatives of the business is one way in which managerial action could change the perceptions of the *need* for developing technology. This, I suggest, would lead to an increasing acceptance of technology - warts and all.

For example, in developing and writing this thesis I relied very much on the use of computer technology. Without this resource I would probably have taken twice as long to submit the work and it would have been infinitely more difficult for anyone to read it. Yes - the computer 'crashed' at the worst possible time, the printer chewed up some of my work, the network didn't always behave as it should, and a web page that I had discovered a few days earlier suddenly ceased to exist. But I could never have finished on time without these resources - I *needed* the technology; reverting to a pencil and paper because I thought that the technology was unreliable was never a serious option.

Another way in which management might improve the current situation is by adopting the network alliance capabilities that could be developed through the use of INMARSAT fleet (discussed in chapter seven - section 7.6). By providing an enhanced communication capability the possibility to address technical problems through remote access to ships will be greatly improved. This would lead to a greater acceptance of the benefits of more advanced navigational and control systems, as well as providing manufacturers with the capability to better understand the needs of the end users of their products.

The managerial actions just discussed are, I propose, fundamental to improving the cultural, environmental and technological climate and would ultimately enhance the prospects for innovation in the industry. However, I believe that in the medium term it will also be necessary to introduce new organisational forms that are more conducive to innovation. In chapter four (section 4.1.5) I discussed the primary characteristics that should be present in an appropriate organisational form based on a virtual organisation. I also drew attention (in chapter four, section 4.2.4) to the main characteristics that organisations in the industry should pursue in re-shaping themselves as learning organisations.

8.11 Suggestions for Further Research

Although this research identified problems within the industry and has provided a viable route plan through which these problems can start to be addressed it does not claim to be able to provide all the answers.

I suggested a framework and outlined the driving features for change, but the exact form that new organisational structures should take will require further input from managers within the industry concerning exactly how their businesses operate and how they see them developing in the future. It will also require further input from ships' officers concerning how they see their future and whether or not they see their future roles as being more aligned with the commercial imperatives of the business. And it will require an in-depth review of current literature in the area of organisational form that ties in with the reviews on innovation and change in the shipping industry that have been the focus of this work.

Another area for further research resides in the technological arena. In terms of communication technology I have identified a number of possible different routes that developments in satellite communications might lead. I also pointed to the completely different scenarios that could result from one system or another emerging as the dominant system for maritime communications. These different scenarios suggest that a potential problem for ship-owners might lie in deciding at a relatively early stage in the development of these systems whether or not they would support one system or the other. And perhaps equally as important, would the appropriate maritime legislation bodies act any differently in responding to these developments as a result of what I have shown here?

Would they, for example, take cognisance of the differences between the *perceived* reliability of a system (such as Morse code) and its *actual* reliability when factors such as environmental (ionosphere) or cultural (human aspects) enter the equation (As discussed in chapter two, section 2.2.1)?

In the area of navigational systems technology I underlined deficiencies in a number of the devices that are purported to 'aid' navigation. In some cases these devices are also known to 'aid' collisions; when that happens, the captain, not the manufacturer, is deemed to be responsible. There is therefore a need for further research into why this is so. How, for example, can the shipping industry progress from its current risk aversive culture towards technology when virtually all the risks of using that technology are vested in the ships crew?

Conclusion

The aim of this research was to define the characteristics of an organisational model for strategic direction in the shipping industry. The imperative for a strategic course change emerged from dramatically changed technological environment in which the industry found itself subsequent to the introduction of GMDSS in February 1999. During the initial literature reviews, a number of relevant research questions and hypotheses emerged; these have been addressed.

The fundamental message emerging from the research is that the UK shipping industry now has the opportunity, the capability, and the infrastructure to develop its capacity to innovate.

Different types of vessels (container ships), exiting developments in technology (communication and navigational satellites), and a new breed of technologically astute 'ship managers' waiting on the quayside, could enable organisations to capitalise on these opportunities.

To do so, however, it will need to design new, more flexible, organisational forms and modify its existing organisational cultures to match its changing environment. The main characteristics of a new organisational model for the UK shipping industry should enable the existing hierarchical structure to be maintained for matters concerning safety and navigation, however, the business imperative could be more effectively managed through a model based on the features of a 'virtual-learning organisation' supported through the infrastructure of an ocean wide network.

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Appendix (a)
Ship Operators Vessel Type Codes

Code	Type of Vessel	Code	Type of Vessel
AA *	Accommodation Vessel	AB *	Ro-Ro Barge
AC *	Container Barge	AD *	Drilling Barge
AH *	Hopper Barge	AM *	Cement Storage Barge
AN *	Barge	AO *	Oil Barge
AP *	Pusher Tug	AR *	Crane / Derrick Barge
AT *	Tug and Barge Combination	AU *	Oil Storage Barge
AZ *	Pontoon	BC	Bulk / Container Carrier
BH	Bulk Wood Chip Carrier	BL	Bulker – Great Lakes Only
BM	Bulk Cement Carrier	BN	Bulker
BO	Ore Carrier	BS	Bulk Carrier Ore Strengthened
BV	Bulk Vehicle Carrier	BX	Bulker Great Lakes Only - Dumb
CF	Container Ship / All Reefer	CN	Container Ship
CR	Container / Reefer General Cargo	DA *	Semi-Sub Heavy Lift Vessel
DC	Multi Purpose Ship	DH	Heavy Lift Ship
DK *	Livestock Carrier	DL *	Log Tipping Vessel
DN	General Cargo Ship	DR	General Cargo – Part Refrigerated ship
FL *	Live Fish Carrier	FP *	Fisheries Protection Vessel
FR	Fisheries Research Vessel	FS *	Sealing Vessel
FT *	Fisheries Training	FV *	Fishing Vessel
FW *	Whaling Vessel	GB *	Bucket Dredger
GC *	Cutter Suction Dredger	GD *	Dragger Dredger
GF *	Hopper Suction Dredger	GC *	Grab Dredger
GH *	Dipper Dredger	GK *	Cutter Dredger
GL *	Sand Loading Dredger	GN *	Dredger
GS *	Suction Dredger	IB	Ice Breaker / Buoy Tender
IN	Ice Breaker	IR	Ice Breaker / Research Vessel
IS	Salvage Vessel	IT	Salvage Tug
IZ	Search and Rescue Vessel	JN *	Training Vessel
JP *	Pleasure Craft	JX *	Sail Training Vessel
LN	Cable Ship	LZ	Cable Repair Ship
MA	Product / Ore / Bulk / Oil Carrier	MB	Ore / Bulk / Oil Carrier
MN	Bulk / Oil Carrier	MS	Ore / Oil Carrier
NA *	Anti-Pollution Vessel	NB *	Buoy Tender
NC *	Pilot Vessel	ND *	Floating Dock
NE *	Maintenance / Utility Vessel	NF *	Fire Fighting Vessel
NP *	Floating Nuclear Power Station	NR *	Floating Wave Powered Power Station

Code	Type of Vessel	Code	Type of Vessel
NS *	Floating Power Station	NT	Tug
NU *	Patrol Vessel	NV *	Naval Vessel
NW	Radioactive Waster Carrier	OA *	Anchor Handling / Tug / Supply Vessel
OB *	Anchor Handling / Tug	OC *	Crew Boat
OD *	AHT / Salvage Vessel	OE *	Diving Support Vessel
OC *	Pipe Carrier / Platform Supply Vessel	OI	Seismic Survey Vessel
OJ *	Safety Standby Vessel	OK *	Offshore Maintenance Utility Vessel
OL *	Offshore Cargo Barge	OR *	Survey Ship ROV Support Vessel
OS *	Supply Vessel	OV *	Offshore Support Vessel
PC *	Multi-Hull Passenger Ferry	PD *	Multi-Hull Passenger / Vehicle Ferry
PE	Passenger Excursion Vessel	PF	Passenger / Cargo Ship
PG *	Casino Ship	PH *	Passenger Hovercraft
PI *	Passenger / Vehicle Hovercraft	PM	Passenger / Train / Vehicle Ferry
PN	Passenger Vessel	PR *	River Cruise Ship
PS *	Surface Effect Passenger Ferry	PT *	Surface Effect Passenger / Vehicle Ferry
PU	Cruise Ship	PV	Passenger / Vehicle Ferry
PY *	Passenger Hydrofoil	QC	Hospital Ship
QE	Geophysical Research Vessel	QN	Research Vessel
QP	Polar Research Vessel	QR *	Radio Station
QS	Oceanographic Vessel	QT *	Satellite Tracking Ship
QV	Survey Ship	QW	Weather Ship
QX *	Rocket Launch Vessel	QY	Survey / Research Vessel
RF	Reefer	RH	Refrigerated Fish Carrier
SD	Spent Nuclear Fuel Carrier	SF *	Floating Hotel
SM *	Museum Ship	SP *	Support Ship
SQ *	Floating Car Park	SR *	Restaurant Ship
SV	Logistics Vessel	SX *	Exhibition Vessel
TA	Asphalt Tanker	TB	Bitumen Tanker
TC	Chemical Tanker	TD	Fruit Juice Tanker
TG	LPG Carrier	TH	LNG Carrier
TI	Storage Tanker	TK	Bunker Tanker
TN	Tanker	TO	Crude Oil Tanker
TP	Parcels Tanker	TQ	Chemical / Oil Tanker
TR	Products Tanker	TS	Replenishment Tanker
TT	Water Tanker	TW	Wine Tanker
TY	Ethylene Tanker	WA	Ro-Ro
WB	Ro-Lo	WC	Multi-Hull Ro-Ro Freight
WD	Vehicle Carrier	WF	Pallet Carrier
WG	Barge Carrier	WH	Ro-Ro / Heavy Lift

Code	Type of Vessel	Code	Type of Vessel
WL	Ro-Ro Cellular	WN	Ro-Ro / General Cargo
XC *	Tank Cleaning Vessel	XD	Waste Disposal Vessel (liquid)
XI	Incinerator and Waste Disposal Vessel	XM *	Diamond Mining Vessel
XP *	Pile Driving Vessel	XS	Sludge Carrier
ZA *	Offshore Accommodation	ZC *	Offshore Construction Vessel
ZD *	Rock Laying Ship	ZE *	Self Elevating Mobile Offshore Drilling Rig
ZF *	FPSO	ZG *	Oil Well Stimulation Vessel
ZH *	Self Elevating Production Unit	ZN *	Drill Ship
ZO *	Offshore Drilling Barge	ZP *	Floating Production Unit
ZS *	Floating Storage Offtake	ZT *	Oil Well Production Test Vessel
ZU *	Semi-Submersible Mobile Offshore Drilling Unit	ZV *	Pipelay Vessel
ZX *	Semi-Sub Pipe Laybarge	ZY *	Pipe Laybarge
ZZ *	Trenching Vessel		

Appendix (b)
List of United Kingdom Ship Owners and Operators

Name of Ship Owner	Type of Ships Owned	Head Office Location
Acomarit (UK) Ltd	TR, TD, DN, BS,BO,DC, BL, BN, TO, LN	Glasgow
Airtours PLC	PU	Rossendale Lancs
Alam Maritime (London) Ltd	DC,	London
Altnamara Shipping PLC	QS	London
Anchor Marine Transportation Ltd	AN, DA	Farnham Surrey
Andreadis (UK) Ltd	BN	London
Angelakos Ltd	BS	London
Anglo Dutch Management Services Ltd	BL, SV	Woking Surrey
Anglo-Georgian Shipping Co Ltd	DN	Glasgow
Argos Ltd	FV	Newbury Berks
ASP Seascot Ship Management Ltd	BN, OJ, TO, TN, DN, TC, BS	Glasgow
Atlantic Marine Sales & Charter Co	QS	Hove Sussex
AA Banks & Co Marine	PV	Orkney
Barber Ship Management (UK) Ltd	BS, MS	London
Bass Leisure Retail Co Ltd	SR	London
BHP Petroleum Ltd	ZE, ZS	Holywell Flintshire
Bibby Harrison Management Services Ltd	TG, BN	Liverpool
Bibby Line Ltd	AA, AZ, OK, SF,TG, ZE, TC, TQ, ZC	Liverpool
Blue Star Line Ltd	CN	London
Boston Putford Offshore Safety Ltd	OJ, IS	Lowestoft
Boyd Line Management Services Ltd	RH	Hull
BP Amoco Exploration Ltd	ZF	Hemel Hempstead Herts
BP Marine Ltd	TK	Hemel Hempstead Herts
BP Shipping Ltd	TR, TO, TH	Hemel Hempstead Herts
John S Braid & Co Ltd	BN	Glasgow
Bray Shipping Co Ltd	BN, BS	London
Bridgewater Leisure Ltd	PF	Liverpool

Name of Ship Owner	Type of Ships Owned	Head Office Location
Briggs Marine Contractors Ltd	IS	Fife
Briggs Marine Environmental Services Ltd	NA	Aberdeen
Brighton Shipping Corp	DC	Watford Herts
Britannia Aggregates Ltd	DC	Gravesend Kent
The Former Royal Yacht Britannia	SM	Edinburgh
Britannic Maritime Ltd	TN, TQ, TO	Wembley Middlesex
Buchan Beamers Ltd	FV	Peterhead Aberdeenshire
Buckie Inshore Fish Selling	FV	Buckie Banffshire
BUE North Sea Ltd	OJ, OS	Leith
Bulkship (Nigeria) Ltd	DC	London
Bullas Tank Craft Co Ltd	DN	Rochester Kent
Caledonian MacBrayne Ltd	PV	Gourock Renfrewshire
Caley Fisheries Ltd	FV	Peterhead Aberdeenshire
Cammell Laird Holdings PLC	OE	Liverpool
Campbell Maritime Ltd	TR, BN, TN, TP,DN	South Shields Tyne and Wear
Canada Maritime Services Ltd	CN	Horley Surrey
Carisbrooke Shipping Ltd	DN, DC, BN,	Cowes Isle of Wight
Carmet Tug Co Ltd	NT	Eastham Merseyside
Celtic Marine (UK) Ltd	MB, WA	London
Cenargo Ltd	PF, WA, PV	Puttenham Surrey
The Charente Steam-Ship Co Ltd	BS	Liverpool
Charisma Fishing Co Ltd	FV	Shetland
Chevron Petroleum UK Ltd	ZS	London
The China Navigation Co Ltd	CN	London
Chios Navigation Co Ltd	BS	London
Cleanaway Ltd	XD	Leigh-on-Sea Essex
Coastal Container Line	DC	Liverpool
Coflexip Stena Offshore Ltd	OE, ZY, ZC, ZU	London
Colne Shipping Co Ltd	FV	Lowestoft
Condor marine Services Ltd	PD	Poole Dorset
Contship Containerlines Ltd	CN	Ipswich Suffolk

Name of Ship Owner	Type of Ships Owned	Head Office Location
D Cook Ltd	GG	Hull
Corus Group Ltd	BS	London
Cory Environmental Ltd	AN	London
Coulouthros Ltd	TO	London
Crescent Marine Services Ltd	BN, WA	Southampton
Crescent Shipping Ltd	BN, DN,	Southampton
Crescent Tankships Ltd	TR	Southampton
Curnow Shipping Ltd	PF	Falmouth Cornwall
Dart Line Ltd	WA, PF	Dartford Kent
Dean & Dyball Marine Ltd	AN, AH	Ringwood Hants
Demline Management (UK) Ltd	WA, WB	London
Denholm Ship Management Ltd	TR, BN, DK, PU	Glasgow
Denval Marine Consultants Ltd	WD	Sevenoaks Kent
Devonport Management Ltd	AR	Plymouth Devon
Diamond Offshore Drilling (UK) Ltd	ZU	Aberdeen
Direct Cruises	PU	London
Dole (UK) Ltd	CF	Chertsey Surrey
Dolphin Drilling Co Ltd	ZA, ZU	Aberdeen
Dover Harbour Board	GF, NT	Dover Kent
Dragon Shipping Line	DN	West Glamorgan
East Africa Maritime	TC	Southampton
Elder Dempster Lines Ltd	PF	Liverpool
Elka Shipping (London) Ltd	TR, TO	London
Ensco Offshore UK Ltd	ZE	Aberdeen
Euronav (UK) Agencies	TO	London
EMC Ltd	ZY	New Malden Surrey
Euroship Ltd	BN, JP	Ramsgate Kent
Euroship Services Ltd	WA, BS	Purfleet Essex
FT Everard & Sons Ltd	TR, TC, BN, DN	Greenhithe Kent
Excelsior Fishing Co	FV	Fraserburgh Aberdeenshire
Falcon Sea freight Ltd	WA, PF	Folkestone Kent
Falmouth Oil Services Ltd	TK	Falmouth Cornwall
Farstad Shipping Ltd	OS, ZV	Aberdeen
Faversham Ships Ltd	BN, DN	Faversham Kent
Festive Cruises	PU	Cheltenham
Field Ship Management Services	BN, DN	Woking Surrey
James Fisher & Sons Plc	BN, LN, SD, WH,WA,SD,BC, DN	Barrow-in-Furness Cumbria

Name of Ship Owner	Type of Ships Owned	Head Office Location
James Fisher Tankships Ltd	TR, TC	Barrow-in-Furness Cumbria
Forth Ports Plc	GS	Edinburgh
Fraserburgh Inshore Fishermen	FV	Fraserburgh
Freight Express Seacon (Rye) Ltd	BN, DN	Rye
Fugro-UDI Ltd	OR	Aberdeen
Furness Withy & Co Ltd	TG, BS	Redhill, Surrey
Gardline Shipping Ltd	NB,	Great Yarmouth
Gardline Surveys Ltd	QV, SV	Great Yarmouth
J and A Gardner & Sons Ltd	FL, WA, TC, DN	Glasgow
The Geest Industries	RF	Southampton
Genchem Marine Ltd	DC, DN	Ipswich Suffolk
Genmar Shipping Ltd	DC, BC,	Wembley Middlesex
Gibson Gas Tankers Ltd	TG	Edinburgh
GT Gillie & Blair Ltd	BN, DN	Newcastle Upon Tyne
Glade Water Shipping Ltd	DN	London
Global Marine Services	OA	Midlothian
Global Marine Systems Ltd	LN, LZ,	Chelmsford Essex
Global Marine UK Ltd	ZE	Aberdeen
Global Reefer Trading Ltd	RF	Farnham Surrey
Graig Ship Management Ltd	DC, BC	Cardiff
London Borough of Greenwich	PV	London
Gulf Offshore NS Ltd	OS, OI, OA,OE, OR, NA	Aberdeen
John C Hadjipateras and Sons Ltd	BS	London
Hadley Shipping Co Ltd	BS	London
Halliburton & Subsea	OE	Aberdeen
Hanson Aggregates Marine Ltd	GS, GF, GN	Aberdeen
IT JD Harcus & TA Cumming	FV	Orkney
Harcus Fishing Co Ltd	FV	Orkney
Harris and Dixon (Shipbrokers) Ltd	BN	London
Hays Ships Ltd	OR, FP, QS	Carnwath Lanarkshire
Hebridean Island Cruises Ltd	PN	Skipton Yorkshire
Helikon Shipping Enterprises	DC	London
Holbud Shipmanagement	BS, BN, DN, DC	London

Name of Ship Owner	Type of Ships Owned	Head Office Location
Ltd		
Holyhead Towing Co Ltd	AH	Holyhead Anglesey
Hooktone Ltd	FV	Ardrossan Ayrshire
Hoverspeed Ltd	PD, PI	Dover Kent
Howard Smith (UK) Ltd	NT	Hull
Humber Work Boats (Barton) Ltd	OE	Grimsby
International Marine Transportation Ltd	TO, TB, TR, TC	Leatherhead Surrey
International Maritime and Marine Services (London) Ltd	DN, DC, BN, BC,	Croydon Surrey
International Shipping Partners (UK) Ltd	PV	Southampton
Intrada Chartering Ltd	WA	Romford Essex
Inverclyde Ship Management Ltd	NE	Greenock
IOSL Marine Services Ltd	WA, OS, OK	Darlington Co Durham
Isle of Scilly Steamship Co Ltd	WF, PF	St Mary's Isles of Scilly
Jayship Ltd	DC	London
JC's	FV	Milford Haven Dyfed
Peter & J Johnstone Ltd	FV	Aberdeen
Kamsco Ltd	TN	London
Kerr-McGee North Sea (UK) Ltd	ZF, ZP	Aberdeen
Klyne Tugs (Lowestoft) Ltd	OB, OA, IT	Lowestoft
JP Knight (Caledonian) Ltd	NT	Invergordon Ross-shire
JP Knight (Paranam) Ltd	AP	Rochester Kent
JP Knight Ltd	AZ, AP, NT	Rochester Kent
R Lapthorn & Co Ltd	BN,	Rochester Kent
Diamantis Lemos Ltd	BS	London
LHD Ltd	FV	Lerwick Shetland
Liquid Gas Shipping Ltd	TG	Edinburgh
London Chartering Ltd	TN, TO	London
London Ship Managers Ltd	RF	London
Lothian Ship Management Ltd	BN	Ruislip Middlesex
Lunar Fishing Co Ltd	FV	Peterhead Aberdeenshire
Lyras Maritime Ltd	MB	London
The Maersk Co Ltd	CN, OA, ZF, OS, TR, WA, TG,	London
John Mander Ltd	IS	Bridgnorth Shropshire

Name of Ship Owner	Type of Ships Owned	Head Office Location
Marquis Marine (Montrose) Ltd	NT	Arbroath Angus
Marr Vessel Management Ltd	FP, FV, RH, JN, OI, QY	Hull
RJ & AR McCullough	FV	Newry Co Down
J McKee & Partners Ltd	QN, QV, QE	Great Yarmouth
Mediterranean Shipping Cruises	PU	London
Mermaid Marine Management Ltd	TC	New Milton Hants
The Mersey Docks and Harbour Co – Marine Division	AR, GC, GF	Liverpool
Mersey Tanker Lighterage Co Ltd	TK	Liverpool
Middle East Navigation Aids	NB	London
MOL Tankship Management Ltd	TO, TR, TQ	London
Morline Ltd	CN, WA, BN	Barking Essex
Murray Marine Contractors	BN	Queensborough Kent
Natural Environmental Research Council Research Vessel Services	QY, QS, QN	Southampton
Nomikos (London) Ltd	TO	London
Nomis Shipping Ltd	OJ, OA,	Aberdeen
Norbulk Shipping (UK) Ltd	RF, TO, BN	Glasgow
Nord Ship Management Ltd	BN	Lerwick Shetland
Norse Management (UK) Ltd	TO	Colchester Essex
Norse Merchant Ferries	PV, WA	Belfast
Nortech (Scotland) Ltd	AO	Coatbridge Lanarkshire
North Atlantic Fishing Co Ltd	RH	Caterham Surrey
North Sea Production Co	ZF	Aberdeen
North Star Shipping (Aberdeen) Ltd	OJ, OS, OA	Aberdeen
Northern Marine Management Ltd	OE	Clydebank
Northwood (Fareham) Ltd	GF, GS	Fareham Hants
Novoship (UK) Ltd	TO, TR, TQ, MB, WA	London
OBC Hay	BN	Lerwick Shetland
Ocean Agencies Ltd	BS, BN, WA,	London

Name of Ship Owner	Type of Ships Owned	Head Office Location
Ocean Fish Selling Ltd	FV	Fraserburgh Aberdeenshire
Oceaneering International Services Ltd	ZF	Aberdeen
Oceanic Maritime Ltd	DC, CN	London
Orient Lines	PU	London
Orion Shipping and Trading Ltd	TB, TR	London
Orkney Ferries Ltd	PF	Kirkwall Orkney
Osprey Maritime (Europe) Ltd	TH, TO	London
Osprey Trawlers Ltd	FV	Peterhead Aberdeenshire
OT Africa Line Ltd	CN, WA	London
P & O Cruises Ltd	PU	Southampton
P & O European Ferries (Irish Sea) Ltd	WA, PV	Fleetwood Lancs
P & O European Ferries (Portsmouth) Ltd	PD, PV	Portsmouth
P & O Holidays	PU	London
P & O Nedlloyd Ltd	CN,WL	London
P & O North Sea Ferries Ltd	PV	Hull
P & O Scottish Ferries Ltd	PV, WA	Aberdeen
P & O Stena Line Ltd	PV	Dover Kent
Pan Oceanic Ship Agency (UK) Ltd	DC	London
Pelican Shipping Ltd	MA, MB	London
Petredec Ltd (Bermuda)	TG	London
Petroleum Shipping Ltd	TC	Southampton
PGS Atlantic Power Ltd	ZP	Aberdeen
Phocean Ship Agency Ltd	BS, BN	London
JJ Prior (Transport) Ltd	BN	Colchester Essex
Prisco (UK) Ltd	TR	London
The Prison Service	AA	London
Racal Survey Group Ltd	OR, QV, QS	Chessington Surrey
Red Funnel Group	PV, NT	Southampton
Rethymnis & Kulukundis Ltd	BS, BN	London
Riverzest (Glasgow) Ltd	SR	Gateshead Tyne & Wear
JR Rix & Sons Ltd	BC, DN, TN, TK	Hull
Ropner Ship Management Ltd	WA	Stockton on Tees
Safe Service Ltd	ZB, ZA, OV	Aberdeen
Saga Shipping	PU	Folkestone Kent
Scotline Ltd	DN	Romford Essex
Sea Container Ferries (Scotland) Ltd	PD	Stranraer Wigtownshire

Name of Ship Owner	Type of Ships Owned	Head Office Location
Sea Containers Ltd	PV	London
Sea Pioneer Ltd	DN, DC	Beckenham Kent
Seacon Shipping Ltd	DN	Northfleet Kent
Seacrest Shipping Co Ltd	TO, BS	London
Sealion Shipping Ltd	OS, OA, OE, OJ	Farnham Surrey
Serco-Denholm Ltd	NT, TK, IS, SV	Greenock
Seven Seas Maritime	BN, BS, DC, BC	London
Shell (UK) Exploration & Production Ltd	ZF	Aberdeen
Shell International Trading & Shipping Co Ltd	TH, TR, TO,TQ,	London
Shetland Towage Ltd	NT	Mossbank Shetland
Silver Line Ltd	PU, DC, TG, BN, WB, WA, CN,	London
Souter Shipping Ltd	TO	Newcastle upon Tyne
South Coast Shipping Co Ltd	GF, GS	Southampton
Southern Shipping & Finance Co Ltd	TO	London
Specialist Marine Services	OA, OS, IN	Hull
Star Reefers	RF	London
Starline Cruises (Guernsey) Ltd	PU	Bromley Kent
Stena Drilling Ltd	ZU	Aberdeen
Stena Line Ltd	PV, PD	Ashford Kent
Sten Tex (UK) Ltd	TR, TO	London
Stephenson Clarke Shipping Ltd	DC, BN, XS,	Newcastle upon Tyne
Stirling Shipmanagement Ltd	OS, OA, OB	Glasgow
Stolt Offshore MS Ltd	OE, ZY, LN, ZV, ZC, LZ, NA, QY, QR, OJ	Sunbury-on-Thames
Sun Cruises-Airtours Plc	PU	Rossendale Lancs
Sunbeam Fishing Co Ltd	FV	Lerwick Shetland
Svitzer Ltd	OI,	Great Yarmouth
Swire Pacific Offshore (North Sea) Ltd	OA	Aberdeen
Synergy Shipbroking Ltd	BS	London
Targe Towing Ltd	TG	Montrose Angus
Tees & Hartlepool Port Authority Ltd	GF, NB	Middlesborough Cleveland
Texaco North Sea UK Co	ZF	Aberdeen
Tidewater Marine North Sea Ltd	OA, OS, OJ, AA, ZC	Aberdeen
Torbulk Ltd	BN	Grimsby

Name of Ship Owner	Type of Ships Owned	Head Office Location
Trader Navigation Agencies Ltd	TR	Old Windsor Berks
Trico Supply (UK) Ltd	OA, OS, OG	Aberdeen
Tropis Shipping Co Ltd	DN	London
TSA Tugs Ltd	SV	Leigh-on-Sea Essex
UB Shipping Ltd	RF	London
Union Transport Group Plc	DC, BN	Bromley Kent
UK Government (MOD Royal Fleet Auxiliary)	SV, TS, NV, WA, IS, QS, NB	Portsmouth
United Marine Dredging Ltd	GS	Chichester Sussex
V Ships (UK) Ltd	DN, DC	Southampton
Valiant Shipping Co (London) Ltd	BN, BH	London
Vector Offshore Ltd	OA, OJ, OS	Great Yarmouth
Vogt & Maguire Ltd	DC	London
VT Services Ltd	QY	Portsmouth
George Walker & Sons (FR)	FV	Fraserburgh Aberdeenshire
Wallem Ltd	BS	London
Warwick & Esplen Ltd	BS	London
Andrew Weir Shipping Ltd	WA, WB, CN	London
West Coast Towing Co (UK) Ltd	OA, NT, OB	Ammanford Dyfed
David West	FV	Banff
Western Ferries (Clyde) Ltd	PV, PF	Glasgow
Westminster Dredging Co Ltd	GF, AH	Fareham Hants
Westward Fishing Co Ltd	FV	Fraserburgh Aberdeenshire
John H Whitaker (Tankers) Ltd	TN, AO, XS, TR, NT	Hull
Wightlink Ltd	PV, PC	Portsmouth Hants
Wijsmuller Marine Ltd	NT, OB	Woking Surrey
Charles M Willie & Co (Shipping) Ltd	DC, DN, BN	Cardiff
Workfox UK Ltd	ZE	Great Yarmouth
World Carrier (London) Ltd	BN	London
Zelta Shipping Co Ltd	BS	London
Zodiac Maritime Agencies	BN, BS, BC, RF, BV, BO, CN,	London

Appendix C
Details of United Kingdom Shipping Industry International Revenue and Expenditure

(a) Revenue — £ Million

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Dry cargo and passenger vessels: (including ferries)											
Freight on:											
Imports	553	510	537	592	564	585	484	482	522	484	461 [1]
Exports	378	367	384	406	421	409	416	322	375	400	387
Cross-trades	869	902	1,129	1,272	1,354	1,345	1,564	1,502	1,412	1,453	1,314
Total freight revenue	1,800	1,779	2,050	2,270	2,339	2,339	2,464	2,306	2,309	2,337	2,162
Charter receipts	89	105	117	98	133	134	147	109	90	140	100
Passenger revenue	479	586	588	594	693	705	697	462	463	630	564
Total revenue	2,368	2,470	2,755	2,962	3,165	3,178	3,308	2,877	2,862	3,107	2,826
Wet (tankers and liquefied gas carriers):											
Freight on:											
Imports	35	63	74	56	49	113	24	29	20	3	3 [1]
Exports	47	50	46	66	64	71	68	60	59	98	107
Cross-trades	469	383	416	502	489	550	536	442	350	458	577
Total freight revenue	551	496	536	624	602	734	628	531	429	559	687
Charter receipts	94	79	96	128	139	120	68	70	87	104	190
Total revenue	645	575	632	752	741	854	696	601	516	663	877
All vessels:											
Freight on:											
Imports	588	573	611	648	613	698	508	511	542	487	464
Exports	425	417	430	472	485	480	484	382	434	498	494
Cross-trades	1,338	1,285	1,545	1,774	1,843	1,895	2,100	1,944	1,762	1,911	1,891
Total freight revenue	2,351	2,275	2,586	2,894	2,941	3,073	3,092	2,837	2,738	2,896	2,849
Charter receipts	183	184	213	226	272	254	215	179	177	244	290
Passenger revenue	479	586	588	594	693	705	697	462	463	630	564
Total revenue	3,013	3,045	3,387	3,714	3,906	4,032	4,004	3,478	3,378	3,770	3,703

(b) Expenditure — £ Million

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Dry cargo operations:											
Bunkers	152	132	146	148	160	197	216	149	165	288	413
Other disbursements	754	771	910	1,094	1,194	1,447	1,473	1,310	1,328	1,463	1,422
Charter payments	142	157	173	191	200	215	282	239	122	149	137
Total expenditure	1,048	1,060	1,229	1,433	1,554	1,859	1,971	1,698	1,615	1,900	1,972
Wet cargo operations:											
Bunkers	89	92	81	89	91	118	100	70	81	141	234
Other disbursements	112	108	116	106	111	142	128	124	148	127	149
Charter payments	196	214	208	200	186	243	161	181	89	172	265
Total expenditure	397	414	405	395	388	503	389	375	318	440	648
All cargo operations:											
Bunkers	241	224	227	237	251	315	316	219	246	429	647
Other disbursements	866	879	1,026	1,200	1,305	1,589	1,601	1,434	1,476	1,590	1,571
Charter payments	338	371	381	391	386	458	443	420	211	321	402
Total expenditure	1,445	1,474	1,634	1,828	1,942	2,362	2,360	2,073	1,933	2,340	2,620

1 Estimate based on other related series

(Source: Department for Transport Marine Statistics)

Appendix (d)

Pilot Questionnaire

Please answer the following questions by ticking the appropriate box.

1) Before installing any GMDSS equipment, which of the following communications systems were installed on **most** of your ships ?
(please tick all applicable)

Radio (voice) ☐ Radio (Morse) ☐ Radio (telex) ☐
Satellite Std C ☐ Satellite Std A ☐ Satellite Std B ☐
Satellite Std M ☐ Sat-Nav (transit) ☐ Decca Navigator ☐ Loran C ☐
GPS ☐ Radar (X band) ☐ Radar (S Band) ☐ ARPA ☐
Inter switched Radar/ARPA ☐ Direction Finder ☐ Echo Sounder ☐
Electronic Log ☐

2) At that time, which of the following was used for **most** of your **commercial** communications ?
(Please tick only one box)

Radio coast station ☐ Satellite (C) ☐ Satellite (A) ☐ Satellite (B) ☐
Satellite (M) ☐ Other means (please specify) ....

3) Which system do you **currently** use most for **commercial** communications to ships ?
(Please tick only one box)

Radio coast station ☐ Satellite (C) ☐ Satellite (A) ☐ Satellite (B) ☐
Satellite (M) ☐ Other means (please specify) ....

4) Do you think that the GMDSS system is better or worse than the original system for **distress and safety communications ?**

Better ☐ Worse ☐

5) Do you think that the equipment that was installed as part of the GMDSS package is adequate for most **commercial** communications ?

Yes ☐ No ☐

6) Did you install additional equipment, over and above the GMDSS requirements, for commercial communications ?

Yes ☐ No ☐

7) What was your **main** consideration in deciding when and which GMDSS equipment to install
(please tick one only box)

Equipment price ☐ Running costs ☐ Delivery time ☐
Ease of use of equipment ☐ Possibilities to integrate with existing equipment ☐ Technical capabilities of equipment ☐
Future plans for integration ☐

8) Subsequent to the installation of GMDSS equipment did you decide that
(Please tick one box only)

The Radio Officer was redundant ☐ The Radio Officer would be retained with the same duties as before ☐ The Radio Officer would be retained, but his/her duties would be mainly administrative ☐ The Radio Officer would be retained but his/her duties would be mainly technical support. ☐

9) Do you believe that the new communication capabilities will make it easier, faster and/or cheaper to communicate with ships at sea ?

Now - Yes ☐ No ☐
In the Future - Yes ☐ No ☐

10) If you answered **NO** to both parts of question 9, could you please explain why you do not expect to see such improvements ?

....
....

Thank you for your explanation

11) Do you think that new navigation systems (such as GPS) will ultimately
make traditional navigational instruments (such as sextants) obsolete ?

Yes ☐ No ☐

12) Do you think that your ship's officers may require additional training in subjects **over and above their core competence** (for example, do you think that training a navigation officer in management techniques or some other
skill would benefit either the company or the individual
(please tick all appropriate boxes)

Yes ☐ Benefits to the company ☐ Benefits to the individual ☐
No ☐ Would not benefit either ☐

If you ticked NO to this question, please go to question 15

13) If you have ticked yes to the above question, what type of training do you think will be required in the future ?

Technical ☐ Commercial ☐ other (please specify)

.

14) Do you think that new communication technologies - such as the internet - could be used to deliver such training to ships at sea economically?

Yes☐ No ☐ Now☐ In the future ☐

15) Do you think that the organisational structure on board ship will change, or already has changed as a result of the developments in information and communication technologies ?

Will change ☐ Will not change ☐ Has already changed ☐

16) Do you think that the organisational structure ashore will change, or already has changed as a result of the developments in information and communication technologies and/or as a result of any changes in the organisational structure at sea ?

Will change ☐ Will not change ☐ Has already changed ☐

17) Do you think that new technology, particularly information and communications technology, will improve the profitability or learning opportunities for the shipping industry as a whole?

Yes ☐ No ☐

18) Are your ships trading world wide, or on specific routes ?

World Wide ☐ Specific routes only ☐

We would appreciate any comments that you think might assist our research into emerging technologies and / or innovation aspects of the shipping industry. The source of any comments will remain strictly confidential.

....

....

.. (please use extra sheet/s if necessary)

Thank you for your co-operation in completing this questionnaire. If you wish to receive feedback on the results of our research please enclose your business card or your e-mail/postal address. If you do not require feedback and wish to remain anonymous please tick this box ☐

Appendix (e)

List of Ship Owners Addressed in Pilot Survey

1 Acomarit (UK) Ltd
2 Airtours PLC
3 Alam Maritime (London) Ltd
4 Andreadis (UK) Ltd
5 Angelakos Ltd
6 Anglo-Georgian Shipping Co Ltd
7 ASP Seascot Ship Management Ltd
8 AA Banks & Co Marine
9 Barber Ship Management (UK) Ltd
10 Bibby Harrison Management Services Ltd
11 Bibby Line Ltd
12 Boyd Line Management Services Ltd
13 John S Braid & Co Ltd
14 Brighton Shipping Corp
15 Britannia Aggregates Ltd
16 Britannic Maritime Ltd
17 Campbell Maritime Ltd
18 Celtic Marine (UK) Ltd
19 The Charente Steam-Ship Co Ltd
20 Crescent Shipping Ltd
21 Euroship Services Ltd
22 Field Ship Management Services
23 James Fisher & Sons Plc
24 Freight Express Seacon (Rye) Ltd
25 J and A Gardner & Sons Ltd
26 Genchem Marine Ltd
27 John C Hadjipateras and Sons Ltd
28 Harris and Dixon (Shipbrokers) Ltd
29 Holbud Shipmanagement
30 International Maritime and Marine Services (London) Ltd
31 R Lapthorn & Co Ltd
32 Liquid Gas Shipping Ltd
33 Lothian Ship Management Ltd
34 Marr Vessel Management Ltd
35 MOL Tankship Management Ltd
36 Ocean Agencies Ltd
37 P & O Stena Line Ltd
38 Pelican Shipping Ltd
39 Red Funnel Group
40 Shell International Trading & Shipping Co Ltd

Appendix (f)

Final Questionnaire

1 <u>Before the installation of GMDSS equipment</u>, which of the following communications and navigation systems were installed on most of your ships? (Please tick all the applicable boxes)

Radio (voice) ☐ Radio (Morse) ☐ Radio (telex) ☐
Satellite Std C ☐ Satellite Std A ☐Satellite Std B ☐ Satellite Std M ☐
Sat-Nav (transit) ☐ Decca Navigator ☐ Loran C ☐ GPS ☐
Radar (X band) ☐ Radar (S Band) ☐ ARPA ☐ Inter switched
Radar/ARPA ☐ Direction Finder ☐ Echo Sounder ☐ Electronic Log ☐

2 Do you think that the methods used for communicating with ships at sea since the introduction of GMDSS is better or worse than the original system?

(a) For distress and safety communications Better ☐ Worse ☐
(b) For commercial communications Better ☐ Worse ☐

3 Do you think that manufacturers of communications and navigational systems should be compelled to adopt a 'standard' method of controlling their equipment so that, regardless of manufacturer, all marine electronic equipment would have a standard set of controls in more or less the same place (like on a car)?

Yes manufacturers should be compelled to standardise on basic operating controls ☐
No - manufacturers should be free to decide on appropriate controls themselves ☐

4 Do you think that technological developments, such as satellite communications, GPS, and ECDIS could create commercial opportunities that you might not have considered prior to these developments? Yes ☐ No ☐

5 Since the mandatory introduction of GMDSS equipment, have you considered or implemented any supplementary systems designed to enhance the communications or navigation facilities for your vessels?

Considered ☐ Not considered ☐ Implemented ☐ (Please specify)
....

6 Do you consider such supplementary systems essential to your longer-term plans in terms of communications or navigation? Yes ☐ No ☐

7 Do you think that further developments in communication and navigational technologies could provide any <u>commercial</u> advantages to shipping organisations? Yes ☐ No ☐

8 Do you think that new technology could be used to support closer collaboration between you and your clients? Yes ☐ No ☐

9 Do you think there would be any commercial advantages in such collaboration? Yes ☐ No ☐ N/A ☐

10 Do you think that your ship's officers may require additional training in subjects over and above their core competence (for example, do you think that training a navigation officer in management techniques or some other skill would benefit either the company or the individual? (please tick all appropriate boxes)

Yes ☐ It would benefit the company ☐
It would benefit the individual ☐
No ☐ It would not benefit either the company or the individual ☐
(If you ticked NO to this question, please go to question 15)

11 What type of training do you think would provide the most benefit?
Technical ☐ Commercial ☐ other (please specify)
....

12 What level of training and/or certification do you think would be the most appropriate?

No certification ☐ Certificate (ONC/ HNC) ☐ Diploma (HND) ☐
Degree (BA/BSc.) ☐ Post Graduate Degree (MA/M.Sc./ MBA) ☐
Professional / other qualification (please specify)
....

13 Do you think that new communication technologies - such as the internet - could be used to deliver such training to ships at sea economically?

Yes ☐ No ☐

14 Do you think that your organisation would consider providing financial support (training costs) to officers undertaking such training? Yes ☐ No ☐

15 Do you think that the organisational structure on board ship will change, or already has changed as a result of developments in information and communication technologies?

Will change ☐ Will not change ☐ Has already changed ☐

16) Do you think that the organisational structure ashore will change, or already has changed as a result of the developments in information and communication technologies and/or as a result of any changes in the organisational structure at sea ?

Will change ☐ Will not change ☐ Has already changed ☐

17) Are your ships trading world wide, or on specific routes ?
World Wide ☐ Specific routes only ☐

Thank you for your co-operation in completing this questionnaire. Any comments that you think might assist our research into emerging technologies and / or innovation aspects of the shipping industry would be greatly appreciated. The names of organisations or individuals returning questionnaires will not be divulged in the research findings. The source of any comments received will also remain strictly confidential.

If you would like to receive feedback on the results of our research please enclose your business card or your e-mail/postal address.

Please use this space for any comments that you wish to make. Thank you again for your time.

Appendix (g)

List of Ship Owners Addressed in Final Survey

1 Bibby Line Ltd
2 Blue Star Line Ltd
3 BP Marine Ltd
4 BP Shipping Ltd
5 Bray Shipping Co Ltd
6 Bulkship (Nigeria) Ltd
7 Bullas Tank Craft Co Ltd
8 Canada Maritime Services Ltd
9 Carisbrooke Shipping Ltd
10 Cenargo Ltd
11 China Navigation Co Ltd
12 Chios Navigation Co Ltd
13 Coastal Container Line
14 Contship Containerlines Ltd
15 Corus Group Ltd
16 Coulouthros Ltd
17 Crescent Marine Services Ltd
18 Crescent Tankships Ltd
19 Dart Line Ltd
20 Demline Management (UK) Ltd
21 Denholm Ship Management Ltd
22 Denval Marine Consultants Ltd
23 Direct Cruises
24 Dole (UK) Ltd
25 Dragon Shipping Line
26 East Africa Maritime
27 Elder Dempster Lines Ltd
28 Elka Shipping (London) Ltd
29 Euronav (UK) Agencies
30 Euroship Ltd
31 FT Everard & Sons Ltd
32 Falcon Sea freight Ltd
33 Farstad Shipping Ltd
34 Festive Cruises
35 James Fisher Tankships Ltd
36 Furness Withy & Co Ltd
37 The Geest Industries
38 Genmar Shipping Ltd
39 Gibson Gas Tankers Ltd
40 GT Gillie & Blair Ltd
41 Glade Water Shipping Ltd
42 Global Reefer Trading Ltd
43 Graig Ship Management Ltd
44 Hadley Shipping Co Ltd
45 Helikon Shipping Enterprises
46 Intrada Chartering Ltd
47 Jayship Ltd
48 Kamsco Ltd
49 Diamantis Lemos Ltd
50 London Chartering Ltd
51 London Ship Managers Ltd
52 Lyras Maritime Ltd
53 The Maersk Co Ltd
54 Mediterranean Shipping Cruises
55 Mermaid Management Ltd
56 Morline Ltd
57 Murray Marine Contractors
58 Nomikos (London) Ltd
59 Norbulk Shipping (UK) Ltd
60 Norse Management (UK) Ltd
61 Novoship (UK) Ltd
62 Oceanic Maritime Ltd
63 Orient Lines
64 Osprey Maritime (Europe) Ltd
65 OT Africa Line Ltd
66 P & O Cruises Ltd
67 P & O Nedlloyd Ltd
68 Pan Oceanic Agency (UK) Ltd
69 Petredec Ltd (Bermuda)
70 Petroleum Shipping Ltd
71 Phocean Ship Agency Ltd
72 JJ Prior (Transport) Ltd
73 Rethymnis & Kulukundis Ltd
74 JR Rix & Sons Ltd
79 Ropner Ship Management Ltd
76 Saga Shipping
77 Sea Containers Ltd
78 Sea Pioneer Ltd
79 Seacon Shipping Ltd
80 Seacrest Shipping Co Ltd
81 Seven Seas Maritime
82 Souter Shipping Ltd
83 Star Reefers
84 Stena Line Ltd
85 Stephenson Clarke Shipping Ltd
86 Stirling Shipmanagement Ltd
87 Trader Navigation Agencies Ltd
88 Tropis Shipping Co Ltd
89 Union Transport Group Plc
90 V Ships (UK) Ltd
91 Valiant Shipping Co Ltd
92 Vogt & Maguire Ltd
93 Andrew Weir Shipping Ltd
94 John H Whitaker (Tankers) Ltd
95 Charles M Willie & Co Ltd
96 Zodiac Maritime Agencies

Appendix (h)

Criteria for Ranking Technological Equipment

This appendix provides brief details of the technological capabilities, the relevant costs, and the specific advantages and disadvantages of the various items listed in question one of the pilot and final questionnaires. The criteria by which the various items were 'ranked' as well as the rationale for the order of their ranking are also provided.

Radio (Morse) is the most basic system of radio transmission. A large number of ships that communicated globally relied upon Morse code for the majority of their communications until 1st February 1999. The system became obsolete with the mandatory introduction of GMDSS on that date. Approved marine electronic equipment to send and receive Morse code costs between USD $2,000 and $5,000.

Radio (voice) is used in several marine frequency bands between 2 and 160 MHz. Although most ships still use voice radio for relatively short-range work its use for long-range communications has diminished dramatically since the introduction of GMDSS, which compelled ship-owners to install more modern systems of communication. Short-range voice radio uses frequencies in the intermediate frequency (IF) and very high frequency (VHF) bands where atmospheric conditions have relatively little influence. Long-range voice radio, which depends on frequencies in the high frequency (HF) band, is subject all kinds of atmospheric disturbances associated with conditions in the ionosphere and is somewhat unreliable. Equipment capable of transmitting and receiving voice radio in the marine bands costs between USD $500 and $15,000.

Telex Over Radio (TOR) equipment costs more or less the same as voice radio, and mainly uses frequencies in the HF band. In adverse atmospheric conditions however it is much more reliable than voice radio. There are two main reasons for this. Firstly TOR requires a much smaller bandwidth, which reduces the 'noise' effect of atmospheric disturbances. The other very important reason is that TOR employs a system known as 'automatic error detection and correction', which basically eliminates most of the errors caused by poor transmission or reception conditions.

Satellite Communications 'INMARSAT C' is completely unaffected by atmospheric disturbances since it utilises a combination of coast earth stations (CES) and orbiting satellites. INMARSAT C is the basic satellite communication system that is approved for use in terms of the GMDSS regulations. It is a 'store and forward' system - in other words there is no direct communication between the subscriber ashore and the ship. Instead, all messages are 'stored' at the coast earth station, who then 'forwards' them to the ship. Messages from ship to shore are handled in the same way. The process of 'storing' and 'forwarding' is very fast - more or less similar to the e-mail systems used ashore although there can be delays in conditions of heavy demand. Distress and safety traffic takes precedence over all other traffic. INMARSAT C cannot be used at all for voice communications; in practice it is a telex only service, although it can also handle low speed data. INMARSAT C terminals cost is the order of USD $5,000 - $8.000.

Satellite communications 'INMARSAT A' was the first satellite communications system available to ships at sea. It is an analogue system that makes use of high altitude geo-stationary satellites in conjunction with coast earth stations to provide a reliable and efficient means of direct voice, telex and high speed (maximum

68kbs) data communications between telephone subscribers ashore and ships at sea. INMARSAT A terminals cost between USD $15,000 and $25,000.

Satellite communications 'INMARSAT B' is a digital version of the ageing INMARSAT A system. The advantage of a digital system is that it can accommodate many more subscribers within the same frequency band and is therefore able to provide a cheaper service to subscribers. It also offers enhanced data facilities. INMARSAT B will ultimately replace INMARSAT A. INMARSAT B terminals cost on average about USD $5000 more than INMARSAT A. Both INMARSAT A and INMARSAT B systems are approved for use as part of a GMDSS installation but are not compulsory. Ship-owners opting to install either INMARSAT A or INMARSAT B would probably do so for commercial rather than for purely safety reasons.

Satellite communications 'INMARSAT M' is also a digital system but it is designed as a low-cost telephone only system, it does not support telex although it can include a very low speed data facility. Portable INMARSAT M often known as 'mini 'M' terminals' are also available.

INMARSAT M is rarely used on commercial ships, its main attraction being for the leisure market. It is not approved for use as part of GMDSS. Ship-owners opting to install INMARSAT M would probably be doing so on the basis that they required low-cost ship-shore telephone communications. Terminal costs vary between USD $2,000 and $7,000.

Transit 'Sat-Nav' was the first satellite navigation system available to ships at sea. It worked by tracking orbiting low-altitude satellites and measuring an apparent frequency change as a single satellite approached, passed overhead and moved away.

The apparent frequency change, called 'Doppler effect', created a 'Doppler curve' that was unique to the receiver's location, and which enabled the system to calculate the ship's latitude and longitude. Systems such as the United States 'Global Positioning System' (GPS) and the Russian equivalent (Glonas) have now superseded the original sat-nav system. The first sat-nav systems cost around USD $50,000 but as the market developed prices were gradually reduced to about $4,000.

Decca Navigator was a short-range low-frequency land based system providing a fairly accurate position fix.

Special charts were required which, as well as having lines of latitude and longitude also had curved lines known as Lines of Position (LOP). The LOPs were displayed in three different colours 'green', 'red', and 'purple' corresponding to three so-called 'Decca chains'.

On the navigation instrument, three separate 'clocks' - also red, green, and purple - were activated by signals from the shore and displayed numbers that changed relative to the ship's distance from the signal source. By reading the numbers displayed on the three clocks and marking the point on the chart where the numbers on three corresponding colours of LOP crossed, the ship's position could be indicated.

Decca navigator systems were very popular for ships operating within the range of the system. The systems were only available on rental and could not be purchased outright.

Loran - C was also a land based system that was designed for long range navigation (hence the acronym). Loran - C, although using a somewhat similar principle of operation was much more difficult to learn to use. It was also less accurate than the

Decca system and was far less popular. The cost of these systems was between USD $1,000 and $3,000.

GPS - the Global Positioning System relies on a constellation of orbiting satellites and, by measuring the time of arrival of signals from four different satellites, calculates the four navigation parameters - latitude, Longitude, Altitude and Time. GPS signals, although transmitted at very high frequencies, are subject to the influence of the ionosphere, which reduces the accuracy of the 'fix' by several hundred meters. For ocean going vessels this error is relatively unimportant, but more precise navigation can be achieved by measuring the influence of the ionosphere and adjusting the calculated position accordingly. For short-range shore based systems this usually involves checking the calculated GPS position against a known survey point and adjusting the GPS position accordingly. For military applications the satellites transmit additional data on a different frequency which enables the system to compensate for ionospheric refraction. Military 'P-code' however is unavailable to commercial users. Due to the huge market for GPS outside of the shipping industry the price of these devices is dramatically lower than any other marine navigational system. Typically a basic GPS system can be purchased for a few hundred dollars.

'X Band' Radar operates on a frequency of about 10,000 MHz, a frequency at which it will 'see' other ships, buoys icebergs, precipitation and so on and display them as valid radar targets. Most ships will have X band radar as their first choice and they range in price between about USD $2,000 and $20,000.

'S Band' radar operates on a frequency of about 3,000 MHz. At this lower frequency the transmitted signals penetrate much 'deeper' than X band signals and the system is therefore capable of penetrating heavy precipitation. S band is capable of detecting targets at a longer range than X band. Whilst this is a useful feature for large vessels there is a possibility that relatively 'weak' targets, such as icebergs may not be identified by an S band radar. S band radar is not able to discriminate between two closely spaced targets as well as X band and most ships that have S band radar installed will also have X band. S band radar costs between USD $7,000 and $40,000.

ARPA is an acronym for Automatic Radar Plotting Aid. An ARPA is an add-on device, which enables the system to calculate factors such as the course, speed, closest point of approach, and time to closest point of approach based upon information generated by the radar. Most equipment manufacturers supply ARPA and Radar in a single package rather than as separate units. ARPA/Radar systems cost between USD $20,000 and $50,000 depending upon the configuration required.

Inter-switched Radar allows the display units, transceiver units, and scanners of two or more radar devices to be shared and hence act as a back up in the event of any single unit failing. With full inter-switching for example it is possible to have several display units working from a single transceiver and scanner, or to view either X or S band data on a single display. A number of radar/ARPA units may be included in the inter-switch network. Full inter-switching facilities would probably add between USD $10,000 and $20,000 to the cost of a standard shipboard system whilst specialised systems used for shore-based vessel traffic management might cost several hundred thousand dollars.

A Direction Finder (DF) is a simple radio device that enables a ship's navigator to determine the direction of an external radio signal. Its use as a navigation device is largely redundant although it is still sometimes used for distress and safety purposes. The cost of such devices varies between USD $200 and $20,000.

Echo Sounders, which rely for their operation on the time taken to receive an 'echo' from a low frequency transmitted 'sound' signal, are primarily used for measuring sea depth. For navigational purposes a basic model is adequate whilst sophisticated echo sounders that can be adjusted to compensate for differences in the speed of sound in water due to differences in temperature and salinity might be used on survey or mining vessels. Fishing vessels also use specialised echo sounders to detect fish. The various models range in price from less than USD $100 to well over $20,000.

An Electronic Log measures the speed of the ship through the water. Sophisticated models use a Doppler principle to measure the precise speed over the ground in shallow water; such devices are mainly used on very large vessels whilst they are berthing. The cost of an electronic log can vary between USD $100 and $20,000 depending on the level of sophistication.

The various items of equipment described above were ranked in order of their technological value using the following criteria as a basis for assigning order.

1. Technological capabilities
2. Cost
3. Relative age of the technology
4. Whether or not installation was mandatory

Separate rankings were assigned to navigation and communication equipment as follows:

Communication Equipment Type	Rank	Navigation Equipment Type	Rank
Satellite INMARSAT B	1	Inter-switched ARPA / Radar	1
Satellite INMARSAT A	2	ARPA	2
Satellite INMARSAT C	3	S Band Radar	3
Radio Telex (TOR)	4	X Band Radar	4
Satellite INMARSAT M	5	Electronic Log	5
Radio (Voice)	6	GPS	6
Radio (Morse Code)	7	Sat-Nav	7
		Loran C	8
		Decca Navigator	9
		Echo Sounder	10
		Direction Finder	11

Appendix (i)

Sample copy of letter that accompanied each questionnaire

Carisbrooke Shipping PLC
10 Mill Hill Road
Cowes
Isle of Wight
PO31 7EA

Attn Captain Steve Smith

Dear Captain Smith

As part of ongoing research into innovation in the shipping industry I am trying to establish the extent to which organisational and technological change have been influenced by the introduction of the Global Maritime Distress and Safety System (GMDSS). I am also trying to establish how GMDSS is perceived within the industry and how it might be improved.

The findings of the research will be used to guide colleges and universities in designing appropriate training schemes and to inform relevant authorities, manufacturers and developers of the views and needs of the industry.

Needles to say any information provided will be strictly confidential and specific sources will not be revealed.

I would be grateful if you would take a few moments to complete the enclosed questionnaire. Any comments that you wish to add would be most welcome.

If you would like to be informed of the results of the survey please tick the appropriate box. A stamped addressed envelope is enclosed for your response.

Thank you in advance for your time and for your kind assistance.

Yours sincerely

John E Robinson

Appendix (j)

Analysed Data

Frequency Tables:

Frequency tables are not relevant to question 1. The detail of the analysis of this question is provided in chapter six.

Q2 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Radio Coast Station	3	14.3	14.3	14.3
	Satellite Standard 'C'	6	28.6	28.6	42.9
	Satellite Standard 'A'	9	42.9	42.9	85.7
	Satellite Standard 'M'	1	4.8	4.8	90.5
	Non-stndard method of marine communication	2	9.5	9.5	100.0
	Total	21	100.0	100.0	

Q3 Pilot Quesionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Satellite Standard 'C'	7	33.3	33.3	33.3
	Satellite Standard 'A'	4	19.0	19.0	52.4
	Satellite Standard 'B'	3	14.3	14.3	66.7
	Satellite Standard 'M'	3	14.3	14.3	81.0
	Non-standard method of marine communication	4	19.0	19.0	100.0
	Total	21	100.0	100.0	

Q4 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	GMDSS worse	10	47.6	47.6	47.6
	GMDSS better	11	52.4	52.4	100.0
	Total	21	100.0	100.0	

Q5 Pilot Quesionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	GMDSS inadequate for commercial communications	11	52.4	52.4	52.4
	GMDSS adequate for commercial communications	10	47.6	47.6	100.0
	Total	21	100.0	100.0	

Q6 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No - only GMDSS equipment installed	3	14.3	14.3	14.3
	Yes - additional equipment installed for commercial use	18	85.7	85.7	100.0
	Total	21	100.0	100.0	

Q7 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Equipment Price	9	42.9	45.0	45.0
	Delivery Time	1	4.8	5.0	50.0
	Ease of Use of Equipment	3	14.3	15.0	65.0
	Technical Capabilities of Equipment	6	28.6	30.0	95.0
	Other	1	4.8	5.0	100.0
	Total	20	95.2	100.0	
Missing	System	1	4.8		
Total		21	100.0		

Q8 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	R/O redundant	8	38.1	50.0	50.0
	R/O retained - same duties	2	9.5	12.5	62.5
	R/O retained - technical support	6	28.6	37.5	100.0
	Total	16	76.2	100.0	
Missing	System	5	23.8		
Total		21	100.0		

Q9 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No improvement now but improvement in future	6	28.6	28.6	28.6
	Improvement now and in the future	15	71.4	71.4	100.0
	Total	21	100.0	100.0	

As discussed in chapter six, the response to pilot questionnaire question 10 is entirely descriptive; it is not analysed using quantitative techniques.

Q11 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Traditional navigation instruments will not be made obsolete	8	38.1	40.0	40.0
	Traditional navigation instrument will become obsolete	12	57.1	60.0	100.0
	Total	20	95.2	100.0	
Missing	System	1	4.8		
Total		21	100.0		

Q12 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Training would benefit both the individual and the company	15	71.4	71.4	71.4
	Training would only benefit the individual	2	9.5	9.5	81.0
	Training would only benefit the company	3	14.3	14.3	95.2
	Training would not benefit either individual or company	1	4.8	4.8	100.0
	Total	21	100.0	100.0	

Q13 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Technical training will be required in the future	8	38.1	40.0	40.0
	Commercial training will be required in the future	7	33.3	35.0	75.0
	Both technical and commercial training will be required	5	23.8	25.0	100.0
	Total	20	95.2	100.0	
Missing	System	1	4.8		
Total		21	100.0		

Q14 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	New technolgoy could not be used to deliver training at sea	3	14.3	15.0	15.0
	New technology could be used to deliver training at sea now	6	28.6	30.0	45.0
	Technolgy could be used in the future to deliver training	11	52.4	55.0	100.0
	Total	20	95.2	100.0	
Missing	System	1	4.8		
Total		21	100.0		

Q15 Pilot and Final Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	On board structure will not change	8	38.1	38.1	38.1
	On board structure will change	5	23.8	23.8	61.9
	On board structure has already changed	8	38.1	38.1	100.0
	Total	21	100.0	100.0	

Q16 Pilot and Final Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Organisational strucure ashore will not change	8	38.1	38.1	38.1
	Organisational structure ashore will change	7	33.3	33.3	71.4
	Organisational structure ashore has already changed	6	28.6	28.6	100.0
	Total	21	100.0	100.0	

Q17 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	technology will not improve learning or profitability	5	23.8	23.8	23.8
	Technology will improve learning or profitability	16	76.2	76.2	100.0
	Total	21	100.0	100.0	

Q18 Pilot Questionnaire

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Organisation's ships trade world wide	16	76.2	76.2	76.2
	Organisation's ships trade only on specific routes	5	23.8	23.8	100.0
	Total	21	100.0	100.0	

The frequency tables for the final questionnaire are not included in this appendix because they appear in the relevant discussions in chapter six.

Non-parametric tests were performed on the data in an attempt to establish the likelihood of organisations in the Netherlands differing substantially from those in the United Kingdom. These inferences to be drawn from these tests have been discussed in chapter six and the output is therefore not reproduced in this appendix.

Although the SPSS software enabled a large number of exploratory tests to be carried out on the data, reproducing an output for every test performed would have occupied considerable space. Since the data reproduced in chapter six together with the discussions in other chapters provides sufficient evidence to support the arguments in the main thesis these outputs have not been reproduced.

Appendix (k)

Professional Development

The primary objective in navigating a ship is to keep the sharp end pointing in the right direction. Maintaining a similar kind of focus is I believe fundamental to PhD research.

Just as in ship navigation however, I discovered that it was sometimes necessary to make course deviations in order to steer clear of obstacles and take on board new competencies, new skills, and new perspectives. It is through such course deviations that additional value is gained from the PhD experience.

Part of my research involved comparing cultural, technological and environmental factors in the United Kingdom with those in the Netherlands. Developing some proficiency in the Dutch language would, I reasoned, lead to a better understanding of that country's culture. I therefore allocated time to becoming reasonably familiar with the Dutch language.

Getting to grips with the intricacies of quantitative data analysis was also necessary since I intended to use the empirical data obtained through questionnaires to support my theoretical arguments. In addition to developing an understanding of the value and limitations of the statistical tests that I planned to use I also learned to use a statistical software package of which I had no previous experience (SPSS)[1].

Planning and managing PhD research and scheduling the various activities involved in the process to appropriate dates is essential if the project is to be completed within the planned time-scale. For me the best way to manage the research process was to regard it as a project that could most effectively be managed using project management techniques.

During the research training phase I studied these techniques and became fairly proficient with the use of appropriate project management software (PMW)[2].

Writing and presenting are equally important aspects of professional development in the PhD process. Conducting or completing research is in itself of little value unless it can be disseminated effectively. I therefore welcomed the opportunities to present my work in a number of departmental seminars, which motivated me to learn to use an appropriate software presentation package[3]. This proved particularly beneficial when I was invited to present part of my work at an international (BAM 2000)[4] conference.

Four years working in a dedicated PhD research environment enabled me to develop an understanding of the concerns and aspirations of PhD students from a wide range of disciplines as well as to make contact with other researchers within my field of interest.

Although the ultimate measure of success can only manifest itself through the award of a PhD the work involved in progressing toward that goal adds substantially to professional competencies which, despite their peripheral appearance are often indispensable.

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[1] Statistical Package for Social Scientists
[2] Project Manager Workbench
[3] Microsoft Power Point
[4] British Academy of Management